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Floodway Analysis for 10th Street Wash

FCD Contract 1999C048
Assignment #2

Encroachment Analysis Report

WEST
CONSULTANTS, INC.

WEST Consultants, Inc.
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May 2000

Introduction

At the direction of Flood Control District of Maricopa County (District), WEST Consultants, Inc. (WEST) conducted a floodway encroachment analysis for 10th Street Wash located in the City of Phoenix, Maricopa County, Arizona. The hydrology and hydraulics were previously developed under Contract FCD 96-12 that was submitted as a Letter of Map Revision (LOMR) to the Federal Emergency Management Agency (FEMA) in June 1997. No floodway district was delineated as part of the LOMR submittal due to the urbanized development of the floodplain. However, based upon the fact that there was a prior floodway district on the previous delineation, FEMA processed the LOMR for 10th Street Wash as the floodway equaling the floodplain.

The purpose of this project was to perform a floodway analysis, utilizing the data generated within contract FCD 96-12 as the base data, to establish a floodway district for 10th Street Wash.

The first task of the project was to review and make refinements to the existing 10th Street Wash HEC-RAS model based on review of the model results by the District, the Arizona Department of Water Resources (ADWR), FEMA, and FEMA's Technical Evaluation Contractor. No major issues or concerns were identified in the review and the model was used in its original form for the encroachment analysis.

Encroachment Analyses

The encroachment analysis was performed with a standard equal conveyance reduction using first the HEC-RAS Method 4 encroachment followed by detailed refinement of encroachment stationing with Method 1. The results of this analysis identified issues near an island of high ground located between river stations 0.99 and 1.12. Figure 1 depicts this island in plan view. It should be noted that Figure 1 is for illustrative purposes only – it is not intended to be an accurate rendering of either the shape or size of the channel or the island.

The standard encroachment analysis effectively flooded the island. At the suggestion of the District, two additional analysis scenarios were evaluated. The second scenario attempted to force the entire flow along the east side of the island. The third scenario did not include encroachment, but considered the flow with no breakouts immediately upstream from the island.

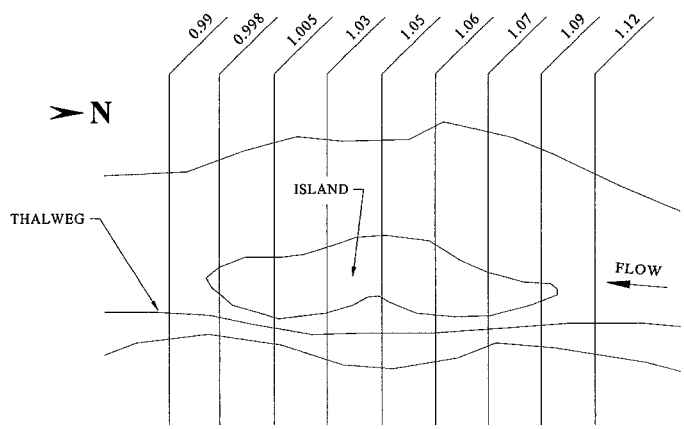

Figure 1 – Plan View of Island

Standard Encroachment Analysis

The standard encroachment analysis in HEC-RAS involves two steps. The Method 4 analysis computes encroachment stations such that the conveyance of the original cross section is maintained in the encroached cross section. A target water surface elevation increase is input and is maintained by the algorithm which calculates the water surface profile within HEC-RAS. Where possible, the program removes conveyance equally from either side of the channel overbanks as it moves the encroachment stations towards the channel bank stations.

In the 10th Street Wash analysis, several different profiles were established utilizing the same model geometry and run with different target values for the encroachment. The target values typically ranged between 0.8 and 1.1 feet. Starting at the downstream end, the target values were incremented until a value close to one foot was established. This procedure was repeated for the entire reach of the wash until each cross section had a surcharge close to one foot. Encroachments were not applied at cross sections with culverts (0.34, 1.39 and 1.509).

Once the Method 4 analysis was complete, the results were exported to a Method 1 encroachment analysis. With this method, the encroachment stations were manually adjusted and refined to bring all cross sections to the optimal encroachment without exceeding the maximum one-foot of surcharge. The results of the analysis are presented in Appendix A of this report.

The standard encroachment method results in a final profile at an elevation above the island for cross sections 1.03 and 1.05 (see Appendix A). This means that the floodway is not contained within the lateral bounds of the existing 100-year floodplain as mapped by the June 1997 LOMR. Figures 2a and 2b are plots of cross sections 1.03 and 1.05, respectively. Two water surface elevations are plotted – one without encroachments (shown in blue) and one with encroachments (shown in red).

