Preliminary Hydraulic and Hydrology Report
Kuchoruk Creek Bridge

February 18, 2008

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A Report Prepared For:

Alaska Department of Transportation and Public Facilities
Fairbanks, Alaska

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1.0 Introduction

The Alaska Department of Transportation and Public Facilities (AKDOT&PF) wishes to construct a new bridge on an airport access road to cross Kuchoruk Creek near Noatak, Alaska. This report discusses the hydrologic and hydraulic aspects of the proposed bridge.

2.0 Project Location and Description

The proposed bridge will replace an existing foot bridge that crosses Kuchoruk Creek approximately 2400 feet upstream (Figure 1). The bridge is part of an ADOT&PF project to construct a new airport in Noatak, located approximately 1.5 miles east of the existing airport. The airport will include a new runway approximately 5,000 feet long by 100 feet wide with a safety area, apron, and taxiway; and a 1.5-mile long access road. The new bridge will allow vehicle traffic to cross Kuchoruk Creek on the new access road.

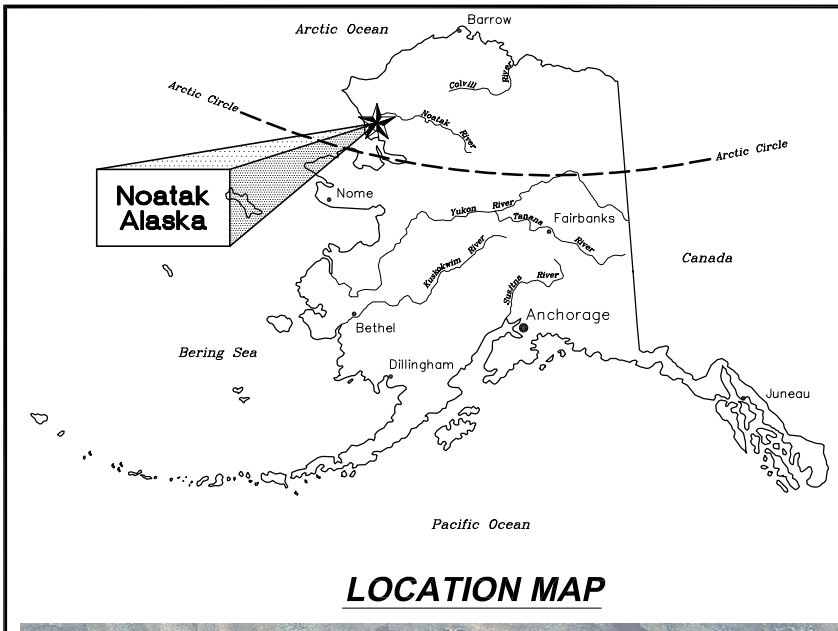
The existing bridge is a very small structure and does not support vehicle traffic. There are currently two proposed bridge designs for this site. Alternative 1 is a single span, 152.5-foot long prefabricated modular bridge. Alternative 2 is a single span, 152.5-foot long steel plate-girder bridge. The bridge design is aligned perpendicular to the stream channel. There are no intermediate piers for either of the two clear span designs.

3.0 Standards

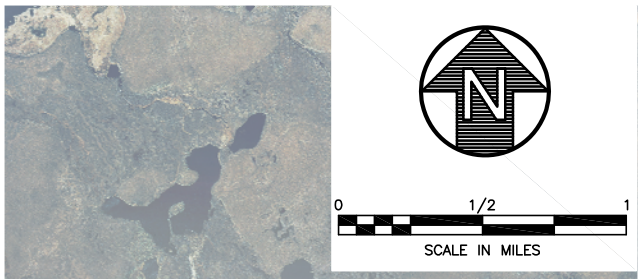
The standards which govern the hydraulic design of the proposed structure were selected in accordance with the criteria and procedures given within the following references:

- Highway Preconstruction Manual, 1983, updated December 1998, State of Alaska, Department of Transportation and Public Facilities

