HYDROLOGY AND HYDRAULICS REPORT

Overview & Purpose

Wadsworth Street Bridge is located on Wadsworth Street in Knox County, Thomaston, Maine and spans the St George River. The St George River is a tidal river that outlets into the Gulf of Maine approximately 10 mi. downstream. The existing bridge is a three span riveted steel truss bridge that is in poor condition and in need of replacement. The St George River channel width is approximately 340' immediately upstream of the bridge. The maximum water depth at the bridge is approximately 22' during mean high water.

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 to be designed to withstand flooding events.

FEMA

The Federal Emergency Management Agency (FEMA) has produced a Flood Insurance Rate Map (FIRM) for the Town of Thomaston which was used as an additional resource for this project (see Appendix D). The FEMA FIRM provides a graphical representation of the Q100 flood zone areas although it does not determine base flood elevations and flood hazard factors.

FPMS

The U.S. Department of Agriculture Soil Conservation Service has prepared a Flood Plain Management Study of the St George River and was used to verify and calibrate the hydraulic model (see Appendix D). Water surface profile elevations require interpolation in order to estimate the water surface profiles at the Wadsworth Street location. Conversion to NAVD 88 is required for data comparison purposes. Datum conversion was performed using the NGS VERTON program (see Appendix D).

Flooding

Eyewitness reports and the preliminary public meeting have provided the Department with additional flooding information for this project. First is that this bridge has no history of roadway overtopping. There is no history of the water tides including wave action reaching above the tops of the piers.

There has also been some river icing reported at this location and some ice flowing. Although river ice has been reported, there is no history of ice jams nor is there an indication of ice being a problem.

Wave action was conservatively approximated to be 4ft maximum. It was determined that wave heights greater than 4ft are unlikely at this location due to the protection that the surrounding land provides from larger waves that can be found in the Gulf of Maine.

Storm surge at the bridge location is estimated at elevation 9.2' during a category-I fast moving hurricane at high tide.

Freeboard

Due to Wadsworth Street Bridge being located in a densely populated portion of Thomaston, it is necessary to minimize the high costs associated with environmental impacts and construction impacts to the area. It is recommended to maintain, at minimum, the existing freeboard in order to minimize costs.

MaineDOT BDG suggests a minimum of 2ft freeboard above Q10 based upon MHW including wave heights and a future 2ft rise in sea level. It was determined that maintaining the existing freeboard will meet this requirement.

Peak Flows

St George 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) The USGS regression equation peak discharges are as follows:

USGS Regression Equations Peak Flow	
Drainage Area	238 mi^2
Wetlands	17.25 %
Discharge (Q_{50})	6900 ft^3/s
Discharge (Q_{100})	7700 ft^3/s
Scour Check Discharge (Q_{500})	9600 ft^3/s
Ordinary High Water ($Q_{1.1}$)	1800 ft^3/s

These peak flows are accurate as compared to the flows determined for the Flood Plain Management Study for the St. George River as shown below. USGS regression equation peak flows are more conservative and were used for the hydraulic model.

FPMS Peak Flows	
Drainage Area	231 mi^2
Q_{10}	4230 ft^3/s
Q_{50}	6290 ft^3/s
Q_{100}	7480 ft^3/s
Q_{500}	8900 ft^3/s

Tidal Elevations

Tidal elevation data was obtained from the National Oceanic and Atmospheric Administration (NOAA, see Appendix D). Tidal Station ID: 8415709, located approximately .5 mi downstream from the Wadsworth Street Bridge, was the source of the tidal data used for hydraulics. Tide predictions for Thomaston, ME were also provided by NOAA (see Appendix D). The tidal elevations are summarized as follows:

Tidal Elevations - Wadsworth St, Thomaston, ME (NAVD 88)	
Mean Higher High Water	5.39 ft
Mean High Water	4.98 ft
Mean Tide Level	.46 ft
Mean Low Water	-4.06 ft
Mean Lower Low Water	-4.46 ft
2011 Predicted High Tide	7.65 ft

Proposed Structure

The proposed structure is a 4 span 280' long Hybrid Composite Beam integral abutment bridge. This structure will be slightly longer than the existing due to the geometry of the riprap slopes in front of the abutments. The additional superstructure length and 1.5% grade will provide an increase in the area of the opening at the bridge from 5160 ft^2 to 6400 ft^2 which will slightly reduce the water velocities and scour potential. Scour depth calculations will be provided during final design.

HEC-RAS Model

Using the peak flow data (listed above), tidal 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 a method of calibration, the computer model results were compared to the Flood Plain Management Study. Once the model was calibrated the geometry for the proposed structure was input to create a hydraulic model of the proposed conditions.

Two steady flow cases were investigated for the Wadsworth Street Bridge location. The first steady flow case assumes a Q50 flow during mean high water. The resulting water surface elevation was used to size the proposed bridge opening and determine freeboard. The second steady flow case uses a Q50 flow during mean low water. This case results in higher velocities which were used in designing erosion and scour countermeasures.

The existing and proposed hydraulic data is listed below:

All Elevations (NAVD 88)	**Existing Bridge**	**Proposed Bridge**
Headwater El. @ $Q_{1.1}$ MHW	4.98 ft	4.98 ft
Headwater El. @ Q_{10} MHW	4.99 ft	5.00 ft
Headwater El. @ Q_{25} MHW	4.99 ft	5.01 ft
Headwater El. @ Q_{50} MHW	5.00 ft	5.01 ft
Headwater El. @ Q_{100} MHW	5.02 ft	5.04 ft
Velocity @ $Q_{1.1}$ MLW	.88 ft/s	.74 ft/s
Velocity @ Q_{10} MLW	2.46 ft/s	2.06 ft/s
Velocity @ Q_{25} MLW	2.96 ft/s	2.47 ft/s
Velocity @ Q_{50} MLW	3.34 ft/s	2.79 ft/s
Velocity @ Q_{100} MLW	3.72 ft/s	3.10 ft/s
Freeboard*	2.0 ft	2.2 ft

* This value is the freeboard at Q10 based upon MHW and accounts for estimated wave heights (4 ft) and future rise in sea level (2ft).

Tidal Influence

Contrary to the FPMS, the water surface profiles of the St. George River at the Wadsworth Street Bridge are greatly influenced by the tidal elevation. This is evident when the range of St. George River peak flows is entered into the hydraulic model. Regardless of the flow magnitudes used for the hydraulic model, the resulting water surface elevation is very nearly the tidal elevation. This phenomenon is attributed to the combination of relatively low river flows occurring over a wide channel width.

Scour Countermeasures

Wadsworth Street Bridge was originally constructed on timber pile supported abutments and piers. The original design has not been evaluated for scour. The existing structure is a constriction on the waterway however there is no evidence of significant scouring due to this constriction. There is no history of scour problems at this location. The hydraulics at the bridge site is governed primarily by the tides and the water velocities are minimal. Given the slow water velocities and the past performance, the use of plain riprap countermeasures would be appropriate at this location.

Conclusion

The proposed bridge replacement structure, due to its geometry, is a slight improvement upon the hydraulics of the existing Wadsworth Street Bridge. The proposed structure increases the size of the waterway opening at the bridge approximately 24%. The larger opening will decrease the water velocities and scour potential. There is sufficient freeboard provided to accommodate future rise in sea level. The existing bridge site and surrounding area is stable, there are no major scour concerns and plain riprap countermeasures are adequate.