HYDROLOGY REPORT

Peak flow calculations by USGS regression equations, Lombard, P.J., and Hodgkins, G.A., 2015. Design discharges were provided by the Hydraulics Section of MaineDOT (November 2, 2020). See additional information in Appendix G.

SUMMARY

Drainage Area	7.3	mi^2
Q1.1	101.4	ft^3/s
Q2	208.5	ft^3/s
Q5	328.2	ft^3/s
Q10	410.9	ft^3/s
Q25	539.9	ft^3/s
Q50	626.5	ft^3/s
Q100	734.2	ft^3/s
Q500	984.7	ft^3/s

Reported by: C. Hebson, MaineDOT
Date: February 7, 2020

SUMMARY OF FLOWS USED BY FEMA FIS

Q10	380	ft^3/s
Q50	620	ft^3/s
Q100	750	ft^3/s
Q500	1130	ft^3/s

These flows were those used by FEMA in the Flood Insurance Study for Oxford County, Maine, updated July 7, 2009.

HYDRAULIC REPORT

The water surface profiles were developed for steady flow at peak discharge for the following design flows using HEC-RAS:

- $Q_{1.1}$, ordinary high water
- Q_{2}
- Q_{5}
- Q_{10}
- Q_{25}
- Q_{50}, design discharge used to evaluate hydraulic clearance
- Q_{100}, check discharge used to evaluate hydraulic clearance and scour
- Q_{500}, super flood discharge used to evaluate scour

River sections were taken from survey data. Geometric data for the existing bridge was taken from the existing bridge plans and confirmed with survey data. All elevations were referenced to the project datum (NAVD 1988).

Tannery Brook Bridge is located on Tannery (Bird) Brook, approximately 475 ft upstream of the confluence with the Pennesseewassee Stream. Tannery Brook has a gravel-cobble bed and an average bed slope of approximately 1.1%. The upstream channel is fully contained by stone masonry retaining walls that extend hundreds of feet upstream, channelizing the stream through downtown Norway. The masonry retaining walls continue through the existing bridge, acting as abutments for the bridge. There is no evidence of overbank flow within the reach studied. Downstream of the bridge the channel is bounded by boulder-armored slopes that confine the channel.

The water surface elevation for all design flows is influenced by the backwater from the Pennesseewassee Stream. Two conditions were evaluated—low tailwater (using normal depth for downstream boundary condition) and a high tailwater condition using flood events of equivalent return period on the Pennesseewassee Stream for the tailwater elevation. The downstream boundary conditions for the 10-year, 50-year, 100-year, and 500-year events were taken from the Federal Emergency Management Agency Flood Insurance Study (FEMA-FIS) for Oxford County, Maine. These data were also used to approximate the high tailwater boundary conditions for the other design flows.

Flow and elevation data for the Flood of Record was not available for this bridge. The FEMA-FIS for Oxford County noted that the most notable events for this location occurred in March of 1936, March of 1953, and April of 1987.

The low chord of the existing bridge is near the calculated existing 100-year water surface elevation. The low chord of the existing bridge is about El. 375.6. The FEMA FIS graph indicates a low chord of 376.7, which appears to closely match the fascia elevation but does not account for the 1 ft slope downward over the outer portion of the existing bridge slab. The proposed low chord is El. 376.0, which allows for the 12" minimum slab thickness plus 3.25" for membrane and wearing surface.

The existing gravity sewer line is a significant obstruction on the bottom of the channel. Based on survey data, this concrete-encased sewer line rises around 2 feet above the bottom of the channel, blocking a significant amount of flow. This sewer line was modeled as an obstruction in the channel at El. 369.4.

The HEC-RAS model indicates that the existing bridge does experience pressure flow conditions at certain high flows. The water elevations are dependent on the tailwater assumptions from the confluence with the Pennesseewassee Stream. While it is not likely that both streams would experience Q100 flows simultaneously, if they did, the headwater would be within 0.1 feet of low chord of the existing bridge (which is 10' inside the structure). The recommended structure does not have a pier and has higher clearance, so there is still 0.5' of calculated clearance with the conservative, high tailwater condition, and 0.7' of clearance with the normal tailwater condition. All Q500 flows, on both existing and proposed structure, exceed low chord and would likely lead to pressure flow and overtopping of the roadway.

The hydraulic conditions with the recommended alternative generally match or slightly lower water elevations.

A local pier scour analysis was prepared for the existing bridge for the 100-year and 500-year events. The pier is aligned with the flow but frequently collects debris. Local pier scour was estimated to be 3.0 ft for both the 100-year and 500-year events, assuming the standard MaineDOT 1.25 width factor for debris. This scour depth would be enough to undermine the shallow pier footings were it to occur.

Because there is no overbank flow and no constriction of the channel at the bridge, there is no conventional abutment or contraction scour potential. However, there is potential for pressure flow scour at the Q500 flow for both the existing and proposed structures. Pressure flow scour was computed, assuming roadway overtopping as the limiting headwater condition and ignoring any effect of debris. Pressure flow scour depth was estimated at 5.7 feet for the existing condition and 4.3 feet for the proposed condition.

The existing structure may also exhibit pressure flow behavior at Q100 as and there is high potential for debris to catch on the existing pier and reduce the waterway opening further.

Headwater elevation data in the following table was taken at the upstream fascia of the bridge. Outlet velocity and the waterway opening data was taken at the location of the existing gravity sewer line.

SUMMARY

		Existing Structure		Recommended Structure	
		2 Span Concrete Slab		Single Span Concrete Slab	
		High Tailwater	Low Tailwater	High Tailwater	Low Tailwater
Total Area of Waterway Opening	ft^2	103.4		109.6	
Waterway Opening Below Existing Q_{50} (373.9)	ft^2	73.6		78.1	
Headwater elevation @ $Q_{1.1}$	ft	371.1	371.1	371.1	371.1
Headwater elevation @ Q_{10}	ft	373.7	373.6	373.6	373.5
Headwater elevation @ Q_{25}	ft	374.4	274.3	374.3	374.2
Headwater elevation @ Q_{50}	ft	374.9	374.8	374.9	374.7
Headwater elevation @ Q_{100}	ft	375.5	375.4	375.5	375.3
Headwater elevation @ Q_{500}	ft	377.4	376.8	377.2	376.6
Freeboard @ Q_{50}	ft	0.7	0.8	1.1	1.3
Freeboard @ Q_{100}	ft	0.1	0.2	0.5	0.7
Outlet Velocity @ $Q_{1.1}$	ft/s	5.8	5.9	5.9	5.9
Outlet Velocity @ Q_{10}	ft/s	7.6	9.4	7.5	9.4
Outlet Velocity @ Q_{25}	ft/s	8.5	10.3	8.4	10.3
Outlet Velocity @ Q_{50}	ft/s	8.7	10.8	8.6	10.8
Outlet Velocity @ Q_{100}	ft/s	9.3	11.4	9.1	11.4
Outlet Velocity @ Q_{500}	ft/s	9.9	12.5	8.7	11.8

Reported by: Ben Smith/Daniel Myers
Date: August 17, 2022

Note: All elevations based on North American Vertical Datum (NAVD) of 1988.

References:

Flood Insurance Study: Oxford County, Maine, U.S. Department of Homeland Security, Federal Emergency Management Agency, July 7, 2009. [Online]. Available: https://map1.msc.fema.gov/data/23/S/PDF/23017CV001A.pdf?LOC=f9c330a06985aebd83c92147683eec1f

MaineDOT Hydrology Report, Maine Department of Transportation, Environmental Office, November 2, 2020.