- Alaska Highway Drainage Manual, January 1995, State of Alaska, Department of Transportation and Public Facilities



LOCATION MAP



KUCHORUK CREEK

PROPOSED AIRPORT ACCESS ROAD

VILLAGE OF NOATAK

EXISTING FOOTBRIDGE LOCATION

PROJECT SITE
PROPOSED BRIDGE LOCATION

PROPOSED AIRPORT

EXISTING
AIRPORT

NOATAK RIVER

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NOATAK AIRPORT RELOCATION
STATE OF ALASKA, DEPARTMENT OF TRANSPORTATION
PROJECT LOCATION
NOATAK, ALASKA

DATE:	2/12/08	DRAWN BY:	MMHN	SHEET:	FIGURE 1
SCALE:	SHOWN	CHECKED BY:	LMH	JOB NO.:	05-113

4.0 Hydraulic History

Typical of most of Alaska, little information is available concerning historical floods on Kuchoruk Creek. The nearest downstream confluence is with the Noatak River, approximately 5 miles downstream from the project site. An inactive USGS gaging station (15746000) is located on the Noatak River at the village of Noatak approximately 1 mile from the project site. With a drainage area of 12,000 square miles, the Noatak River's largest recorded flood in the period of record from 1965 to 1971 was 240,000 cfs (July 20, 1967). The ordinary high water (OHW) boundary at the new bridge site occurs approximately at elevation 65.2 feet.

5.0 Hydrology

Since this site is ungaged, flood magnitude estimations were developed using USGS regression equations for estimating the magnitude of peak streamflows in Alaska. The latest USGS regression method for estimating peak streamflows at ungaged locations is described in the USGS Water Resources Investigations Report 03-4188. Basin characteristic information is used in the USGS regression analysis.

For Region 7, the sole characteristic in the regression equation is drainage area upstream from the site. For the Kuchoruk Creek watershed, the area of drainage was obtained by planimetric techniques used with USGS 1:63360 quad maps. The drainage area is 29.5 square miles.

The estimated flood frequency magnitudes for the Q2 through Q500 floods are shown in Figure 2 and Table 1. Confidence limits provide a measure of the error in a particular prediction. The 5% and 95% confidence limits provide a 90% prediction interval for a particular site. Because the project site is ungaged and has limited historic hydraulic information, the upper confidence limit (95%) was calculated and included in Table 1.

Figure 2. Estimated discharge and exceedance probability for new bridge at Kuchoruk Creek near Noatak, Alaska.

