Knik Arm Bridge - Preliminary Scour Estimate

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Introduction

This task consisted of preparing a preliminary estimate of the depth of contraction scour and the depth of abutment scour likely to occur at a proposed bridge crossing of Knik Arm. The location and alignment of the proposed bridge crossing are shown in Figure 1.

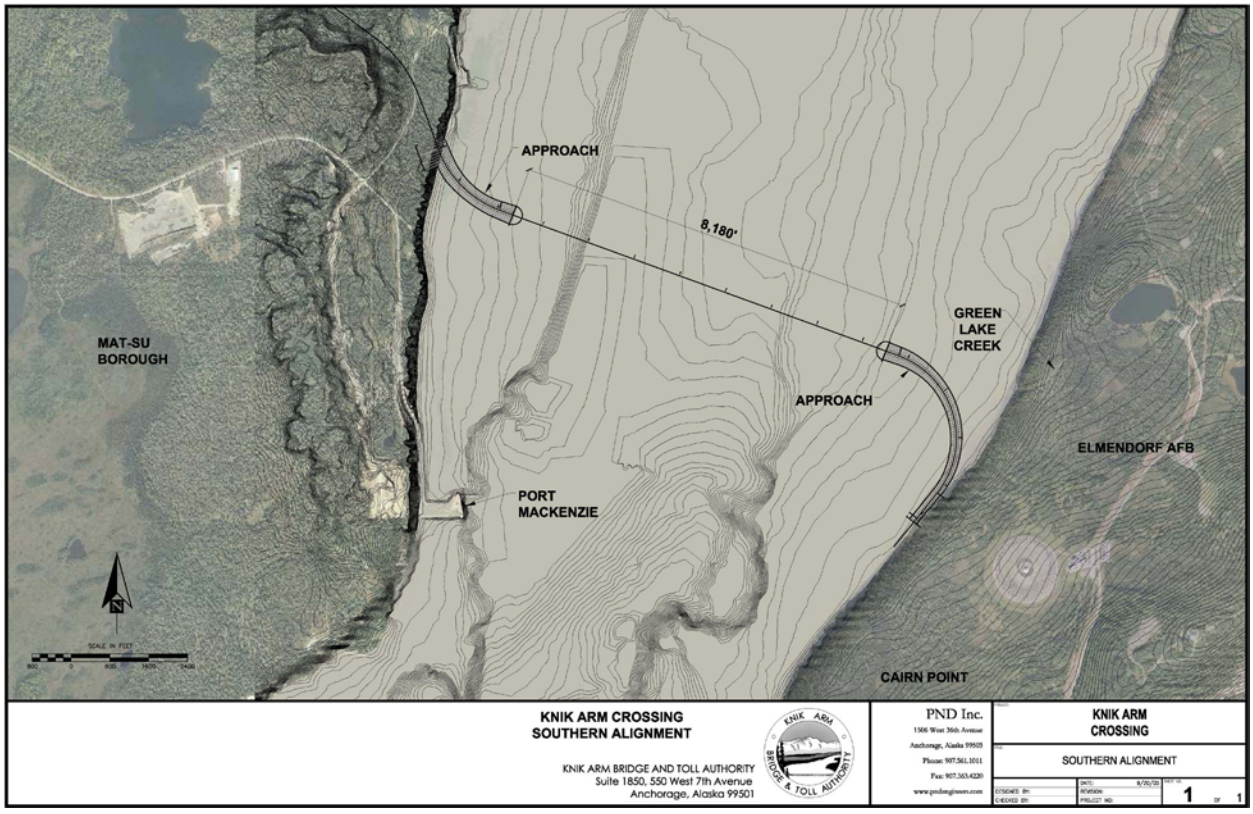

Figure 1: September 2005 Proposed Alignment of Knik Arm Bridge

Background

A conceptual design of the bridge has been developed by PND, Inc. The proposed bridge is located about 3 miles northeast of the Port of Anchorage, north of Cairn Point. The width of the unobstructed tidal waterway is about 12,000 feet at an elevation of 10 feet above mean lower low water (MLLW). The proposed bridge will be about 8,180 feet long, and a road embankment will extend into the tidal waterway on each side of the bridge. The bridge will have spill-through abutments with 3H:1V side slopes. The distance between the spill-through embankments will be about 7,940 feet at an elevation of 10 feet (MLLW). The bridge will have a number of piers consisting of 4-foot diameter pile between the abutments. The top width of the bridge (perpendicular to the drive lane) is proposed to be 44 feet initially and to be capable of expansion to 66 feet in the future.

Preliminary Design Event

The tidal conditions on which the contraction and abutment scour estimates are based are those of the 2 August 2004 spring ebb tide in Knik Arm. Water velocity, water depth, boat speed and boat location measurements were made, near the mid-tide water level, by Dr. Orson Smith (Colonell et. al 2004, Smith 2004), and were used to compute the discharge at the time of the measurements. A one-dimensional tidal basin model was then used to estimate the maximum discharge during the 2 August 2004 spring ebb tidal cycle under present conditions, and to estimate the maximum discharge through the proposed bridge on a tidal cycle similar to that of 2 August 2004. The contraction scour and abutment scour depths were estimated based on the maximum discharge estimated to occur at the proposed bridge on a spring ebb tide similar to that of 2 August 2004.

Preliminary Scour Depth Computation

The discharge during the 2 August 2004 spring ebb tide measurements was computed by URS using information collected at the time of the measurements (Khokhlov 2005) and digital bathymetric information provided by PND Incorporated. Based on this information, the discharge at the time of the measurements, between 11.6 and 11.85 hrs Alaska Daylight Time (ADT), was estimated to be 4,431,000 cfs. A more detailed description of the methods and a summary of the computations are presented in Attachment A.

Using the TideRout2 (Maryland State Highway Administration 2004) computer program (Version 2, Build 1.09) a one-dimensional tidal basin model of Knik Arm north of the 2 August 2004 measurements was prepared and calibrated to the discharge at the time of the measurements. Using the calibrated model, the maximum discharge during the 2 August 2004 spring ebb tide was estimated to be 4,453,000 cfs at 11.9 hrs (ADT).

The tidal basin areas associated with the TideRout2 model were then adjusted to reflect the difference between the location where the 2 August 2004 measurements were made and the proposed September 2005 location of the Knik Arm Bridge. The cross section used in the model was also changed from that at which the measurements were made to that of the proposed bridge location without the bridge in-place. Thus, at the location of the proposed Knik Arm Bridge, the peak discharge during the 2 August 2004 spring ebb tide was estimated to be 4,527,000 cfs at 11.9 hrs (ADT). The cross section in the model was then replace with a cross section that represented the bridge in-place, and the peak discharge through the proposed bridge was

estimated to be 4,516,000 cfs at 12.0 hrs (ADT). A more detailed description of the methods and summaries of the computations are presented in Attachment B.

Using the HEC-RAS (Hydrologic Engineering Center 2002) computer program (Version 3.1.2) a one-dimensional hydraulic model of the proposed bridge was prepared to estimate the hydraulic conditions within the bridge waterway opening. The discharge (4,515,602 cfs), water surface elevation on the downstream side of the bridge (17.54 ft MLLW), and water surface elevation on the upstream side of the bridge (18.98 ft MLLW) were obtained from the TideRout2 model. The bridge was assumed to be 66 feet wide (perpendicular to the drive lane), and the spill-through abutments and road side slopes were assumed to be 3H:1V. In order to obtain the information needed to compute the scour depth, the cross section was divided into three segments. The West Segment started at the west end of the cross section and ended at Station 45+59.3 (Attachment A, Figure A-1). The East Segment started at Station 94+77.4 and ended at the east end of the cross section, and the Center Segment started at Station 45+59.3 and ended at Station 94+77.4. Using the data from the TideRout2 model, the hydraulic roughness in the HEC-RAS model was adjusted until the upstream water surface elevation predicted by the HEC-RAS model matched that of the TideRout2 model. A Manning's Roughness value of 0.026 provided an upstream water surface elevation within 0.01 foot of the target value, was within the range expected for a seabed with sand waves, and thus, was accepted as a reasonable estimate of the hydraulic roughness. Based on the results from the model, the average center segment velocity within the bridge will be about 10.2 fps, while the average center segment velocity on the downstream and upstream sides of the bridge will be about 9.8 and 9.9 fps, respectively. A more detailed description of the methods and a summary of the computations are presented in Attachment C.

Contraction and abutment scour depth at the proposed bridge were estimated using the ABSCOUR (Maryland State Highway Administration 2004) computer program (Version 7, Build 1.01). The ABSCOUR program uses Laursen's method to estimate the contraction scour depth and a method calibrated to actual scour depth data collected at bridge abutments to estimate the abutment scour depth. It should be noted that the abutment scour depth predicted by the ABSCOUR program includes the depth of contraction scour. The total depth of scour at an abutment includes the sum of the abutment scour depth, long-term agradation or degradation, and one-half the height of sand waves (if present).

Based on the expected conditions during a spring ebb tide similar to the one that occurred on 2 August 2004, it is estimated that the contraction scour depth could be about 6 feet and the abutment scour depth could be about 28 feet at the West Abutment. It is estimated that the contraction scour depth could be about 5 feet and the abutment scour depth could be about 22 feet at the East Abutment. Each of these estimates includes a 10 percent safety factor. In the center segment of the channel, the deepest portion, the contraction scour depth is estimated to be less than 1 foot. A more detailed description of the methods and a summary of the computations are presented in Attachment C.

Results and Discussion

Hydraulic computations were performed to estimate the depth of contraction scour and abutment scour likely to occur at a proposed 8,180-foot-long bridge on Knik Arm, located about 3 miles

northeast of the Port of Anchorage. The analysis was performed using hydraulic conditions similar to that which occurred during the 2 August 2004 spring ebb tide.

The analyses suggest that as a result of constructing the bridge, the peak discharge will decrease from about 4,527,000 cfs to about 4,516,000 cfs. This is a decrease of about 0.2 percent, and results from the constriction in the waterway opening at the bridge. The analyses also suggest that the average velocity in the center segment of the waterway will increase from about 9.8 fps with no bridge to about 10.2 fps within the bridge opening, after construction of the bridge. The water velocity in the East and West segments of the channel will also increase at the bridge. The average velocity in the East and West segments, without the bridge, are estimated to be about 5 fps. With the bridge in-place, the average velocity in the East and West segments of the bridge opening are estimated to be about 8 and 6 fps (based on the ABSCOUR adjustments for flow constriction at the embankments).

With regard to contraction scour, the analyses suggest that the depth of contraction scour could be about 5 and 6 feet in the vicinity of the east and west abutments, respectively. In the center segment of the channel, the deepest portion, the depth of the contraction scour is likely to be less than 1 foot.

With regard to the abutment scour, the analyses suggest that the depth of abutment scour could be about 22 and 28 feet at the east and west abutments, respectively. The total depth of scour at the abutments is the sum of the abutment scour depth, the long-term agradation or degradation, and one-half the sand wave height (if present). Smith et al. (2005) report that an analysis of data collected in 2004 indicate that sand waves were present on the seabed and that the maximum height of the sand waves was on the order of 4.9 feet. Thus, if there is no long-term agradation or degradation at the abutments, the total depth of scour at the abutments is likely to be on the order of 24 and 30 feet at the east and west abutments, respectively.

In reviewing these results, it should be noted that these computations were for a spring ebb tide considered to be somewhat typical of annual conditions. For the design of the bridge foundation, it will be desirable to consider the conditions that are likely to occur during the 100- and 500-year events, and to consider the depth of scour at the piers.

References

Colonell, J., O. Smith, J. Aldrich, and P. Mineart. 2004. Knik Arm Hydraulic Studies: Preliminary Data Analyses. Prepared for: PND Incorporated. Anchorage, Alaska. Prepared by: URS Corporation.

Hydrologic Engineering Center. 2002. HEC-RAS River Analysis System, User's Manual. U.S. Army Corps of Engineers. Davis, California.

Khokhlov, A. 2005. Personal Communication. Terra Surveys LLC. Palmer, Alaska.

Maryland State Highway Administration. 2004. Manual on Hydrologic and Hydraulic Design. Office of Bridge Development.

Smith, O.P. 2004. Knik Arm Current, Sediment Transport, and Ice Studies. Prepared for: PND, Incorporated. Anchorage, Alaska.

Smith, 0.P., A. Khokhlov, and M. Zieserl. 2005. Water Property, sediment, Tide and current Measurements and Analyses in the Vicinity of the Proposed Knik Arm Bridge. Prepared for: URS Incorporated. Anchorage, Alaska.

Attachment A: Computation of 2 August 2004 Discharge Based on Spring Ebb Tide Measurements by Dr. Orson Smith and Terra Surveys.

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Table A-1: Summary

1 Acoustic Doppler current Profiler (ADCP) and Global Positioning System (GPS) measurements were made on 2 August 2004 between 11:36 and 11:51 ADT hours by Dr. Orson Smith and Terra Surveys (Smith, O. 2004. Appendix A in Knik Arm Hydraulic Studies: Preliminary Data Analysis).

2 The total discharge (shore to shore) had previously been estimated to be 4, 180,118 cfs (Smith, O. 2004. Appendix A, Knik Arm Hydraulic Studies: Preliminary Data Analysis).

3 This analysis uses the data collected on 2 August 2004 and the bathymetric mapping provided by PND in 2005 to refine the total discharge estimate.

5 Data used in the analysis were provided by a number of sources.

a The ADCP and GPS data were provided by Terra Surveys.

b The salinity on 2 August 2004 was reported to be between 5 and 6 psu (practical salinity units) (Smith, O. 2004. Knik Arm Bridge Conceptual Engineering: Knik Arm Current, Sediment Transport, and Ice Studies. Prepared for: PND, Inc.).

c Other data related to the ADCP measurement were obtained from Appendix A of the report titled "Knik Arm Hydraulic Studies: Preliminary Data Analysis" (Colonell et al. 2004).

d The ensemble width, bin velocity, average bin depth, bin thickness and total depth data were provided by Terra Surveys and are in presented in Table A-2.

6 Plots of two cross sections are provided in Figure A-1. The first cross section is based on the ADCP and GPS data provided by Terra Surveys. This cross section is over-laid on a cross section based on the PND bathymetric data.

The cross-sectional areas associated with the areas to the east and west of the measurements are also shown on the figure.

7 The discharge estimate was prepared using the "Winriver" computer program. In computing the discharge several assumptions were analyzed. The assumptions and the results of the analyses are summarized in Table A-3.

8 Based on the computations summarized in Table A-3, the total average discharge on 2 August 2004 during the Spring Ebb tide, between 11:36 and 11:51 ADT, was probably 4,431,320 cfs. This represents approximately a 6 percent increase in the previous estimate.

Table A-2: Summary of Measurements made on 2 August 2004 Spring Ebb Tide.

Col 1	2	Col 3	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Col 26	Col 27	Col 28	Col 29	Col 30
Station (C.L. of Ensem-ble) (feet)	Ensemble No.	Width (feet)	BIN 1 DEPTH in Feet From Water Surface to Center of BIN 15.42 VELOCITY MAGNITUDE (fps)	2 18.70	3 21.98	4 25.26	5 28.54	6 31.82	7 35.10	8 38.39	9 41.67	10 44.95	11 48.23	12 51.51	13 54.79	14 58.07	15 61.35	16 64.63	17 67.91	18 71.19	19 74.48	Total Depth (feet)	Count	X-Sec Area Associ-ated w/ Meas. Vel. (sf)	Average of Measured Velocities (fps)	Measured Discharge (cfs)
0	East Edge of Water																									
2330	1	60.80	6.77	6.35																		23.82	2	398.99	6.56	2,617
2391	2	60.74	6.81	6.12																		25.77	2	398.54	6.46	2,576
2450	3	57.88	7.12	6.63																		27.47	2	379.81	6.88	2,611
2508	4	57.32	7.69	6.90	6.04																	28.50	3	564.16	6.88	3,879
2567	5	60.50	7.12	6.84	5.49																	31.29	3	595.46	6.48	3,861
2628	6	62.02	7.57	7.22	6.98	5.76																31.57	4	813.91	6.88	5,602
2692	7	64.77	7.80	7.35	6.56	6.35																33.56	4	850.03	7.02	5,965
2756	8	64.24	7.78	7.19	6.43	6.08	5.57															36.72	5	1053.85	6.61	6,968
2819	9	62.32	7.88	7.40	7.22	6.50	5.94															36.77	5	1022.44	6.99	7,145
2882	10	63.49	7.65	7.03	6.96	6.75	6.65															36.91	5	1041.51	7.01	7,299
2945	11	62.38	8.16	7.85	6.91	6.81	5.97															37.20	5	1023.28	7.14	7,305
3008	12	62.67	7.62	7.82	6.97	6.74	6.47															37.65	5	1028.05	7.12	7,324
3071	13	63.71	8.31	7.98	7.54	6.79	6.63	6.27														38.02	6	1254.18	7.25	9,098
3134	14	61.59	8.04	8.25	7.82	7.28	6.92	6.84														37.93	6	1212.46	7.53	9,127
3195	15	61.04	8.45	8.14	7.79	7.65	6.93	6.31														38.51	6	1201.69	7.54	9,067
3256	16	60.97	7.52	7.51	7.58	7.40	7.40	6.11														37.99	6	1200.34	7.26	8,709
3316	17	59.54	8.86	8.42	7.89	7.23	7.10	7.12														38.80	6	1172.07	7.77	9,107
3374	18	56.87	8.93	8.29	8.15	8.27	7.47	7.08														39.74	6	1119.58	8.03	8,994
3431	19	56.34	8.01	8.00	7.92	7.72	7.47	7.03														39.98	6	1109.15	7.69	8,531
3488	20	57.18	8.88	8.41	8.16	8.24	7.50	7.71														40.38	6	1125.63	8.15	9,174
3545	21	57.61	8.74	8.18	8.03	8.19	6.98	6.48														40.81	6	1134.05	7.77	8,808
3603	22	58.67	9.02	8.37	7.56	7.07	6.10	6.02	5.93													42.55	7	1347.40	7.15	9,636
3663	23	59.81	8.13	8.01	7.55	6.71	6.78	6.60	6.38													43.65	7	1373.70	7.16	9,842
3722	24	58.77	8.60	8.46	7.90	7.63	7.14	6.42	5.93													45.17	7	1349.75	7.44	10,042
3780	25	57.62	9.24	8.61	7.16	6.32	6.76	6.38	5.89	5.82	4.99											49.35	9	1701.58	6.80	11,563
3838	26	58.96	8.35	8.52	8.24	6.94	6.83	6.19	6.02	5.14	4.54											49.87	9	1740.95	6.75	11,754
3899	27	61.56	9.08	8.47	7.66	7.50	7.24	6.75	5.50	5.26	4.78											49.81	9	1817.67	6.92	12,570
3960	28	61.09	8.52	8.09	7.24	7.53	7.20	7.05	6.81	5.88												48.94	8	1603.60	7.29	11,690
4020	29	58.94	9.29	8.78	8.60	7.52	7.47	6.80	7.11	6.59												47.74	8	1547.06	7.77	12,020
4080	30	60.53	8.95	8.33	7.59	6.87	6.47	5.67	5.97	4.73												46.59	8	1588.79	6.82	10,839
4141	31	62.87	8.58	8.15	7.64	6.90	6.52	6.10	5.99	5.16												46.15	8	1650.26	6.88	11,356
4204	32	61.54	9.42	8.68	8.74	7.76	7.51	7.01	6.26	5.83												46.31	8	1615.26	7.65	12,356
4263	33	57.68	8.85	8.58	8.15	7.93	7.37	7.39	2188/3	6.41												46.34	7	1324.63	7.81	10,345
4321	34	57.25	9.16	9.24	8.57	7.90	7.84	7.49	5.76	5.05												46.53	8	1502.64	7.63	11,461
4378	35	58.34	9.85	9.43	8.61	7.63	7.91	7.11	6.01	5.89												46.69	8	1531.36	7.80	11,952
4437	36	58.85	9.60	9.33	8.39	8.19	7.17	7.08	6.37	5.67												46.91	8	1544.82	7.72	11,931
4494	37	55.03	10.26	10.03	9.81	8.75	8.96	9.27	7.96	7.35												47.47	8	1444.31	9.05	13,068
4547	38	51.90	10.76	9.98	9.06	8.08	8.52	8.71	7.45	6.67												48.24	8	1362.20	8.65	11,788
4600	39	53.13	10.12	10.86	10.33	8.74	9.30	8.42	7.69	6.90												48.85	8	1394.51	9.05	12,615
4653	40	53.68	10.83	10.24	9.69	8.99	8.78	8.84	8.32	7.04												49.87	8	1408.87	9.09	12,809
4706	41	51.44	10.64	10.75	9.92	9.53	8.93	8.29	8.11	7.02	6.14											50.67	9	1518.85	8.81	13,388
4757	42	51.73	10.79	10.64	10.25	9.55	9.43	8.76	8.60	7.42	6.69											52.04	9	1527.43	9.13	13,940
4810	43	53.73	10.81	10.79	10.19	9.65	8.82	8.50	7.76	7.62	6.80	5.70										54.20	10	1762.77	8.66	15,272
4864	44	53.79	11.00	11.15	10.69	10.60	9.35	8.16	8.20	7.65	6.60	6.32										56.01	10	1765.01	8.97	15,836

