

**ADDENDUM TO APPENDIX III.
HYDRODYNAMIC MODELING TO DETERMINE CUMULATIVE EFFECT OF
THE KNIK ARM CROSSING WITH THE PORT OF ANCHORAGE EXPANSION**

1.0 INTRODUCTION

The draft report for the proposed Knik Arm Crossing (KAC), *Hydrology and Hydraulic Environment of Knik Arm* (URS 2005), addressed the hydrodynamic processes that could potentially be affected by the proposed KAC. Two crossing alternatives were considered in that report: 8,200-ft pier-supported bridge with gravel fill embankments (Alternative 1); and 14,000-ft bridge, pile-supported roadway (Alternative 2). The potential changes to current velocities, flow patterns, and sedimentation rates were analyzed using the MIKE 21 hydrodynamic model developed by the Danish Hydraulic Institute (DHI). The model was calibrated and verified to Knik Arm conditions with extensive data sets developed during the summers of 2004 and 2005 (Smith 2004, Smith et al. 2005). These periods included the oceanographic processes considered essential for representation in the models.

In the URS (2005) draft report, potential effects of the two KAC alternatives were compared to the Base Case scenario, which represented existing hydrographic conditions. The model geometry and roughness parameters were adjusted from Base Case to represent the two bridge alternatives. These scenarios incorporated existing conditions at the Port of Anchorage; however, the Port is planning a major expansion, which is to be completed by 2012. Effects of the proposed KAC, acting in concert with the future configuration of the Port of Anchorage, are cumulative effects, which must be considered in the KAC Environmental Impact Statement. In this Addendum we describe the methods used to evaluate the cumulative effects of the proposed KAC. These effects are determined by comparing hydrodynamic modeling results obtained with the completed Port expansion represented in the model, both with and without the proposed 8,200-foot KAC.

1.1 Method

The Port of Anchorage expansion was represented in the model by filling in an area approximately 10,000 ft long and 1,000 ft wide along the existing port, as represented in the environmental assessment for the Port expansion (Ebersole and Raad, 2004). Relative to existing conditions, the model water elements in the Port area were converted to land to account for the expanded port. Figure III-A.1¹ shows the bathymetry used for the Base Case scenario and the bathymetry used for the scenario with the expanded port and the 8,200-foot bridge. The 14,000-ft bridge alternative was not modeled with the expanded port because the November 2005 report showed only very minor changes in hydrodynamics compared to the Base Case.

For this study, the scenario with the 8,200-ft bridge and the expanded port were compared to a scenario without the bridge, but with the expanded port to determine

¹ All figures are placed at the end of the narrative.

the effects of the KAC on the port. The same tidal boundary conditions, inflows, and suspended sediment concentrations used in the previous modeling described in Appendix III of the November 2005 report were used for this analysis.

1.2 Results

Figures III-A.2 and III-A.3 show the Root-Mean-Square (RMS) speed and maximum speed of currents for the scenario with the expanded port but without the proposed KAC. Over a 28-day tidal cycle the *average* speed in the main channel is between 1.2 and 1.8 m/s, while the *peak* speed is between 2.1 and 3 m/s. The average speed decreases to less than 0.6 m/s near shore. These results are nearly identical to the results for the Base Case scenario presented in the November 2005 report (compare to Figures 6.1-1 and 6.1-2 in Appendix III), which indicates that the Port expansion has little effect on hydrodynamics in Knik Arm.

The effects of the proposed 8,200-ft bridge are shown with respect to changes in current speeds (Figures III-A.4 through III-A.9) and sedimentation rates (Figure III-A.10 and III-A.11).

Figures III-A.4 and III-A.5 show flow patterns with and without the bridge during a spring and neap tide respectively. During a flood tide there is a small narrowing of the flow past the bridge location. This effect is amplified during an ebb tide when the flow narrows and forms a jet-like flow between the bridge embankments and Cairn Point. This forms an area of lower flow speeds between the channel and shore from the bridge embankments to Cairn Point.