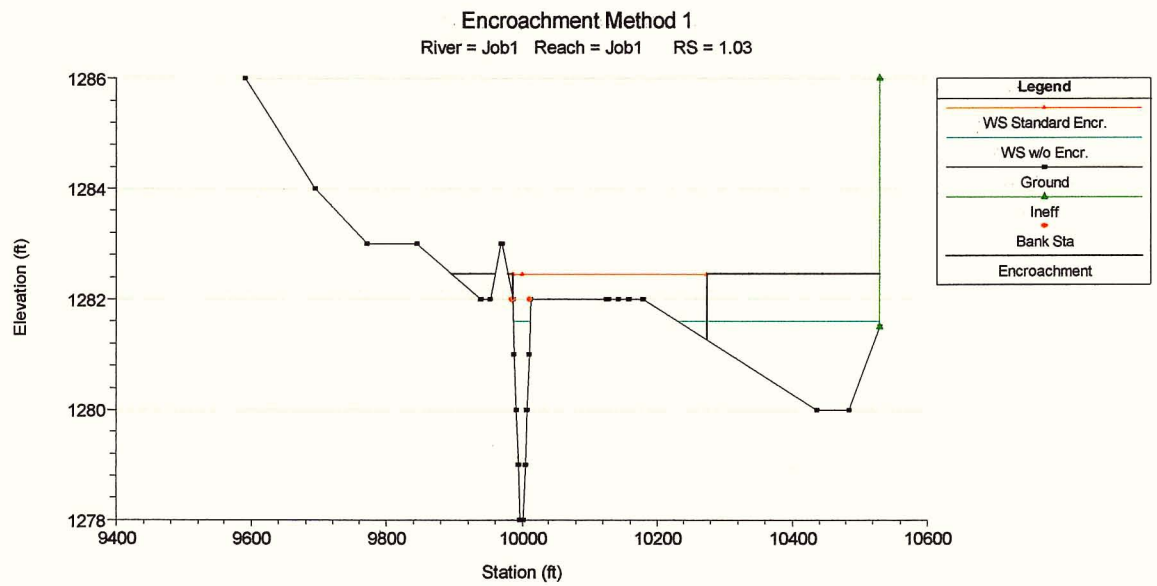

Figure 2a – River Station 1.03, *Standard Encroachment Analysis*

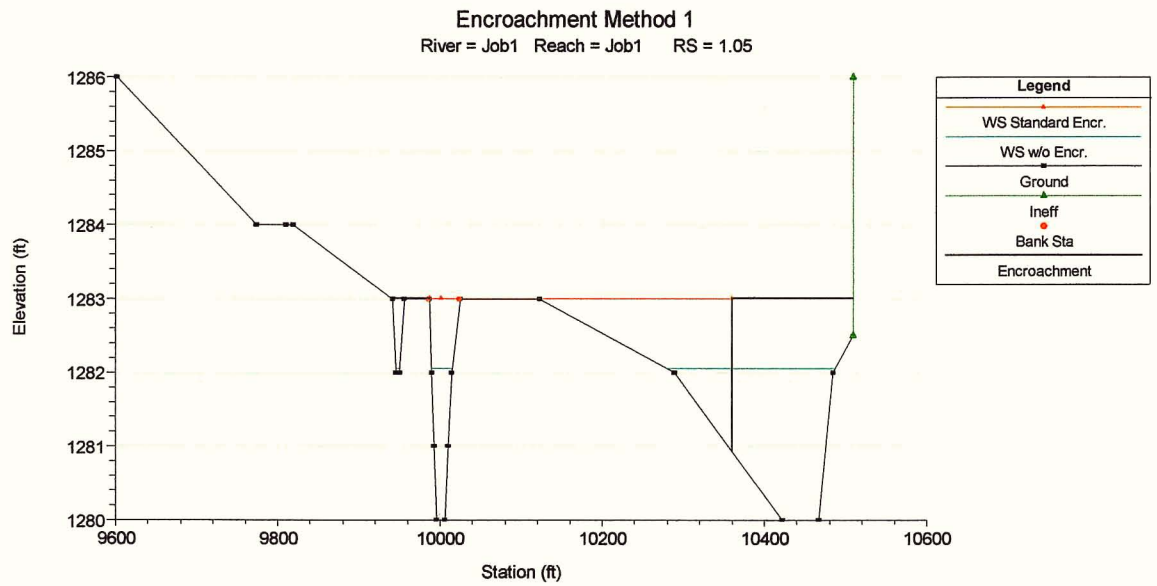

Figure 2b – River Station 1.05, *Standard Encroachment Analysis*

East Channel Analysis

The second scenario was an attempt to avoid the flooding of the island between cross sections 0.99 and 1.12 in the standard encroachment analysis. Instead of removing conveyance equally from both overbanks in the portion of the reach around the island, an attempt was made to convey the entire flow along the east side of the island.

Utilizing the Method 4 results of the first scenario, the encroachment stations for cross sections at and surrounding the island were manually adjusted with Method 1 to convey all the flow along the east side of the island. At those cross sections that included the island, the right encroachment station was set at the right bank station. On the left side, there was typically no encroachment included in order to maintain maximum conveyance.

After repeated adjustments to the encroachment stationing, it became evident that this approach was not feasible. It was not possible to convey the entire flow along the east side of the island and still remain under the FEMA-mandated surcharge of one foot. Appendix A shows that at cross sections 1.05 and 1.06 it is not possible to obtain a surcharge of less than one foot. At these cross sections the lowest surcharges attainable were 1.29 feet and 1.63 feet, respectively. These two cross sections are shown in Figure 3a and 3b.

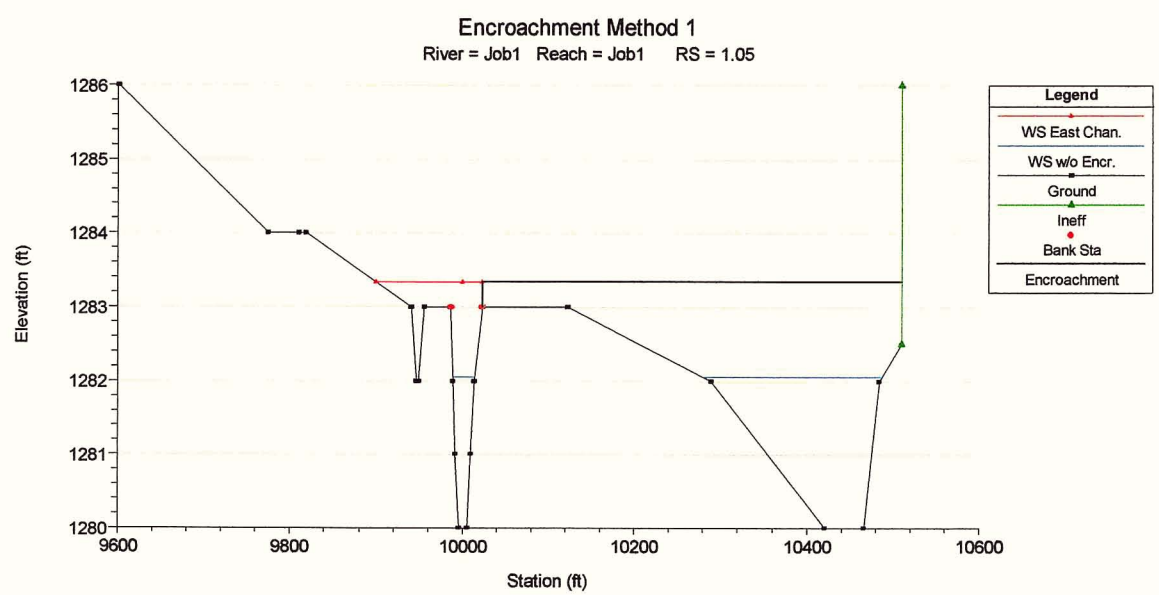

Figure 3a – River Station 1.05, *East Channel Analysis*

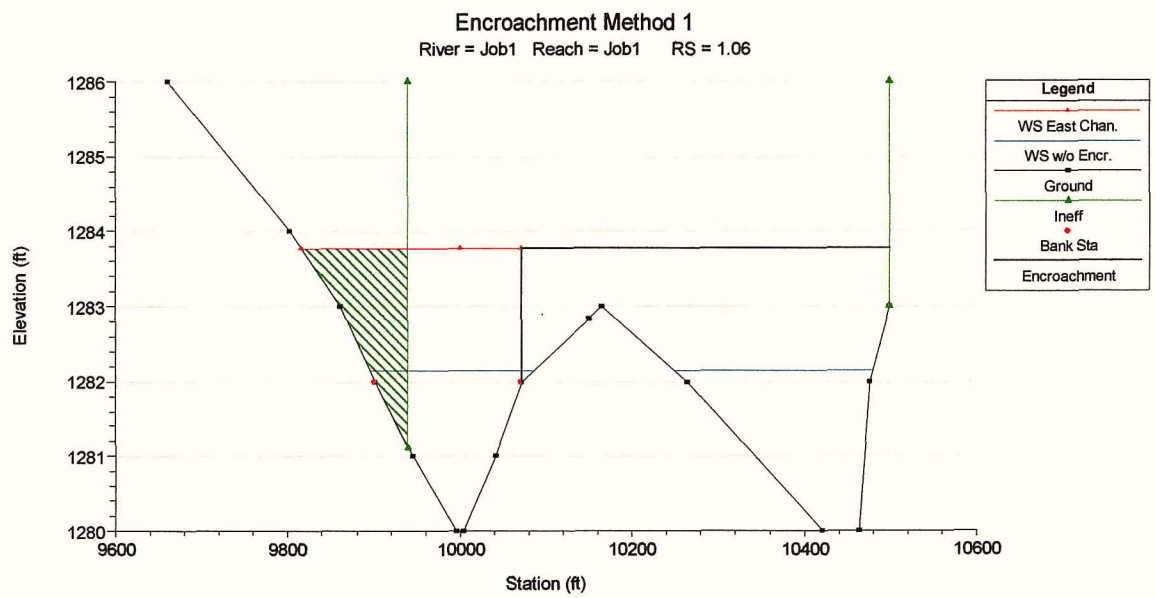

Figure 3b – River Station 1.06, *East Channel Analysis*

Third Analysis – No Breakouts

The third scenario was a condition with all conveyance maintained within the channel (no breakouts upstream of the island) and no encroachment. In the 1997 model, there were several locations where flow broke out from the main channel. This was accounted for in the model by reducing the flow in downstream cross sections. One breakout area was just upstream of the island where the flow was reduced from 960 cubic feet per second (cfs) to 380 cfs. For the third scenario, the flow of 960 cfs was maintained through cross section 0.57 where the discharge changed to 840 cfs, the same value as in the original model.

Appendix A shows that the change in flow characteristics typically increased the computed water surface elevations. The greatest increase was 1.95 feet at cross section 0.79 with the average increase just over 0.9 feet. At cross section 0.96, there was a slight decrease in the water surface as a result of the increased flow. For comparison purposes, Figure 4 shows cross section 1.05 with no breakouts or encroachments.