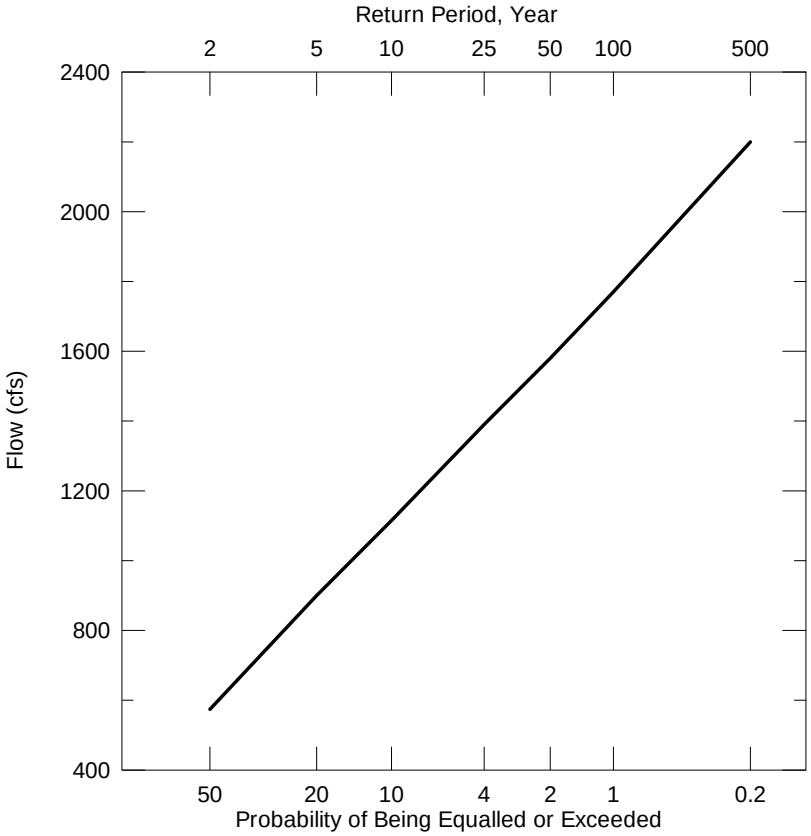


Table 1. Flood magnitude for Q2 through Q500 flood, with 95% upper confidence limit.

Recurrence Interval	Discharge (cfs)	95% Confidence (cfs)
2	574	1280
5	900	1940
10	1120	2400
25	1390	3000
50	1580	3460
100	1770	3930
500	2200	5100

6.0 Hydraulics

6.1 Overview

The hydraulic analysis for the Kuchoruk Creek project site consisted of modeling the flow characteristics using the U.S. Army Corps of Engineers Hydrologic Engineering Center water surface profiling computer program HEC-RAS version 3.1.3 for the existing and proposed structures. Three hydraulic runs were conducted:

- Existing Conditions
- Alternative 1 (prefabricated modular bridge) (Figure 3)
- Alternative 2 (steel plate-girder bridge) (Figure 4)

Floodplain and channel cross sections above and below the crossings were taken directly from field surveys performed by R&M Consultants, Inc. during November 2005 and December 2006. Cross sections begin 200 feet upstream of the proposed bridge site, and end 200 feet downstream of the site. A discharge measurement by ADOT&PF personnel was used to calibrate the hydraulic model at low flow. Channel and overbank roughness coefficients were estimated based on engineering judgment.

Figure 3. Kuchoruk Creek Bridge Cross Section Model Output, 500-year Flood, Alternative 1.