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Col 1	2	Col 3	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Col 26	Col 27	Col 28	Col 29	Col 30
Station (C.L. of Ensem- ble) (feet)	Ensemble No.	Width (feet)	BIN 1 15.42	2 18.70	3 21.98	4 25.26	5 28.54	6 31.82	7 35.10	8 38.39	9 41.67	10 44.95	11 48.23	12 51.51	13 54.79	14 58.07	15 61.35	16 64.63	17 67.91	18 71.19	19 74.48	Total Depth (feet)	Count	X-Sec Area Associ- ated w/ Meas. Vel. (sf)	Average of Measured Velocities (fps)	Measured Discharge (cfs)
			DEPTH in Feet From Water Surface to Center of BIN																							
			VELOCITY MAGNITUDE (fps)																							
4918	45	54.46	10.60	10.88	10.49	10.19	9.69	9.61	8.62	8.28	7.69	7.22	6.29									58.90	11	1965.57	9.05	17,792
4973	46	54.92	10.70	11.13	10.41	10.09	9.67	8.81	9.25	8.34	7.51	7.14	6.51	6.30								58.44	12	2162.43	8.82	19,074
5027	47	53.83	11.19	10.99	11.24	10.34	10.18	9.77	8.87	8.01	7.22	6.93	6.06	5.32								57.99	12	2119.36	8.84	18,740
5081	48	53.04	10.40	10.83	11.30	10.14	9.89	9.19	8.47	7.25	6.77	6.36	5.78									57.54	11	1914.36	8.76	16,772
5133	49	51.95	11.23	11.23	11.15	10.42	10.09	9.17	8.45	8.02	7.64	7.28	6.80	4.49								57.10	12	2045.32	8.83	18,062
5184	50	50.70	11.54	10.50	10.73	11.00	10.56	9.87	9.22	8.73	8.12	7.55	6.71									56.68	11	1829.84	9.50	17,387
5235	51	51.32	11.24	11.37	11.11	10.57	10.76	9.95	9.32	8.88	8.91	8.21										56.96	10	1683.69	10.03	16,890
5287	52	51.50	10.92	11.34	11.07	11.42	10.79	10.48	10.06	9.56	8.96	9.34	7.68									56.44	11	1858.84	10.15	18,860
5338	53	50.94	11.01	11.10	11.46	11.09	11.46	10.96	10.05	9.27	8.53	7.67	6.86									58.24	11	1838.48	9.95	18,290
5389	54	51.47	11.47	10.84	11.16	11.26	10.88	10.62	9.95	9.06	8.23	7.96	6.71									58.05	11	1857.61	9.83	18,263
5442	55	53.08	10.88	11.27	10.80	10.88	10.46	10.10	9.82	9.22	8.97	8.29	7.29	6.11								59.60	12	2089.74	9.51	19,870
5495	56	53.81	11.41	11.03	11.48	10.48	10.93	10.65	10.12	9.19	8.51	7.46	7.16	6.31								60.84	12	2118.68	9.56	20,255
5549	57	54.19	11.56	11.38	11.21	10.91	10.60	10.45	10.26	9.38	9.10	8.73	7.98	7.21								62.97	12	2133.49	9.90	21,115
5603	58	53.04	11.14	11.34	11.03	10.62	10.52	10.49	10.59	9.98	8.98	8.18	7.68	7.52	6.58							61.92	13	2262.43	9.59	21,692
5655	59	51.30	11.89	11.71	11.45	11.26	10.85	10.10	10.29	9.90	9.14	8.85	8.62	7.57								60.90	12	2019.75	10.14	20,472
5706	60	51.90	10.95	10.94	11.41	11.67	10.36	10.45	10.46	9.97	9.50	8.65	7.62	7.87								61.03	12	2043.30	9.99	20,408
5759	61	52.72	11.39	11.38	10.75	10.87	10.17	10.36	9.81	9.86	9.26	8.30	7.50	6.69	6.22							61.28	13	2248.58	9.43	21,200
5811	62	52.22	11.55	11.69	11.38	11.11	10.06	10.43	9.92	9.90	10.12	9.86	9.57	8.38								61.52	12	2056.09	10.33	21,242
5864	63	54.19	10.93	11.22	10.83	10.85	10.39	10.76	10.14	9.60	9.87	9.70	9.09	8.85								60.96	12	2133.49	10.18	21,729
5918	64	52.43	11.13	11.50	10.80	10.48	10.36	10.62	10.36	10.45	9.77	9.48	9.25	9.32								62.74	12	2064.17	10.30	21,251
5969	65	49.78	10.56	10.91	11.25	10.63	9.93	10.41	9.94	9.94	9.92	9.99	9.96	9.49								61.57	12	1959.85	10.24	20,079
6019	66	50.75	11.48	11.40	11.40	10.88	10.51	9.98	10.22	10.00	9.90	9.45	9.62	8.72								61.93	12	1998.21	10.30	20,577
6071	67	52.91	11.63	11.58	11.07	11.08	10.48	10.32	9.89	9.73	9.45	9.01	8.80	8.33								62.59	12	2083.01	10.11	21,066
6123	68	50.91	11.28	11.27	11.12	10.57	10.55	10.27	9.75	10.13	10.44	9.58	9.03	8.82								62.60	12	2004.27	10.23	20,513
6174	69	50.87	10.80	10.96	10.88	10.58	10.31	9.97	9.39	9.56	9.71	9.58	9.46	8.24	7.78							64.25	13	2169.83	9.79	21,233
6224	70	50.15	11.21	10.88	10.69	10.65	10.25	10.27	9.72	9.23	9.41	9.26	9.11	8.90	7.94							65.90	13	2139.21	9.81	20,982
6274	71	49.73	11.18	11.17	11.27	11.10	10.52	9.93	9.94	10.01	9.65	9.38	9.19	8.70	8.03	7.52						65.34	14	2284.14	9.83	22,448
6325	72	51.30	11.04	11.28	10.73	10.72	10.33	9.53	9.53	9.87	9.82	9.76	9.49	8.86	8.09							64.77	13	2188.06	9.93	21,719
6376	73	52.48	11.29	11.24	11.09	10.62	9.91	9.83	9.79	9.39	9.24	10.11	9.06	8.65	8.36							64.20	13	2238.37	9.89	22,137
6429	74	52.92	11.43	11.14	10.68	10.66	10.10	10.04	9.66	9.77	9.44	10.02	9.74	8.88	8.36							63.47	13	2257.33	9.99	22,561
6481	75	51.23	11.27	11.22	10.93	10.27	10.59	9.61	9.15	9.57	9.45	9.35	9.09	8.35	7.73							64.96	13	2185.15	9.74	21,276
6532	76	49.30	11.72	11.86	10.75	10.22	10.63	9.92	10.06	9.64	9.56	9.45	9.18	8.76	7.92							64.93	13	2102.76	9.97	20,971
6581	77	48.82	11.42	10.85	10.69	10.41	9.80	9.88	9.52	9.85	9.60	9.99	10.20	8.82	8.00							66.30	13	2082.34	9.93	20,669
6629	78	48.00	11.62	11.20	10.77	10.18	10.32	10.14	9.14	9.41	9.50	9.42	9.99	9.27	8.56							65.77	13	2047.34	9.96	20,399
6677	79	48.32	11.18	10.62	10.32	9.87	9.96	9.42	9.36	9.49	9.78	9.78	9.56	8.99	8.44	7.30						67.14	14	2219.75	9.58	21,261
6726	80	49.09	11.70	10.35	10.34	10.14	9.45	10.16	9.87	9.74	9.96	9.84	9.48	9.02	8.95	8.03						67.74	14	2255.08	9.79	22,072
6774	81	46.53	10.79	10.84	10.64	10.18	10.04	9.73	9.65	9.81	9.77	10.23	9.83	9.79	9.48	8.59						68.33	14	2137.30	9.96	21,277
6819	82	44.34	10.88	10.83	10.81	10.34	10.01	9.93	9.87	9.97	10.12	10.75	10.55	10.37	10.33	9.49	8.09					68.56	15	2182.28	10.16	22,167
6863	83	44.22	11.24	10.46	10.85	10.24	10.19	10.15	9.86	10.53	10.09	10.65	10.51	10.05	10.42	9.74						68.78	14	2031.30	10.36	21,036
6908	84	45.52	11.41	10.62	10.48	10.15	9.77	10.44	9.92	10.52	10.22	9.79	10.14	10.54	9.69	9.46						69.01	14	2090.98	10.22	21,380
6955	85	47.54	11.05	10.49	10.28	9.99	10.05	9.85	10.42	9.69	9.56	10.37	10.40	9.75	9.88	9.31	8.82					69.25	15	2339.60	9.99	23,380
7001	86	44.10	10.57	10.64	10.29	9.96	10.04	10.26	9.92	9.62	9.81	10.60	10.21	10.58	10.12	9.94						69.48	14	2025.81	10.18	20,631
7043	87	41.44	11.15	10.62	10.56	10.90	10.60	10.41	10.95	10.51	10.84	11.15	10.92	10.21	9.98	9.64						69.48	14	1903.32	10.60	20,180
7086	88	42.94	10.68	10.54	10.32	10.02	9.70	10.16	9.82	10.59	10.68	10.40	10.27	10.11	9.08	8.56						69.49	14	1972.41	10.07	19,856
7130	89	45.04	10.71	10.20	10.32	10.02	9.84	10.15	10.03	10.12	10.02	10.10	10.26	9.61	9.59	8.67	7.31					69.50	15	2216.78	9.80	21,717

Table A-2: Summary of Measurements made on 2 August 2004 Spring Ebb Tide.

Col 1	2	Col 3	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Col 26	Col 27	Col 28	Col 29	Col 30
Station (C.L. of Ensem- ble) (feet)	Ensemble No.	Width (feet)	BIN 1 DEPTH in Feet From Water Surface to Center of BIN 15.42 VELOCITY MAGNITUDE (fps)	2 18.70	3 21.98	4 25.26	5 28.54	6 31.82	7 35.10	8 38.39	9 41.67	10 44.95	11 48.23	12 51.51	13 54.79	14 58.07	15 61.35	16 64.63	17 67.91	18 71.19	19 74.48	Total Depth (feet)	Count	X-Sec Area Associ- ated w/ Meas. Vel. (sf)	Average of Measured Velocities (fps)	Measured Discharge (cfs)
7174	90	43.68	10.79	10.57	10.25	9.83	9.69	10.16	10.45	10.54	10.16	10.34	10.16	10.36	10.11	9.29	8.56					69.50	15	2149.47	10.08	21,676
7216	91	41.38	10.94	10.30	10.41	10.17	10.29	10.52	10.54	10.43	10.18	10.48	10.09	9.99	9.52	8.72	7.86					69.51	15	2036.74	10.03	20,428
7258	92	41.66	10.40	10.52	9.74	10.13	10.34	10.52	10.44	10.56	10.36	10.31	9.75	9.73	9.67	8.93						69.51	14	1913.52	10.10	19,326
7300	93	43.04	10.94	10.71	10.22	10.50	10.47	9.92	10.00	10.16	10.59	10.56	9.89	9.75	9.95	8.94	8.41	7.88				71.03	16	2259.57	9.93	22,438
7343	94	43.15	10.99	10.49	10.34	10.40	10.47	10.78	10.45	10.21	10.45	10.24	10.10	10.04	9.70	9.31	8.82	6.92				72.57	16	2264.95	9.98	22,611
7386	95	42.74	10.92	10.67	10.43	10.61	10.33	10.39	10.53	10.33	10.40	10.04	9.97	9.68	9.55	9.49	8.73	8.38	7.17			74.10	17	2383.63	9.86	23,504
7429	96	43.20	10.75	10.38	10.18	9.92	10.18	10.40	10.73	10.56	10.41	10.32	9.91	9.73	9.41	9.48	8.86					75.63	15	2125.92	10.08	21,434
7474	97	45.64	10.59	10.72	10.79	10.25	10.59	10.09	10.13	10.53	9.50	10.33	9.85	9.56	9.43	9.21	8.85	7.99				76.39	16	2395.97	9.90	23,719
7521	98	48.05	10.87	10.70	11.07	10.81	11.35	10.12	9.49	10.25	10.18	9.82	10.12	8.51	9.47	9.75	9.10	8.30				76.15	16	2522.50	9.99	25,211
7569	99	48.97	11.72	10.93	10.71	10.09	10.66	10.56	10.97	10.57	11.00	10.27	9.99	10.51	9.68	9.74	9.59	9.38				76.94	16	2570.96	10.40	26,734
7619	100	50.34	10.85	10.62	11.21	10.79	10.38	10.77	11.14	10.49	10.19	10.97	10.71	9.76	9.84	10.06	9.67	9.85				77.48	16	2642.75	10.46	27,633
7671	101	53.23	10.60	10.12	10.16	9.72	10.28	10.43	10.43	10.51	10.59	10.52	9.75	10.44	9.52	9.39	8.89	9.42	8.40			78.04	17	2969.05	9.95	29,543
7724	102	52.92	10.31	11.06	10.95	10.27	9.95	10.24	10.25	10.57	10.18	9.71	9.47	9.75	9.43	9.31	9.22	9.52				78.01	16	2778.25	10.01	27,814
7777	103	54.12	10.15	9.85	10.26	9.69	9.80	9.41	9.88	9.66	9.84	10.11	9.46	9.56	8.79	8.59	9.44	8.51				77.44	16	2841.06	9.56	27,165
7830	104	51.79	10.52	10.41	9.86	9.79	9.56	9.14	9.75	9.36	9.66	10.07	9.25	9.29	9.31	8.65	8.44	7.74				77.54	16	2719.02	9.43	25,631
7882	105	51.08	10.66	10.60	10.89	10.98	11.17	10.09	9.82	10.29	10.17	8.64	9.73	9.74	9.17	9.30	8.95	8.43	8.62			78.48	17	2848.92	9.84	28,029
7933	106	52.14	10.61	10.14	10.27	10.41	10.18	10.02	9.89	10.28	10.35	8.78	9.40	9.10	9.33	8.85	8.25	8.20	7.97			77.61	17	2908.03	9.53	27,713
7986	107	53.69	9.72	10.00	10.90	10.71	10.48	10.35	10.24	10.58	9.29	9.41	9.98	8.99	8.86	8.63	8.55	7.82	8.07			78.48	17	2994.79	9.56	28,639
8040	108	53.37	9.85	10.23	9.11	9.56	9.65	9.60	10.01	10.10	10.10	9.28	8.90	7.30	8.90	8.89	8.38	8.01	8.63			77.64	17	2976.68	9.20	27,400
8093	109	52.67	10.18	10.78	11.08	9.82	10.25	10.22	10.72	9.82	9.31	8.95	8.62	9.30	8.36	8.74	8.24	7.85	7.98			78.55	17	2937.59	9.43	27,688
8146	110	53.09	10.17	10.63	9.77	9.66	10.24	9.71	10.25	10.06	9.78	9.14	8.85	8.91	8.50	8.79	8.79	8.46	8.81			79.01	17	2961.42	9.44	27,964
8199	111	53.32	10.33	10.26	9.70	10.20	9.90	10.18	10.31	9.60	8.94	9.30	9.70	9.19	9.25	8.36	8.15	8.84	8.40			78.99	17	2973.82	9.45	28,097
8251	112	50.89	10.04	10.18	10.44	10.21	10.23	9.96	9.93	9.33	9.58	9.78	9.24	9.40	9.23	9.24	9.01	8.98	8.66			78.94	17	2838.43	9.61	27,288
8301	113	49.95	10.44	10.52	10.38	10.33	10.33	9.93	9.27	9.76	9.23	9.44	9.49	8.81	9.43	8.91	9.28	8.95	8.70			79.78	17	2785.99	9.60	26,745
8351	114	49.42	10.50	10.26	10.14	10.30	10.22	10.06	9.50	9.16	9.40	9.74	9.51	9.07	8.79	9.23	8.87	9.16	9.38			79.85	17	2756.43	9.61	26,480
8400	115	48.77	10.90	10.32	9.46	10.49	10.56	11.64	10.04	10.78	10.29	9.98	9.81	9.70	8.89	9.32	9.47	8.64	8.90			79.97	17	2720.20	9.95	27,072
8449	116	49.16	10.18	10.45	10.73	10.35	10.45	9.88	9.71	9.56	9.18	8.52	8.67	9.25	8.74	9.19	8.66	8.74	8.92	7.98		80.76	18	2903.43	9.40	27,286
8498	117	49.88	9.82	9.93	10.58	11.38	10.83	10.11	10.45	10.08	9.72	9.50	10.42	10.30	9.57	9.59	9.37	8.68	8.35	8.77		81.43	18	2945.83	9.86	29,036
8549	118	51.03	9.59	10.04	10.10	10.08	9.47	10.14	9.72	9.83	9.52	9.83	10.08	9.15	8.85	8.58	9.10	9.16	9.68			80.61	17	2846.06	9.58	27,275
8600	119	51.03	9.38	9.30	10.53	10.09	9.67	9.33	8.97	8.04	8.68	8.85	8.29	8.14	8.91	8.51	8.49	8.41	7.64	7.67		81.57	18	3013.47	8.83	26,606
8650	120	49.83	9.74	9.51	9.81	10.28	9.77	9.92	9.38	9.38	9.77	9.11	8.76	8.66	8.86	8.35	8.74	8.57	8.22	8.77		82.61	18	2942.80	9.20	27,075
8699	121	47.64	10.23	9.99	10.20	9.73	9.70	9.68	9.44	9.15	9.00	9.25	9.02	9.63	9.09	8.96	9.35	9.38	8.99	8.46		83.03	18	2813.58	9.40	26,452
8746	122	47.01	10.02	10.08	9.64	9.10	9.57	9.53	9.49	9.46	9.25	9.39	9.26	8.86	9.14	8.84	8.77	8.92	9.29	8.77		83.10	18	2776.23	9.30	25,815
8793	123	45.91	10.65	10.78	10.69	10.53	10.04	9.90	9.56	10.04	9.97	9.96	9.26	9.38	9.59	10.05	9.44	9.72	9.41	9.44	8.61	84.04	19	2862.26	9.84	28,174
8840	124	48.51	9.10	9.75	9.26	9.17	9.40	10.17	9.69	10.09	10.25	9.36	9.79	9.85	9.81	9.43	9.22	10.28	9.77	9.01		84.17	18	2865.07	9.63	27,597
8889	125	50.00	10.36	9.68	9.63	10.02	10.51	10.26	10.21	9.70	9.81	10.69	10.37	10.11	9.94	8.28	8.68	7.95	7.85	8.22	6.88	84.98	19	3116.95	9.43	29,394
8939	126	48.44	10.43	9.61	9.72	9.53	10.02	10.13	10.29	10.08	9.76	8.98	9.47	9.83	9.68	9.09	8.65	8.65	7.84	6.89	6.70	83.85	19	3019.98	9.23	27,871
8987	127	47.81	10.16	10.32	10.07	10.05	10.40	10.19	10.41	9.55	9.74	9.11	8.80	8.92	8.90	8.86	8.90	8.28	8.10	7.45		82.24	18	2823.68	9.35	26,388
9032	128	43.32	10.15	9.85	9.93	9.82	9.75	9.56	9.17	8.84	8.51	8.43	8.69	8.83	8.50	7.89	7.61	6.99	7.51			78.79	17	2416.05	8.83	21,323
9078	129	47.98	9.91	9.77	8.73	7.94	7.20	8.08	8.46	8.15	8.72	8.59	8.45	7.40	7.90	8.03	7.21					73.71	15	2361.48	8.30	19,608
9124	130	43.47	8.57	8.51	8.38	7.95	7.74	7.95	8.09	8.58	7.69	7.37	7.05	6.46	5.94	6.13						69.19	14	1996.75	7.60	15,176
9170	131	48.96	7.73	6.99	6.87	7.14	5.93	6.32	6.46	6.56	5.67	5.74	5.33	5.42	5.66							66.17	13	2088.17	6.29	13,144
9220	132	51.68	7.40	7.01	7.14	7.17	7.44	6.90	6.96	6.91	6.74	6.04	5.77									59.94	11	1865.01	6.86	12,796
9273	133	54.55	6.72	6.41	6.15	6.41	6.71	6.74	6.27	6.56	5.94	6.10										56.21	10	1789.69	6.40	11,454
9330	134	57.90	6.71	7.20	6.25	6.06	5.57	5.90	5.49	4.63	4.56	4.13										52.88	10	1899.61	5.65	10,732

Table A-2: Summary of Measurements made on 2 August 2004 Spring Ebb Tide.

Col 1	2	Col 3	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Col 26	Col 27	Col 28	Col 29	Col 30
Station (C.L. of Ensem- ble) (feet)	Ensemble No.	Width (feet)	BIN 1 DEPTH in Feet From Water Surface to Center of BIN 15.42 VELOCITY MAGNITUDE (fps)	2 18.70	3 21.98	4 25.26	5 28.54	6 31.82	7 35.10	8 38.39	9 41.67	10 44.95	11 48.23	12 51.51	13 54.79	14 58.07	15 61.35	16 64.63	17 67.91	18 71.19	19 74.48	Total Depth (feet)	Count	X-Sec Area Associ- ated w/ Meas. Vel. (sf)	Average of Measured Velocities (fps)	Measured Discharge (cfs)
9388	135	59.91	7.67	7.73	7.06	6.28	6.31	6.11	5.60	5.16	3.75											49.44	9	1769.22	6.19	10,943
9447	136	56.97	6.58	6.52	6.79	6.42	6.08	6.02	5.38	5.36												46.28	8	1495.46	6.15	9,192
9504	137	57.23	7.40	6.45	6.62	6.46	5.75	5.26														42.01	6	1126.64	6.32	7,123
9562	138	57.78	5.94	6.01	5.79	5.56	5.69	4.88														39.36	6	1137.41	5.64	6,420
9620	139	58.31	7.34	7.63	6.32	5.89	6.37															37.90	5	956.54	6.71	6,418
9676	140	54.97	6.77	6.16	5.78	5.63	5.42															37.54	5	901.85	5.95	5,369
9732	141	56.75	7.30	7.36	7.12	6.91	6.16															37.40	5	931.02	6.97	6,489
9788	142	54.72	7.24	6.45	6.82	6.55	6.08															37.11	5	897.65	6.63	5,949
9842	143	54.51	7.84	7.24	6.90	6.99	6.12															36.30	5	894.28	7.02	6,275
9897	144	54.05	6.06	5.59	5.73	5.51	5.76															35.82	5	886.71	5.73	5,080
9950	145	53.21	6.42	6.39	6.45	5.96	6.21															36.70	5	872.97	6.29	5,489
10004	146	53.71	6.52	6.46	6.75	6.18	5.52															37.22	5	881.10	6.29	5,538
10057	147	53.37	5.95	6.41	5.94	6.22	6.06															37.19	5	875.49	6.12	5,356
10112	148	55.11	6.81	6.29	6.29	6.37	6.06															37.11	5	904.10	6.36	5,754
10167	149	56.58	6.27	6.15	6.18	5.99	5.64															36.89	5	928.21	6.05	5,613
10226	150	59.97	6.79	6.03	6.14	5.58	5.74															36.09	5	983.74	6.06	5,959
10285	151	58.32	5.73	5.39	5.91	6.19	5.71															35.07	5	956.82	5.79	5,536
10343	152	58.87	5.39	5.48	5.29	5.66	5.29															34.82	5	965.79	5.42	5,235
10403	153	60.44	5.80	5.34	4.78	4.99	4.79															34.79	5	991.59	5.14	5,097
10464	154	60.58	5.79	5.55	4.90	4.73	4.85															34.65	5	993.83	5.17	5,134
10525	155	61.28	4.90	4.58	4.83	4.25	4.53															34.48	5	1005.33	4.62	4,642
10586	156	61.59	5.02	5.02	4.82	4.51	4.17															34.16	5	1010.38	4.71	4,756
10647	157	61.28	4.91	4.75	4.92	4.20																33.99	4	804.27	4.70	3,779
10709	158	62.09	4.51	4.78	4.54	4.07																32.93	4	814.81	4.48	3,649
10771	159	62.12	4.74	4.24	4.47	4.02																32.31	4	815.26	4.37	3,560
10834	160	63.18	4.60	4.27	4.12	4.36																31.33	4	829.17	4.34	3,597
10897	161	62.91	4.48	3.79	3.60																	30.85	3	619.18	3.96	2,451
10960	162	63.06	4.39	3.80	4.01																	28.69	3	620.70	4.07	2,524
11023	163	63.09	3.83	3.65	3.74																	27.87	3	621.03	3.74	2,321
11087	164	64.24	3.90	3.61	3.49																	28.45	3	632.31	3.67	2,319
11151	165	65.11	4.46	3.48	3.41																	28.18	3	640.89	3.78	2,423
11216	166	64.36	3.47	3.46	3.45																	27.68	3	633.49	3.46	2,193
11281	167	65.64	3.85	3.26																		26.95	2	430.74	3.56	1,532
11346	168	64.55	4.12	4.04																		26.26	2	423.56	4.08	1,729
11411	169	64.79	3.10	2.97																		25.21	2	425.13	3.03	1,289
11476	170	66.31	3.10																			23.91	1	217.56	3.10	675
11544	171	68.50	2.34																			22.21	1	224.73	2.34	526
11613	172	69.64	2.99																			21.26	1	228.49	2.99	684
12013	West Edge of Water																					Total Measured Discharge (cfs):				2,612,593

Notes:

1 The discharge measurement was made on 2 August 2004 between 11:36 and 11:51 ADT hours (Orson Smith, Appendix A, Knik Arm Hydraulic Studies: Preliminary Data Analysis, 2004).

2 The total estimated discharge (shore to shore): 4, 180,118 cfs (Orson Smith, Appendix A, Knik Arm Hydraulic Studies: Preliminary Data Analysis, 2004).

3 High Tide had been predicted to occur at 08:54 ADT hrs, at an elevation of 31.6 feet MLLW. Low Tide had been predicted to occur at 16:07 ADT hrs, at an elevation of -4.2 feet MLLW (Orson Smith, Appendix A, Knik Arm Hydraulic Studies: Preliminary Data Analysis, 2004).

Table A-2: Summary of Measurements made on 2 August 2004 Spring Ebb Tide.