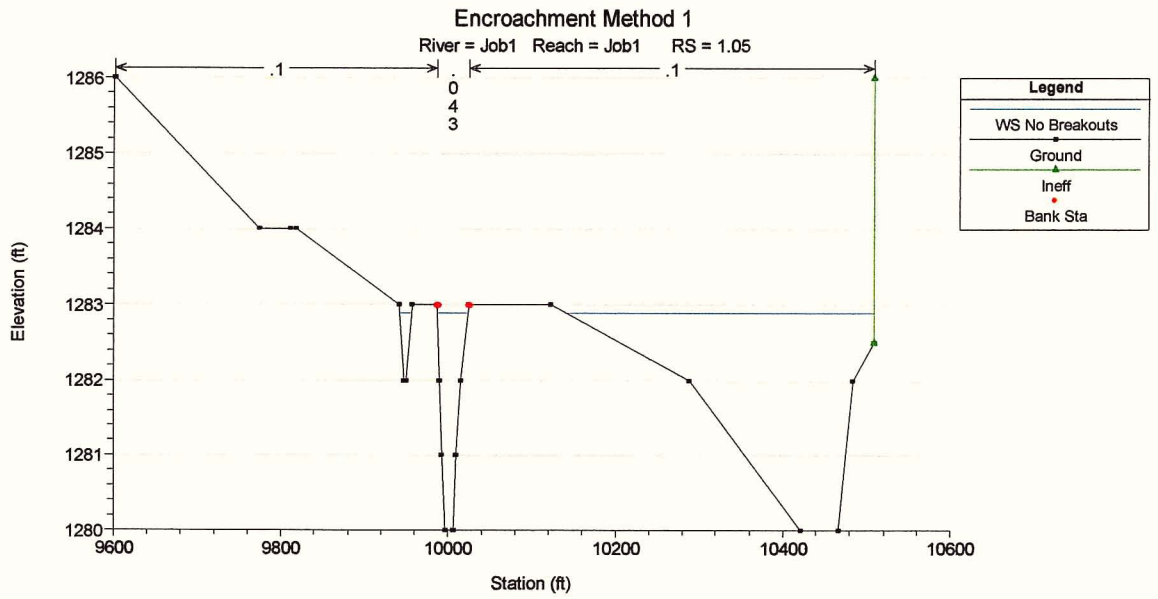

Figure 4 – River Station 1.05, *No Breakouts Analysis*

Summary

FEMA's decision to map the floodway equal to the floodplain is appropriate, based on the results of this study. While a floodway can be successfully defined at many cross sections, encroachment at the cross sections containing and bounding the island (cross sections 0.99 through 1.12) is not feasible. Definition of a floodway in this reach is not possible due to split flow conditions around the island of high ground.

The normal encroachment analysis, in which conveyance was removed from each overbank, resulted in flooding of the island. If water was allowed to cover the island, areas that were not initially included in the floodplain would then be included in the floodway. Conveying the entire flow along the east side of the island produced a flow constriction with a greater than one foot increase in water surface elevation. It was not possible to obtain less than one foot of increase by modifying the encroachment stations.

