HYDROLOGY REPORT

The Falls Bridge carries State Route 175 over the Salt Pond Outlet in the town of Blue Hill. The opening of the Falls Bridge passes flows due to tidal variations filling and emptying the Salt Pond as well as runoff from upland areas. The ocean tidal flows reverse twice daily at approximately 6 hours from high tide to low tide. The runoff summary is shown in the table below based on the USGS Regional Regression Formula prepared and reported by Northstar Hydro in their 2011 hydraulics report.

SUMMARY

Drainage Area	34.2	mi^2
Q1.1	436.5	ft^3/s
Q10	1594.0	ft^3/s
Q25	2010.8	ft^3/s
Q50	2334.2	ft^3/s
Q100	2678.9	ft^3/s
Q500	3520.9	ft^3/s

Reported by: HNTB
Date: October 11, 2019

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

HYDRAULIC REPORT

A hydraulic analysis was performed by North Star Hydro in 2011 in support of the previous bridge study. Since significant physical changes to the site have not occurred since 2011, the previous hydraulic analysis has been carried forward as part of the current alternative analysis and preliminary design. The previous analysis was supplemented by HNTB field observations in August of 2019. These field observations were to verify the time lag between the tidal maximum and the slack tide through the bridge opening and to measure the maximum water elevation differential between the Salt Pond side and the ocean side of the bridge.

The primary hydraulic feature of the bridge is a hydraulic jump that forms on either side of the bridge depending on the direction of the tide change. The hydraulic jump is known locally as the "reversing falls" and is commonly used for recreational activities. The hydraulic jump forms because the bridge opening significantly constricts tidal movements, forcing the water through the opening and beneath the bridge at high velocity whereupon it immediately slows as the channel opens substantially on either side. As the water slows, the water level rises and loses energy to turbulence. The reversing falls are a prominent feature of the bridge and important to the community; therefore, the existing hydraulic opening will be maintained in both replacement and rehabilitation alternatives.

As part of the previous 2011 analysis, Northstar Hydro used changes in the energy grade lines to estimate the variation of the velocity through the opening through the tidal cycle. Additionally, this velocity was compared to field observations of how fast water was flowing under the bridge to determine a maximum flow velocity.

The field observations by Northstar Hydro in December 2010, and by HNTB in August 2019, indicate that the slack tide lags approximately 3 hours behind the tidal maximum or minimum. Additionally, the constricted opening of the bridge results in the Salt Pond never fully filling or emptying, the low water elevation in the Salt Pond is as much as 4-5 feet higher than the low tide water elevation in the bay.

A more detailed hydraulic analysis and modeling may be required during final design to simulate storm conditions and to refine flow velocity and water elevations on both the Salt Pond and ocean sides of the bridge. Direct measurement of the flow velocity during a tidal cycle both at the surface and at depth is recommended.

SUMMARY*

		Existing Structure	Recommended Structure
		110' Concrete Through Arch	105' NEBT Beam Bridge
Total Area of Waterway Opening	ft^2	1900	2000
Headwater elevation @ Q_{50}	ft	10.8	10.8
Headwater elevation @ Q_{100}	ft	10.9	10.9
Headwater elevation plus Storm Surge	ft	14.4	14.4
Mean Lower Low Water (MLLW)	ft	-5.71	-5.71
Mean Low Water (MLW)	ft	-5.36	-5.36
Mean Tide Level (MTL)	ft	0.31	0.31
Mean High Water (MHW)	ft	4.74	4.74
Mean Higher High Water (MHHW)	ft	5.09	5.09
Freeboard @ Q_{50}	ft	8.65	9.47
Freeboard @ Q_{100}	ft	8.29	9.12
Estimated Daily Velocity	ft/s	7 - 15	7 -15

* As reported in Northstar Hydro's 2011 hydraulics report.

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