Col 1	2	Col 3	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Col 26	Col 27	Col 28	Col 29	Col 30
Station (C.L. of Ensem-ble) (feet)	Ensemble No.	Width (feet)	BIN 1 DEPTH in Feet From Water Surface to Center of BIN 15.42 VELOCITY MAGNITUDE (fps)	2 18.70	3 21.98	4 25.26	5 28.54	6 31.82	7 35.10	8 38.39	9 41.67	10 44.95	11 48.23	12 51.51	13 54.79	14 58.07	15 61.35	16 64.63	17 67.91	18 71.19	19 74.48	Total Depth (feet)	Count	X-Sec Area Associ-ated w/ Meas. Vel. (sf)	Average of Measured Velocities (fps)	Measured Discharge (cfs)

4 East-to-West Transect began about 2,300 feet from water line on east shore and ended about 400 feet from water line on west shore (Orson Smith, Appendix A, Knik Arm Hydraulic Studies: Preliminary Data Analysis, 2004).

5 Highlighted cells are basic data cells (total water depth) that were linearly interpolated by URS due to lack of data.

6 Note that the cross sectional area estimate assumes that the velocity is exactly perpendicular to the cross section at each ensemble.

7 Data provided by Terra Surveys and converted to English units by URS. Station, cross sectional area, average velocity and measured discharge computed by URS.

Table A-3: 2 August 2004 Spring Ebb Tide Discharge Estimate (11:36 to 11:51 ADT)

Trail #5 has been selected as the discharge estimate mostly to represent the actual discharge.

Trial Number:	1	2	3	4	5
Configuration Settings					
Offsets					
ADCP Transducer Depth (ft):	3.94	3.94	3.94	3.94	3.94
Processing					
Speed of Sound					
Use ADCP Value:	Yes	Yes	Yes	Yes	Yes
Calculate for each ping	No	No	No	No	No
Use salinity of (ppt):					
Backscatter, Near-Zone Distance (ft):	6.89	6.89	6.89	6.89	6.89
Cross Sectional Area					
Perpendicular to Mean Flow	Yes	Yes	Yes	Yes	Yes
Perpendicular to Proj. Angle	No	No	No	No	No
Parallel to Average Course	No	No	No	No	No
Data Screening					
Mark Below Bottom "Bad"	Yes	Yes	Yes	Yes	Yes
Use 3 Beam Solution for BT	Yes	Yes	Yes	Yes	Yes
Use 3 Beam Solution for WT	No	No	No	No	No
Screen Depth	No	No	No	No	No
Thresholds					
BT Error Vel. (ft/s):	32.81	32.81	32.81	32.81	32.81
WT Error Vel. (ft/s):	3.5	3.5	3.5	3.5	3.5
BT Up Vel. (ft/s):	1	1	1	1	1
WT Up Vel. (ft/s):	3.28	3.28	3.28	3.28	3.28
Fish Intensity (count):	50	50	50	50	50
Discharge					
Parameters					
Top Discharge Method	3-pt	Power	Power	Power	Power
Bottom Discharge Method	Power-0	Power	Power	Power	Power
Power Curve Coeff:	0.1667	0.1667	0.1667	0.1667	0.1667
Cut Water Profile Bins					
Top Bins	0	0	0	0	0
Bins Above Sidelobe	0	0	0	0	0
Shore					
Left Bank Edge Type (East)					
Triangular	Yes	Yes	Yes	Yes	Yes
Square					
Coefficient					
Right Bank Edge Type (West)					
Triangular	Yes				
Square		Yes	Yes	Yes	Yes
Coefficient					
Shore Ensembles	1	1	1	5	1

Trial Number:			1	2	3	4	5
Edge Estimates							
Begin Transect							
Shore Distance (ft):			2,300	2,300	3,100	3,100	3,485
Left Bank			Yes	Yes	Yes	Yes	Yes
Right Bank							
End Transect							
Shore Distance (ft):			400	400	800	800	730
	Discharge (GGA) Left to Right						
	# Ensembles		172	172	172	172	172
	Start Time		11:36:03	11:36:03	11:36:03	11:36:03	11:36:03
	Duration	[s]	891.39	891.39	891.39	891.39	891.39
	Total Q	**[ft³/s]**	**4,349,146**	**4,343,520**	**4,412,637**	**4,453,825**	**4,431,320**
	Top Q	[ft³/s]	1,084,359	1,051,911	1,051,911	1,051,911	1,051,911
	Measured Q	[ft³/s]	2,653,028	2,653,054	2,653,054	2,653,054	2,653,054
	Bottom Q	[ft³/s]	468,290	481,501	481,501	481,501	481,501
	(T+M+B) Q	[ft³/s]	4,205,677	4,186,466	4,186,466	4,186,466	4,186,466
East	Left Distance	[ft]	2,300	2,300	3,100	3,100	3,485
	Left Velocity	[ft/s]	6.43	6.43	6.43	6.73	6.43
	Left Depth	[ft]	25.78	25.78	25.78	28.92	25.78
	Left Area	**[ft²]**	**29,641**	**29,641**	**39,951**	**44,831**	**44,913**
	Left Q	[ft³/s]	134,838	134,838	181,738	213,412	204,309
West	Right Distance	[ft]	400	400	800	800	730
	Right Velocity	[ft/s]	2.87	2.87	2.87	3.12	2.87
	Right Depth	[ft]	21.26	21.26	21.26	23.77	21.26
	Right Area	**[ft²]**	**4,253**	**8,505**	**17,011**	**19,019**	**15,522**
	Right Q	[ft³/s]	8,630	22,216	44,433	53,947	40,545
	Width	[ft]	11,928	11,928	13,128	13,128	13,443
	Total Area	[ft²]	533,123	537,376	556,191	563,079	559,665
	Q/Area	[ft/s]	8.16	8.08	7.93	7.91	7.92
	Flow Dir.	[°]	195.02	195.02	195.02	195.02	195.02
	Avg Course	[°]	287.06	287.06	287.06	287.06	287.06
	Boat Speed	[ft/s]	10.40	10.40	10.40	10.40	10.40
	Start Ens #		1	1	1	1	1
	End Ens #		172	172	172	172	172
	Increase in Total Discharge above Orson Smith Estimate of 4,180,118 cfs (%):		4.04	3.91	5.56	6.55	6.01

Notes

1 These estimates of discharge were prepared using the "Winriver" software package. This is the package recommended by RDI for collecting the velocity data and for estimating discharge. However, based on phone conversations with Alex at Terra Surveys, apparently the data was collected with a "blue water program" and converted for use with "Winriver". It should be noted that the ADCP lost it's bottom tacking and thus, the data from the on-board GPS were used to obtain the boat speed and direction. Since we know there were sand waves on parts of the bed, use of a GPS to obtain boat speed and direction would be the recommended method anyway.

Trial Number:	1	2	3	4	5
2	Changing the method of computing the "cross sectional area" on the "processing" worksheet, only changes the magnitude of the cross sectional area and not the magnitude of the discharge. Because we wanted to be able to compare the computed cross sectional area with our estimate of what the cross sectional area should be in the areas beyond the discharge measurement, the "perpendicular to mean flow" method was used.				
3	In Orson Smiths 2004 report on the data collection efforts in Knik Arm, it is shown that the salinity was fairly uniform with depth and had a magnitude of about 6 PSU. One unit of psu is equivalent to one ppt. Using 6 ppt salinity rather than 0 ppt salinity decreases the magnitude of the discharge estimate slightly. The User's Manual for the "Winriver" program suggests that 35 ppt of salinity decreases the discharge measurement 8 to 10 percent.				
4	The cross sectional area to the east of the transect was estunated ti be 44,913 square feet. The cross sectional area to the west of the transect was estimated to be 15,599 square feet. (see Figure A-1))				
6	The trials were set up as follows. Trial #1: This trial was intended to duplicate the computation made by Dr. Smith. Trial #2: Trial #2 used the same input data as Trial #1, except that a pwer curve was used to estimate the top and bottom discharge (i.e. the discharge above and below the actual measurements.) Also, the cross sectional area on the West bank was represented as rectangular rather than triangular. Trial #3: Trial #3 used the same values as were used in Trial #2, except the lengths of the unmeasured areas were changed to match the lengths measured on the cross section plotted from the PND bathymetry data (see Figure A-1). Trial #4: Trial #4 used the same values as were used in Trial #3, except that the number of shore ensembles was increased from 1 to 5. This seems to have caused the depth used to estimate the discharge in the areas beyond the ends of the measurement to increase. Note that only one value represents both sides (i.e. the two sides can not be handled separately). Trail #5: Trial #5 used the same values as were used in Trial #3, except that the number of shore ensembles was reduced to one, and the length of the areas beyond the measurement were adjusted until the cross sectional area of the east and west unmeasured zones matched those of the estimate based on the PND bathymetry.				
7	Note that the Threshold values (BT Error Vel., WT Error Vel., BT Up Vel., WT Up Vel., and fish Intensity) were set to the default values used by the U.S. Geological Survey (32.81, 3.5, 1, 3.28 and 50 respectively). These were different than the default values in the program when received from Terra Surveys (0.33, 4.92, 32.81, 32.81 and 50 respectively). This change did not affect the magnitude of the discharge estimate.				

Figure A-1: Cross Section Showing ADCP Measurement and PND Bathymetry

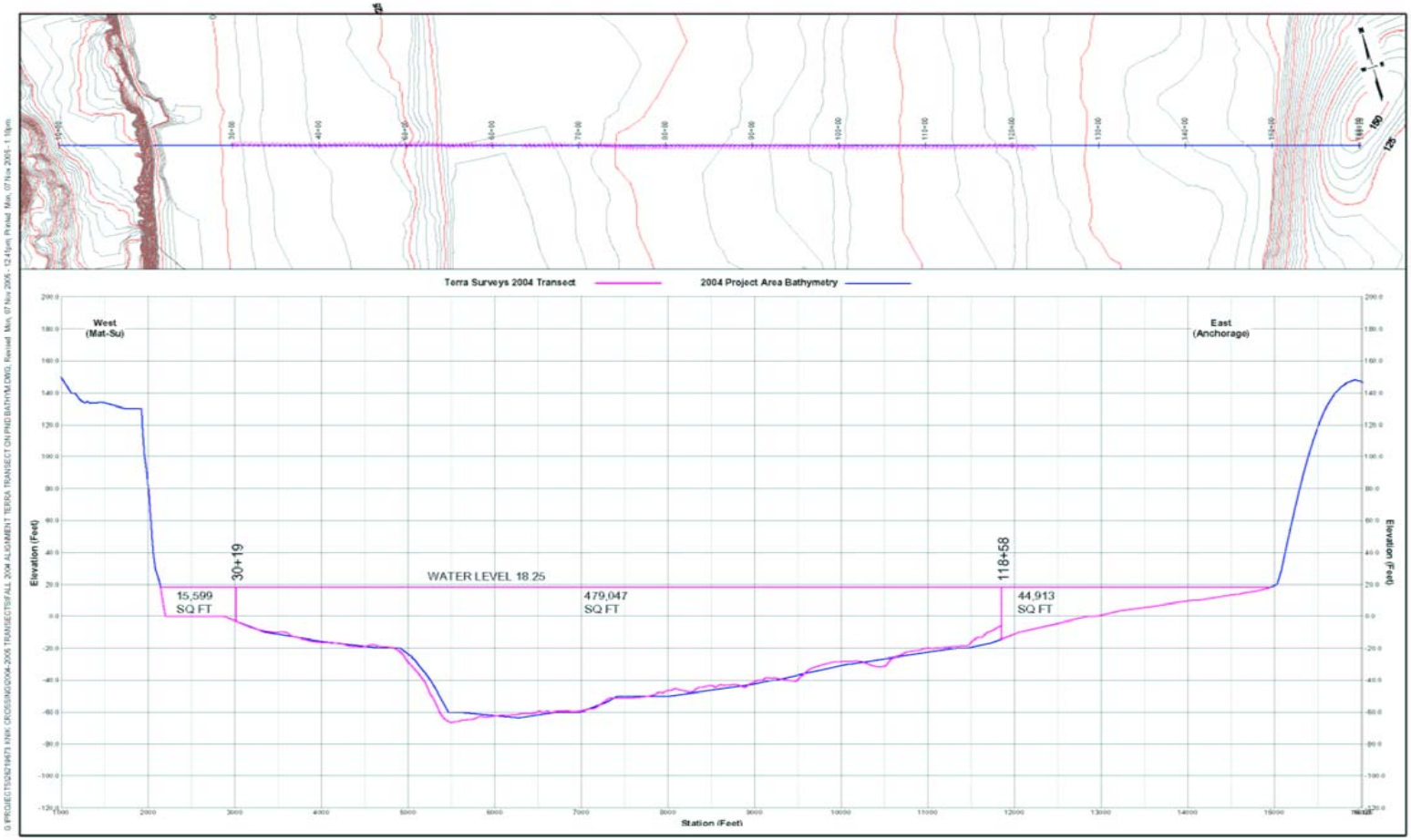

Figure 1 Notes:

1 The blue line represents the bathymetry data provided by PND in 2005.

2 The purple lines between station 30+19 and 118+59 represent the cross section as defined by the information provided by Terra Surveys concerning the 2 August 2004 centerline discharge measurement.

3 The location of the Terra Survey's data on the cross-section made from the PND bathymetric data was estimated based on the horizontal coordinates provided by Terra Surveys.

4 The water surface elevation of 18.25 is based on an average of the seabed elevations from the PND bathymetry and the water depths at the end stations provided by Terra Surveys.

5 The purple line representing the seabed beyond station 30+19 and 118+59 is also based on the PND bathymetry.

6 The cross sectional areas shown to the left of station 30+19 and to the right of station 118+59, represent an estimate of the cross sectional area missed by the Terra Surveys discharge measurement, using an estimate of the end station locations and the PND Bathymetry.

Attachment B: Estimate of Peak Discharge at SEP05 Bridge Site

List of Tables

List of Figures

Table B-1: Methods and Data

1 Method of Estimating Peak Discharge and Velocity at Proposed Bridge.

A Use the TideRout2 Model.

B Calibrate the TideRout2 to the 2 Aug 2004 discharge measurement at the Fall 2004 Bridge Alignment (no bridge).

1) Use the predicted high and low tide elevation and times.
2) Use twice the time between the high and low tide to estimate the tidal period, so that the high and low tides on the 2 Aug 2004 spring ebb tide occur at the correct time.
3) Start the model with tidal basin surface areas measured at MHW and MLLW, and surface areas at -10 and +40 feet based on extrapolation from the two measured areas.
4) Calibrate the model by uniformly adjusting the tidal basin surface areas until the average predicted discharge equals the measured discharge during the time the discharge measurement was being made.

C Run a partially calibrated TideRout2 model based on the cross section at the SEP05 bridge alignment without the bridge, and 2Aug04 tidal conditions.

1) The tidal basin surface areas in the calibrated 2Aug04 model will be increase by the difference in the tidal basin surface area between the two bridge alignments.
2) The cross sectional area at the SEP05 bridge location, with no bridge, will be used in the model, rather than the cross sectional area at the Fall04 bridge site.
3) All other conditions will be as modeled at the Fall04 alignment.
4) Compare the magnitude and timing of the peak discharge at the two sites.
5) See Figure B-1 for location of Fall 2004 and September 2005 alignments.

D Run a partially calibrated TideRout2 model based on the cross section at the SEP05 bridge alignment with the bridge in-place, and 2Aug04 tidal conditions.

1) The tidal basin surface areas will be the same as in the SEP05 model without the bridge in place.
2) The cross sectional area at the SEP05 bridge location with the bridge in-place will be used in the model.
3) All other conditions will be as modeled at the SEP05 model without the bridge in-place.
4) Compare the magnitude and timing of the peak discharge predicted by the three models.

2 Anchorage Tide Gage Data

a Source: URS Fall 2004 Computations
MHHW = 29.16 feet above MLLW.
MHW = 28.44 feet above MLLW.
NGV029 = 16.27 feet above MLLW.
MTL = 15.34 feet above MLLW.
NAV088 = 10.5 feet above MLLW.
MLW = 2.25 feet above MLLW.
MLLW = 0.00 feet above MLLW.
Location: Port of Anchorage.
Maximum recorded water level: 5.43 feet above MHHW.
Minimum recorded water level: -6.39 feet below MLLW.
Gage Established: April 24, 1964.
Mean Tidal Range: 26.19 feet.
Diurnal Tidal Range: 29.16 feet.
Station Identification Number: 9455920

3 2 August 2004 Spring Ebb Tide

a A discharge measurement was made under the direction of Orson Smith on 2 August 2004, during the spring ebb tide.

b Based on computations by URS using the data collected on 2 August 2004, we estimate the Total Discharge to be 4, 431,000 cfs at the time of the measurements.

c The following information applies to the 2 August 2004 discharge measurement.
Date and times: 2 August 2004, begin 1136 (11.60) and end 1151 (11.85) ADT
Tides (predicted): HW 0854 31.6 ft; LW 1607 -4.2 ft MLLW

4 Surface Areas Associated with the Tidal Basin

Water Surface Elevation (ft)	Notes	Surface Area Above Fall04 Alignment (sf)	Surface Area Above 20SEP05 Alignment (sf)	Surface Area Difference (sf)
40.00	3	3,591,019,578	3,619,875,808	28,856,230
28.44	1	2,913,030,775	2,941,886,896	28,856,121
0.00	2	1,245,037,561	1,273,893,413	28,855,852
-10.00	3	658,542,057	687,397,814	28,855,757

Notes
1 This is the high water line on the USGS map which corresponds to MHW.
2 This is from some the PND 2005 bathymetry data.
3 These values were linearly interpolated from values at 28.44 and 0 feet.

5 Cross Sectional Area without Bridge at location of 2 August 2004 Discharge Measurement.

a See Figure B-1 for location.
b From PND Bathymetric Data Received in 2005.

WSE (ft ab MLLW) (ft)	Total Cross-Sectional Area Below WSE (sf)	Top Width (ft)
40	824,224	13,065
30	693,984	13,001
20	564,506	12,892
10	439,473	11,892
0	326,821	10,081
-10	233,360	8,701
-20	155,195	6,467
-30	98,408	4,985
-40	53,654	3,945

Notes:
1 Widths and cross sectional areas were estimated from the PND bathymetric data received in 2005.

6 Cross Sectional Area at 20SEP05 Bridge Alignment, without Bridge.

a See Figure B-1 for location.
b From PND Bathymetric Data Received in 2005.

WSE (ft ab MLLW) (ft)	Total Cross-Sectional Area Below WSE (sf)	Top Width (ft)
40	841,831	12,787
30	714,294	12,720
20	587,826	12,573
10	464,221	12,057
0	352,347	10,265
-10	257,202	8,168
-20	182,647	6,642
-30	123,323	4,778
-40	77,328	4,476

Notes:
1 Widths and cross sectional areas were estimated from the PND bathymetric data received in 2005.

7 Cross Sectional Area at 20SEP05 Bridge Alignment within Bridge Abutments

a From Bathymetric and Bridge Data Received from PND in September 2005.

1) Bridge Length (Perpendicular to the flow)
   a) Begin Bridge at Station 33+50 (Wasilla Side; West Side)
   b) End Bridge at Station 115+30 (Anchorage Side; East side)
   c) Length of Bridge Deck: 8180 feet

2) Top elevation of abutment embankment, and location:
   a) Assumed top of embankment elevation of 50 feet.

3) Abutment side slope:
   a) Based on profile received from Kenley (27 Sep 2005): 3H;1V (Phone conversation with Earl Kubaskie 27 Sep 05).

4) Toe of Embankment slope
   a) West Side: Station 35+34, Elevation -11.46.
   b) East Side: Station 113+30, Elevation -16.50.

5) Cross Sectional Area and Width of Waterway Opening at SEP 2005 Bridge Section

WSE (ft ab MLLW) (ft)	Total Cross-Sectional Area Below WSE (sf)	Top Width (ft)
40	655,011	8,120
30	574,111	8,060
20	493,811	8,000
10	414,111	7,940
0	335,011	7,880
-10	256,511	7,820
-20	182,647	6,642
-30	123,323	4,778
-40	77,328	4,476

Notes:
1 Widths and cross sectional areas were estimated from the PND bathymetric data received in 2005.
2 Values are for clear span between the abutments. Due to the fall 2005 conceptual configuration of the piers, it was decided there was no need to reduce the cross sectional area due to the piers.

8 The TideRout2 Calibration Model for 2 Aug 04 Spring Ebb Tide

a The data to be used in the model is as follows.

1) High tide predicted to occur at 08:54 hrs (8.9 hrs), WSE = 31.6 ft.
2) Low tide predicted to occur at 16:07 hrs (16.1 hrs), WSE = -4.2 ft.
3) Tidal amplitude = [(31.6+4.2)/2] = 17.9 feet.
4) Mean tidal elevation = {31.6 - [(31.6+4.2)/2]} = 13.7 feet.
5) Tidal Period = [(16.1 - 8.9) * 2] = 14.4 hrs.
6) Average Discharge = 4,431,320 cfs between 11.6 and 11.85 hrs.
7) River Discharge = 0 cfs.
8) Use cross sectional area from location at which discharge measurement was made (I.e.
9) Tidal Basin Surface Area
   The tidal basin area will be adjusted until the predicted discharge matches the average discharge at the time of the measurement.
   The original tidal basin area and the final tidal basin area are presented below.
   Also presented below are some of the trial solution results leading to the final solution.

Water Surface Elevation (ft)	Original Surface Area Estimate Fall04 Align (sf)	Percent of Original Area (dec)	New Surface Area Estimate Fall 04 Align (sf)
-10.00	658,542,057	0.9341	615,144,135
0.00	1,245,037,561	0.9341	1,162,989,586
28.44	2,913,030,775	0.9341	2,721,062,047
40.00	3,591,019,578	0.9341	3,354,371,388

Percent of Original Area (dec)	Predicted Avg. Discharge Between 11.6 & 11.85 hrs (cfs)	Target Avg. Discharge Between 11.6 and 11.85 hrs (cfs)
100	4,713,241.02	4,431,320.00
93	4,413,568.23	
93.41	4,431,332.41	

b Results of Analysis

1) The average discharge between 11.6 and 11.85 hrs, predicted with the TideRout2 model, is 4,431,322 cfs.
2) To obtain this discharge estimate, the tidal basin areas were reduced to 93.41 percent of the values measured from the available mapping.
3) The peak discharge predicted with the TideRout2 model is 4,453,177 cfs and occurred at 11.9 hours.
4) Based on the ADCP measurements and the PND 2005 bathymetric data, the average discharge between 11.6 and 11.85 hrs had been estimated to be 4,431,320 cfs.
5) See Table B-2 for a summary of the computations.

9 TideRout2 Model of Sep05 Bridge Location Without the Bridge In-Place and the 2 Aug 04 Spring Ebb Tide.

a The data to be used in the model is as follows.

1) High tide predicted to occur at 0854 hrs (8.9 hrs), WSE = 31.6 ft.
2) Low tide predicted to occur at 1607 hrs (16.12 hrs), WSE = -4.2 ft.
3) Tidal amplitude = [(31.6+4.2)/2] = 17.9 feet.
4) Mean tidal elevation = {31.6 - [(31.6+4.2)/2]} = 13.7 feet.
5) Tidal Period = [(16.1 - 8.9) * 2] = 14.4 hrs.
6) River Discharge = 0 cfs.
7) Use cross sectional area from SEP05 bridge alignment location without the bridge.
8) Tidal Basin Surface Area

Water Surface Elevation (ft)	Calibrated Tidal Basin Surface Area Based on 2Aug04 Discharge Measurement (ft)	Incremental Increase In Tidal Basin Area Between Fall04 and 20Sep05 Bridge Alignments (ft)	Effective Tidal Basin Surface Area At 20Sep05 Bridge Alignment (ft)
-10.00	615,144,135	28,855,757	643,999,892
0.00	1,162,989,586	28,855,852	1,191,845,438
28.44	2,721,062,047	28,856,121	2,749,918,168
40.00	3,354,371,388	28,856,230	3,383,227,618

b Results of Analysis

1) The average discharge between 11.6 and 11.85 hrs, predicted with the TideRout2 model, is 4,504,115 cfs.
2) This discharge is 1.6 percent greater than the average discharge predicted to occur at the Fall04 bridge alignment between 11.6 and 11.85 hours.
3) The peak discharge predicted with the TideRout2 model is 4,526,653 cfs and occurred at 11.9 hours.
4) See Table B-3 for a summary of the computations.