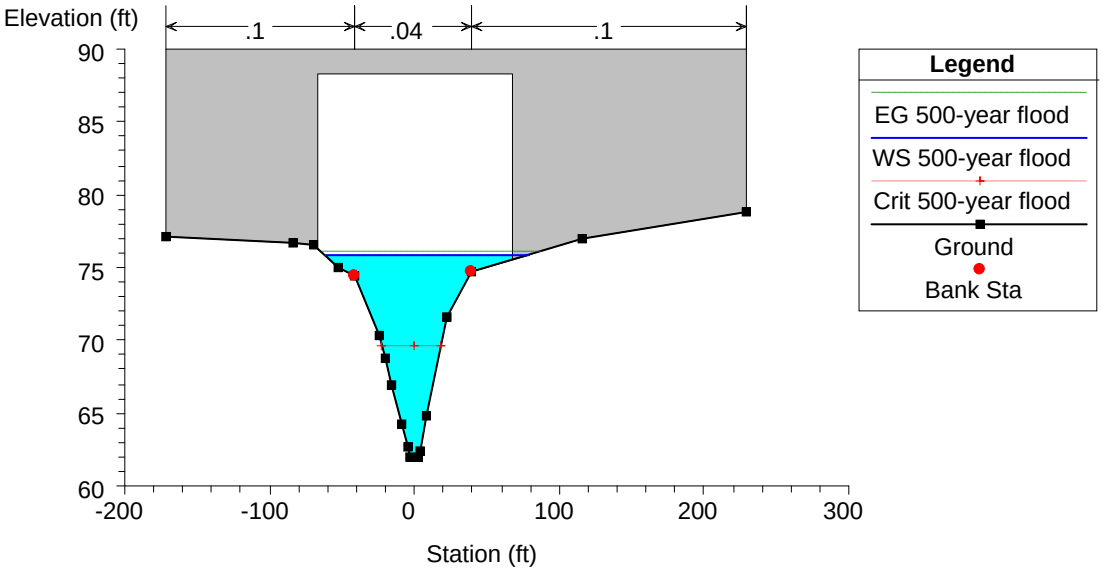
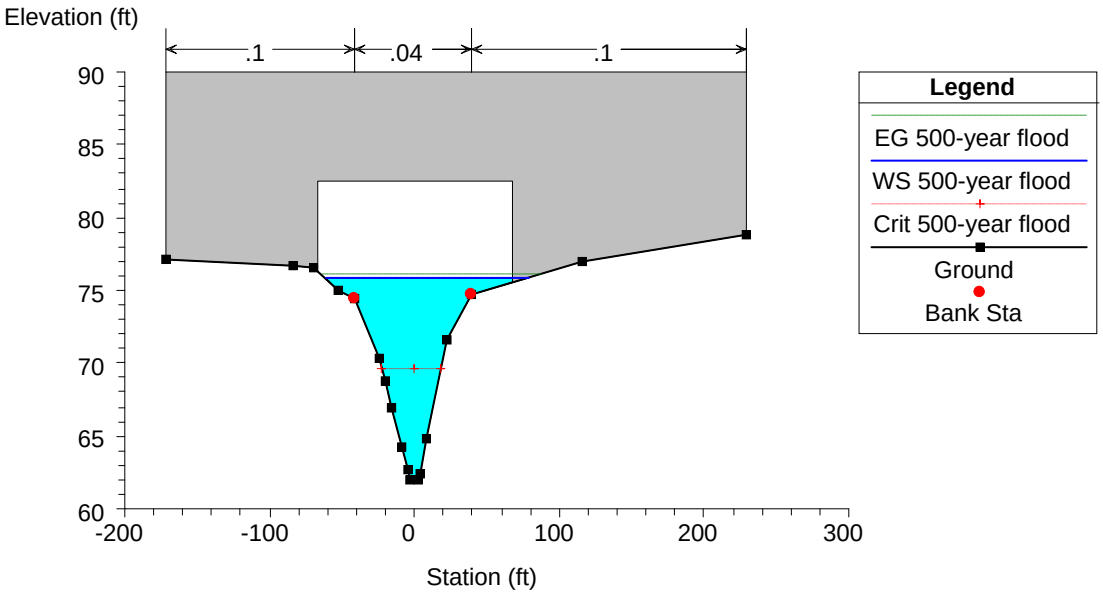


Figure 4. Kuchoruk Creek Bridge Cross Section Model Output, 500-year Flood, Alternative 2.



6.2 Design High Water

The computed design high water elevations and a summary of the modeling results for the existing conditions and proposed structures are presented in Table 2. The table presents information for cross section number 4, which is immediately upstream of the proposed structure. Input and output data files are included on an accompanying CD.

Table 2. Computed design high water elevations and modeled hydraulic parameters for the two proposed bridge alternatives. Information is for Cross-section 4, located immediately upstream of the proposed structure.

At Cross-Section 4	Min Channel Elevation (ft)	W.S. Elev. (ft)	E.G. Elev. (ft)	E.G. Slope (ft/ft)	Channel Velocity (ft/sec)	Froude Number
Discharge = 1580 cfs (Q50)						
Existing	61.99	74.57	74.74	0.00082	3.36	0.24
Alternative 1	61.99	74.58	74.75	0.00082	3.36	0.24
Alternative 2	61.99	74.58	74.75	0.00082	3.36	0.24
Discharge = 1770 cfs (Q100)						
Existing	61.99	75.06	75.25	0.00080	3.48	0.24
Alternative 1	61.99	75.06	75.25	0.00080	3.47	0.24
Alternative 2	61.99	75.06	75.25	0.00080	3.47	0.24
Discharge = 2200 cfs (Q500)						
Existing	61.99	75.91	76.13	0.00080	3.79	0.25
Alternative 1	61.99	75.92	76.14	0.00080	3.78	0.24
Alternative 2	61.99	75.92	76.14	0.00080	3.78	0.25

Both at the design flood and at the 500-year flood, no increase in the water surface elevation is noted at Cross Section 4 when comparing Alternatives 1 and 2 to the no bridge condition.

