HYDROLOGY/HYDRAULIC/SCOUR REPORT

INTRODUCTION

TranSystems prepared this report to provide documentation of the engineering calculations used in the analysis of the existing and proposed bridges at this crossing. The existing bridge is a 125' long through truss (total bridge length of 131') that has been in place since 1936. The truss is founded on two concrete abutments with spread footings.

HYDRAULIC SITE VISIT

A hydraulic site visit was made at the existing crossing of U.S. Route 1 over Crane Mill Stream in December of 2011 and again in May of 2012. The upstream floodplain is wide and flat and consists mainly of trees and thick underbrush. The area upstream of the bridge is swampy and a beaver dam was observed immediately upstream and under the existing bridge. At the time of the site visit, the main channel was inundated by the backwater from the beaver dam. However, the project survey and supplied contour information indicate a low flow channel that is 15' - 20' wide and meanders just upstream of the bridge.

The downstream floodplain is notably more narrow and steeper down to the downstream dam, which is approximately 350' downstream of the bridge. The dam is constructed of stone and has a rectangular weir opening that is approximately 10' wide and 12' high. TranSystems personnel spoke with Mr. Aaron Bell whose family owns the property on which the dam is located. Mr. Bell spoke of a recent flood event in which the water reached within approximately 2' of the top of this dam with a raging torrent flowing through the weir opening. The channel between the bridge and the dam is well defined and approximately 10' - 15' wide.

Approximately 3,300' downstream from the dam is a 45' long single span bridge founded on rock outcroppings. There is a narrow rock channel immediately downstream of the bridge that extends out into the bay. The area between this bridge and the upstream dam is tidally influenced. As a result, the floodplain here is clear with little to no vegetation within the tide range. Mr. Bell provided information regarding the tides on his families' property. He said, "*the typical tide range is 14' - 15' with peaks as high as 19' when the pressure is high and the moon is strong*".

HYDROLOGY

The design and check discharges were provided by Maine DOT. These discharges are based on a drainage area of 3.39 mi^2. TranSystems' independent check of the drainage area is 3.23 mi^2. The 3.39 mi^2 area is used for this study. The available FEMA data was researched and no FIS exists for Edmunds Township. A review of the existing bridge plans reveals a high water event from 1923 +/-. The elevation shown was converted from the previous datum to the current project survey. A summary of the discharges used for this study are shown in the following table:

Drainage Area	3.39 mi^2
Q25	343.3 ft^3/s
Design Discharge (Q50))	458.6 ft^3/s
Check Discharge (Q100)	539.2 ft^3/s
Scour Check Discharge (Q500)	742.7 ft^3/s
Ordinary Highwater (Q1.1)	19.56
Flood of Record (1923 +/-)	Elevation 31.1

At its' outlet into Whiting Bay, Crane Mill Stream is subject to a significant tide range. The National Oceanic and Atmospheric Administration (NOAA) data was investigated for this site to determine the tidal impact to the project site. NOAA has a subordinate gage site at Gravely Point in Whiting Bay, which is in close proximity to the Crane Mill Stream outlet. The mean high water (MHW) at this gage is 18.57' and the mean higher high water (MHHW) is 18.98'. At the reference station of Passamaquoddy Bay, the MHHW is slightly higher at 19.32'. This reference station has a published high water level of 24.14' from April 6, 1977.

HYDRAULICS

As previously stated, no FEMA floodway has been established and therefore no FEMA coordination is required. Although Crane Mill Stream is subjected to a significant tide range at the downstream bridge, the stream bed elevation is much higher at the project site. This along with the influence of the downstream dam, prevents the tides from controlling the elevations at this site. As a result, all of the existing and proposed models are based on normal depth.

Both the existing and proposed conditions were modeled under two possible downstream dam scenarios. First with the dam in its' current state, with the gates removed, and second, in a "restored" condition. It is our understanding that a local property owner has the right to return the existing dam to its' previous function. To model this condition, it was assumed that some type of gate system would be employed, thereby closing off the existing rectangular weir and returning the dam to its' full height across the entire width of the dam.