10 TideRout2 Model of Sep05 Bridge Location with the Bridge In-Place and the 2 Aug 04 Spring Ebb Tide.

a The data to be used in the model is as follows.

1) High tide predicted to occur at 0854 hrs (8.9 hrs), WSE = 31.6 ft.
2) Low tide predicted to occur at 1607 hrs (16.12 hrs), WSE = -4.2 ft.
3) Tidal amplitude = [(31.6+4.2)/2] = 17.9 feet.
4) Mean tidal elevation = {31.6 - [(31.6+4.2)/2]} = 13.7 feet.
5) Tidal Period = [(16.1 - 8.9) * 2] = 14.4 hrs.
6) River Discharge = 0 cfs.
7) Use cross sectional area from SEP05 bridge alignment location with the bridge in-place.
8) Use the same tidal basin surface area that was used to model the Sep05 bridge alignment

b Results of Analysis

1) The average discharge between 11.6 and 11.85 hrs, predicted with the TideRout2 model, is 4,464,918 cfs.
2) The peak discharge predicted with the TideRout2 model is 4,515,602 cfs and occurred at 12.0 hours.
3) The predicted peak discharge with the bridge in-place is estimated to be 0.2 percent less than without the bridge in-place.
4) See Table B-4 for a summary of the computations.

Table B-2: TideRout2 Model Calibrated to 2 August 2004 Spring Ebb Tide Measurement

```
Project:  Proposed Knik Arm Bridge
Subject:  TideRout2 Model Calibrated to Average Discharge of 4, 431,320 cfs between 11.6
          and 11.85 hrs on 2 August 2004.
Calibration Data:
    1.  High Tide:  31.6 ft, 8.9 hrs.
    2.  Low tide:  -4.2 ft, 16.12 hrs.
    3.  Average Discharge:  4,431,320 cfs between 11.60 and 11.85 hrs.
    4.  Tidal Basin Surface Area at Elevation 0 (ft):  1,245,037,561 sf.
    5.  Tidal Basin Surface Area at elevation 28.44 (ft):  2,913,030,775 sf.

Calibration Method:
    1.  Used the tidal basin surface areas measured from the available data and linear
        extrapolation to estimate the tidal basin surface area at elevation -10 and +40.
    2.  Adjusted the magnitude of the tidal basin surface area uniformly at all elevations (i.e.
        -10, 0 28.44, and 40 ft) until the average discharge between 11.6 and 11.85 hrs is
        approximately 4,431,320 cfs

Results:
    1.  The predicted average discharge between 11.6 and 11.85 hrs is 4,431,332 cfs.
    2.  The calibrated tidal basin surface area is 93.41 percent as large as the measured tidal
        basin surface area.
    3.  The peak discharge during the 2 August 2004 spring ebb tide is estimated to have occurred
        at 11.9 hours and to have been 4,453,177. cfs.

************************************************************
*          Maryland State Highway Administration           *
*                    TideRout2 Program                     *
*      Tidal Flow Through A Contracted Bridge Opening      *
*         Version 2 Build 1.09, September 22, 2004         *
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Project:2 August 2004 Spring Ebb Tide - Knik Arm

Time stamp: 11/15/2005 10:45:11 PM

Input Data:

Unit: English Units
Analysis starting time (hr.): 8.9
Analysis ending time (hr.): 20.9
Time step (hr.): 0.1
Use default starting bridge headwater EL. by assuming zero initial rate of storage change
Tidal amplitude (ft): 17.9
Mean tidal elevation (ft): 13.7
Tidal period (hr.): 14.4
Tidal Peak Time (hr):8.9
Stream flow is of constant discharge
Constant flow discharge (cfs): 0

Upstream Tidal Basin Area rating Table:
Data#     Elevation (ft)    Area (sf)
1               -10         615144135
2                 0        1162989586
3             28.44        2721062047
4                40        3354371388

Bridge Opening Area rating Table:
Data#     Elevation (ft)    Area (sf)
1               -70             0
2               -40           53654
3               -30           98408
4               -20          155195
5               -10          233360
6                 0          326821
7                10          439473
8                20          564506
```

9	30	693984
10	40	824224

No Roadway Data Were Specified

Output Results:

Note: Remark with * indicates critical flow, # indicates fail to converge after 100 cycles

Time (hrs)	Tide EL. (ft)	Basin EL. (ft)	Bridge Q av.(cfs)	Weir Q av.(cfs)	Bridge V av.(ft/s)	Basin Area (sf)	Flow Area av.(sf)	Remark
8.90	31.600	31.600	0.00	0.00	0.000	2894181209.4	714822.40	
9.00	31.583	31.584	128833.57	0.00	0.180	2893303138.1	714711.46	
9.10	31.532	31.539	362344.81	0.00	0.507	2890832130.1	714267.89	
9.20	31.447	31.463	611315.88	0.00	0.857	2886658470.9	713381.61	
9.30	31.328	31.357	850358.58	0.00	1.194	2880842731.2	712054.29	
9.40	31.176	31.220	1089141.13	0.00	1.533	2873376725.9	710288.47	
9.50	30.990	31.054	1324012.17	0.00	1.870	2864274483.7	708087.50	
9.60	30.772	30.858	1554685.92	0.00	2.204	2853549356.6	705455.58	
9.70	30.520	30.633	1780412.64	0.00	2.535	2841217306.2	702397.71	
9.80	30.237	30.379	2000491.13	0.00	2.862	2827296706.0	698919.72	
9.90	29.923	30.096	2214252.57	0.00	3.186	2811808271.1	695031.16	
10.00	29.577	29.786	2421074.35	0.00	3.505	2794774907.7	690749.66	
10.10	29.202	29.447	2620331.21	0.00	3.819	2776221921.0	686081.63	
10.20	28.797	29.081	2811415.51	0.00	4.128	2756177103.9	681026.89	
10.30	28.363	28.688	2993789.60	0.00	4.431	2734670470.0	675595.07	
10.40	27.901	28.270	3166949.08	0.00	4.728	2711734256.3	669796.52	
10.50	27.412	27.826	3330428.50	0.00	5.018	2687402900.5	663642.26	
10.60	26.897	27.357	3483804.22	0.00	5.301	2661713007.9	657144.01	
10.70	26.357	26.864	3626696.49	0.00	5.577	2634703314.6	650314.15	
10.80	25.793	26.347	3758770.92	0.00	5.844	2606414647.9	643165.67	
10.90	25.206	25.808	3879739.75	0.00	6.103	2576889884.6	635712.19	
11.00	24.597	25.248	3989362.79	0.00	6.353	2546173908.2	627967.88	
11.10	23.967	24.666	4087448.09	0.00	6.593	2514313564.9	619947.49	
11.20	23.318	24.065	4173852.36	0.00	6.824	2481357618.1	611666.30	
11.30	22.650	23.444	4248481.14	0.00	7.044	2447356703.1	603140.05	
11.40	21.965	22.805	4311288.69	0.00	7.253	2412363281.1	594384.99	
11.50	21.265	22.149	4362277.65	0.00	7.452	2376431592.6	585417.78	
11.60	20.550	21.477	4401498.41	0.00	7.638	2339617612.2	576255.48	
11.70	19.822	20.790	4429309.29	0.00	7.812	2301976766.0	566955.07	
11.80	19.083	20.089	4446637.69	0.00	7.974	2263559138.8	557659.16	
11.90	18.333	19.375	4453177.08	0.00	8.121	2224420143.1	548348.58	
12.00	17.574	18.648	4448188.73	0.00	8.254	2184625079.0	538918.81	
12.10	16.808	17.911	4432064.48	0.00	8.372	2144239846.2	529387.80	
12.20	16.036	17.164	4405188.58	0.00	8.475	2103331266.5	519773.70	
12.30	15.260	16.409	4367952.63	0.00	8.563	2061967284.5	510094.81	
12.40	14.481	15.647	4320763.81	0.00	8.635	2020217093.5	500369.54	
12.50	13.700	14.879	4264049.01	0.00	8.691	1978151216.6	490616.42	
12.60	12.919	14.107	4198256.40	0.00	8.731	1935841560.6	480854.00	
12.70	12.140	13.332	4123855.48	0.00	8.754	1893361453.6	471100.88	
12.80	11.364	12.555	4041335.97	0.00	8.759	1850785674.4	461375.61	
12.90	10.592	11.777	3951206.08	0.00	8.747	1808190474.7	451696.72	
13.00	9.826	11.000	3854796.61	0.00	8.718	1765644594.0	442190.50	
13.10	9.067	10.226	3755085.05	0.00	8.668	1723189479.3	433236.98	
13.20	8.317	9.453	3650741.70	0.00	8.595	1680886355.7	424740.96	
13.30	7.578	8.686	3539077.28	0.00	8.500	1638835101.2	416352.34	
13.40	6.850	7.925	3421064.74	0.00	8.383	1597134003.9	408087.06	
13.50	6.135	7.172	3297572.61	0.00	8.245	1555880681.6	399960.87	
13.60	5.435	6.429	3169396.17	0.00	8.085	1515172685.8	391989.24	
13.70	4.750	5.697	3037278.57	0.00	7.906	1475107861.2	384187.34	
13.80	4.082	4.979	2901925.20	0.00	7.706	1435784500.8	376570.02	
13.90	3.433	4.277	2764013.23	0.00	7.487	1397301321.7	369151.78	
14.00	2.803	3.592	2624197.55	0.00	7.250	1359757274.7	361946.75	
14.10	2.194	2.925	2483114.19	0.00	6.995	1323251194.5	354968.64	
14.20	1.607	2.280	2341381.41	0.00	6.724	1287881296.0	348230.72	
14.30	1.043	1.657	2199598.92	0.00	6.436	1253744525.0	341745.83	
14.40	0.503	1.058	2058345.22	0.00	6.135	1220935776.2	335526.32	
14.50	-0.012	0.485	1918226.54	0.00	5.820	1189546118.6	329595.72	
14.60	-0.501	-0.061	1781668.49	0.00	5.492	1159630235.0	324422.70	
14.70	-0.963	-0.579	1647604.09	0.00	5.149	1131261574.1	319980.37	
14.80	-1.397	-1.067	1513901.89	0.00	4.794	1104552887.8	315794.81	

Time (hrs)	Tide EL. (ft)	Basin EL. (ft)	Bridge Q av.(cfs)	Weir Q av.(cfs)	Bridge V av.(ft/s)	Basin Area (sf)	Flow Area av.(sf)	Remark
14.90	-1.802	-1.522	1381868.13	0.00	4.431	1079596901.6	311873.96	
15.00	-2.177	-1.944	1252470.29	0.00	4.063	1056468617.3	308225.30	
15.10	-2.523	-2.332	1126379.27	0.00	3.695	1035227536.6	304855.78	
15.20	-2.837	-2.685	1004002.74	0.00	3.327	1015919924.1	301771.80	
15.30	-3.120	-3.001	885516.45	0.00	2.962	998581097.8	298979.24	
15.40	-3.372	-3.281	770897.18	0.00	2.600	983237645.6	296483.41	
15.50	-3.590	-3.524	659957.97	0.00	2.243	969909433.8	294289.07	
15.60	-3.776	-3.731	552383.88	0.00	1.889	958611286.2	292400.38	
15.70	-3.928	-3.900	447765.77	0.00	1.540	949354272.3	290820.96	
15.80	-4.047	-4.031	345629.06	0.00	1.194	942146612.9	289553.79	
15.90	-4.132	-4.125	245456.08	0.00	0.851	936994267.0	288601.30	
16.00	-4.183	-4.182	146701.92	0.00	0.509	933901289.2	287965.30	
16.10	-4.200	-4.200	48805.06	0.00	0.170	932870038.4	287646.99	
16.20	-4.183	-4.183	-44553.17	0.00	-0.155	933811492.1	287643.51	
16.30	-4.132	-4.137	-120172.85	0.00	-0.417	936346146.3	287940.02	
16.40	-4.047	-4.058	-206734.14	0.00	-0.717	940690548.1	288526.79	
16.50	-3.928	-3.948	-287749.26	0.00	-0.994	946704251.7	289410.33	
16.60	-3.776	-3.807	-372480.96	0.00	-1.282	954432503.8	290582.50	
16.70	-3.590	-3.635	-457526.53	0.00	-1.567	963840484.7	292044.20	
16.80	-3.372	-3.433	-544202.03	0.00	-1.852	974912539.5	293791.12	
16.90	-3.120	-3.201	-632512.11	0.00	-2.138	987625343.6	295819.93	
17.00	-2.837	-2.939	-722683.31	0.00	-2.424	1001953077.9	298126.46	
17.10	-2.523	-2.649	-814893.84	0.00	-2.710	1017867061.0	300706.04	
17.20	-2.177	-2.330	-909299.14	0.00	-2.996	1035335956.4	303553.55	
17.30	-1.802	-1.983	-1006028.9	0.00	-3.281	1054325957.5	306663.45	
17.40	-1.397	-1.610	-1105185.4	0.00	-3.565	1074800970.2	310029.76	
17.50	-0.963	-1.210	-1206842.3	0.00	-3.848	1096722786.2	313646.16	
17.60	-0.501	-0.784	-1311043.1	0.00	-4.129	1120051248.7	317505.94	
17.70	-0.012	-0.333	-1417800.2	0.00	-4.409	1144744404.5	321602.13	
17.80	0.503	0.142	-1527571.5	0.00	-4.685	1170766679.3	326064.30	
17.90	1.043	0.641	-1641472.1	0.00	-4.956	1198099443.0	331230.36	
18.00	1.607	1.163	-1758602.0	0.00	-5.219	1226707017.8	336981.80	
18.10	2.194	1.707	-1877500.2	0.00	-5.474	1256530088.9	342989.27	
18.20	2.803	2.273	-1998395.5	0.00	-5.722	1287514785.0	349241.13	
18.30	3.433	2.859	-2121261.7	0.00	-5.963	1319608738.0	355726.48	
18.40	4.082	3.464	-2245944.4	0.00	-6.197	1352759480.9	362434.53	
18.50	4.750	4.087	-2372211.8	0.00	-6.423	1386913770.3	369354.41	
18.60	5.435	4.728	-2499776.7	0.00	-6.640	1422017292.8	376475.06	
18.70	6.135	5.385	-2628306.3	0.00	-6.848	1458014536.3	383785.19	
18.80	6.850	6.058	-2757427.0	0.00	-7.047	1494848736.2	391273.25	
18.90	7.578	6.744	-2886727.3	0.00	-7.236	1532461855.2	398927.46	
19.00	8.317	7.444	-3015760.0	0.00	-7.415	1570794578.7	406735.73	
19.10	9.067	8.156	-3144043.2	0.00	-7.582	1609786319.3	414685.74	
19.20	9.826	8.878	-3271062.3	0.00	-7.737	1649375224.9	422764.90	
19.30	10.592	9.611	-3396271.6	0.00	-7.881	1689498190.0	430960.37	
19.40	11.364	10.352	-3520581.3	0.00	-8.011	1730107804.7	439478.56	
19.50	12.140	11.101	-3644734.9	0.00	-8.125	1771168857.3	448557.18	
19.60	12.919	11.858	-3765925.8	0.00	-8.223	1812618433.0	457972.74	
19.70	13.700	12.620	-3881658.5	0.00	-8.304	1854372430.6	467467.39	
19.80	14.481	13.386	-3991578.0	0.00	-8.368	1896350283.4	477022.31	
19.90	15.260	14.155	-4095192.9	0.00	-8.416	1938473307.2	486619.35	
20.00	16.036	14.925	-4191922.1	0.00	-8.447	1980663676.2	496240.63	
20.10	16.808	15.695	-4281124.2	0.00	-8.463	2022843790.1	505868.44	
20.20	17.574	16.464	-4362118.7	0.00	-8.462	2064935886.6	515485.02	
20.30	18.333	17.229	-4434200.7	0.00	-8.445	2106861812.4	525072.60	
20.40	19.083	17.990	-4496652.5	0.00	-8.411	2148542897.9	534613.28	
20.50	19.822	18.745	-4548753.2	0.00	-8.360	2189899900.8	544089.04	
20.60	20.550	19.492	-4589786.0	0.00	-8.293	2230852998.2	553481.73	
20.70	21.265	20.231	-4619406.6	0.00	-8.208	2271324945.0	562824.71	
20.80	21.965	20.959	-4637574.5	0.00	-8.105	2311243289.0	572211.55	
20.90	22.650	21.677	-4642897.7	0.00	-7.983	2350528461.7	581571.05	

Table B-3: TideRout2 Model of September 2005 Bridge Alignment without Bridge, During 2 August 2004 Spring Ebb Tide

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Project:  Proposed Knik Arm Bridge
Subject:  TideRout2 Model of the 20Sep05 Bridge Alignment without the Bridge, during the 2 August
          2004 Spring Ebb Tide.
Data:
    1.  High Tide:  31.6 ft, 8.9 hrs.
    2.  Low Tide:  -4.2 ft, 16.12 hrs.
    3.  Tidal basin surface area set equal to calibrated surface area at Fall04 Bridge Alignment
        plus difference in surface area between the Fall04 and Sep05 bridge alignments.
    4.  The cross sectional area represent the tidal cross section at the Sep05 bridge alignment
        without the bridge in-place.

Results:
    1.  The predicted average discharge between 11.6 and 11.85 hrs is:  4,504,115 cfs. This is
        1.6 percent greater than the average discharge at the Fall04 bridge alignment.
    2.  The peak discharge during the 2 August 2004 spring ebb tide is estimated to have occurred
        at 11.9 hours and to have been 4,526,653 cfs.  This is 1.6 percent greater than estimated
        to have occurred at the Fall04 alignment.

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*          Maryland State Highway Administration           *
*                    TideRout2 Program                     *
*      Tidal Flow Through A Contracted Bridge Opening      *
*         Version 2 Build 1.09, September 22, 2004         *
************************************************************

Project:2 August 2004 Spring Ebb Tide - SEP05 Bridge Site without Bridge

Time stamp: 11/15/2005 11:28:53 PM

Input Data:

Unit: English Units
Analysis starting time (hr.): 8.9
Analysis ending time (hr.): 20.9
Time step (hr.): 0.1
Use default starting bridge headwater EL. by assuming zero initial rate of storage change
Tidal amplitude (ft): 17.9
Mean tidal elevation (ft): 13.7
Tidal period (hr.): 14.4
Tidal Peak Time (hr):8.9
Stream flow is of constant discharge
Constant flow discharge (cfs): 0

Upstream Tidal Basin Area rating Table:
Data#     Elevation (ft)    Area (sf)
1               -10         643999892
2                 0        1191845438
3             28.44        2749918168
4                40        3383227618

Bridge Opening Area rating Table:
Data#     Elevation (ft)    Area (sf)
1               -70              0
2               -40            77328
3               -30           123323
4               -20           182647
5               -10           257202
6                 0           352347
7                10           464221
8                20           587826
9                30           714294
10               40           841831

No Roadway Data Were Specified
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Output Results:

Note: Remark with * indicates critical flow, # indicates fail to converge after 100 cycles

Time (hrs)	Tide EL. (ft)	Basin EL. (ft)	Bridge Q av.(cfs)	Weir Q av.(cfs)	Bridge V av.(ft/s)	Basin Area (sf)	Flow Area av.(sf)	Remark
8.90	31.600	31.600	0.00	0.00	0.000	2923037360.2	734699.92	
9.00	31.583	31.584	130369.63	0.00	0.177	2922157592.4	734591.28	
9.10	31.532	31.539	367249.79	0.00	0.500	2919677871.1	734156.92	
9.20	31.447	31.462	619514.49	0.00	0.845	2915490044.0	733289.03	
9.30	31.328	31.356	861725.29	0.00	1.177	2909654884.4	731989.26	
9.40	31.176	31.219	1103783.44	0.00	1.511	2902163493.3	730260.08	
9.50	30.990	31.052	1341861.45	0.00	1.843	2893030137.9	728104.80	
9.60	30.772	30.856	1575728.79	0.00	2.172	2882268021.4	725527.50	
9.70	30.520	30.630	1804622.10	0.00	2.498	2869893002.6	722533.09	
9.80	30.237	30.375	2027835.62	0.00	2.820	2855923338.4	719127.28	
9.90	29.923	30.091	2244697.97	0.00	3.138	2840379600.5	715320.67	
10.00	29.577	29.779	2454590.09	0.00	3.452	2823284481.7	711134.85	
10.10	29.202	29.439	2656877.19	0.00	3.760	2804663092.9	706575.33	
10.20	28.797	29.072	2850936.28	0.00	4.063	2784543091.4	701638.10	
10.30	28.363	28.678	3036226.77	0.00	4.360	2762954330.0	696332.56	
10.40	27.901	28.258	3212238.70	0.00	4.651	2739928879.0	690668.81	
10.50	27.412	27.812	3378499.92	0.00	4.935	2715501011.0	684657.62	
10.60	26.897	27.341	3534579.52	0.00	5.211	2689707173.4	678310.44	
10.70	26.357	26.846	3680089.95	0.00	5.479	2662585956.3	671639.35	
10.80	25.793	26.327	3814688.63	0.00	5.739	2634178058.2	664657.06	
10.90	25.206	25.786	3938079.16	0.00	5.991	2604526249.7	657376.84	
11.00	24.597	25.223	4050012.35	0.00	6.233	2573675336.4	649812.57	
11.10	23.967	24.639	4150286.85	0.00	6.465	2541672121.6	641978.64	
11.20	23.318	24.035	4238749.67	0.00	6.687	2508565367.9	633889.95	
11.30	22.650	23.411	4315296.35	0.00	6.898	2474405759.3	625561.92	
11.40	21.965	22.769	4379870.91	0.00	7.099	2439245863.5	617010.39	
11.50	21.265	22.110	4432465.53	0.00	7.287	2403140094.8	608251.64	
11.60	20.550	21.435	4473120.02	0.00	7.464	2366144677.8	599302.34	
11.70	19.822	20.744	4502083.85	0.00	7.628	2328316233.4	590204.99	
11.80	19.083	20.040	4519975.28	0.00	7.779	2289708846.9	581057.36	
11.90	18.333	19.322	4526652.70	0.00	7.916	2250380708.8	571853.11	
12.00	17.574	18.592	4521729.66	0.00	8.038	2210396854.4	562531.04	
12.10	16.808	17.851	4505549.55	0.00	8.146	2169823355.9	553108.89	
12.20	16.036	17.101	4478462.97	0.00	8.238	2128727545.9	543604.59	
12.30	15.260	16.343	4440837.86	0.00	8.316	2087178155.2	534036.24	
12.40	14.481	15.577	4393064.73	0.00	8.377	2045245399.4	524422.04	
12.50	13.700	14.806	4335558.94	0.00	8.422	2003001034.7	514780.31	
12.60	12.919	14.031	4268761.13	0.00	8.451	1960518395.2	505129.39	
12.70	12.140	13.252	4193136.54	0.00	8.463	1917872418.5	495487.66	
12.80	11.364	12.472	4109173.52	0.00	8.457	1875139664.2	485873.46	
12.90	10.592	11.692	4017381.66	0.00	8.434	1832398326.2	476305.11	
13.00	9.826	10.913	3919016.59	0.00	8.394	1789720226.7	466903.03	
13.10	9.067	10.136	3816799.08	0.00	8.333	1747153488.1	458028.05	
13.20	8.317	9.362	3709520.67	0.00	8.251	1704765003.2	449590.71	
13.30	7.578	8.594	3594816.22	0.00	8.147	1662656496.2	441260.01	
13.40	6.850	7.832	3473692.94	0.00	8.021	1620927890.5	433051.82	
13.50	6.135	7.079	3347048.06	0.00	7.876	1579678232.9	424981.75	
13.60	5.435	6.337	3215703.71	0.00	7.710	1539006262.2	417065.17	
13.70	4.750	5.607	3080430.16	0.00	7.526	1499010700.2	409317.16	
13.80	4.082	4.891	2941961.15	0.00	7.323	1459790319.6	401752.44	
13.90	3.433	4.191	2801003.59	0.00	7.102	1421443818.4	394385.44	
14.00	2.803	3.509	2658243.14	0.00	6.865	1384069524.7	387230.16	
14.10	2.194	2.846	2514346.53	0.00	6.611	1347764947.5	380300.24	
14.20	1.607	2.205	2369961.37	0.00	6.343	1312626189.6	373608.86	
14.30	1.043	1.586	2225713.51	0.00	6.062	1278747243.6	367168.76	
14.40	0.503	0.993	2082202.45	0.00	5.768	1246219197.6	360992.20	
14.50	-0.012	0.425	1940037.33	0.00	5.463	1215128697.0	355101.14	
14.60	-0.501	-0.115	1801254.27	0.00	5.148	1185532577.8	349905.48	
14.70	-0.963	-0.627	1665015.47	0.00	4.821	1157502120.3	345383.12	
14.80	-1.397	-1.108	1529720.64	0.00	4.484	1131137265.1	341122.13	
14.90	-1.802	-1.557	1396578.19	0.00	4.143	1106518709.4	337130.64	
15.00	-2.177	-1.974	1266413.54	0.00	3.798	1083711273.8	333416.24	
15.10	-2.523	-2.356	1139741.80	0.00	3.454	1062766741.7	329986.01	
15.20	-2.837	-2.704	1016825.13	0.00	3.111	1043726306.5	326846.46	
15.30	-3.120	-3.016	897721.09	0.00	2.771	1026622668.2	324003.58	