Appendix A

HEC-RAS Plan: Method 1 River: Job1 Reach: Job1

Reach	River Sta	Profile	W.S. Elev	Prof Delta WS	E.G. Elev	Q Total	Q Left	Q Channel	Q Right	Enc Sta L	Ch Sta L	Ch Sta R	Enc Sta R	Froude # Chl	Length Chnl
			(ft)	(ft)	(ft)	(cfs)	(cfs)	(cfs)	(cfs)	(ft)	(ft)	(ft)	(ft)		(ft)
Job1	0.00	w/o Encr	1233.79		1234.27	1280.00		1280.00			9946.82	10214.66		0.99	
Job1	0.00	M-4 Final	1233.79	0.00	1234.27	1280.00		1280.00		9946.82	9946.82	10214.66	10214.66	0.99	
Job1	0.00	Method 1	1233.79	0.00	1234.27	1280.00		1280.00		9946.82	9946.82	10214.66	10214.66	0.99	
Job1	0.00	East Chan.	1233.79	0.00	1234.27	1280.00		1280.00		9946.82	9946.82	10214.66	10214.66	0.99	
Job1	0.00	No Breakouts	1233.79	0.00	1234.27	1280.00		1280.00			9946.82	10214.66		0.99	
Job1	0.01	w/o Encr	1237.13		1237.33	1280.00		381.40	898.60		9989.98	10050.00		0.80	60.00
Job1	0.01	M-4 Final	1238.11	0.97	1238.33	1280.00		532.43	747.57	9989.98	9989.98	10050.00	10400.05	0.80	60.00
Job1	0.01	Method 1	1238.11	0.97	1238.33	1280.00		532.43	747.57	9989.98	9989.98	10050.00	10400.05	0.80	60.00
Job1	0.01	East Chan.	1238.11	0.97	1238.33	1280.00		532.43	747.57	9989.98	9989.98	10050.00	10400.05	0.80	60.00
Job1	0.01	No Breakouts	1237.13	0.00	1237.33	1280.00		381.40	898.60		9989.98	10050.00		0.80	60.00
Job1	0.08	w/o Encr	1238.99		1239.02	1280.00		191.68	1088.32		9985.33	10016.62		0.45	350.00
Job1	0.08	M-4 Final	1239.98	0.99	1240.06	1280.00		345.53	934.47	9985.33	9985.33	10016.62	10601.65	0.47	350.00
Job1	0.08	Method 1	1239.98	0.99	1240.06	1280.00		345.53	934.47	9985.33	9985.33	10016.62	10601.65	0.47	350.00
Job1	0.08	East Chan.	1239.98	0.99	1240.06	1280.00		345.53	934.47	9985.33	9985.33	10016.62	10601.65	0.47	350.00
Job1	0.08	No Breakouts	1238.99	0.00	1239.02	1280.00		191.68	1088.32		9985.33	10016.62		0.45	350.00
Job1	0.16	w/o Encr	1240.95		1241.20	1280.00	4.45	709.89	565.65		9915.00	10031.00		0.87	450.00
Job1	0.16	M-4 Final	1241.54	0.59	1242.16	1280.00		1280.00		9915.00	9915.00	10031.00	10031.00	0.85	450.00
Job1	0.16	Method 1	1241.54	0.59	1242.16	1280.00		1280.00		9915.00	9915.00	10031.00	10031.00	0.85	450.00
Job1	0.16	East Chan.	1241.54	0.59	1242.16	1280.00		1280.00		9915.00	9915.00	10031.00	10031.00	0.85	450.00
Job1	0.16	No Breakouts	1240.95	0.00	1241.20	1280.00	4.45	709.89	565.65		9915.00	10031.00		0.87	450.00
Job1	0.24	w/o Encr	1243.71		1244.41	1280.00	35.56	1244.44			9930.00	10040.00		0.84	415.00
Job1	0.24	M-4 Final	1244.11	0.40	1244.63	1280.00		1280.00		9930.00	9930.00	10040.00	10040.00	0.72	415.00
Job1	0.24	Method 1	1244.11	0.40	1244.63	1280.00		1280.00		9930.00	9930.00	10040.00	10040.00	0.72	415.00
Job1	0.24	East Chan.	1244.11	0.40	1244.63	1280.00		1280.00		9930.00	9930.00	10040.00	10040.00	0.72	415.00
Job1	0.24	No Breakouts	1243.71	0.00	1244.41	1280.00	35.56	1244.44			9930.00	10040.00		0.84	415.00
Job1	0.33	w/o Encr	1245.95		1246.43	840.00		840.00			9950.00	10050.00		0.53	455.00
Job1	0.33	M-4 Final	1245.80	-0.15	1246.33	840.00		840.00		9950.00	9950.00	10050.00	10050.00	0.56	455.00
Job1	0.33	Method 1	1245.80	-0.15	1246.33	840.00		840.00		9950.00	9950.00	10050.00	10050.00	0.56	455.00
Job1	0.33	East Chan.	1245.80	-0.15	1246.33	840.00		840.00		9950.00	9950.00	10050.00	10050.00	0.56	455.00
Job1	0.33	No Breakouts	1245.95	0.00	1246.43	840.00		840.00			9950.00	10050.00		0.53	455.00
Job1	0.34		Culvert												
Job1	0.35	w/o Encr	1245.44		1246.77	840.00		840.00			9950.00	10050.00		1.01	100.00
Job1	0.35	M-4 Final	1245.44	0.00	1246.77	840.00		840.00		9950.00	9950.00	10050.00	10050.00	1.01	100.00
Job1	0.35	Method 1	1245.44	0.00	1246.77	840.00		840.00		9950.00	9950.00	10050.00	10050.00	1.01	100.00
Job1	0.35	East Chan.	1245.44	0.00	1246.77	840.00		840.00		9950.00	9950.00	10050.00	10050.00	1.01	100.00
Job1	0.35	No Breakouts	1245.44	0.00	1246.77	840.00		840.00			9950.00	10050.00		1.01	100.00
Job1	0.41	w/o Encr	1248.11		1248.83	840.00		840.00			9947.57	10050.00		0.63	330.00
Job1	0.41	M-4 Final	1248.11	0.00	1248.83	840.00		840.00		9947.57	9947.57	10050.00	10050.00	0.63	330.00
Job1	0.41	Method 1	1248.11	0.00	1248.83	840.00		840.00		9947.57	9947.57	10050.00	10050.00	0.63	330.00
Job1	0.41	East Chan.	1248.11	0.00	1248.83	840.00		840.00		9947.57	9947.57	10050.00	10050.00	0.63	330.00
Job1	0.41	No Breakouts	1248.11	0.00	1248.83	840.00		840.00			9947.57	10050.00		0.63	330.00
Job1	0.48	w/o Encr	1250.47		1251.97	840.00		840.00			9950.00	10050.00		1.00	365.00
Job1	0.48	M-4 Final	1250.47	0.00	1251.97	840.00		840.00		9950.00	9950.00	10050.00	10050.00	1.00	365.00
Job1	0.48	Method 1	1250.47	0.00	1251.97	840.00		840.00		9950.00	9950.00	10050.00	10050.00	1.00	365.00
Job1	0.48	East Chan.	1250.47	0.00	1251.97	840.00		840.00		9950.00	9950.00	10050.00	10050.00	1.00	365.00
Job1	0.48	No Breakouts	1250.47	0.00	1251.97	840.00		840.00			9950.00	10050.00		1.00	365.00
Job1	0.54	w/o Encr	1253.84		1255.19	840.00		840.00			9950.00	10050.00		1.00	345.00
Job1	0.54	M-4 Final	1253.85	0.01	1255.19	840.00		840.00		9950.00	9950.00	10050.00	10050.00	1.00	345.00
Job1	0.54	Method 1	1253.85	0.01	1255.19	840.00		840.00		9950.00	9950.00	10050.00	10050.00	1.00	345.00
Job1	0.54	East Chan.	1253.85	0.01	1255.19	840.00		840.00		9950.00	9950.00	10050.00	10050.00	1.00	345.00
Job1	0.54	No Breakouts	1253.84	0.00	1255.19	840.00		840.00			9950.00	10050.00		1.00	345.00
Job1	0.57	w/o Encr	1257.87		1258.63	840.00		840.00			9938.98	10050.00		1.00	165.00
Job1	0.57	M-4 Final	1257.87	0.00	1258.63	840.00		840.00		9938.98	9938.98	10050.00	10050.00	1.00	165.00
Job1	0.57	Method 1	1257.87	0.00	1258.63	840.00		840.00		9938.98	9938.98	10050.00	10050.00	1.00	165.00
Job1	0.57	East Chan.	1257.87	0.00	1258.63	840.00		840.00		9938.98	9938.98	10050.00	10050.00	1.00	165.00
Job1	0.57	No Breakouts	1257.87	0.00	1258.63	840.00		840.00			9938.98	10050.00		1.00	165.00
Job1	0.72	w/o Encr	1264.37		1264.84	340.00	2.37	335.43	2.21		9974.78	10034.80		0.96	785.00
Job1	0.72	M-4 Final	1264.45	0.08	1264.87	340.00		340.00		9974.78	9974.78	10034.80	10034.80	0.87	785.00
Job1	0.72	Method 1	1264.45	0.08	1264.87	340.00		340.00		9974.78	9974.78	10034.80	10034.80	0.87	785.00
Job1	0.72	East Chan.	1264.45	0.08	1264.87	340.00		340.00		9974.78	9974.78	10034.80	10034.80	0.87	785.00
Job1	0.72	No Breakouts	1265.34	0.97	1266.02	960.00	66.09	831.43	62.48		9974.78	10034.80		0.87	785.00
Job1	0.73	w/o Encr	1265.72		1266.71	340.00		340.00			9985.00	10015.00		1.01	60.00
Job1	0.73	M-4 Final	1265.72	0.00	1266.71	340.00		340.00		9985.00	9985.00	10015.00	10015.00	1.01	60.00
Job1	0.73	Method 1	1265.72	0.00	1266.71	340.00		340.00		9985.00	9985.00	10015.00	10015.00	1.01	60.00
Job1	0.73	East Chan.	1265.72	0.00	1266.71	340.00		340.00		9985.00	9985.00	10015.00	10015.00	1.01	60.00
Job1	0.73	No Breakouts	1267.63	1.91	1268.27	960.00	25.45	716.41	218.14		9985.00	10015.00		0.72	60.00
Job1	0.79	w/o Encr	1270.16		1271.00	340.00	0.02	339.98	0.00		9991.35	10020.00		1.02	295.00
Job1	0.79	M-4 Final	1270.18	0.03	1271.00	340.00		340.00		9991.35	9991.35	10020.00	10020.00	0.99	295.00
Job1	0.79	Method 1	1270.18	0.03	1271.00	340.00		340.00		9991.35	9991.35	10020.00	10020.00	0.99	295.00
Job1	0.79	East Chan.	1270.18	0.03	1271.00	340.00		340.00		9991.35	9991.35	10020.00	10020.00	0.99	295.00
Job1	0.79	No Breakouts	1272.11	1.95	1273.10	960.00	69.30	861.47	29.23		9991.35	10020.00		0.79	295.00
Job1	0.85	w/o Encr	1273.34		1273.48	340.00	25.50	313.20	1.29		9974.00	10014.00		0.34	305.00
Job1	0.85	M-4 Final	1273.35	0.00	1273.52	340.00		340.00		9974.00	9974.00	10014.00	10014.00	0.37	305.00
Job1	0.85	Method 1	1273.35	0.00	1273.52	340.00		340.00		9974.00	9974.00	10014.00	10014.00	0.37	305.00
Job1	0.85	East Chan.	1273.35	0.00	1273.52	340.00		340.00		9974.00	9974.00	10014.00	10014.00	0.37	305.00
Job1	0.85	No Breakouts	1274.48	1.14	1274.71	960.00	280.66	666.56	12.78		9974.00	10014.00		0.41	305.00
Job1	0.86	w/o Encr	1273.54		1273.58	340.00		340.00			9806.04	10047.93		0.26	50.00
Job1	0.86	M-4 Final	1273.61	0.07	1273.64	340.00		340.00		9806.04	9806.04	10047.93	10047.93	0.24	50.00
Job1	0.86	Method 1	1273.61	0.07	1273.64	340.00		340.00		9806.04	9806.04	10047.93	10047.93	0.24	50.00
Job1	0.86	East Chan.	1273.61	0.07	1273.64	340.00		340.00		9806.04	9806.04	10047.93	10047.93	0.24	50.00
Job1	0.86	No Breakouts	1274.79	1.25	1274.84	960.00	8.82	920.57	30.61		9806.04	10047.93		0.22	50.00