Project effects on current speeds are shown in Figures III-A.6 through III-A.9. During a flood tide there is an increase in maximum current speed north of the bridge of about 0.2 to 0.3 m/s (see Figure III-A.6). Behind the embankments there is a decrease in maximum current speed of over 1 m/s mostly north of the bridge. The effects of the bridge are larger during an ebb tide when current speeds are generally larger even during the Base Case. Figure III-A.7 shows the difference in maximum speed during a spring ebb tide. It should be noted that the exact pattern shown in the figure changes with time, especially at the location of the eddy just north of Cairn Point. However, the increase in speed in the center of the channel is about 0.5 to 0.75 m/s and persists as far as 1.5 km south of the bridge Alignment. This is due to the flow accelerating through the bridge opening and past Cairn Point (see Figures III-A.4 and III-A.5).

The difference in RMS speed is shown in Figure III-A.8 and the difference in the maximum speed over the 28-day period is shown in Figure III-A.9. In terms of average speed, the greatest change is near the distal ends of the bridge approach embankments where there is an increase of 0.15 to 0.3 m/s. This may be sufficient to cause scour at the tips, though the increase is small relative to the ability of the sediments to resist erosion. Figure III-A.9 shows the maximum change in current speed over a 28-day tide cycle; that is, this figure shows the difference in maximum speed at each location in the model with and without the bridge without regard to time. The project effects on current speeds shown for the Port of Anchorage expansion in Figures III-A.6 through

III-A.9 are virtually identical to the project effects shown without the expansion in Figures 6.2-4 through 6.2-9 in Appendix III of the November 2005 report.

Figures III-A.10 and III-A.11 show the expected changes in sedimentation *rates* due to the proposed KAC with the Port of Anchorage expansion in place. The model was not used to simulate morphological changes in the seabed over time, but rather, changes in patterns of erosion and deposition as indicated by sedimentation rates. However, it can be inferred that areas with changes to erosion and deposition rates would generally correspond to locations with morphological or seabed changes. As would be expected, the rates of deposition increase greatly on both sides of the embankments due to current speed reductions in those areas. The area affected by the KAC project extends about two kilometers to the north and south of the proposed alignment. The rate of increase in sedimentation behind the embankments is predicted to be large due to the high sediment concentrations observed (>5,000 mg/L, Smith 2004, Smith et al. 2005). The blue areas in Figure III-A.11 indicate areas with reduced sedimentation rates, as compared to the Base Case. This can be attributed to two factors. First, the increased accumulation of sediment behind the embankments deprives sediment from other locations. That is, close to shore behind the embankments there is less sediment after the project because sediment can settle out of the water column farther from shore with the embankments in place. Second, from Cairn Point to the south there is less accumulated sediment after the project because much of the sediment is trapped behind the embankments and is thus not available to settle out elsewhere.

In the two eddies (one on the east side north of Cairn Point and one on the west side south of Cairn Point) there is a strengthening of the eddies. This results in less sedimentation at these locations.

The rates shown in the figures are maximum sedimentation rates. It is anticipated that these high rates of erosion or deposition would quickly decrease as the bed changes in elevation. The areas with high rates of sedimentation are indicative of areas that will quickly fill in with sediment.

When comparing Figures III-A.10 and III-A.11 to the results without the Port of Anchorage expansion (Figure 6.2-10 in Appendix III of the November 2005 report), the sedimentation effects of the project appear virtually identical. However, a comparison of these two figures shows that sediment is not expected to accumulate along the expanded port.

2.0 REFERENCES

Ebersole, B., and Layla Raad. 2004. Tidal circulation modeling study to support the Port of Anchorage expansion (Appendix E) *in* Port Intermodal Expansion Project: Marine Terminal Redevelopment Environmental Assessment, U. S. Maritime Administration, March 2005.

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