Time (hrs)	Tide EL. (ft)	Basin EL. (ft)	Bridge Q av.(cfs)	Weir Q av.(cfs)	Bridge V av.(ft/s)	Basin Area (sf)	Flow Area av.(sf)	Remark
15.40	-3.372	-3.292	782324.69	0.00	2.434	1011481784.2	321462.78	
15.50	-3.590	-3.532	670405.09	0.00	2.100	998324271.9	319228.90	
15.60	-3.776	-3.736	561636.57	0.00	1.770	987166483.1	317306.19	
15.70	-3.928	-3.903	455623.70	0.00	1.443	978021289.8	315698.30	
15.80	-4.047	-4.033	351920.82	0.00	1.119	970898640.0	314408.30	
15.90	-4.132	-4.126	250046.54	0.00	0.798	965805940.0	313438.65	
16.00	-4.183	-4.182	149494.60	0.00	0.478	962748314.5	312791.19	
16.10	-4.200	-4.200	49742.34	0.00	0.159	961728774.9	312467.15	
16.20	-4.183	-4.183	-45849.53	0.00	-0.147	962668564.8	312463.97	
16.30	-4.132	-4.137	-124968.60	0.00	-0.400	965225433.3	312767.60	
16.40	-4.047	-4.057	-214529.17	0.00	-0.685	969598996.6	313369.41	
16.50	-3.928	-3.946	-298586.31	0.00	-0.950	975653583.6	314274.94	
16.60	-3.776	-3.804	-386536.26	0.00	-1.225	983436216.2	315476.51	
16.70	-3.590	-3.631	-474639.68	0.00	-1.497	992909309.2	316974.92	
16.80	-3.372	-3.428	-564446.20	0.00	-1.771	1004058468.7	318765.67	
16.90	-3.120	-3.194	-655865.50	0.00	-2.044	1016859844.8	320845.42	
17.00	-2.837	-2.931	-749144.54	0.00	-2.318	1031287477.0	323209.87	
17.10	-2.523	-2.638	-844456.29	0.00	-2.592	1047312435.0	325854.24	
17.20	-2.177	-2.317	-941953.07	0.00	-2.865	1064903076.3	328773.27	
17.30	-1.802	-1.968	-1041760.7	0.00	-3.138	1084025224.2	331961.25	
17.40	-1.397	-1.592	-1143976.8	0.00	-3.411	1104642346.4	335412.03	
17.50	-0.963	-1.189	-1248669.4	0.00	-3.682	1126715726.5	339119.09	
17.60	-0.501	-0.760	-1355875.8	0.00	-3.952	1150204628.0	343075.52	
17.70	-0.012	-0.306	-1465601.3	0.00	-4.220	1175066447.6	347274.08	
17.80	0.503	0.172	-1578289.1	0.00	-4.486	1201264576.0	351851.71	
17.90	1.043	0.674	-1694715.1	0.00	-4.746	1228773540.7	357079.22	
18.00	1.607	1.199	-1814011.5	0.00	-5.000	1257552336.8	362826.40	
18.10	2.194	1.747	-1935086.3	0.00	-5.247	1287543057.9	368826.98	
18.20	2.803	2.315	-2058110.0	0.00	-5.487	1318692165.1	375069.58	
18.30	3.433	2.904	-2183015.4	0.00	-5.722	1350947004.2	381543.35	
18.40	4.082	3.512	-2309620.5	0.00	-5.949	1384254497.2	388237.50	
18.50	4.750	4.138	-2437674.0	0.00	-6.169	1418560633.2	395141.09	
18.60	5.435	4.782	-2566873.7	0.00	-6.381	1453810267.9	402242.99	
18.70	6.135	5.441	-2696875.1	0.00	-6.585	1489947048.6	409531.80	
18.80	6.850	6.116	-2827294.5	0.00	-6.780	1526913389.6	416995.89	
18.90	7.578	6.805	-2957712.0	0.00	-6.965	1564650470.1	424623.38	
19.00	8.317	7.507	-3087672.6	0.00	-7.141	1603098240.5	432402.12	
19.10	9.067	8.220	-3216688.0	0.00	-7.305	1642195433.1	440319.74	
19.20	9.826	8.945	-3344237.9	0.00	-7.459	1681879574.8	448363.60	
19.30	10.592	9.679	-3469771.9	0.00	-7.600	1722087000.6	456520.82	
19.40	11.364	10.421	-3594317.1	0.00	-7.729	1762770842.9	465027.21	
19.50	12.140	11.172	-3718125.7	0.00	-7.843	1803890813.2	474067.03	
19.60	12.919	11.929	-3838312.1	0.00	-7.940	1845379046.0	483386.07	
19.70	13.700	12.692	-3952931.6	0.00	-8.022	1887153076.6	492778.89	
19.80	14.481	13.458	-4061624.2	0.00	-8.087	1929133746.6	502227.26	
19.90	15.260	14.227	-4163890.9	0.00	-8.137	1971243563.6	511713.52	
20.00	16.036	14.996	-4259143.2	0.00	-8.171	2013405716.6	521220.25	
20.10	16.808	15.765	-4346735.1	0.00	-8.190	2055543486.3	530730.13	
20.20	17.574	16.533	-4425983.9	0.00	-8.193	2097579897.4	540225.82	
20.30	18.333	17.297	-4496185.2	0.00	-8.179	2139437522.2	549689.92	
20.40	19.083	18.056	-4556624.5	0.00	-8.150	2181038380.7	559104.87	
20.50	19.822	18.809	-4606585.9	0.00	-8.104	2222303904.2	568453.04	
20.60	20.550	19.555	-4645359.5	0.00	-8.041	2263154941.4	577716.61	
20.70	21.265	20.292	-4672531.2	0.00	-7.961	2303514210.7	586919.70	
20.80	21.965	21.018	-4687740.2	0.00	-7.864	2343306439.0	596107.33	
20.90	22.650	21.733	-4689824.4	0.00	-7.749	2382451390.0	605218.50	

Table B-4: TideRout2 Model of September 2005 Bridge Alignment with Bridge, During 2 August 2004 Spring Ebb Tide

Project: Proposed Knik Arm Bridge
Subject: TideRout2 Model of the Sep05 Bridge Alignment with the Bridge, during the 2 August 2004 Spring Ebb Tide.
Data:

1. High Tide: 31.6 ft, 8.9 hrs.
2. Low Tide: -4.2 ft, 16.12 hrs.
3. Tidal basin surface area set equal to calibrated surface area at Fall04 Bridge Alignment plus difference in surface area between the Fall04 and 20Sep05 bridge alignments.
4. The bridge cross sectional area represents the cross section at the Sep05 bridge alignment with the bridge in-place. The cross sectional area used represents the area between the abutments.

Results:

1. The predicted average discharge between 11.6 and 11.85 hrs is: 4,464,918 cfs.
2. The predicted peak discharge through the proposed bridge during a tide similar to the 2 August 2004 spring ebb tide is estimated to be 4,515,602 cfs and to occur at 12.0 hours.

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**********************************************************
*          Maryland State Highway Administration         *
*                    TideRout2 Program                   *
*      Tidal Flow Through A Contracted Bridge Opening    *
*         Version 2 Build 1.09, September 22, 2004       *
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```

Project:2 August 2004 Spring Ebb Tide - SEP05 Bridge Site with Bridge

Time stamp: 11/16/2005 12:09:33 AM

Input Data:

Unit: English Units
Analysis starting time (hr.): 8.9
Analysis ending time (hr.): 20.9
Time step (hr.): 0.1
Use default starting bridge headwater EL. by assuming zero initial rate of storage change
Tidal amplitude (ft): 17.9
Mean tidal elevation (ft): 13.7
Tidal period (hr.): 14.4
Tidal Peak Time (hr):8.9
Stream flow is of constant discharge
Constant flow discharge (cfs): 0

Upstream Tidal Basin Area rating Table:

Data#	Elevation (ft)	Area (sf)
1	-10	643999892
2	0	1191845438
3	28.44	2749918168
4	40	3383227618

Bridge Opening Area rating Table:

Data#	Elevation (ft)	Area (sf)
1	-70	0
2	-40	77328
3	-30	123323
4	-20	182647
5	-10	256511
6	0	335011
7	10	414111
8	20	493811
9	30	574111
10	40	655011

No Roadway Data Were Specified

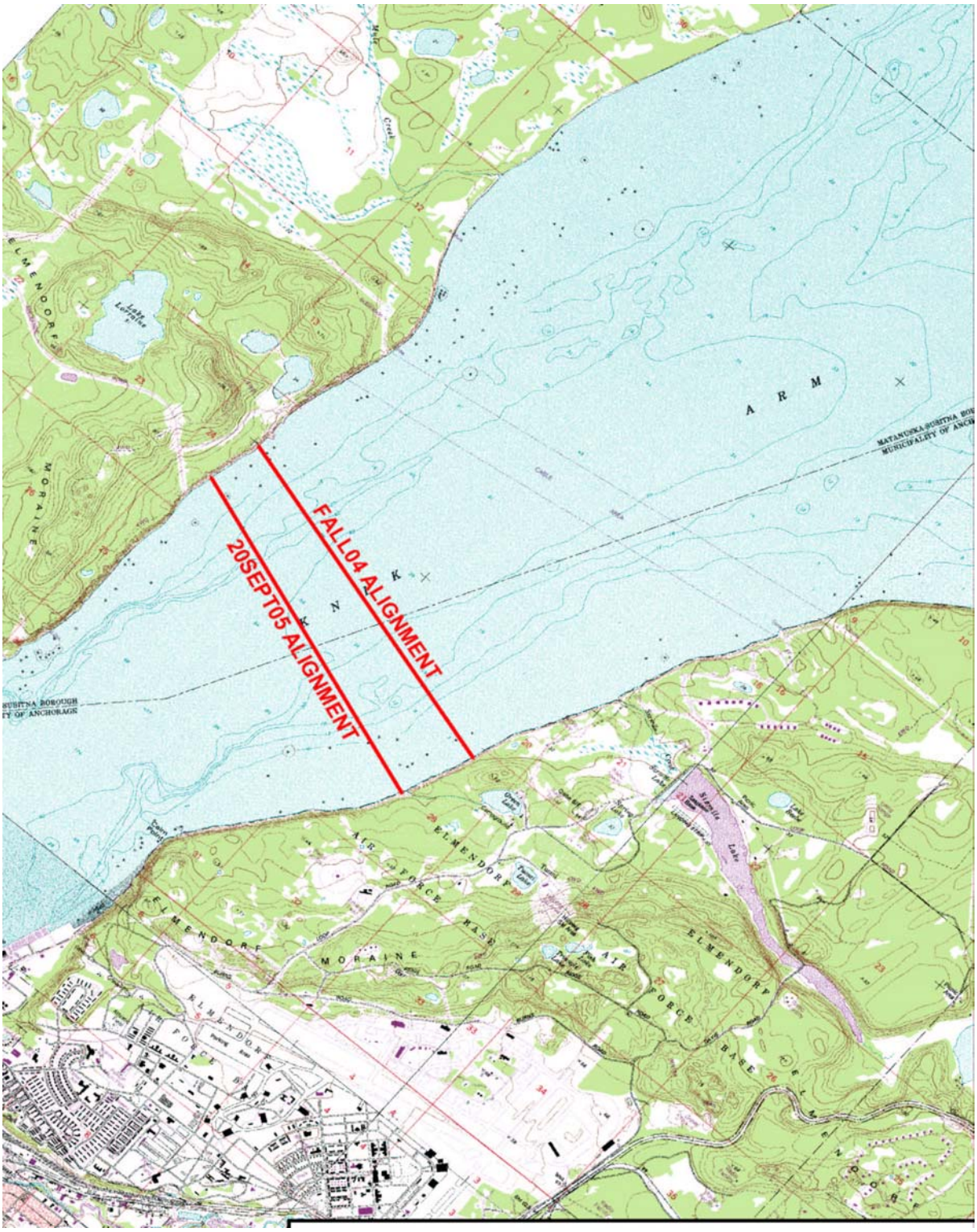
Output Results:

Note: Remark with * indicates critical flow, # indicates fail to converge after 100 cycles

Time (hrs)	Tide EL. (ft)	Basin EL. (ft)	Bridge Q av.(cfs)	Weir Q av.(cfs)	Bridge V av.(ft/s)	Basin Area (sf)	Flow Area av.(sf)	Remark
8.90	31.600	31.600	0.00	0.00	0.000	2923037360.2	587055.00	
9.00	31.583	31.584	126585.80	0.00	0.216	2922183130.4	586986.09	
9.10	31.532	31.541	348814.02	0.00	0.595	2919827960.8	586710.56	
9.20	31.447	31.469	589259.49	0.00	1.005	2915844997.8	586160.04	
9.30	31.328	31.367	820823.85	0.00	1.402	2910287744.1	585335.56	
9.40	31.176	31.237	1051409.63	0.00	1.800	2903153807.1	584238.70	
9.50	30.990	31.078	1278931.99	0.00	2.194	2894452402.4	582871.54	
9.60	30.772	30.891	1502808.55	0.00	2.586	2884194273.7	581236.70	
9.70	30.520	30.676	1722413.69	0.00	2.973	2872392070.8	579337.27	
9.80	30.237	30.432	1937135.03	0.00	3.356	2859060361.5	577176.87	
9.90	29.923	30.161	2146384.89	0.00	3.734	2844215578.6	574761.94	
10.00	29.577	29.863	2349614.88	0.00	4.107	2827875878.2	572105.12	
10.10	29.202	29.538	2546267.31	0.00	4.473	2810061347.4	569210.08	
10.20	28.797	29.186	2735790.21	0.00	4.833	2790794127.4	566075.22	
10.30	28.363	28.808	2917689.17	0.00	5.185	2770098186.8	562706.51	
10.40	27.901	28.405	3091495.03	0.00	5.529	2747999329.8	559110.34	
10.50	27.412	27.976	3256767.20	0.00	5.865	2724525193.0	555293.58	
10.60	26.897	27.523	3413095.70	0.00	6.191	2699705239.4	551263.48	
10.70	26.357	27.046	3560102.69	0.00	6.508	2673570750.7	547027.72	
10.80	25.793	26.546	3697443.75	0.00	6.814	2646154821.0	542594.36	
10.90	25.206	26.023	3824808.87	0.00	7.110	2617492352.0	537971.84	
11.00	24.597	25.478	3941923.24	0.00	7.393	2587620050.7	533168.95	
11.10	23.967	24.911	4048547.94	0.00	7.665	2556576429.9	528194.85	
11.20	23.318	24.324	4144480.34	0.00	7.924	2524401813.4	523059.00	
11.30	22.650	23.716	4229554.44	0.00	8.169	2491138344.5	517771.17	
11.40	21.965	23.090	4303640.99	0.00	8.400	2456830000.6	512341.43	
11.50	21.265	22.446	4366647.45	0.00	8.616	2421522614.2	506780.12	
11.60	20.550	21.784	4418517.79	0.00	8.818	2385263899.5	501097.82	
11.70	19.822	21.106	4459274.52	0.00	9.003	2348103133.5	495310.69	
11.80	19.083	20.412	4489062.56	0.00	9.172	2310090430.0	489446.61	
11.90	18.333	19.703	4507861.62	0.00	9.323	2271278436.8	483511.75	
12.00	17.574	18.981	4515601.95	0.00	9.457	2231723182.7	477500.91	
12.10	16.808	18.247	4512413.45	0.00	9.572	2191482776.7	471425.55	
12.20	16.036	17.501	4498455.17	0.00	9.668	2150617525.2	465297.21	
12.30	15.260	16.745	4473915.59	0.00	9.744	2109190053.0	459127.58	
12.40	14.481	15.979	4439012.50	0.00	9.801	2067265432.3	452928.39	
12.50	13.700	15.206	4393992.80	0.00	9.836	2024911319.6	446711.44	
12.60	12.919	14.427	4339132.01	0.00	9.851	1982198101.7	440488.56	
12.70	12.140	13.642	4274733.93	0.00	9.843	1939199048.7	434271.61	
12.80	11.364	12.853	4201130.31	0.00	9.814	1895990472.8	428072.42	
12.90	10.592	12.062	4118680.56	0.00	9.762	1852651887.3	421902.79	
13.00	9.826	11.270	4027816.35	0.00	9.687	1809265675.9	415779.68	
13.10	9.067	10.479	3929087.59	0.00	9.589	1765916164.7	409732.30	
13.20	8.317	9.690	3822837.79	0.00	9.468	1722692231.9	403766.72	
13.30	7.578	8.905	3709360.44	0.00	9.323	1679688438.7	397876.54	
13.40	6.850	8.126	3589173.76	0.00	9.154	1637002970.5	392072.97	
13.50	6.135	7.354	3462824.52	0.00	8.963	1594737605.5	386367.07	
13.60	5.435	6.592	3330890.28	0.00	8.748	1552997574.3	380769.69	
13.70	4.750	5.842	3193981.49	0.00	8.511	1511891283.0	375291.49	
13.80	4.082	5.105	3052743.10	0.00	8.252	1471529873.5	369942.89	
13.90	3.433	4.384	2907855.46	0.00	7.973	1432026592.3	364734.09	
14.00	2.803	3.681	2760034.06	0.00	7.674	1393495945.7	359674.98	
14.10	2.194	2.997	2610027.53	0.00	7.357	1356052628.1	354775.21	
14.20	1.607	2.336	2458613.23	0.00	7.024	1319810224.2	350044.10	
14.30	1.043	1.698	2306589.75	0.00	6.676	1284879711.9	345490.66	
14.40	0.503	1.086	2154765.50	0.00	6.317	1251367815.3	341123.55	
14.50	-0.012	0.503	2003944.78	0.00	5.947	1219375270.2	336951.45	
14.60	-0.501	-0.052	1854964.63	0.00	5.571	1188994194.1	332996.61	
14.70	-0.963	-0.576	1708500.60	0.00	5.189	1160308404.6	329265.40	
14.80	-1.397	-1.067	1565120.71	0.00	4.805	1133392957.5	325749.85	
14.90	-1.802	-1.525	1425400.85	0.00	4.420	1108311703.3	322456.65	
15.00	-2.177	-1.948	1289779.35	0.00	4.038	1085117339.6	319392.06	
15.10	-2.523	-2.336	1158539.43	0.00	3.660	1063852053.9	316561.92	
15.20	-2.837	-2.689	1031800.87	0.00	3.286	1044548673.8	313971.61	
15.30	-3.120	-3.005	909523.09	0.00	2.919	1027232156.5	311626.08	

Time (hrs)	Tide EL. (ft)	Basin EL. (ft)	Bridge Q av.(cfs)	Weir Q av.(cfs)	Bridge V av.(ft/s)	Basin Area (sf)	Flow Area av.(sf)	Remark
15.40	-3.372	-3.284	791519.42	0.00	2.557	1011921200.2	309529.78	
15.50	-3.590	-3.527	677479.99	0.00	2.202	998629760.7	307686.70	
15.60	-3.776	-3.732	566999.22	0.00	1.852	987368311.7	306100.35	
15.70	-3.928	-3.901	459602.90	0.00	1.508	978144775.6	304773.75	
15.80	-4.047	-4.032	354771.22	0.00	1.168	970965135.4	303709.43	
15.90	-4.132	-4.125	251955.75	0.00	0.832	965833800.3	302909.41	
16.00	-4.183	-4.182	150590.65	0.00	0.498	962753810.7	302375.22	
16.10	-4.200	-4.200	50099.56	0.00	0.166	961726951.3	302107.87	
16.20	-4.183	-4.183	-45898.64	0.00	-0.152	962667749.2	302105.06	
16.30	-4.132	-4.137	-124274.52	0.00	-0.411	965210437.5	302354.63	
16.40	-4.047	-4.057	-213594.41	0.00	-0.705	969565054.1	302848.78	
16.50	-3.928	-3.947	-297231.06	0.00	-0.979	975592454.6	303592.59	
16.60	-3.776	-3.806	-384657.31	0.00	-1.263	983337886.4	304579.34	
16.70	-3.590	-3.634	-472269.11	0.00	-1.544	992764824.7	305809.64	
16.80	-3.372	-3.431	-561468.80	0.00	-1.827	1003857094.4	307279.72	
16.90	-3.120	-3.199	-652213.51	0.00	-2.111	1016590158.0	308986.67	
17.00	-2.837	-2.937	-744722.69	0.00	-2.395	1030936974.8	310926.79	
17.10	-2.523	-2.646	-839159.57	0.00	-2.680	1046867515.1	313095.99	
17.20	-2.177	-2.327	-935665.18	0.00	-2.966	1064349000.3	315489.77	
17.30	-1.802	-1.980	-1034354.8	0.00	-3.252	1083346110.9	318103.25	
17.40	-1.397	-1.607	-1135316.6	0.00	-3.538	1103821192.2	320931.21	
17.50	-0.963	-1.207	-1238610.4	0.00	-3.823	1125734455.4	323968.09	
17.60	-0.501	-0.781	-1344266.6	0.00	-4.108	1149044168.6	327208.06	
17.70	-0.012	-0.331	-1452285.8	0.00	-4.392	1173706838.0	330645.01	
17.80	0.503	0.143	-1562652.7	0.00	-4.675	1199677620.2	334276.89	
17.90	1.043	0.640	-1675342.7	0.00	-4.955	1226910788.6	338107.85	
18.00	1.607	1.159	-1790238.4	0.00	-5.233	1255358842.7	342127.59	
18.10	2.194	1.700	-1907175.6	0.00	-5.507	1284972426.3	346319.16	
18.20	2.803	2.261	-2026011.6	0.00	-5.777	1315701303.5	350675.40	
18.30	3.433	2.841	-2146565.8	0.00	-6.043	1347494322.9	355188.97	
18.40	4.082	3.440	-2268623.9	0.00	-6.304	1380299441.6	359852.43	
18.50	4.750	4.056	-2391939.8	0.00	-6.559	1414063763.1	364658.21	
18.60	5.435	4.689	-2516236.4	0.00	-6.808	1448733574.8	369598.60	
18.70	6.135	5.337	-2641207.0	0.00	-7.050	1484254379.8	374665.79	
18.80	6.850	6.000	-2766515.2	0.00	-7.283	1520570920.3	379851.86	
18.90	7.578	6.677	-2891796.2	0.00	-7.508	1557627194.5	385148.78	
19.00	8.317	7.366	-3016657.2	0.00	-7.724	1595366465.1	390548.41	
19.10	9.067	8.066	-3140678.4	0.00	-7.930	1633731263.6	396042.51	
19.20	9.826	8.777	-3263413.8	0.00	-8.126	1672663387.6	401622.72	
19.30	10.592	9.496	-3384392.1	0.00	-8.310	1712103895.6	407280.59	
19.40	11.364	10.225	-3503167.4	0.00	-8.482	1751993654.2	413014.33	
19.50	12.140	10.960	-3619326.4	0.00	-8.642	1792273879.4	418830.74	
19.60	12.919	11.701	-3732249.4	0.00	-8.788	1832884008.5	424714.66	
19.70	13.700	12.447	-3841246.5	0.00	-8.920	1873761269.6	430642.02	
19.80	14.481	13.197	-3945752.2	0.00	-9.037	1914842295.4	436603.62	
19.90	15.260	13.950	-4045177.9	0.00	-9.140	1956063028.7	442590.21	
20.00	16.036	14.703	-4138915.7	0.00	-9.226	1997358657.3	448592.40	
20.10	16.808	15.457	-4226341.3	0.00	-9.297	2038663564.4	454600.72	
20.20	17.574	16.210	-4306816.3	0.00	-9.350	2079911291.6	460605.56	
20.30	18.333	16.961	-4379691.5	0.00	-9.386	2121034508.3	466597.18	
20.40	19.083	17.708	-4444308.6	0.00	-9.405	2161964986.7	472565.72	
20.50	19.822	18.450	-4500003.2	0.00	-9.404	2202633580.1	478501.20	
20.60	20.550	19.187	-4546107.0	0.00	-9.385	2242970203.3	484393.47	
20.70	21.265	19.915	-4581950.8	0.00	-9.346	2282903815.7	490232.29	
20.80	21.965	20.636	-4607024.0	0.00	-9.288	2322363739.8	496026.40	
20.90	22.650	21.346	-4620641.5	0.00	-9.209	2361278040.9	501767.68	

Figure B-1: Location of Fall 2004 and September 2005 Bridge Alignments



Attachment C: Computation of Scour Depth at September 2005 Bridge During 2 August 2004 Spring Ebb Tide

List of Tables

List of Figures

Table C-1: Data for Scour Analysis

1 Method of Scour Computation

a Use a peak discharge of 4,515,602 cfs at 12.0 hrs. through the Proposed September 2005

b Use the HEC-RAS model to obtain the hydraulic values that are required to compute scour

c Use the ABSCOUR method to compute the scour depth at the proposed bridge.

d Will use Laursen method to compute contraction scour within bridge.

e Divide the tidal waterway into three segment: West (left), Center, and East (Right).
The west segment will extend from Station 10+00 to 45+59.3.
The central segment will extend from Station 45+59.3 to 94+77.4
The east segment will extend from Station 94+77.4 to 160+25.2.
The seabed elevation at Station 45+59.3 is -20 ft.
The seabed elevation at Station 94+77.4 is -30 ft.
Check computations have demonstrated that if the tidal water way is treated as a main
This is probably not consistent with the actual conditions at the site.