HEC-RAS Plan: Method 1 River: Job1 Reach: Job1 (Continued)

Reach	River Sta	Profile	W.S. Elev	Prof Delta WS	E.G. Elev	Q Total	Q Left	Q Channel	Q Right	Enc Sta L	Ch Sta L	Ch Sta R	Enc Sta R	Froude # Chl	Length Chnl
			(ft)	(ft)	(ft)	(cfs)	(cfs)	(cfs)	(cfs)	(ft)	(ft)	(ft)	(ft)		(ft)
Job1	0.87	w/o Encr	1274.37		1274.92	340.00	8.06	328.63	3.32		9978.00	10011.59		0.83	75.00
Job1	0.87	M-4 Final	1274.29	-0.09	1274.96	340.00		340.00		9978.00	9978.00	10011.59	10011.59	0.93	75.00
Job1	0.87	Method 1	1274.29	-0.09	1274.96	340.00		340.00		9978.00	9978.00	10011.59	10011.59	0.93	75.00
Job1	0.87	East Chan.	1274.29	-0.09	1274.96	340.00		340.00		9978.00	9978.00	10011.59	10011.59	0.93	75.00
Job1	0.87	No Breakouts	1275.41	1.04	1275.83	960.00	238.63	582.86	138.51		9978.00	10011.59		0.70	75.00
Job1	0.89	w/o Encr	1276.28		1276.63	340.00	8.50	331.38	0.12		9990.86	10026.19		0.60	120.00
Job1	0.89	M-4 Final	1276.73	0.45	1276.98	340.00		340.00		9990.86	9990.86	10026.19	10026.19	0.45	120.00
Job1	0.89	Method 1	1276.73	0.45	1276.98	340.00		340.00		9990.86	9990.86	10026.19	10026.19	0.45	120.00
Job1	0.89	East Chan.	1276.73	0.45	1276.98	340.00		340.00		9990.86	9990.86	10026.19	10026.19	0.45	120.00
Job1	0.89	No Breakouts	1277.45	1.16	1277.89	960.00	129.87	692.74	137.39		9990.86	10026.19		0.62	120.00
Job1	0.929	w/o Encr	1277.36		1277.64	340.00	0.73	337.71	1.56		9969.31	10021.33		0.61	180.00
Job1	0.929	M-4 Final	1277.45	0.09	1277.71	340.00		340.00		9969.31	9969.31	10021.33	10021.33	0.57	180.00
Job1	0.929	Method 1	1277.45	0.09	1277.71	340.00		340.00		9969.31	9969.31	10021.33	10021.33	0.57	180.00
Job1	0.929	East Chan.	1277.45	0.09	1277.71	340.00		340.00		9969.31	9969.31	10021.33	10021.33	0.57	180.00
Job1	0.929	No Breakouts	1278.42	1.06	1278.77	960.00	49.93	727.29	182.78		9969.31	10021.33		0.60	180.00
Job1	0.935	w/o Encr	1277.61		1277.76	340.00		340.00			9924.95	10075.13		0.43	30.00
Job1	0.935	M-4 Final	1277.67	0.06	1277.81	340.00		340.00		9924.95	9924.95	10075.13	10075.13	0.40	30.00
Job1	0.935	Method 1	1277.67	0.06	1277.81	340.00		340.00		9924.95	9924.95	10075.13	10075.13	0.40	30.00
Job1	0.935	East Chan.	1277.67	0.06	1277.81	340.00		340.00		9924.95	9924.95	10075.13	10075.13	0.40	30.00
Job1	0.935	No Breakouts	1278.41	0.79	1278.92	960.00		960.00			9924.95	10075.13		0.66	30.00
Job1	0.94	w/o Encr	1277.71		1278.60	340.00		340.00			9983.86	10010.85		1.00	35.00
Job1	0.94	M-4 Final	1277.72	0.01	1278.60	340.00		340.00		9983.86	9983.86	10010.85	10010.85	0.99	35.00
Job1	0.94	Method 1	1277.72	0.01	1278.60	340.00		340.00		9983.86	9983.86	10010.85	10010.85	0.99	35.00
Job1	0.94	East Chan.	1277.72	0.01	1278.60	340.00		340.00		9983.86	9983.86	10010.85	10010.85	0.99	35.00
Job1	0.94	No Breakouts	1278.97	1.26	1279.11	960.00	66.87	369.64	523.49		9983.86	10010.85		0.49	35.00
Job1	0.96	w/o Encr	1280.39		1280.40	340.00	6.99	87.80	245.22		9988.26	10020.00		0.10	125.00
Job1	0.96	M-4 Final	1280.49	0.10	1280.69	340.00		340.00		9988.26	9988.26	10020.00	10020.00	0.37	125.00
Job1	0.96	Method 1	1280.49	0.10	1280.69	340.00		340.00		9988.26	9988.26	10020.00	10020.00	0.37	125.00
Job1	0.96	East Chan.	1280.49	0.10	1280.69	340.00		340.00		9988.26	9988.26	10020.00	10020.00	0.37	125.00
Job1	0.96	No Breakouts	1279.80	-0.59	1279.98	960.00	0.26	371.14	588.60		9988.26	10020.00		0.60	125.00
Job1	0.99	w/o Encr	1280.59		1280.65	380.00	8.12	186.72	185.16		9990.67	10020.00		0.33	145.00
Job1	0.99	M-4 Final	1281.13	0.55	1281.46	380.00	2.66	377.34		9988.26	9990.67	10020.00	10020.00	0.48	145.00
Job1	0.99	Method 1	1281.13	0.55	1281.46	380.00	2.66	377.34		9988.26	9990.67	10020.00	10020.00	0.48	145.00
Job1	0.99	East Chan.	1281.13	0.55	1281.46	380.00	2.66	377.34		9988.26	9990.67	10020.00	10020.00	0.48	145.00
Job1	0.99	No Breakouts	1280.99	0.41	1281.10	960.00	43.75	326.62	589.63		9990.67	10020.00		0.45	145.00
Job1	0.998	w/o Encr	1280.68		1280.70	380.00	3.81	325.61	50.58		9940.67	10048.56		0.16	30.00
Job1	0.998	M-4 Final	1281.56	0.89	1281.58	380.00		380.00		9940.67	9940.67	10048.56	10048.56	0.11	30.00
Job1	0.998	Method 1	1281.56	0.89	1281.58	380.00		380.00		9940.67	9940.67	10048.56	10048.56	0.11	30.00
Job1	0.998	East Chan.	1281.57	0.89	1281.58	380.00	11.08	368.92		0.00	9940.67	10048.56	10048.56	0.11	30.00