SUMMARY

The appropriate hydraulic and hydrological procedures were used in this study's development. No regulatory floodway has been established for Crane Mill Stream. Therefore, no FEMA or Community coordination is required. The results are reasonable and within MaineDOT guidelines for backwater values, velocities and scour depths. The proposed Composite Arch Bridge was selected as the preferred alternate that provides acceptable setback from the endfill toes to the channel banks while providing acceptable velocity values. As previously discussed, the existing and proposed bridges were analyzed with the downstream dam in place (existing dam) as well as with the

dam restored to its' previous height (restored dam). The results of these two modeling scenarios are summarized in the following tables:

Existing Dam in Place	Existing Bridge 125 ft span (90 degrees)	Proposed Bridge 60 ft span (23 degrees)
Headwater El. @ Q25	23.19	23.16
Headwater El. @ Q50	23.91	23.88
Headwater El. @ Q100	24.64	24.62
Discharge Velocity @ Q50	2.55	2.40
Discharge Velocity @Q100	2.54	2.40
Ordinary High Water (Q1.1)	19.56	19.47
Discharge Velocity @ Q1.1	1.51	1.58
Clearance @ Q50	8.19	9.52

Restored Dam in Place	Existing Bridge 125 ft span (90 degrees)	Proposed Bridge 60 ft span (23 degrees)
Headwater El. @ Q25	29.61	29.61
Headwater El. @ Q50	29.80	29.80
Headwater El. @ Q100	30.00	30.01
Discharge Velocity @ Q50	1.01	0.98
Discharge Velocity @Q100	1.16	1.13
Ordinary High Water (Q1.1)	28.49	28.49
Discharge Velocity @ Q1.1	0.16	0.16
Clearance @ Q50	2.30	3.60

SCOUR

Scour depths were calculated for the 100 year event (Design Flood) and the 500 year event (Super Flood). The resulting scour depths are 2.6 ft and 3.8 ft, respectively. Given the relatively low velocities, scour is not expected to be a significant concern. In addition, with a clear span, the concern for debris influence on local scour is eliminated.

REFERENCES

The following references were utilized for these analyses:

- Hydrologic Engineering Center (HEC) River Analysis System (HEC-RAS), Water-Surface Computational Model Version 4.1.0, dated January 2010.

- Hydrologic Engineering Center (HEC) River Analysis System (HEC-RAS) Users Manual Version 3.1, dated November 2002.

- Hydrologic Engineering Center (HEC) River Analysis System (HEC-RAS) Hydraulic Reference Manual Version 3.1, dated November 2002.

- Hydraulic Engineering Circular No. 18 (HEC-18) *Evaluating Scour at Bridges,* (FHWA-HIF-12-003), dated April 2012, Fifth Edition.

- Hydraulic Engineering Circular No. 20 (HEC-20) *Stream Stability at Highway Structures* (FHWA-HIF-12-004) dated April 2012, Fourth Edition.

- Hydraulic Engineering Circular No. 23 (HEC-23) *Bridge Scour and Stream Instability Countermeasures* (FHWA-NHI-09-111) dated September 2009, Third Edition.

- The United States Geological Survey (USGS) publication, *Roughness Characteristics of Natural Channels,* Harry H. Barnes, Jr.—1987 (3rd Printing), Water-Supply Paper 1849.

- The United States Geological Survey (USGS) publication, *Guide for selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains,* George J. Arcement, Jr., and Verne R. Schneider—1992 (2nd Printing); Water-Supply Paper 2339.

- *Computer Assisted Floodplain Hydrology & Hydraulics*, Daniel H. Hoggan, McGraw-Hill, New York, 1989.

- The current Georgia Department of Transportation Drainage Manual for Highways with Supplemental Guidelines for Hydraulic and Hydrological Studies.

- The United States Geological Survey (USGS) publication, *Techniques for Estimating Magnitude and Frequency of Floods in Rural Basins of Georgia*-- 1993, Water Resources Investigations Report 93-4016.