2 Cross Sectional Area without Bridge at location of 2 August 2004 Discharge

a See Figure B-1 for location.

b From PND Bathymetric Data Received in 2005.

WSE (ft ab MLLW) (ft)	Total Cross-Sectional Area Below WSE (sf)	Top Width (ft)
40	824,224	13,065
30	693,984	13,001
20	564,506	12,892
10	439,473	11,892
0	326,821	10,081
-10	233,360	8,701
-20	155,195	6,467
-30	98,408	4,985
-40	53,654	3,945

Notes:
1 Widths and cross sectional areas were estimated from the PND bathymetric data received in 2005.

3 Cross Sectional Area at September 2005 Bridge Alignment, without Bridge.

a See Figure B-1 for location.
b From PND Bathymetric Data Received in 2005.

WSE (ft ab MLLW) (ft)	Total Cross-Sectional Area Below WSE (sf)	Top Width (ft)
40	841,831	12,787
30	714,294	12,720
20	587,826	12,573
10	464,221	12,057
0	352,347	10,265
-10	257,202	8,168
-20	182,647	6,642
-30	123,323	4,778
-40	77,328	4,476

Notes:
1 Widths and cross sectional areas were estimated from the PND bathymetric data received in 2005.

4 Cross Sectional Area at September 2005 Bridge Alignment within Bridge Abutments

a From Bathymetric and Bridge Data Received from PND in September 2005.
1) Bridge Length (Perpendicular to the flow)
a) Begin Bridge at Station 33+50 (Wasilla Side; West Side)
b) End Bridge at Station 115+30 (Anchorage Side; East side)
c) Length of Bridge Deck: 8180 feet
2) Top elevation of abutment embankment, and location:
a) Assumed top of embankment elevation of 50 feet.
3) Abutment side slope:
a) Based on profile received from Kenley (27 Sep 2005): 3H;1V (Phone conversation with Earl Kubaskie 27 Sep 05).
4) Toe of Embankment slope"
a) West Side: Station 35+34, Elevation -11.46.
b) East Side: Station 113+30, Elevation -16.50.

5) Cross Sectional Area and Width of Waterway Opening at SEP 2005 Bridge Section

WSE (ft ab MLLW) (ft)	Total Cross-Sectional Area Below WSE (sf)	Top Width (ft)
40	655,011	8,120
30	574,111	8,060
20	493,811	8,000
10	414,111	7,940
0	335,011	7,880
-10	256,511	7,820
-20	182,647	6,642
-30	123,323	4,778
-40	77,328	4,476

Notes:

1 Widths and cross sectional areas were estimated from the PND bathymetric data received in 2005.

2 Values are for clear span between the abutments. Due to the fall 2005 conceptual configuration of the piers, it was decided there was no need to reduce the cross sectional area due to the piers.

5 Embankment Width Parallel to Flow

a Based on a future condition drawing for the proposed bridge, assume embankment top width is 66 feet.

b The toe of the west abutment is at elevation -11.46 ft. At a 3H:1V Side Slope, and a 66 ft top width, and a top elevation of 50 feet, the upstream and downstream toes of the embankment will be 217 feet from the centerline of the road embankment.

c The toe of the east abutment is at elevation -16.50 ft. At a 3H:1V Side Slope, and a 66 ft top width, and a top elevation of 50 feet, the upstream and downstream toes of the embankment will be 233 feet from the centerline of the road embankment.

d The average of the two ends of the bridge is (233+217/2) 225 ft.

6 Bed Material

a Smith, O.P. 2004. Knik Arm Current, Sediment Transport, and Ice Studies. Draft October 4, 2004. Prepared for PND Inc.

1) Median D50 = 0.16 mm = 0.0005249 ft.

7 Results of the TideRout2 Analysis

2 Aug 2004 Spring Ebb Tide at Proposed September 2005 Bridge Site with Bridge In-Place.

Parameter	Start of Period	End of Period	Average During Period
Time in storm event (TideRout2) (hrs):	11.95	12.05	12.00
Tide Elevation (downstream side of bridge) (ft):			17.54
Basin Elevation (upstream side of bridge) (ft):			18.98
Discharge through Bridge (cfs) =			4,515,602
Velocity through Bridge (fps) =			9.457
Cross Sectional Flow Area through Bridge (sf) =			477,501

Notes:
The above information is based on the assumption that the bridge can be treated as an orifice and the discharge routed through the orifice. The computations were made with the TideRout2 program.

8 Results of HEC-RAS Analysis/Input for ABSCOUR Model

a Project Info

Safety factor: 1.1

b Approach Section

Approach section water surface elevation (ft): 18.99

Description	West (Left) Segment	Center Segment	East (Right) Segment
Discharge (cfs):	442921.4	3455830	616850.2
Flow top width (ft):	2768.98	5160.3	4915.12
Average flow depth (hydraulic depth) (ft):	28.72	67.78	24.82
Median bed grain size (D50) (ft):	0.000525	0.000525	0.000525
Average bank slope (Z) in vicinity of bridge:	0.01		0.006
Average Energy Slope between Approach and Bridge Sections (ft/ft):			0.000108

c Downstream Bridge Data

Downstream water surface elevation under bridge (ft):		18.38	
	West (Left) Segment	**Center Segment**	**East (Right) Segment**
HEC-RAS discharge under bridge (cfs):	215592.6	3697285	602724.1
Override discharge under bridge			
Waterway area measured normal to flow (sf):	36295.84	361169.1	84208.48
Top width measured normal to flow (ft):	1114.3	4918.1	1957.6
Low chord elev. at downstream side of bridge (ft):	49	49	49
Abutment style:	Spill-thru		Spill-thru
Setback (measured from ABSCOUR x-section) (ft):	1025		1853
Median particle size under bridge, D50 (ft):	0.000525	0.000525	0.000525
Est. long-term aggradation(+) or degradation(-) (ft):	0	0	0

d Upstream Bridge Data

Water surface elevation upstream side of bridge (ft):		18.39	
	West (Left) Segment	**Center Segment**	**East (Right) Segment**
Low chord elev. At upstream side of bridge (ft):	49	49	49
Abutment shape factor X1 (ft):	100		125
For spill through embankments X1 is the horizontal distance, perpendicular to the flow, between the abutment toe (on the ABSCOUR x-section) and the location of the water surface line on the spill-through slope.			
Abutment shape factor X2 (ft):	1715		2750
For spill-though embankments X2 is the horizontal distance from where the water meets the face of the spill-through slope to where the water meets the edge of the cross section.			
Embankment skew angle (degrees):	90		90

Is future lateral migration of channel likely to occur? No

Table C-2: Peak Discharge during 2 Aug 2004 Spring Ebb Tide with Proposed September 2005 Bridge In-Place

```
                     HEC-RAS Version 3.1.2 April 2004
                       U.S. Army Corp of Engineers
                      Hydrologic Engineering Center
                            609 Second Street
                            Davis, California


           X     X  XXXXXX    XXXX        XXXX       XX      XXXX
           X     X  X        X    X       X   X     X  X    X
           X     X  X        X            X   X    X    X   X
           XXXXXXX  XXXX     X       XXX  XXXX     XXXXXX    XXXX
           X     X  X        X            X  X     X    X        X
           X     X  X        X    X       X   X    X    X        X
           X     X  XXXXXX    XXXX        X    X   X    X   XXXXX


PROJECT DATA
Project Title: SEP05 Proposed Knik Arm Bridge
Project File : 05KAB.prj
Run Date and Time: 11/16/2005 2:34:23 PM

Project in English units


PLAN DATA

Plan Title: 2 Aug 2004 Spring Ebb Tide- Sep 2005 Br
Plan File : f:\Projects\2005\26219702.00510_Knik_Br_Scour\Scour\HEC-RAS_2Aug04\05KAB.p01

          Geometry Title: Sep 2005 Proposed Knik Arm Bridge
          Geometry File : f:\Projects\2005\26219702.00510_Knik_Br_Scour\Scour\HEC-RAS_2Aug04\05KAB.g01

          Flow Title    : 2Aug04 Spring Ebb Tide with SEP05 Bridge
          Flow File     : f:\Projects\2005\26219702.00510_Knik_Br_Scour\Scour\HEC-RAS_2Aug04\05KAB.f01

Plan Summary Information:
Number of:  Cross Sections =    4    Multiple Openings  =    0
            Culverts       =    0    Inline Structures  =    0
            Bridges        =    1    Lateral Structures =    0

Computational Information
    Water surface calculation tolerance  =  0.01
    Critical depth calculation tolerance =  0.01
    Maximum number of iterations         =  20
    Maximum difference tolerance         =  0.3
    Flow tolerance factor                =  0.001

Computation Options
    Critical depth computed only where necessary
    Conveyance Calculation Method: At breaks in n values only
    Friction Slope Method:         Average Conveyance
    Computational Flow Regime:     Subcritical Flow
```

FLOW DATA

Flow Title: 2Aug04 Spring Ebb Tide with SEP05 Bridge
Flow File : f:\Projects\2005\26219702.00510_Knik_Br_Scour\Scour\HEC-RAS_2Aug04\05KAB.f01

Flow Data (cfs)

River	Reach	RS	PF 1
Knik Arm	SEP05 Br Align	30	4515602

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
Knik Arm	SEP05 Br Align	PF 1		Known WS = 17.54

GEOMETRY DATA

Geometry Title: Sep 2005 Proposed Knik Arm Bridge
Geometry File : f:\Projects\2005\26219702.00510_Knik_Br_Scour\Scour\HEC-RAS_2Aug04\05KAB.g01

CROSS SECTION

RIVER: Knik Arm
REACH: SEP05 Br Align RS: 30

INPUT
Description: Approach Section
Station Elevation Data num= 170

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1410.1	80	1417.8	75.8	1418.5	75.3	1422	72.8	1422.2	72.6
1424.1	71.2	1425.6	70	1432.7	64.5	1438.6	60	1444.4	55.5
1451.5	50	1459.4	44.1	1464.9	40	1467.3	39	1468	38.7
1488.6	30	1500.2	27.9	1523.2	23.8	1538.7	21.1	1544.6	20
1559.8	14.9	1574.7	10	1581.4	7.8	1604.9	0	2273.5	0
2339.1	-1.4	2405	-2.7	2420	-3	2514.4	-5	2560.6	-5.9
2609	-6.9	2640	-7.6	2663.3	-8.1	2684.5	-8.5	2696.1	-8.8
2703.5	-8.9	2754.7	-10	2760.4	-10	2821.1	-10.5	2823.8	-10.6
2871.6	-11	2877.5	-11	2919.1	-11.4	3130.4	-13.3	3147.2	-13.4
3302.4	-14.8	3436	-15.9	3451.1	-16	3472.3	-16.1	3484.4	-16.2
3492.4	-16.3	4104.7	-20	4316.6	-20	4406.4	-23.8	4411.3	-24
4435.6	-24.7	4443.3	-25.2	4460.8	-26.3	4473	-26.7	4479.1	-26.9
4503.8	-28.7	4504.9	-28.8	4520.9	-30	4566.8	-33.2	4612.2	-36.2
4622.3	-36.7	4658.5	-39.5	4660.2	-39.6	4665.2	-40	4745.4	-47.5
4770.5	-50	4846.3	-57.6	4861.6	-59.1	4870.3	-60	4996.3	-60
5683	-63.5	5685.7	-63.5	5694.7	-63.4	6064.8	-60.4	6094.9	-60.1
6111.9	-60	6398.8	-60	6697	-53.9	6709.8	-53.5	6723.4	-53
6775.3	-51.3	6780.5	-51.3	6800.3	-50.6	6802.7	-50.6	6822.3	-50
7425.2	-50	8384.1	-42.6	8394.3	-42.5	8529.7	-40.8	8531.1	-40.8
8544.3	-40.7	8547.6	-40.7	8557	-40.6	8558.4	-40.6	8610.1	-40
8652.5	-40	8857.8	-37.4	8913.1	-36.7	9095.2	-34.6	9121.2	-34.3
9141.4	-34.1	9476.9	-30	9510.4	-30	9604.7	-29.2	9709.4	-28.3
9840.6	-27.2	10447.4	-22.2	10475.2	-21.9	10487	-21.8	10514.6	-21.7
10523.4	-21.6	10529.4	-21.5	10551.6	-21.4	10730.3	-20	10860	-20
10900.1	-19.4	11129.6	-16.7	11138.9	-16.6	11154.8	-16.2	11176	-15.8
11197.7	-15.4	11250.6	-14.4	11276.6	-13.9	11309.3	-13.2	11345.8	-12.5

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
11351	-12.4	11388.3	-11.6	11461.9	-10	11466.1	-10	12254.2	0
12355.4	0	12633.3	3.6	12682.6	3.9	13006.5	6.3	13121.6	7.3
13278	8.6	13467	10	13530.8	10	13921.1	13.5	14013.7	14
14035	14.4	14055.8	14.7	14061.3	14.8	14133.4	15.3	14138.6	15.3
14192.5	15.7	14199.6	15.8	14211.1	16	14228	16.3	14251.2	16.6
14289.3	16.9	14407.4	19.3	14437.6	20	14475.8	27.2	14490.1	30
14504	33.5	14529.6	40	14550.6	45.3	14569	50	14585.6	54
14610.7	60	14626.8	63.9	14651.9	70	14668.6	73.8	14696.7	80

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
1410.1	.026	4316.6	.026	9476.9	.026

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
4316.6	9476.9	3350	3350	3350	.1	.3

CROSS SECTION OUTPUT Profile #PF 1

			Left OB	Channel	Right OB
E.G. Elev (ft)	20.25	Element			
Vel Head (ft)	1.26	Wt. n-Val.	0.026	0.026	0.026
W.S. Elev (ft)	18.99	Reach Len. (ft)	3350.00	3350.00	3350.00
Crit W.S. (ft)		Flow Area (sq ft)	79514.36	349771.10	121969.80
E.G. Slope (ft/ft)	0.000108	Area (sq ft)	79514.36	349771.10	121969.80
Q Total (cfs)	4515602.00	Flow (cfs)	442921.40	3455830.00	616850.20
Top Width (ft)	12844.40	Top Width (ft)	2768.98	5160.30	4915.12
Vel Total (ft/s)	8.19	Avg. Vel. (ft/s)	5.57	9.88	5.06
Max Chl Dpth (ft)	82.49	Hydr. Depth (ft)	28.72	67.78	24.82
Conv. Total (cfs)	434114800.0	Conv. (cfs)	42580970.0	332231900.0	59301900.0
Length Wtd. (ft)	3350.00	Wetted Per. (ft)	2772.19	5162.15	4915.42
Min Ch El (ft)	-63.50	Shear (lb/sq ft)	0.19	0.46	0.17
Alpha	1.21	Stream Power (lb/ft s)	1.08	4.52	0.85
Frctn Loss (ft)	0.35	Cum Volume (acre-ft)	16460.64	110531.50	32950.59
C & E Loss (ft)	0.02	Cum SA (acres)	596.77	1526.63	1023.11

Profile #PF 1

	Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1	LOB	1410.10	1700.75	8247.64	2364.40	156.20	0.18	15.44	3.49
2	LOB	1700.75	1991.40	22390.33	5518.71	290.65	0.50	18.99	4.06
3	LOB	1991.40	2282.05	22395.51	5519.49	290.65	0.50	18.99	4.06
4	LOB	2282.05	2572.70	28986.41	6443.98	290.71	0.64	22.17	4.50
5	LOB	2572.70	2863.35	42633.32	8122.29	290.70	0.94	27.95	5.25
6	LOB	2863.35	3154.00	51201.06	9065.15	290.66	1.13	31.19	5.65
7	LOB	3154.00	3444.65	58346.00	9804.25	290.66	1.29	33.73	5.95
8	LOB	3444.65	3735.30	64632.48	10424.98	290.66	1.43	35.87	6.20
9	LOB	3735.30	4025.95	70021.80	10938.16	290.66	1.55	37.63	6.40
10	LOB	4025.95	4316.60	74066.93	11312.97	290.65	1.64	38.92	6.55
11	Chan	4316.60	4574.62	85946.41	11604.62	258.41	1.90	44.98	7.41
12	Chan	4574.62	4832.63	150539.00	16258.93	259.02	3.33	63.02	9.26
13	Chan	4832.63	5090.65	218953.90	20331.31	258.20	4.85	78.80	10.77
14	Chan	5090.65	5348.66	225241.90	20673.69	258.02	4.99	80.13	10.90
15	Chan	5348.66	5606.68	231436.80	21012.99	258.02	5.13	81.44	11.01
16	Chan	5606.68	5864.69	233652.80	21133.60	258.02	5.17	81.91	11.06
17	Chan	5864.69	6122.71	224458.20	20630.64	258.02	4.97	79.96	10.88
18	Chan	6122.71	6380.72	219935.60	20379.96	258.02	4.87	78.99	10.79
19	Chan	6380.72	6638.74	209420.10	19791.14	258.07	4.64	76.71	10.58

	Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
20	Chan	6638.74	6896.75	183738.70	18297.77	258.09	4.07	70.92	10.04
21	Chan	6896.75	7154.77	175515.50	17799.81	258.02	3.89	68.99	9.86
22	Chan	7154.77	7412.78	175515.50	17799.81	258.02	3.89	68.99	9.86
23	Chan	7412.78	7670.80	171704.10	17567.07	258.02	3.80	68.09	9.77
24	Chan	7670.80	7928.81	163426.20	17053.92	258.02	3.62	66.10	9.58
25	Chan	7928.81	8186.83	155303.30	16540.14	258.02	3.44	64.11	9.39
26	Chan	8186.83	8444.84	147233.30	16019.04	258.03	3.26	62.09	9.19
27	Chan	8444.84	8702.86	137163.40	15352.52	258.03	3.04	59.50	8.93
28	Chan	8702.86	8960.87	126643.30	14634.86	258.03	2.80	56.72	8.65
29	Chan	8960.87	9218.89	115431.00	13843.04	258.03	2.56	53.65	8.34
30	Chan	9218.89	9476.90	104571.20	13046.26	258.03	2.32	50.56	8.02
31	ROB	9476.90	9998.88	158574.70	24560.30	522.00	3.51	47.05	6.46
32	ROB	9998.88	10520.86	135043.80	22303.76	522.00	2.99	42.73	6.05
33	ROB	10520.86	11042.84	115470.80	20303.81	522.00	2.56	38.90	5.69
34	ROB	11042.84	11564.82	84539.98	16840.40	522.06	1.87	32.26	5.02
35	ROB	11564.82	12086.80	53160.83	12748.43	522.02	1.18	24.42	4.17
36	ROB	12086.80	12608.78	33556.09	9673.01	522.01	0.74	18.53	3.47
37	ROB	12608.78	13130.76	20230.76	7140.03	522.00	0.45	13.68	2.83
38	ROB	13130.76	13652.74	11370.58	5053.15	522.00	0.25	9.68	2.25
39	ROB	13652.74	14174.72	4583.17	2929.51	522.00	0.10	5.61	1.56
40	ROB	14174.72	14696.70	319.49	417.40	217.33	0.01	1.92	0.77

CROSS SECTION

RIVER: Knik Arm
REACH: SEP05 Br Align RS: 20

INPUT
Description: Upstream Toe of Road Embankment
Downstream Toe of Bridge Side
Slope
Station Elevation Data num= 178

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1548.5	80	1551.3	78.1	1564.1	70	1567.6	67.7	1568.3	67.2
1569.8	66.2	1573.5	63.3	1577.7	60	1580.8	57.3	1589.2	50
1592.8	46.9	1600.6	40	1613.1	31.3	1615	30	1655	25.6
1678.9	22.9	1704.3	20	1715.9	19	1725.6	18.2	1772.4	14.3
1809.3	11.3	1814.9	10.9	1825.7	10	1826.8	10	1845.2	9.7
1846.5	9.7	1877	9.2	1899.7	8.9	1905.3	8.8	1930.7	8.4
1938.6	8.3	1964.1	7.9	1973.6	7.8	1997.1	7.4	2007	7.3
2055.8	6.5	2098.4	6	2112.9	5.8	2134.4	5.6	2150.4	5.3
2528.9	0	2566.8	0	2621.3	-.8	2623.3	-.8	2687.7	-1.7
2692.5	-1.8	2742.6	-2.5	2751.6	-2.6	2765.2	-2.8	2784.5	-3
2819.8	-3.5	2849.4	-3.9	3315.1	-10	3355.3	-10	3418.6	-10.5
3428.9	-10.6	3508.1	-11.2	3675.7	-12.6	3863.8	-14.2	4285.8	-17.7
4297.9	-17.8	4346.8	-18.2	4553.4	-20	4559.3	-20	4567.7	-20.6
4584.6	-21.9	4656.6	-27.2	4696	-30	4726.2	-32.4	4739	-33.4
4798.7	-38.1	4821.7	-40	4860.3	-45.5	4892.3	-50	4917.8	-54.6
4948.4	-60	4999.5	-69.9	4999.8	-70	5841.1	-70	6152.2	-66.1
6199.1	-65.6	6222.1	-65.3	6246.9	-64.9	6280.2	-64.5	6301.9	-64.3
6317.6	-64.1	6333.9	-63.9	6352.7	-63.6	6359	-63.6	6397.6	-63.1
6479.3	-62	6486.1	-61.9	6494.2	-61.8	6622.9	-60.2	6624.2	-60.1
6635.7	-60	6794.5	-58.2	6891.6	-57.1	6952.7	-56.4	7000.2	-55.8
7015.4	-55.6	7197.8	-53.6	7236.9	-53.2	7291.1	-52.5	7377.1	-51.6
7385	-51.5	7392	-51.4	7429.8	-51	7434	-51	7437	-50.9