Job1	0.998	No Breakouts	1281.10	0.42	1281.18	960.00	15.51	737.65	206.84		9940.67	10048.56		0.28	30.00
Job1	1.005	w/o Encr	1280.72		1280.96	380.00		246.42	133.58		9980.58	10019.40		0.62	35.00
Job1	1.005	M-4 Final	1281.47	0.75	1281.85	380.00		380.00		9980.58	9980.58	10019.40	10019.40	0.62	35.00
Job1	1.005	Method 1	1281.47	0.75	1281.85	380.00		380.00		9980.58	9980.58	10019.40	10019.40	0.62	35.00
Job1	1.005	East Chan.	1281.50	0.78	1281.79	380.00	31.14	348.86		0.00	9980.58	10019.40	10019.40	0.56	35.00
Job1	1.005	No Breakouts	1281.30	0.58	1281.46	960.00	14.10	347.50	598.40		9980.58	10019.40		0.65	35.00
Job1	1.03	w/o Encr	1281.59		1281.66	380.00		160.30	219.70		9986.11	10013.63		0.36	125.00
Job1	1.03	M-4 Final	1282.46	0.87	1282.62	380.00		285.67	94.33	9986.11	9986.11	10013.63	10273.65	0.39	125.00
Job1	1.03	Method 1	1282.46	0.87	1282.62	380.00		285.67	94.33	9986.11	9986.11	10013.63	10273.65	0.39	125.00
Job1	1.03	East Chan.	1282.28	0.69	1282.70	380.00	3.83	376.17		0.00	9986.11	10013.63	10013.63	0.57	125.00
Job1	1.03	No Breakouts	1282.17	0.58	1282.29	960.00	1.23	313.58	645.19		9986.11	10013.63		0.50	125.00
Job1	1.05	w/o Encr	1282.06		1282.10	380.00	0.03	94.77	285.21		9986.82	10024.30		0.39	140.00
Job1	1.05	M-4 Final	1283.00	0.94	1283.07	380.00		190.98	189.02	9986.82	9986.82	10024.30	10367.17	0.38	140.00
Job1	1.05	Method 1	1283.01	0.95	1283.09	380.00		201.21	178.79	9986.82	9986.82	10024.30	10360.00	0.40	140.00
Job1	1.05	East Chan.	1283.34	1.29	1283.63	380.00	25.66	354.34		0.00	9986.82	10024.30	10024.30	0.55	140.00
Job1	1.05	No Breakouts	1282.89	0.83	1282.95	960.00	5.38	204.39	750.23		9986.82	10024.30		0.44	140.00
Job1	1.06	w/o Encr	1282.14		1282.17	380.00		290.86	89.14		9901.83	10072.00		0.23	40.00
Job1	1.06	M-4 Final	1283.12	0.98	1283.14	380.00		380.00		9901.83	9901.83	10072.00	10072.00	0.14	40.00
Job1	1.06	Method 1	1283.15	1.00	1283.17	380.00		380.00		9901.83	9901.83	10072.00	10072.00	0.13	40.00
Job1	1.06	East Chan.	1283.78	1.63	1283.79	380.00		380.00		0.00	9901.83	10072.00	10072.00	0.09	40.00
Job1	1.06	No Breakouts	1282.98	0.84	1283.04	960.00		695.45	264.55		9901.83	10072.00		0.27	40.00
Job1	1.07	w/o Encr	1283.04		1283.31	380.00		230.22	149.78		9985.81	10032.43		0.69	35.00
Job1	1.07	M-4 Final	1283.36	0.32	1284.18	380.00		380.00		9985.81	9985.81	10032.43	10032.43	1.00	35.00
Job1	1.07	Method 1	1283.36	0.32	1284.18	380.00		380.00		9985.81	9985.81	10032.43	10032.43	1.00	35.00
Job1	1.07	East Chan.	1283.42	0.37	1284.19	380.00		380.00		0.00	9985.81	10032.43	10032.43	0.97	35.00
Job1	1.07	No Breakouts	1283.52	0.48	1283.87	960.00		407.29	552.71		9985.81	10032.43		0.98	35.00
Job1	1.09	w/o Encr	1284.38		1284.73	420.00		277.64	142.36		9976.63	10007.88		0.73	135.00
Job1	1.09	M-4 Final	1284.58	0.20	1285.54	420.00		420.00		9976.63	9976.63	10007.88	10007.88	0.99	135.00
Job1	1.09	Method 1	1284.58	0.20	1285.54	420.00		420.00		9976.63	9976.63	10007.88	10007.88	0.99	135.00
Job1	1.09	East Chan.	1284.57	0.19	1285.54	420.00		420.00		0.00	9976.63	10007.88	10007.88	1.00	135.00
Job1	1.09	No Breakouts	1284.90	0.52	1285.33	960.00		466.94	493.06		9976.63	10007.88		0.92	135.00
Job1	1.12	w/o Encr	1285.43		1285.87	560.00	0.05	440.31	119.64		9989.27	10021.90		0.70	125.00
Job1	1.12	M-4 Final	1285.79	0.37	1286.46	560.00		560.00		9989.27	9989.27	10021.90	10021.90	0.71	125.00
Job1	1.12	Method 1	1285.79	0.37	1286.46	560.00		560.00		9989.27	9989.27	10021.90	10021.90	0.71	125.00
Job1	1.12	East Chan.	1285.81	0.39	1286.47	560.00		560.00		9989.27	9989.27	10021.90	10021.90	0.71	125.00
Job1	1.12	No Breakouts	1285.83	0.40	1286.39	960.00	0.34	636.29	323.37		9989.27	10021.90		0.79	125.00
Job1	1.13	w/o Encr	1285.97		1286.01	880.00		397.26	482.74		9963.24	10055.61		0.19	45.00
Job1	1.13	M-4 Final	1286.54	0.56	1286.63	880.00		687.35	192.65	9963.24	9963.24	10055.61	10094.07	0.25	45.00
Job1	1.13	Method 1	1286.54	0.56	1286.63	880.00		687.35	192.65	9963.24	9963.24	10055.61	10094.07	0.25	45.00
Job1	1.13	East Chan.	1286.54	0.57	1286.63	880.00		687.22	192.78	9963.24	9963.24	10055.61	10094.07	0.25	45.00
Job1	1.13	No Breakouts	1286.54	0.57	1286.56	960.00		382.76	577.24		9963.24	10055.61		0.14	45.00