6.3 Scour

Scour potential for the proposed structure has been evaluated for the Q100 and Q500 discharges. Bridge scour calculations were conducted using the bridge scour hydraulic design function within the HEC-RAS 3.1.3 software program.

In addition to other input data requirements, calculations for estimating contraction scour require the D_{50} bed material particle sizes. From a review of soil borings taken at the new bridge foundation locations, the representative particle size for a depth of 17 feet was selected: the D_{50} = 5 millimeters.

Estimated contraction and abutment scour depths for the two alternatives are included in Tables 3 and 4, respectively. The contraction scour depth is relative to the existing cross-section elevations across the contracted section. The local scour depths calculated for the abutments are relative to the existing ground elevations at their respective locations. Though individual scour depths are calculated for both the right and left abutments, only the maximum depths are listed in the tables.

6.4 Debris clearance

For Alternative 1, a minimum clearance of more than 13 feet is provided between the design approach water surface elevation and the estimated low chord of the bridge (88.4 feet), which will allow for passage of ice and debris. For Alternative 2, a minimum clearance of more than 7 feet is provided between the design approach water surface elevation and the estimated low chord of the bridge (82.5 feet), which will allow for passage of ice and debris.

6.5 Riprap

For Alternative 1, the HEC-RAS run calculated average velocities at the upstream bridge cross-section of 3.4 feet/sec (Q50), 3.5 feet/sec (Q100) and 3.8 feet/sec (Q500). For Alternative 2, velocities of 3.4 feet/sec (Q50), 3.5 feet/sec (Q100), and 3.8 feet/sec (Q500) were calculated. It is recommended that Class I riprap be placed over a filter fabric at the base of the abutments for scour protection.

7.0 Conclusions

7.1 Hydraulic and Hydrologic Summary Tables

Tables 3 and 4 below provide the Hydraulic and Hydrologic Summary for the two alternatives.

7.2 Hazards to Adjacent Properties

There will be no increase in hazard to properties adjacent to the proposed structures.

Table 3. Preliminary Hydraulic and Hydrologic Summary for Kuchoruk Creek Bridge, Alternative 1.

PRELIMINARY HYDRAULIC & HYDROLOGIC SUMMARY			
Flood Frequency (year)	50	100	500
Exceedance Probability (%)	2	1	0.2
Design Discharge (cfs)	1580	1770	2200
Design High Water (ft)	74.6	75.1	75.9
Anticipated Additional Backwater (ft)	0.0	0.0	0.0
Contraction Scour (ft)	nc	0.0	0.0
Abutment Scour (ft)	nc	0.0	1.3
Pier Scour (ft)	na	na	na

nc = not calculated
na = not applicable

Drainage Area, this crossing: 29.5 mi^2

Hydraulic Capacity: 17,000 cfs at low chord roadway elevation of 88.4 feet approximately 56 feet from bridge, which has an exceedance probability of less than 0.2 percent.

Total Scour = Contraction Scour + Local Scour

Table 4. Preliminary Hydraulic and Hydrologic Summary for Kuchoruk Creek Bridge, Alternative 2.

PRELIMINARY HYDRAULIC & HYDROLOGIC SUMMARY			
Flood Frequency (year)	50	100	500
Exceedance Probability (%)	2	1	0.2
Design Discharge (cfs)	1580	1770	2200
Design High Water (ft)	74.6	75.1	75.9
Anticipated Additional Backwater (ft)	0.0	0.0	0.0
Contraction Scour (ft)	nc	0.0	0.0
Abutment Scour (ft)	nc	0.0	1.3
Pier Scour (ft)	na	na	na

nc = not calculated
na = not applicable

Drainage Area, this crossing: 29.5 mi^2

Hydraulic Capacity: 8,500 cfs at low chord roadway elevation of 82.5 feet approximately 54 feet from bridge, which has an exceedance probability of less than 0.2 percent.

Total Scour = Contraction Scour + Local Scour