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
7471.9	-50.6	7473.8	-50.5	7475.7	-50.5	7476.8	-50.5	7478.1	-50.5
7506.9	-50.2	7507.6	-50.2	7508.2	-50.2	7528.3	-50	8150.5	-50
8450.2	-49.1	8457.9	-49.1	8670.4	-50	9133.4	-50	9193.9	-46.4
9225.3	-44.8	9239.7	-43.8	9266.3	-42.1	9278.3	-41.5	9299.6	-40
9304.4	-39.7	9330.2	-38.3	9434.6	-32.4	9455.1	-31.3	9477.4	-30
9784.4	-30	10167.7	-27.8	10175.9	-27.8	10186.9	-27.7	10199	-27.6
10283.8	-27	10293.6	-27	10304.7	-26.9	10732.9	-23.7	10771.4	-23.4
10814	-23.1	10956.1	-22	11011.6	-21.6	11209.6	-20	11226.4	-20
11309.9	-17.2	11369	-15.2	11414.9	-13.7	11441.2	-12.8	11522.8	-10
12061.6	-10	12099.3	-9.5	12104.8	-9.5	12209.1	-8.1	12275.8	-7.3
12831.5	0	12851.8	0	13884	10	13948.1	10	14118.5	15.2
14276.6	20	14329.7	29.1	14334.7	30	14358.5	34.5	14387.2	40
14398.9	42.5	14434.1	50	14483	59.6	14485.1	60	14486.3	60.2
14543.2	70	14571.2	74.3	14609.3	80				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
1548.5	.026	4559.3	.026	9477.4	.026

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
4559.3	9477.4	450	450	450	.1	.3

Left Levee Station= 3445 Elevation= 50
Right Levee Station= 11435 Elevation= 50

CROSS SECTION OUTPUT Profile #PF 1

E.G. Elev (ft)	19.88	Element	Left OB	Channel	Right OB	
Vel Head (ft)	1.45	Wt. n-Val.	0.026	0.026	0.026	
W.S. Elev (ft)	18.42	Reach Len. (ft)	192.00	192.00	192.00	
Crit W.S. (ft)	-24.81	Flow Area (sq ft)	37627.43	361375.70	85143.99	
E.G. Slope (ft/ft)	0.000104	Area (sq ft)	37627.43	361375.70	85143.99	
Q Total (cfs)	4515602.00	Flow (cfs)	224711.70	3684976.00	605914.30	
Top Width (ft)	7990.00	Top Width (ft)	1114.30	4918.10	1957.60	
Vel Total (ft/s)	9.33	Avg. Vel. (ft/s)	5.97	10.20	7.12	
Max Chl Dpth (ft)	88.42	Hydr. Depth (ft)	33.77	73.48	43.49	
Conv. Total (cfs)	443743600.0	Conv. (cfs)	22082190.0	362118900.0	59542580.0	
Length Wtd. (ft)	192.00	Wetted Per. (ft)	1143.49	4922.13	1989.19	
Min Ch El (ft)	-70.00	Shear (lb/sq ft)	0.21	0.47	0.28	
Alpha	1.07	Stream Power (lb/ft s)	1.27	4.84	1.97	
Frctn Loss (ft)	0.02	Cum Volume (acre-ft)	11956.22	83186.01	24986.50	
C & E Loss (ft)	0.00	Cum SA (acres)	447.44	1139.09	758.83	

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, energy was used.

Profile #PF 1

	Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1	LOB	3445.00	3723.58	44252.45	8431.77	307.73	0.98	30.27	5.25
2	LOB	3723.58	4002.15	53542.14	9084.23	278.58	1.19	32.61	5.89
3	LOB	4002.15	4280.73	60034.37	9729.94	278.58	1.33	34.93	6.17
4	LOB	4280.73	4559.30	66882.74	10381.48	278.59	1.48	37.27	6.44
5	Chan	4559.30	4805.21	88146.57	11702.10	246.61	1.95	47.59	7.53
6	Chan	4805.21	5051.11	186049.60	18376.13	248.52	4.12	74.73	10.12
7	Chan	5051.11	5297.02	248027.60	21744.11	245.90	5.49	88.42	11.41
8	Chan	5297.02	5542.92	248028.10	21744.15	245.91	5.49	88.42	11.41

	Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
9	Chan	5542.92	5788.83	248028.10	21744.15	245.91	5.49	88.42	11.41
10	Chan	5788.83	6034.73	243566.00	21509.10	245.92	5.39	87.47	11.32
11	Chan	6034.73	6280.64	229825.80	20772.78	245.92	5.09	84.47	11.06
12	Chan	6280.64	6526.54	216122.20	20020.54	245.93	4.79	81.42	10.80
13	Chan	6526.54	6772.45	202557.90	19256.88	245.93	4.49	78.31	10.52
14	Chan	6772.45	7018.35	190451.80	18557.72	245.92	4.22	75.47	10.26
15	Chan	7018.35	7264.26	178739.20	17864.22	245.92	3.96	72.65	10.01
16	Chan	7264.26	7510.16	167620.40	17189.00	245.92	3.71	69.90	9.75
17	Chan	7510.16	7756.07	161796.70	16827.68	245.91	3.58	68.43	9.61
18	Chan	7756.07	8001.97	161770.50	16826.01	245.90	3.58	68.42	9.61
19	Chan	8001.97	8247.88	161542.20	16811.78	245.91	3.58	68.37	9.61
20	Chan	8247.88	8493.78	159260.40	16668.92	245.91	3.53	67.79	9.55
21	Chan	8493.78	8739.69	160713.00	16759.99	245.91	3.56	68.16	9.59
22	Chan	8739.69	8985.59	161770.20	16825.98	245.90	3.58	68.42	9.61
23	Chan	8985.59	9231.50	157230.20	16545.44	246.07	3.48	67.28	9.50
24	Chan	9231.50	9477.40	113729.20	13628.99	246.33	2.52	55.42	8.34
25	ROB	9477.40	9966.80	180524.70	23603.69	489.40	4.00	48.23	7.65
26	ROB	9966.80	10456.20	166108.70	22454.12	489.41	3.68	45.88	7.40
27	ROB	10456.20	10945.60	145411.80	20731.05	489.41	3.22	42.36	7.01
28	ROB	10945.60	11435.00	113869.10	18355.13	520.96	2.52	37.51	6.20

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, energy was used.

BRIDGE

RIVER: Knik Arm
REACH: SEP05 Br Align RS: 15

INPUT
Description: SEP05 Proposed Bridge
Distance from Upstream XS = 192
Deck/Roadway Width = 66
Weir Coefficient = 2.6
Upstream Deck/Roadway Coordinates
num= 2

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
3350	50	49	11530	50	49

Upstream Bridge Cross Section Data
Station Elevation Data num= 178

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1548.5	80	1551.3	78.1	1564.1	70	1567.6	67.7	1568.3	67.2
1569.8	66.2	1573.5	63.3	1577.7	60	1580.8	57.3	1589.2	50
1592.8	46.9	1600.6	40	1613.1	31.3	1615	30	1655	25.6
1678.9	22.9	1704.3	20	1715.9	19	1725.6	18.2	1772.4	14.3
1809.3	11.3	1814.9	10.9	1825.7	10	1826.8	10	1845.2	9.7
1846.5	9.7	1877	9.2	1899.7	8.9	1905.3	8.8	1930.7	8.4
1938.6	8.3	1964.1	7.9	1973.6	7.8	1997.1	7.4	2007	7.3
2055.8	6.5	2098.4	6	2112.9	5.8	2134.4	5.6	2150.4	5.3
2528.9	0	2566.8	0	2621.3	-.8	2623.3	-.8	2687.7	-1.7
2692.5	-1.8	2742.6	-2.5	2751.6	-2.6	2765.2	-2.8	2784.5	-3
2819.8	-3.5	2849.4	-3.9	3315.1	-10	3355.3	-10	3418.6	-10.5
3428.9	-10.6	3508.1	-11.2	3675.7	-12.6	3863.8	-14.2	4285.8	-17.7
4297.9	-17.8	4346.8	-18.2	4553.4	-20	4559.3	-20	4567.7	-20.6

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
4584.6	-21.9	4656.6	-27.2	4696	-30	4726.2	-32.4	4739	-33.4
4798.7	-38.1	4821.7	-40	4860.3	-45.5	4892.3	-50	4917.8	-54.6
4948.4	-60	4999.5	-69.9	4999.8	-70	5841.1	-70	6152.2	-66.1
6199.1	-65.6	6222.1	-65.3	6246.9	-64.9	6280.2	-64.5	6301.9	-64.3
6317.6	-64.1	6333.9	-63.9	6352.7	-63.6	6359	-63.6	6397.6	-63.1
6479.3	-62	6486.1	-61.9	6494.2	-61.8	6622.9	-60.2	6624.2	-60.1
6635.7	-60	6794.5	-58.2	6891.6	-57.1	6952.7	-56.4	7000.2	-55.8
7015.4	-55.6	7197.8	-53.6	7236.9	-53.2	7291.1	-52.5	7377.1	-51.6
7385	-51.5	7392	-51.4	7429.8	-51	7434	-51	7437	-50.9
7471.9	-50.6	7473.8	-50.5	7475.7	-50.5	7476.8	-50.5	7478.1	-50.5
7506.9	-50.2	7507.6	-50.2	7508.2	-50.2	7528.3	-50	8150.5	-50
8450.2	-49.1	8457.9	-49.1	8670.4	-50	9133.4	-50	9193.9	-46.4
9225.3	-44.8	9239.7	-43.8	9266.3	-42.1	9278.3	-41.5	9299.6	-40
9304.4	-39.7	9330.2	-38.3	9434.6	-32.4	9455.1	-31.3	9477.4	-30
9784.4	-30	10167.7	-27.8	10175.9	-27.8	10186.9	-27.7	10199	-27.6
10283.8	-27	10293.6	-27	10304.7	-26.9	10732.9	-23.7	10771.4	-23.4
10814	-23.1	10956.1	-22	11011.6	-21.6	11209.6	-20	11226.4	-20
11309.9	-17.2	11369	-15.2	11414.9	-13.7	11441.2	-12.8	11522.8	-10
12061.6	-10	12099.3	-9.5	12104.8	-9.5	12209.1	-8.1	12275.8	-7.3
12831.5	0	12851.8	0	13884	10	13948.1	10	14118.5	15.2
14276.6	20	14329.7	29.1	14334.7	30	14358.5	34.5	14387.2	40
14398.9	42.5	14434.1	50	14483	59.6	14485.1	60	14486.3	60.2
14543.2	70	14571.2	74.3	14609.3	80				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
1548.5	.026	4559.3	.026	9477.4	.026

Bank Sta: Left	Right	Coeff Contr.	Expan.
4559.3	9477.4	.1	.3

Left Levee Station= 3445 Elevation= 50
Right Levee Station= 11435 Elevation= 50

Downstream Deck/Roadway Coordinates
num= 2

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
3350	50	49	11530	50	49

Downstream Bridge Cross Section Data
Station Elevation Data num= 178

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1548.5	80	1551.3	78.1	1564.1	70	1567.6	67.7	1568.3	67.2
1569.8	66.2	1573.5	63.3	1577.7	60	1580.8	57.3	1589.2	50
1592.8	46.9	1600.6	40	1613.1	31.3	1615	30	1655	25.6
1678.9	22.9	1704.3	20	1715.9	19	1725.6	18.2	1772.4	14.3
1809.3	11.3	1814.9	10.9	1825.7	10	1826.8	10	1845.2	9.7
1846.5	9.7	1877	9.2	1899.7	8.9	1905.3	8.8	1930.7	8.4
1938.6	8.3	1964.1	7.9	1973.6	7.8	1997.1	7.4	2007	7.3
2055.8	6.5	2098.4	6	2112.9	5.8	2134.4	5.6	2150.4	5.3
2528.9	0	2566.8	0	2621.3	-.8	2623.3	-.8	2687.7	-1.7
2692.5	-1.8	2742.6	-2.5	2751.6	-2.6	2765.2	-2.8	2784.5	-3
2819.8	-3.5	2849.4	-3.9	3315.1	-10	3355.3	-10	3418.6	-10.5
3428.9	-10.6	3508.1	-11.2	3675.7	-12.6	3863.8	-14.2	4285.8	-17.7
4297.9	-17.8	4346.8	-18.2	4553.4	-20	4559.3	-20	4567.7	-20.6
4584.6	-21.9	4656.6	-27.2	4696	-30	4726.2	-32.4	4739	-33.4
4798.7	-38.1	4821.7	-40	4860.3	-45.5	4892.3	-50	4917.8	-54.6
4948.4	-60	4999.5	-69.9	4999.8	-70	5841.1	-70	6152.2	-66.1
6199.1	-65.6	6222.1	-65.3	6246.9	-64.9	6280.2	-64.5	6301.9	-64.3

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     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  6317.6   -64.1  6333.9   -63.9  6352.7   -63.6    6359   -63.6  6397.6   -63.1
  6479.3     -62  6486.1   -61.9  6494.2   -61.8  6622.9   -60.2  6624.2   -60.1
  6635.7     -60  6794.5   -58.2  6891.6   -57.1  6952.7   -56.4  7000.2   -55.8
  7015.4   -55.6  7197.8   -53.6  7236.9   -53.2  7291.1   -52.5  7377.1   -51.6
    7385   -51.5    7392   -51.4  7429.8     -51    7434     -51    7437   -50.9
  7471.9   -50.6  7473.8   -50.5  7475.7   -50.5  7476.8   -50.5  7478.1   -50.5
  7506.9   -50.2  7507.6   -50.2  7508.2   -50.2  7528.3     -50  8150.5     -50
  8450.2   -49.1  8457.9   -49.1  8670.4     -50  9133.4     -50  9193.9   -46.4
  9225.3   -44.8  9239.7   -43.8  9266.3   -42.1  9278.3   -41.5  9299.6     -40
  9304.4   -39.7  9330.2   -38.3  9434.6   -32.4  9455.1   -31.3  9477.4     -30
  9784.4     -30 10167.7   -27.8 10175.9   -27.8 10186.9   -27.7   10199   -27.6
 10283.8     -27 10293.6     -27 10304.7   -26.9 10732.9   -23.7 10771.4   -23.4
   10814   -23.1 10956.1     -22 11011.6   -21.6 11209.6     -20 11226.4     -20
 11309.9   -17.2   11369   -15.2 11414.9   -13.7 11441.2   -12.8 11522.8     -10
 12061.6     -10 12099.3    -9.5 12104.8    -9.5 12209.1    -8.1 12275.8    -7.3
 12831.5       0 12851.8       0   13884      10 13948.1      10 14118.5    15.2
 14276.6      20 14329.7    29.1 14334.7      30 14358.5    34.5 14387.2      40
 14398.9    42.5 14434.1      50   14483    59.6 14485.1      60 14486.3    60.2
 14543.2      70 14571.2    74.3 14609.3      80

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  1548.5    .026  4559.3    .026  9477.4    .026

Bank Sta: Left   Right    Coeff Contr.   Expan.
        4559.3  9477.4            .1       .3
Left Levee      Station=    3445      Elevation=      50
Right Levee     Station=   11435      Elevation=      50

Upstream Embankment side slope              =       3 horiz. to 1.0 vertical
Downstream Embankment side slope            =       3 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =     .95
Elevation at which weir flow begins         =
Energy head used in spillway design         =
Spillway height used in design              =
Weir crest shape                            = Broad Crested

Number of Abutments =  2

Abutment Data
Upstream     num=       2
     Sta    Elev     Sta    Elev
    3350      50    3534   -11.5
Downstream     num=       2
     Sta    Elev     Sta    Elev
    3350      50    3534   -11.5

Abutment Data
Upstream     num=       2
     Sta    Elev     Sta    Elev
   11330     -30   11530      50
Downstream     num=       2
     Sta    Elev     Sta    Elev
   11330     -30   11530      50

Number of Bridge Coefficient Sets =  1

Low Flow Methods and Data
```

```
       Energy
Selected Low Flow Methods = Highest Energy Answer

High Flow Method
       Energy Only

Additional Bridge Parameters
       Add Friction component to Momentum
       Do not add Weight component to Momentum
       Class B flow critical depth computations use critical depth
           inside the bridge at the upstream end
       Criteria to check for pressure flow = Upstream energy grade line

BRIDGE OUTPUT  Profile #PF 1
```

E.G. US. (ft)	19.88	Element	Inside BR US	Inside BR DS	
W.S. US. (ft)	18.42	E.G. Elev (ft)	19.85	19.85	
Q Total (cfs)	4515602.00	W.S. Elev (ft)	18.39	18.38	
Q Bridge (cfs)	4515602.00	Crit W.S. (ft)	-24.81	-24.81	
Q Weir (cfs)		Max Chl Dpth (ft)	88.39	88.38	
Weir Sta Lft (ft)		Vel Total (ft/s)	9.37	9.37	
Weir Sta Rgt (ft)		Flow Area (sq ft)	481731.60	481673.40	
Weir Submerg		Froude # Chl	0.21	0.21	
Weir Max Depth (ft)		Specif Force (cu ft)	17375000.00	17371660.00	
Min El Weir Flow (ft)	50.01	Hydr Depth (ft)	60.29	60.28	
Min El Prs (ft)	50.00	W.P. Total (ft)	8004.26	8004.26	
Delta EG (ft)	0.05	Conv. Total (cfs)	441929200.0	441844900.0	
Delta WS (ft)	0.05	Top Width (ft)	7990.00	7990.00	
BR Open Area (sq ft)	726304.00	Frctn Loss (ft)	0.01	0.02	
BR Open Vel (ft/s)	9.37	C & E Loss (ft)	0.00	0.00	
Coef of Q		Shear Total (lb/sq ft)	0.39	0.39	
Br Sel Method	Energy only	Power Total (lb/ft s)	3.68	3.68	

```
Note:    Multiple critical depths were found at this location.  The critical depth with the lowest, valid,
         energy was used.
Note:    Multiple critical depths were found at this location.  The critical depth with the lowest, valid,
         energy was used.