HEC-RAS Plan: Method 1 River: Job1 Reach: Job1 (Continued)

Reach	River Sta	Profile	W.S. Elev	Prof Delta WS	E.G. Elev	Q Total	Q Left	Q Channel	Q Right	Enc Sta L	Ch Sta L	Ch Sta R	Enc Sta R	Froude # Chl	Length Chnl
			(ft)	(ft)	(ft)	(cfs)	(cfs)	(cfs)	(cfs)	(ft)	(ft)	(ft)	(ft)		(ft)
Job1	1.136	w/o Encr	1287.78		1288.32	960.00	314.24	616.72	29.04		9980.00	10007.32		0.71	50.00
Job1	1.136	M-4 Final	1287.90	0.12	1289.28	960.00	85.75	874.25		9965.63	9980.00	10007.32	10007.32	0.96	50.00
Job1	1.136	Method 1	1287.89	0.11	1289.27	960.00	88.80	871.20		9965.00	9980.00	10007.32	10007.32	0.96	50.00
Job1	1.136	East Chan.	1287.89	0.11	1289.27	960.00	88.80	871.20		9965.00	9980.00	10007.32	10007.32	0.96	50.00
Job1	1.136	No Breakouts	1287.78	0.00	1288.32	960.00	314.24	616.72	29.04		9980.00	10007.32		0.71	50.00
Job1	1.138	w/o Encr	1288.24		1288.46	820.00	341.12	420.77	58.10		9988.41	10009.81		0.44	10.00
Job1	1.138	M-4 Final	1289.31	1.06	1289.57	820.00	295.41	524.59		9937.50	9988.41	10009.81	10009.81	0.39	10.00
Job1	1.138	Method 1	1289.11	0.87	1289.55	820.00	208.24	611.76		9958.00	9988.41	10009.81	10009.81	0.48	10.00
Job1	1.138	East Chan.	1289.11	0.87	1289.55	820.00	208.24	611.76		9958.00	9988.41	10009.81	10009.81	0.48	10.00
Job1	1.138	No Breakouts	1288.24	0.00	1288.46	820.00	341.12	420.77	58.10		9988.41	10009.81		0.44	10.00
Job1	1.18	w/o Encr	1289.49		1289.74	880.00	140.20	571.01	168.79		9983.75	10015.56		0.45	220.00
Job1	1.18	M-4 Final	1290.45	0.96	1291.01	880.00		880.00		9983.75	9983.75	10015.56	10015.56	0.49	220.00
Job1	1.18	Method 1	1290.48	0.99	1291.01	880.00	14.12	865.22	0.66	9980.00	9983.75	10015.56	10016.00	0.48	220.00
Job1	1.18	East Chan.	1290.48	0.99	1291.01	880.00	14.12	865.22	0.66	9980.00	9983.75	10015.56	10016.00	0.48	220.00
Job1	1.18	No Breakouts	1289.49	0.00	1289.74	880.00	140.26	570.87	168.87		9983.75	10015.56		0.45	220.00
Job1	1.22	w/o Encr	1290.95		1291.59	920.00	48.68	851.19	20.13		9981.38	10011.90		0.57	230.00
Job1	1.22	M-4 Final	1291.99	1.04	1292.50	920.00	2.54	915.62	1.84	9980.00	9981.38	10011.90	10013.00	0.44	230.00
Job1	1.22	Method 1	1291.83	0.88	1292.33	920.00	15.77	889.63	14.60	9975.00	9981.38	10011.90	10018.00	0.45	230.00
Job1	1.22	East Chan.	1291.83	0.88	1292.33	920.00	15.77	889.63	14.60	9975.00	9981.38	10011.90	10018.00	0.45	230.00
Job1	1.22	No Breakouts	1290.95	0.00	1291.59	920.00	48.65	851.23	20.12		9981.38	10011.90		0.57	230.00
Job1	1.23	w/o Encr	1291.78		1291.92	920.00	213.33	621.91	84.76		9976.07	10013.91		0.30	50.00
Job1	1.23	M-4 Final	1292.42	0.64	1292.73	920.00	30.90	889.10		9971.27	9976.07	10013.91	10013.91	0.35	50.00
Job1	1.23	Method 1	1292.24	0.46	1292.57	920.00	30.84	889.16		9971.27	9976.07	10013.91	10013.91	0.37	50.00
Job1	1.23	East Chan.	1292.24	0.46	1292.57	920.00	30.84	889.16		9971.27	9976.07	10013.91	10013.91	0.37	50.00
Job1	1.23	No Breakouts	1291.78	0.00	1291.92	920.00	213.33	621.91	84.76		9976.07	10013.91		0.30	50.00
Job1	1.238	w/o Encr	1291.93		1291.96	940.00	137.09	665.71	137.20		9947.85	10046.02		0.14	25.00
Job1	1.238	M-4 Final	1292.74	0.81	1292.80	940.00		940.00		9947.85	9947.85	10046.02	10046.02	0.15	25.00
Job1	1.238	Method 1	1292.58	0.66	1292.65	940.00		940.00		9947.85	9947.85	10046.02	10046.02	0.16	25.00
Job1	1.238	East Chan.	1292.58	0.66	1292.65	940.00		940.00		9947.85	9947.85	10046.02	10046.02	0.16	25.00
Job1	1.238	No Breakouts	1291.93	0.00	1291.96	940.00	137.09	665.71	137.20		9947.85	10046.02		0.14	25.00
Job1	1.242	w/o Encr	1291.79		1292.37	980.00	197.13	715.80	67.08		9975.00	10007.70		0.70	25.00
Job1	1.242	M-4 Final	1292.34	0.55	1293.38	980.00		980.00		9975.00	9975.00	10007.70	10007.70	0.75	25.00
Job1	1.242	Method 1	1292.16	0.37	1293.31	980.00		980.00		9975.00	9975.00	10007.70	10007.70	0.81	25.00
Job1	1.242	East Chan.	1292.16	0.37	1293.31	980.00		980.00		9975.00	9975.00	10007.70	10007.70	0.81	25.00
Job1	1.242	No Breakouts	1291.79	0.00	1292.37	980.00	197.13	715.80	67.08		9975.00	10007.70		0.70	25.00
Job1	1.244	w/o Encr	1292.37		1292.51	720.00	121.82	541.42	56.76		9970.39	10009.50		0.30	10.00
Job1	1.244	M-4 Final	1293.39	1.01	1293.59	720.00		720.00		9970.39	9970.39	10009.50	10009.50	0.29	10.00
Job1	1.244	Method 1	1293.34	0.97	1293.55	720.00		720.00		9970.39	9970.39	10009.50	10009.50	0.29	10.00
Job1	1.244	East Chan.	1293.34	0.97	1293.55	720.00		720.00		9970.39	9970.39	10009.50	10009.50	0.29	10.00
Job1	1.244	No Breakouts	1292.37	0.00	1292.51	720.00	121.82	541.42	56.76		9970.39	10009.50		0.30	10.00
Job1	1.27	w/o Encr	1293.17		1293.51	760.00	109.92	597.66	52.42		9980.00	10014.26		0.51	160.00
Job1	1.27	M-4 Final	1294.08	0.91	1294.51	760.00		760.00		9980.00	9980.00	10014.26	10014.26	0.45	160.00
Job1	1.27	Method 1	1294.05	0.89	1294.49	760.00		760.00		9980.00	9980.00	10014.26	10014.26	0.45	160.00
Job1	1.27	East Chan.	1294.05	0.89	1294.49	760.00		760.00		9980.00	9980.00	10014.26	10014.26	0.45	160.00
Job1	1.27	No Breakouts	1293.17	0.00	1293.51	760.00	109.92	597.66	52.42		9980.00	10014.26		0.51	160.00
Job1	1.35	w/o Encr	1296.51		1296.88	840.00	43.79	748.32	47.89		9980.00	10020.00		0.48	395.00
Job1	1.35	M-4 Final	1296.92	0.41	1297.31	840.00	2.54	816.58	20.89	9978.61	9980.00	10020.00	10028.12	0.45	395.00
Job1	1.35	Method 1	1296.92	0.42	1297.32	840.00	2.54	816.52	20.94	9978.61	9980.00	10020.00	10028.12	0.45	395.00
Job1	1.35	East Chan.	1296.92	0.42	1297.32	840.00	2.54	816.52	20.94	9978.61	9980.00	10020.00	10028.12	0.45	395.00
Job1	1.35	No Breakouts	1296.51	0.00	1296.88	840.00	43.79	748.32	47.89		9980.00	10020.00		0.48	395.00
Job1	1.38	w/o Encr	1297.61		1297.85	840.00	8.24	822.52	9.24		9982.84	10027.90		0.32	170.00
Job1	1.38	M-4 Final	1297.91	0.29	1298.13	840.00	0.00	840.00		9982.84	9982.84	10027.90	10027.90	0.30	170.00
Job1	1.38	Method 1	1297.91	0.30	1298.13	840.00	0.00	840.00		9982.84	9982.84	10027.90	10027.90	0.30	170.00
Job1	1.38	East Chan.	1297.91	0.30	1298.13	840.00	0.00	840.00		9982.84	9982.84	10027.90	10027.90	0.30	170.00
Job1	1.38	No Breakouts	1297.61	0.00	1297.85	840.00	8.24	822.52	9.24		9982.84	10027.90		0.32	170.00
Job1	1.39		Culvert												
Job1	1.40	w/o Encr	1296.43		1297.97	840.00		840.00			9985.01	10018.11		0.99	105.00
Job1	1.40	M-4 Final	1297.36	0.93	1298.25	840.00		840.00		9982.84	9985.01	10018.11	10027.90	0.70	105.00
Job1	1.40	Method 1	1297.36	0.94	1298.25	840.00		840.00		9982.84	9985.01	10018.11	10027.90	0.70	105.00
Job1	1.40	East Chan.	1297.36	0.94	1298.25	840.00		840.00		9982.84	9985.01	10018.11	10027.90	0.70	105.00
Job1	1.40	No Breakouts	1296.43	0.00	1297.97	840.00		840.00			9985.01	10018.11		0.99	105.00
Job1	1.46	w/o Encr	1300.02		1301.03	840.00	0.00	840.00	0.00		9986.32	10027.87		0.90	290.00
Job1	1.46	M-4 Final	1299.78	-0.24	1301.01	840.00		840.00		9986.32	9986.32	10027.87	10027.87	1.00	290.00
Job1	1.46	Method 1	1299.78	-0.24	1301.01	840.00		840.00		9986.32	9986.32	10027.87	10027.87	1.00	290.00
Job1	1.46	East Chan.	1299.78	-0.24	1301.01	840.00		840.00		9986.32	9986.32	10027.87	10027.87	1.00	290.00
Job1	1.46	No Breakouts	1300.02	0.00	1301.03	840.00	0.00	840.00	0.00		9986.32	10027.87		0.90	290.00
Job1	1.49	w/o Encr	1302.64		1303.04	840.00		840.00			9976.32	10018.86		0.44	190.00
Job1	1.49	M-4 Final	1302.79	0.15	1303.16	840.00		840.00		9976.32	9976.32	10018.86	10018.86	0.42	190.00
Job1	1.49	Method 1	1302.79	0.15	1303.16	840.00		840.00		9976.32	9976.32	10018.86	10018.86	0.42	190.00
Job1	1.49	East Chan.	1302.79	0.15	1303.16	840.00		840.00		9976.32	9976.32	10018.86	10018.86	0.42	190.00
Job1	1.49	No Breakouts	1302.64	0.00	1303.04	840.00		840.00			9976.32	10018.86		0.44	190.00
Job1	1.509		Culvert												
Job1	1.527	w/o Encr	1302.82		1304.46	840.00		840.00			9979.17	10016.72		1.01	180.00
Job1	1.527	M-4 Final	1302.82	0.00	1304.46	840.00		840.00		9976.32	9979.17	10016.72	10018.86	1.01	180.00
Job1	1.527	Method 1	1302.82	0.00	1304.46	840.00		840.00		9976.32	9979.17	10016.72	10018.86	1.01	180.00
Job1	1.527	East Chan.	1302.82	0.00	1304.46	840.00		840.00		9976.32	9979.17	10016.72	10018.86	1.01	180.00
Job1	1.527	No Breakouts	1302.82	0.00	1304.46	840.00		840.00			9979.17	10016.72		1.01	180.00
Job1	1.528	w/o Encr	1304.69		1304.96	600.00		600.00			9978.99	10014.50		0.36	10.00
Job1	1.528	M-4 Final	1304.69	0.00	1304.96	600.00		600.00		9978.99	9978.99	10014.50	10014.50	0.36	10.00
Job1	1.528	Method 1	1304.69	0.00	1304.96	600.00		600.00		9978.99	9978.99	10014.50	10014.50	0.36	10.00

