HYDROLOGY AND HYDRAULICS REPORT

Overview & Purpose

The Great Hill Bridge project is located in South Berwick, York County, Maine. The existing bridge is a 40 foot single span steel girder bridge with timber decking that carries Great Hill Road over the Great Works River. The existing bridge is structurally deficient, therefore warrants replacement. The primary purpose of this hydrology and hydraulics report is to model and predict the water surface elevations, flow rates and water velocities during various flooding events. Using these predicted velocities, flows and their corresponding elevations as design criteria; the replacement bridge is designed to have proper scour protection as well as having proper freeboard depth that will enable it to withstand flooding events.

FEMA

The Federal Emergency Management Agency (FEMA) has provided a Flood Insurance Study, a Flood Boundary and Floodway map and a Flood Insurance Rate Map for the Town of South Berwick which were used as added resources for this project. The FEMA flood insurance study provides flood profiles, i.e. water surface elevations for various flooding events (see Appendix D). This study is dated December 5, 1984; therefore vertical datum shift conversions from the NGVD 29 to the NAVD 88 datum are necessary for data comparison purposes. Datum conversion was performed using the NGS VERTON program (see Appendix F). The approximate upstream and downstream Q_{100} water surface elevations for the existing bridge structure are taken to be 99.28 ft and 100.28 ft respectively.

Peak Flow Calculations

The Great Works River drainage basin characteristics produced by the Hydrology Section of the MaineDOT Environmental Office are tabulated below. In accordance with MaineDOT policy, the USGS regression equations (Hodgkins, 1999) were used to compute the peak discharges. (see Appendix D)

Drainage Area	56.023 mi^2
Wetlands	15.3 %
Design Discharge (Q_{50})	2574.6 ft^3/s
Check Discharge (Q_{100})	2925.9 ft^3/s
Scour Check Discharge (Q_{500})	3765.8 ft^3/s
Ordinary High Water ($Q_{1.1}$)	550.6 ft^3/s

HEC-RAS Model

Using the peak flow data (listed above), ground surface data (MaineDOT field survey) and bridge geometry a computerized model was generated utilizing HEC-RAS v 4.1. HEC-RAS is a computer program developed by the Army Corps of Engineers that models the hydraulics of water flow through natural rivers and other channels. With the aid of HEC-RAS, values for flood flow rates, velocities and elevations were first generated for the existing structure. As a check

for accuracy and method of calibration, the computer model results were compared to the flow elevations produced for the FEMA flood profile (see Appendix D). Once the model was calibrated the geometry for the proposed structure was input to create a hydraulic model of the proposed conditions.

Summary of Hydraulic Data

	Existing Bridge	Proposed Bridge
Headwater El. @ Q_{50}	98.89 ft	98.79 ft
Headwater El. @ Q_{100}	99.58 ft	99.44 ft
Discharge Velocity @ Q_{50}	4.31 ft/s	2.83 ft/s
Discharge Velocity @ Q_{100}	4.90 ft/s	3.03 ft/s
Headwater El. @ $Q_{1.1}$	92.53 ft	92.53 ft
Discharge Velocity @ $Q_{1.1}$	1.58 ft/s	1.31 ft/s
Freeboard @ Q_{50}	-0.43 ft	1.50 ft

NOTE: The MaineDOT Bridge Design Guide specifies a minimum freeboard depth of 2 ft (distance between the Q_{50} water surface elevation and bottom of bridge) for smaller streams where there is no history of ice jams. A design exception for a Q_{50} freeboard depth of 1.5 ft minimum has been issued for this project.

Scour

The existing Great Hill Bridge is made up of stone abutments on unknown foundations. Since the foundations are unknown the structure is considered scour critical. However, the substructure has performed remarkably well over time. The existing structure is showing only minor scour related concerns. There is evidence of some wingwall settlement and a small amount of abutment shifting. Heavy riprap is to be used at this site in order to reduce wetlands and right of way impacts. Given that the existing abutments have performed well and discharge velocity is low, heavy riprap protection will be more than adequate.

Conclusion

As shown in the table above, the existing bridge has a Q_{50} freeboard depth of -0.43 ft which does not meet current MaineDOT design standards. Replacing Great Hill Bridge as proposed will provide a Q_{50} freeboard depth of 1.5 ft. There are no major scour concerns at this site therefore the use of heavy riprap slope protection will be sufficient.