CROSS SECTION


RIVER: Knik Arm
REACH: SEP05 Br Align     RS: 10

INPUT
Description: Downstream Toe of Road Embankment
Downstream Toe of Bridge Side
            Slope
Station Elevation Data    num=     178
```

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1548.5	80	1551.3	78.1	1564.1	70	1567.6	67.7	1568.3	67.2
1569.8	66.2	1573.5	63.3	1577.7	60	1580.8	57.3	1589.2	50
1592.8	46.9	1600.6	40	1613.1	31.3	1615	30	1655	25.6
1678.9	22.9	1704.3	20	1715.9	19	1725.6	18.2	1772.4	14.3
1809.3	11.3	1814.9	10.9	1825.7	10	1826.8	10	1845.2	9.7
1846.5	9.7	1877	9.2	1899.7	8.9	1905.3	8.8	1930.7	8.4
1938.6	8.3	1964.1	7.9	1973.6	7.8	1997.1	7.4	2007	7.3
2055.8	6.5	2098.4	6	2112.9	5.8	2134.4	5.6	2150.4	5.3

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
2528.9	0	2566.8	0	2621.3	-.8	2623.3	-.8	2687.7	-1.7
2692.5	-1.8	2742.6	-2.5	2751.6	-2.6	2765.2	-2.8	2784.5	-3
2819.8	-3.5	2849.4	-3.9	3315.1	-10	3355.3	-10	3418.6	-10.5
3428.9	-10.6	3508.1	-11.2	3675.7	-12.6	3863.8	-14.2	4285.8	-17.7
4297.9	-17.8	4346.8	-18.2	4553.4	-20	4559.3	-20	4567.7	-20.6
4584.6	-21.9	4656.6	-27.2	4696	-30	4726.2	-32.4	4739	-33.4
4798.7	-38.1	4821.7	-40	4860.3	-45.5	4892.3	-50	4917.8	-54.6
4948.4	-60	4999.5	-69.9	4999.8	-70	5841.1	-70	6152.2	-66.1
6199.1	-65.6	6222.1	-65.3	6246.9	-64.9	6280.2	-64.5	6301.9	-64.3
6317.6	-64.1	6333.9	-63.9	6352.7	-63.6	6359	-63.6	6397.6	-63.1
6479.3	-62	6486.1	-61.9	6494.2	-61.8	6622.9	-60.2	6624.2	-60.1
6635.7	-60	6794.5	-58.2	6891.6	-57.1	6952.7	-56.4	7000.2	-55.8
7015.4	-55.6	7197.8	-53.6	7236.9	-53.2	7291.1	-52.5	7377.1	-51.6
7385	-51.5	7392	-51.4	7429.8	-51	7434	-51	7437	-50.9
7471.9	-50.6	7473.8	-50.5	7475.7	-50.5	7476.8	-50.5	7478.1	-50.5
7506.9	-50.2	7507.6	-50.2	7508.2	-50.2	7528.3	-50	8150.5	-50
8450.2	-49.1	8457.9	-49.1	8670.4	-50	9133.4	-50	9193.9	-46.4
9225.3	-44.8	9239.7	-43.8	9266.3	-42.1	9278.3	-41.5	9299.6	-40
9304.4	-39.7	9330.2	-38.3	9434.6	-32.4	9455.1	-31.3	9477.4	-30
9784.4	-30	10167.7	-27.8	10175.9	-27.8	10186.9	-27.7	10199	-27.6
10283.8	-27	10293.6	-27	10304.7	-26.9	10732.9	-23.7	10771.4	-23.4
10814	-23.1	10956.1	-22	11011.6	-21.6	11209.6	-20	11226.4	-20
11309.9	-17.2	11369	-15.2	11414.9	-13.7	11441.2	-12.8	11522.8	-10
12061.6	-10	12099.3	-9.5	12104.8	-9.5	12209.1	-8.1	12275.8	-7.3
12831.5	0	12851.8	0	13884	10	13948.1	10	14118.5	15.2
14276.6	20	14329.7	29.1	14334.7	30	14358.5	34.5	14387.2	40
14398.9	42.5	14434.1	50	14483	59.6	14485.1	60	14486.3	60.2
14543.2	70	14571.2	74.3	14609.3	80				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
1548.5	.026	4559.3	.026	9477.4	.026

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
4559.3	9477.4	9639	9639	.1	.3

Left Levee Station= 3445 Elevation= 50
Right Levee Station= 11435 Elevation= 50

CROSS SECTION OUTPUT Profile #PF 1

			Left OB	Channel	Right OB
E.G. Elev (ft)	19.82	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.45	Wt. n-Val.	0.026	0.026	0.026
W.S. Elev (ft)	18.37	Reach Len. (ft)	9639.00	9639.00	9639.00
Crit W.S. (ft)	-24.81	Flow Area (sq ft)	37566.89	361108.50	85037.65
E.G. Slope (ft/ft)	0.000104	Area (sq ft)	37566.89	361108.50	85037.65
Q Total (cfs)	4515602.00	Flow (cfs)	224433.90	3685647.00	605520.70
Top Width (ft)	7990.00	Top Width (ft)	1114.30	4918.10	1957.60
Vel Total (ft/s)	9.34	Avg. Vel. (ft/s)	5.97	10.21	7.12
Max Chl Dpth (ft)	88.37	Hydr. Depth (ft)	33.71	73.42	43.44
Conv. Total (cfs)	443116200.0	Conv. (cfs)	22023710.0	361672700.0	59419770.0
Length Wtd. (ft)	9639.00	Wetted Per. (ft)	1143.43	4922.13	1989.14
Min Ch El (ft)	-70.00	Shear (lb/sq ft)	0.21	0.48	0.28
Alpha	1.07	Stream Power (lb/ft s)	1.27	4.85	1.97
Frctn Loss (ft)	0.97	Cum Volume (acre-ft)	11575.51	79454.50	24112.64
C & E Loss (ft)	0.06	Cum SA (acres)	435.93	1088.28	738.61

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section.

This may indicate the need for additional cross sections.
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, energy was used.

Profile #PF 1

	Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1	LOB	3445.00	3723.58	44187.54	8416.64	307.68	0.98	30.21	5.25
2	LOB	3723.58	4002.15	53468.82	9069.10	278.58	1.18	32.56	5.90
3	LOB	4002.15	4280.73	59963.21	9714.81	278.58	1.33	34.87	6.17
4	LOB	4280.73	4559.30	66814.35	10366.35	278.59	1.48	37.21	6.45
5	Chan	4559.30	4805.21	88101.96	11688.74	246.61	1.95	47.53	7.54
6	Chan	4805.21	5051.11	186084.10	18362.78	248.52	4.12	74.67	10.13
7	Chan	5051.11	5297.02	248120.20	21730.75	245.90	5.49	88.37	11.42
8	Chan	5297.02	5542.92	248120.70	21730.79	245.91	5.49	88.37	11.42
9	Chan	5542.92	5788.83	248120.70	21730.79	245.91	5.49	88.37	11.42
10	Chan	5788.83	6034.73	243654.20	21495.74	245.92	5.40	87.41	11.34
11	Chan	6034.73	6280.64	229900.70	20759.42	245.92	5.09	84.42	11.07
12	Chan	6280.64	6526.54	216183.80	20007.19	245.93	4.79	81.36	10.81
13	Chan	6526.54	6772.45	202606.70	19243.52	245.93	4.49	78.26	10.53
14	Chan	6772.45	7018.35	190489.40	18544.36	245.92	4.22	75.41	10.27
15	Chan	7018.35	7264.26	178766.10	17850.86	245.92	3.96	72.59	10.01
16	Chan	7264.26	7510.16	167637.50	17175.64	245.92	3.71	69.85	9.76
17	Chan	7510.16	7756.07	161808.60	16814.32	245.91	3.58	68.38	9.62
18	Chan	7756.07	8001.97	161782.50	16812.65	245.90	3.58	68.37	9.62
19	Chan	8001.97	8247.88	161554.00	16798.42	245.91	3.58	68.31	9.62
20	Chan	8247.88	8493.78	159270.20	16655.56	245.91	3.53	67.73	9.56
21	Chan	8493.78	8739.69	160724.00	16746.63	245.91	3.56	68.10	9.60
22	Chan	8739.69	8985.59	161782.10	16812.62	245.90	3.58	68.37	9.62
23	Chan	8985.59	9231.50	157238.30	16532.08	246.07	3.48	67.23	9.51
24	Chan	9231.50	9477.40	113702.20	13615.63	246.33	2.52	55.37	8.35
25	ROB	9477.40	9966.80	180439.30	23577.10	489.40	4.00	48.18	7.65
26	ROB	9966.80	10456.20	166014.20	22427.53	489.41	3.68	45.83	7.40
27	ROB	10456.20	10945.60	145305.20	20704.46	489.41	3.22	42.31	7.02
28	ROB	10945.60	11435.00	113762.00	18328.54	520.91	2.52	37.45	6.21

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section.
This may indicate the need for additional cross sections.
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, energy was used.

CROSS SECTION

RIVER: Knik Arm
REACH: SEP05 Br Align RS: 0

INPUT
Description: Expansion Section on Downstream Side of Bridge
Expansion Section
on Downstream Side of Bridge
Station Elevation Data num= 178

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1548.5	80	1551.3	78.1	1564.1	70	1567.6	67.7	1568.3	67.2
1569.8	66.2	1573.5	63.3	1577.7	60	1580.8	57.3	1589.2	50
1592.8	46.9	1600.6	40	1613.1	31.3	1615	30	1655	25.6
1678.9	22.9	1704.3	20	1715.9	19	1725.6	18.2	1772.4	14.3

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1809.3	11.3	1814.9	10.9	1825.7	10	1826.8	10	1845.2	9.7
1846.5	9.7	1877	9.2	1899.7	8.9	1905.3	8.8	1930.7	8.4
1938.6	8.3	1964.1	7.9	1973.6	7.8	1997.1	7.4	2007	7.3
2055.8	6.5	2098.4	6	2112.9	5.8	2134.4	5.6	2150.4	5.3
2528.9	0	2566.8	0	2621.3	-.8	2623.3	-.8	2687.7	-1.7
2692.5	-1.8	2742.6	-2.5	2751.6	-2.6	2765.2	-2.8	2784.5	-3
2819.8	-3.5	2849.4	-3.9	3315.1	-10	3355.3	-10	3418.6	-10.5
3428.9	-10.6	3508.1	-11.2	3675.7	-12.6	3863.8	-14.2	4285.8	-17.7
4297.9	-17.8	4346.8	-18.2	4553.4	-20	4559.3	-20	4567.7	-20.6
4584.6	-21.9	4656.6	-27.2	4696	-30	4726.2	-32.4	4739	-33.4
4798.7	-38.1	4821.7	-40	4860.3	-45.5	4892.3	-50	4917.8	-54.6
4948.4	-60	4999.5	-69.9	4999.8	-70	5841.1	-70	6152.2	-66.1
6199.1	-65.6	6222.1	-65.3	6246.9	-64.9	6280.2	-64.5	6301.9	-64.3
6317.6	-64.1	6333.9	-63.9	6352.7	-63.6	6359	-63.6	6397.6	-63.1
6479.3	-62	6486.1	-61.9	6494.2	-61.8	6622.9	-60.2	6624.2	-60.1
6635.7	-60	6794.5	-58.2	6891.6	-57.1	6952.7	-56.4	7000.2	-55.8
7015.4	-55.6	7197.8	-53.6	7236.9	-53.2	7291.1	-52.5	7377.1	-51.6
7385	-51.5	7392	-51.4	7429.8	-51	7434	-51	7437	-50.9
7471.9	-50.6	7473.8	-50.5	7475.7	-50.5	7476.8	-50.5	7478.1	-50.5
7506.9	-50.2	7507.6	-50.2	7508.2	-50.2	7528.3	-50	8150.5	-50
8450.2	-49.1	8457.9	-49.1	8670.4	-50	9133.4	-50	9193.9	-46.4
9225.3	-44.8	9239.7	-43.8	9266.3	-42.1	9278.3	-41.5	9299.6	-40
9304.4	-39.7	9330.2	-38.3	9434.6	-32.4	9455.1	-31.3	9477.4	-30
9784.4	-30	10167.7	-27.8	10175.9	-27.8	10186.9	-27.7	10199	-27.6
10283.8	-27	10293.6	-27	10304.7	-26.9	10732.9	-23.7	10771.4	-23.4
10814	-23.1	10956.1	-22	11011.6	-21.6	11209.6	-20	11226.4	-20
11309.9	-17.2	11369	-15.2	11414.9	-13.7	11441.2	-12.8	11522.8	-10
12061.6	-10	12099.3	-9.5	12104.8	-9.5	12209.1	-8.1	12275.8	-7.3
12831.5	0	12851.8	0	13884	10	13948.1	10	14118.5	15.2
14276.6	20	14329.7	29.1	14334.7	30	14358.5	34.5	14387.2	40
14398.9	42.5	14434.1	50	14483	59.6	14485.1	60	14486.3	60.2
14543.2	70	14571.2	74.3	14609.3	80				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
1548.5	.026	4559.3	.026	9477.4	.026

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
4559.3	9477.4	0	0	0 .1	.3

CROSS SECTION OUTPUT Profile #PF 1

			Left OB	Channel	Right OB
E.G. Elev (ft)	18.79	Element			
Vel Head (ft)	1.25	Wt. n-Val.	0.026	0.026	0.026
W.S. Elev (ft)	17.54	Reach Len. (ft)			
Crit W.S. (ft)	-24.83	Flow Area (sq ft)	67055.81	357023.70	132899.20
E.G. Slope (ft/ft)	0.000098	Area (sq ft)	67055.81	357023.70	132899.20
Q Total (cfs)	4515602.00	Flow (cfs)	312775.20	3507842.00	694985.30
Top Width (ft)	12462.05	Top Width (ft)	2825.78	4918.10	4718.17
Vel Total (ft/s)	8.11	Avg. Vel. (ft/s)	4.66	9.83	5.23
Max Chl Dpth (ft)	87.54	Hydr. Depth (ft)	23.73	72.59	28.17
Conv. Total (cfs)	456832400.0	Conv. (cfs)	31642700.0	354879700.0	70309950.0
Length Wtd. (ft)		Wetted Per. (ft)	2826.27	4922.13	4718.61
Min Ch El (ft)	-70.00	Shear (lb/sq ft)	0.14	0.44	0.17
Alpha	1.23	Stream Power (lb/ft s)	0.68	4.35	0.90
Frctn Loss (ft)		Cum Volume (acre-ft)			
C & E Loss (ft)		Cum SA (acres)			

Profile #PF 1

	Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1	LOB	1548.50	1849.58	768.88	534.73	116.37	0.02	4.61	1.44
2	LOB	1849.58	2150.66	7432.00	3050.98	301.11	0.16	10.13	2.44
3	LOB	2150.66	2451.74	13274.37	4320.98	301.11	0.29	14.35	3.07
4	LOB	2451.74	2752.82	19757.30	5485.41	301.11	0.44	18.22	3.60
5	LOB	2752.82	3053.90	27342.43	6666.14	301.11	0.61	22.14	4.10
6	LOB	3053.90	3354.98	35867.19	7844.92	301.10	0.79	26.06	4.57
7	LOB	3354.98	3656.06	42239.13	8653.50	301.09	0.94	28.74	4.88
8	LOB	3656.06	3957.14	48561.53	9408.90	301.09	1.08	31.25	5.16
9	LOB	3957.14	4258.22	55240.80	10165.27	301.09	1.22	33.76	5.43
10	LOB	4258.22	4559.30	62291.64	10924.99	301.09	1.38	36.29	5.70
11	Chan	4559.30	4805.21	82959.88	11484.49	246.61	1.84	46.70	7.22
12	Chan	4805.21	5051.11	177115.00	18158.53	248.52	3.92	73.84	9.75
13	Chan	5051.11	5297.02	236847.60	21526.51	245.90	5.25	87.54	11.00
14	Chan	5297.02	5542.92	236848.10	21526.55	245.91	5.25	87.54	11.00
15	Chan	5542.92	5788.83	236848.10	21526.55	245.91	5.25	87.54	11.00
16	Chan	5788.83	6034.73	232544.20	21291.50	245.92	5.15	86.58	10.92
17	Chan	6034.73	6280.64	219293.40	20555.18	245.92	4.86	83.59	10.67
18	Chan	6280.64	6526.54	206081.10	19802.94	245.93	4.56	80.53	10.41
19	Chan	6526.54	6772.45	193006.70	19039.28	245.93	4.27	77.43	10.14
20	Chan	6772.45	7018.35	181341.30	18340.12	245.92	4.02	74.58	9.89
21	Chan	7018.35	7264.26	170058.30	17646.62	245.92	3.77	71.76	9.64
22	Chan	7264.26	7510.16	159350.80	16971.40	245.92	3.53	69.02	9.39
23	Chan	7510.16	7756.07	153743.80	16610.08	245.91	3.40	67.55	9.26
24	Chan	7756.07	8001.97	153718.60	16608.41	245.90	3.40	67.54	9.26
25	Chan	8001.97	8247.88	153498.90	16594.17	245.91	3.40	67.48	9.25
26	Chan	8247.88	8493.78	151302.30	16451.32	245.91	3.35	66.90	9.20
27	Chan	8493.78	8739.69	152700.60	16542.38	245.91	3.38	67.27	9.23
28	Chan	8739.69	8985.59	153718.30	16608.38	245.90	3.40	67.54	9.26
29	Chan	8985.59	9231.50	149348.90	16327.84	246.07	3.31	66.40	9.15
30	Chan	9231.50	9477.40	107515.50	13411.39	246.33	2.38	54.54	8.02
31	ROB	9477.40	9990.59	157732.00	24275.02	513.19	3.49	47.30	6.50
32	ROB	9990.59	10503.78	143839.50	22968.77	513.20	3.19	44.76	6.26
33	ROB	10503.78	11016.97	124423.70	21054.92	513.21	2.76	41.03	5.91
34	ROB	11016.97	11530.16	94609.31	17865.95	513.36	2.10	34.81	5.30
35	ROB	11530.16	12043.35	64031.26	14133.24	513.19	1.42	27.54	4.53
36	ROB	12043.35	12556.54	52643.17	12566.84	513.23	1.17	24.49	4.19
37	ROB	12556.54	13069.73	31691.08	9267.88	513.22	0.70	18.06	3.42
38	ROB	13069.73	13582.92	18189.37	6642.10	513.21	0.40	12.94	2.74
39	ROB	13582.92	14096.11	7727.57	3974.30	513.27	0.17	7.74	1.94
40	ROB	14096.11	14609.30	98.21	150.22	99.51	0.00	1.51	0.65

SUMMARY OF MANNING'S N VALUES

River:Knik Arm

Reach	River Sta.	n1	n2	n3
SEP05 Br Align	30	.026	.026	.026
SEP05 Br Align	20	.026	.026	.026
SEP05 Br Align	15	Bridge		
SEP05 Br Align	10	.026	.026	.026
SEP05 Br Align	0	.026	.026	.026

SUMMARY OF REACH LENGTHS

River: Knik Arm

Reach	River Sta.	Left	Channel	Right
SEP05 Br Align	30	3350	3350	3350
SEP05 Br Align	20	450	450	450
SEP05 Br Align	15	Bridge		
SEP05 Br Align	10	9639	9639	9639
SEP05 Br Align	0	0	0	0

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: Knik Arm

Reach	River Sta.	Contr.	Expan.
SEP05 Br Align	30	.1	.3
SEP05 Br Align	20	.1	.3
SEP05 Br Align	15	Bridge	
SEP05 Br Align	10	.1	.3
SEP05 Br Align	0	.1	.3

Profile Output Table - Standard Table 1

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
SEP05 Br Align	0	PF 1	4515602.00	-70.00	17.54	-24.83	18.79	0.000098	9.83	556978.70	12462.05	0.20
SEP05 Br Align	10	PF 1	4515602.00	-70.00	18.37	-24.81	19.82	0.000104	10.21	483713.10	7990.00	0.21
SEP05 Br Align	15		Bridge									
SEP05 Br Align	20	PF 1	4515602.00	-70.00	18.42	-24.81	19.88	0.000104	10.20	484147.10	7990.00	0.21
SEP05 Br Align	30	PF 1	4515602.00	-63.50	18.99		20.25	0.000108	9.88	551255.30	12844.40	0.21

Profile Output Table - Standard Table 2

Reach	River Sta	Profile	E.G. Elev (ft)	W.S. Elev (ft)	Vel Head (ft)	Frctn Loss (ft)	C & E Loss (ft)	Q Left (cfs)	Q Channel (cfs)	Q Right (cfs)	Top Width (ft)
SEP05 Br Align	0	PF 1	18.79	17.54	1.25			312775.20	3507842.00	694985.30	12462.05
SEP05 Br Align	10	PF 1	19.82	18.37	1.45	0.97	0.06	224433.90	3685647.00	605520.70	7990.00
SEP05 Br Align	15		Bridge								
SEP05 Br Align	20	PF 1	19.88	18.42	1.45	0.02	0.00	224711.70	3684976.00	605914.30	7990.00
SEP05 Br Align	30	PF 1	20.25	18.99	1.26	0.35	0.02	442921.40	3455830.00	616850.20	12844.40

Profile Output Table - Six XS Bridge

Reach	River Sta	Profile	E.G. Elev (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Frctn Loss (ft)	C & E Loss (ft)	Top Width (ft)	Q Left (cfs)	Q Channel (cfs)	Q Right (cfs)	Vel Chnl (ft/s)
SEP05 Br Align	0	PF 1	18.79	17.54	-24.83			12462.05	312775.20	3507842.00	694985.30	9.83
SEP05 Br Align	10	PF 1	19.82	18.37	-24.81	0.97	0.06	7990.00	224433.90	3685647.00	605520.70	10.21
SEP05 Br Align	15 BR D	PF 1	19.85	18.38	-24.81	0.02	0.00	7990.00	215592.60	3697285.00	602724.10	10.24
SEP05 Br Align	15 BR U	PF 1	19.85	18.39	-24.81	0.01	0.00	7990.00	215631.70	3697191.00	602779.30	10.24
SEP05 Br Align	20	PF 1	19.88	18.42	-24.81	0.02	0.00	7990.00	224711.70	3684976.00	605914.30	10.20
SEP05 Br Align	30	PF 1	20.25	18.99		0.35	0.02	12844.40	442921.40	3455830.00	616850.20	9.88

Profile Output Table - Bridge Only

Reach	River Sta	Profile	E.G. US. (ft)	Min El Prs (ft)	BR Open Area (sq ft)	Prs O WS (ft)	Q Total (cfs)	Min El Weir Flow (ft)	Q Weir (cfs)	Delta EG (ft)
SEP05 Br Align	15	PF 1	19.88	50.00	726304.00		4515602.00	50.01		0.05

Table C-3: Scour Assessment at 2 August 2004 Spring Ebb Tide Peak Discharge and Proposed September 2005 Knik Arm Bridge

```
1:   ************************************************
2:   *      Maryland State Highway Administration       *
3:   *              Abutment Scour Program              *
4:   *      Version 7 Build 1.01, August 25, 2005       *
5:   ************************************************
6:
7:   Time stamp: 11/16/2005 5:49:58 PM
8:
9:   Input Data:
10:
11:  Project information:
12:  ---------------------------------------------------------------------------------------------------------
13:  Project name: Knik Arm Bridge
14:  Project number:
15:  Description: 2 August 2004 Spring Ebb Tide at Proposed September 2005 Bridge
16:
17:
18:  Project options:
19:    Program calculates critical and boundary shear stresses at approach section
20:    Program decides the scour type as either live bed or clear water scour
21:    Program calculates the unit width discharge at the bridge section
22:    Program calculates critical velocity at bridge section
23:    Program calculates sediment transport parameter k2
24:    Program calculate the flow velocity at abutment face
25:    Clear-water scour uses Neill's method
26:    English Units
27:    Section orientation is looking downstream
28:
29:  Approach Section Data:
30:  ---------------------------------------------------------------------------------------------------------
31:                                                                    Left        Channel          Right
32:                                                                    ------------------------------------
33:  Approach section discharge (cfs):                          442921.40     3455830.00      616850.20
34:  Approach section top width (ft):                            2768.98        5160.30        4915.12
35:  Approach flow depth (hydraulic depth) (y1) (ft):               28.72          67.78          24.82
36:  Approach median particle size, D50(ft):                   0.0005249      0.0005249      0.0005249
37:  Bank slope (Z) in the vicinity of the bridge (Z=H/V):           0.01                          0.006
38:  Energy slope (S) at approach section: 0.000108
39:
40:  ABSCOUR Overrides
41:
42:  Reserved for override approach critical shear stress
43:  Reserved for override approach boundary shear stress
44:  Reserved for override scour type
45:  Reserved for override sediment transport parameter
46:  Reserved for override location header
47:  Reserved for override unit width discharge
48:  Reserved for override critical velocity
49:  Reserved for override 2-D velocity at abutment
50:  Reserved for override average velocity in portion of bridge
51:
52:  Downstream Bridge Data:
53:  ---------------------------------------------------------------------------------------------------------
54:  Downstream water surface elevation under bridge: 18.38  ft
55:
56:                                                                    Left        Channel          Right
57:                                                                    ------------------------------------
58:  HEC-RAS discharge under Bridge (cfs):                       215592.60     3697285.00      602724.10
59:  Waterway area (A) measured normal to flow (sf):              36295.84      361169.10       84208.48
60:  Top width (T) measured normal to flow (ft):                  1114.30        4918.10        1957.60
61:  Hydraulic depth (A/T) (ft):                                     32.57          73.44          43.02
62:  ABSCOUR X-Section elevation (#54-#61) (ft):                   -14.19         -55.06         -24.64
63:  Abutment type:                                          Spill-through                  Spill-through
64:  Setback (- for an abutment in channel) (ft):                    1025                           1853
65:  Low chord elevation downstream side of bridge (ft):             49.0           49.0           49.0
66:  Correction factor for low chord submergence (#54-#65>0)(ft):    0.00           0.00           0.00
67:  Median particle size under bridge, D50(ft):               0.0005249      0.0005249      0.0005249
68:  Estimated long-term aggradation(+) or degradation(-) (ft):          0              0              0
69:  Safety factor (typical ranges 1.2 to 1.4): 1.1
70:
```

Upstream Bridge Data

Water surface elevation upstream side of bridge: 18.39 ft

	Left	Channel	Right
Water depth at upstream side of bridge (#73-#62) (ft):	32.58	73.45	43.03
Low chord elevation upstream side of bridge (ft):	49	49	49
Low chord height (#78-#62) (ft):	63.19	104.06	73.64
Pressure flow, Yes or NO: (Yes if #77>#79)	No	No	No
X1: (ft):	100		125
X2: (ft):	1715		2750
Ratio (X1/X2):	0.06		0.05
Embankment skew angle (degrees):	90		90

Is future lateral migration of channel likely to occur?: No

Output Computation And Results

Approach Section:

Total approach discharge (cfs): 4515601.6

	Left	Channel	Right
Approach average flow velocity (fps):	5.57	9.88	5.056
Approach unit width discharge (cfs/ft):	159.958	669.696	125.501
Approach section depth (ft):	28.72	67.78	24.82
Approach section Froude Number:	0.1831	0.2115	0.1789
Approach section critical shear stress(psf):	0.0021	0.0021	0.0021
Approach boundary shear stress(psf):	0.1935	0.4568	0.1673
Approach sediment transport parameter (k2):	0.639	0.638	0.639
Scour type:	Live Bed	Live Bed	Live Bed

Downstream Bridge Computations:

Total discharge under Bridge (cfs): 4515601.7

	Left	Channel	Right
Method of computing flow velocity adjustment:	Medium Setback		Medium Setback
Flow velocity (fps):	7.678	10.237	8.002
Adjustment to hydraulic depth (y0)adj (ft):	32.573	73.437	43.016
Unit width discharge (#110*#109)(cfs/ft):	250.09	751.771	344.221
Critical velocity (fps):	N/A	N/A	N/A

Downstream Contraction Scour Computations:

	Left	Channel	Right
Clear water scour flow depth (y2)(ft):	42.917	89.719	53.161
Live bed scour flow depth (y2)(ft):	38.205	72.969	47.279
Interpolated scour flow depth (y2)(ft):	**38.205**	**72.969**	**47.279**
Pressure flow coefficient (Kp):	1	1	1
Adjusted scour flow depth (y2)adj (#121*#120(ft):	38.205	72.969	47.279
Contraction scour depth (ys) (#122-#110>0)(ft):	**5.632**	**0**	**4.263**
Final contraction scour depth (#123*#69)(ft):	6.195	0	4.689
Contraction scour elevation(#54-#110-#124-#66)(ft):	-20.388	-55.057	-29.325

Total Bridge Scour At Abutment:

	Left	Channel	Right
Abutment local velocity factor (Kv):	1.409		1.176
Abutment spiral flow factor (Kf):	1.222		1.204
Pressure flow coefficient (Kp):	1		1
Abut. scour flow depth (y2a)adj(#120*#132*#131^#100*#133)(ft):	**58.114**		**63.141**
Initial abutment scour depth (ysa)(#134-#110>0)(ft):	25.541		20.125
Coefficient for abutment shape factor (Kt):	1		1
Coefficient for embankment angle (Ke):	1		1
Final abutment scour depth (ysa)adj(#135*#136*#137*#69)(ft):	**28.095**		**22.137**
Abutment scour elevation(#54-#110-#139-#66)(ft):	-42.288		-46.774