HEC-RAS Plan: Method 1 River: Job1 Reach: Job1 (Continued)

Reach	River Sta	Profile	W.S. Elev	Prof Delta WS	E.G. Elev	Q Total	Q Left	Q Channel	Q Right	Enc Sta L	Ch Sta L	Ch Sta R	Enc Sta R	Froude # Chl	Length Chnl
			(ft)	(ft)	(ft)	(cfs)	(cfs)	(cfs)	(cfs)	(ft)	(ft)	(ft)	(ft)		(ft)
Job1	1.528	East Chan.	1304.69	0.00	1304.96	600.00		600.00		9978.99	9978.99	10014.50	10014.50	0.36	10.00
Job1	1.528	No Breakouts	1304.69	0.00	1304.96	600.00		600.00			9978.99	10014.50		0.36	10.00
Job1	1.55	w/o Encr	1306.00		1306.51	600.00		600.00			9986.65	10020.00		0.49	125.00
Job1	1.55	M-4 Final	1306.00	0.00	1306.51	600.00		600.00		9986.65	9986.65	10020.00	10020.00	0.49	125.00
Job1	1.55	Method 1	1306.00	0.00	1306.51	600.00		600.00		9986.65	9986.65	10020.00	10020.00	0.49	125.00
Job1	1.55	East Chan.	1306.00	0.00	1306.51	600.00		600.00		9986.65	9986.65	10020.00	10020.00	0.49	125.00
Job1	1.55	No Breakouts	1306.00	0.00	1306.51	600.00		600.00			9986.65	10020.00		0.49	125.00
Job1	1.57	w/o Encr	1307.54		1307.78	600.00	1.79	524.97	73.25		9987.74	10020.00		0.37	100.00
Job1	1.57	M-4 Final	1307.58	0.05	1307.93	600.00		600.00		9987.74	9987.74	10020.00	10020.00	0.42	100.00
Job1	1.57	Method 1	1307.58	0.05	1307.93	600.00		600.00		9987.74	9987.74	10020.00	10020.00	0.42	100.00
Job1	1.57	East Chan.	1307.58	0.05	1307.93	600.00		600.00		9987.74	9987.74	10020.00	10020.00	0.42	100.00
Job1	1.57	No Breakouts	1307.54	0.00	1307.78	600.00	1.79	524.97	73.25		9987.74	10020.00		0.37	100.00
Job1	1.61	w/o Encr	1308.80		1309.48	600.00	0.38	591.14	8.48		9991.27	10025.52		0.73	180.00
Job1	1.61	M-4 Final	1309.13	0.33	1309.69	600.00		600.00		9991.27	9991.27	10025.52	10025.52	0.62	180.00
Job1	1.61	Method 1	1309.13	0.33	1309.69	600.00		600.00		9991.27	9991.27	10025.52	10025.52	0.62	180.00
Job1	1.61	East Chan.	1309.13	0.33	1309.69	600.00		600.00		9991.27	9991.27	10025.52	10025.52	0.62	180.00
Job1	1.61	No Breakouts	1308.80	0.00	1309.48	600.00	0.38	591.14	8.48		9991.27	10025.52		0.73	180.00
Job1	1.64	w/o Encr	1310.27		1310.43	600.00	152.36	365.81	81.83		9993.47	10020.00		0.37	165.00
Job1	1.64	M-4 Final	1310.20	-0.07	1310.88	600.00		600.00		9993.47	9993.47	10020.00	10020.00	0.63	165.00
Job1	1.64	Method 1	1310.20	-0.07	1310.88	600.00		600.00		9993.47	9993.47	10020.00	10020.00	0.63	165.00
Job1	1.64	East Chan.	1310.20	-0.07	1310.88	600.00		600.00		9993.47	9993.47	10020.00	10020.00	0.63	165.00
Job1	1.64	No Breakouts	1310.27	0.00	1310.43	600.00	152.36	365.81	81.83		9993.47	10020.00		0.37	165.00
Job1	1.65	w/o Encr	1310.45		1310.66	600.00	191.93	379.08	28.99		9985.00	10006.92		0.41	95.00
Job1	1.65	M-4 Final	1310.87	0.42	1311.52	600.00		600.00		9985.00	9985.00	10006.92	10006.92	0.55	95.00
Job1	1.65	Method 1	1310.87	0.42	1311.52	600.00		600.00		9985.00	9985.00	10006.92	10006.92	0.55	95.00
Job1	1.65	East Chan.	1310.87	0.42	1311.52	600.00		600.00		9985.00	9985.00	10006.92	10006.92	0.55	95.00
Job1	1.65	No Breakouts	1310.45	0.00	1310.66	600.00	191.93	379.08	28.99		9985.00	10006.92		0.41	95.00
Job1	1.66	w/o Encr	1310.73		1310.74	600.00	4.35	595.65			9902.71	10058.67		0.07	50.00
Job1	1.66	M-4 Final	1311.72	0.99	1311.73	600.00		600.00		9902.71	9902.71	10058.67	10058.67	0.05	50.00
Job1	1.66	Method 1	1311.72	0.99	1311.73	600.00		600.00		9902.71	9902.71	10058.67	10058.67	0.05	50.00
Job1	1.66	East Chan.	1311.72	0.99	1311.73	600.00		600.00		9902.71	9902.71	10058.67	10058.67	0.05	50.00
Job1	1.66	No Breakouts	1310.73	0.00	1310.74	600.00	4.35	595.65			9902.71	10058.67		0.07	50.00