Hydrologic Report

Excerpted from the PDR

Little Falls Brook Bridge #6488
over
Little Falls Brook

Bristol, Maine

WIN 17531.00

Maine Department of Transportation
Bridge Program

HYDROLOGY REPORT

The drainage basin characteristics for Little Falls Brook Bridge on Harrington Road in Bristol over Little Falls Brook were provided by the MaineDOT Environmental Office. The peak flows are calculated using the 1999 USGS full regression equations and no other flow data is available. FEMA maps for the area show the bridge in flood zone A with approximate analysis only and no flood elevations determined.

The town road commissioner reported an approximate height where water rose to on a nearby building, and the height was measured at an approximate elevation of 21 ft, but no dates or exact heights of water were available.

SUMMARY

Drainage Area	4.012	mi^2
Q1.1	63.1	ft^3/s
Q10	275.0	ft^3/s
Q25	358.5	ft^3/s
Q50	424.9	ft^3/s
Q100	496.8	ft^3/s
Q500	676.3	ft^3/s

Reported by: Joshua Hasbrouck
Date: September 3, 2014

HYDRAULIC REPORT

The existing and proposed bridges were analyzed using HY-8 version 7.3 (build date Sep 11, 2012) the culvert hydraulic analysis program distributed by the Federal Highway Administration. The same tailwater and roadway cross sections were used for all models. A Manning's n of 0.08 (light to medium brush and trees, in summer) was used for the stream banks, and 0.055 was used for the channel (clean, winding, weeds and more stones). Basic testing showed that the model was not highly sensitive to the Manning's n used. The stream slope used was 0.0040 ft/ft based on the USGS topographic map of the area.

A rough model of the existing granite block culvert as a 5' span by 6' rise box shows the roadway overtopping between Q25 and Q50. There are no reports of the roadway flooding, and the only first-hand report of water level places the flood elevation at around 21 ft for an unknown flow. The low point in the road is approximately 25.5 ft, so, assuming a high flood 1-2 ft higher than the reported elevation, the water should still be 2-3 ft below the roadway. The cause of the inaccuracy could be multiple things; for instance, it is difficult to model a granite culvert in HY-8 since the sides and bottom are not even. There is also a possibility that the hydrology equations are underestimating the amount of water stored in wetlands, resulting in calculated flows that are larger than actual.

Since the structure will be on exposed ledge, the options considered will be arch and rigid frame types. The bridge is on a corridor priority 5 road, so structure cost and impacts should be minimized. The stream is not tidal, and there is no noticeable salt concentration in the air, so steel is an acceptable construction material. A steel arch is likely the cheapest option and also more restrictive than a rigid frame of the same width, so the proposed options will be modelled as arches. Bankfull width (BFW) for the site is 20' as measured by MaineDOT biologists. A 20' clear width and a 12' clear width option were analyzed to check the feasibility of reducing cost by limiting the span to 0.6BFW.

The existing structure has water ponded through it for fish passage, and any replacement structure will better match the stream width and have a natural ledge bottom, so low fish passage flows will not be checked.

EXISTING

The existing culvert is dry-laid granite blocks, presumed on ledge. Ledge is visible immediately downstream of the culvert and appears to be the bottom in the culvert as well. There is stable grade control including ledge outcrops and large rocks downstream with water ponded back through the culvert and a riffle immediately upstream of the culvert. The culvert necks down the stream width significantly.

The existing culvert has a total waterway opening of 36 SF. At Q50, the HW/D ratio is 1.91, so the culvert is clearly undersized. The velocity for Q1.1 is 7.38 fps and for the November monthly flow is 1.54 fps. Brook trout are the primary species for consideration in this location, and sea-run brook trout is present and spawns during September-November. According to the MaineDOT *Waterway and Wildlife Crossing Policy and Design Guide, 3rd edition* the sustained swimming speed for sea-run brook trout is 2.0-3.5 fps, and for brook trout it is 0.5-2.0 fps, so the existing culvert velocities are too high for proper fish passage.

PROPOSED 0.8 BFW STRUCTURE

The footing reduces the clear width of the opening to less than the span width. The estimated footing width inside of the arch line is 10”, based on the plans for Stetson, Hill Mill Bridge #5629. So, for 16' of clear width, a 18' span would be necessary with at least 10” of footing width inside of the arch line. The shallowest steel arch produced by Contech with that span is a 5'-9” rise. Assuming a top footing elevation of 16.5 ft so that it is above the calculated Q1.1 elevation, the total rise is approximately 7.75 ft.

The total waterway opening is 106 SF and at Q50 the calculated HW/D ratio for this option is 0.63. Stream velocity at Q1.1 is 1.50 fps and for November flow is 0.19 fps, which is still well below the desired value of 0.5 fps, so the 16' clear width is sufficient for fish passage.

SUMMARY

		Existing Structure	Recommended Structure
		6' span granite culvert	18' span arch
Total Area of Waterway Opening	ft^2	36	106
Headwater elevation @ $Q_{1.1}$	ft	17.72	16.48
Headwater elevation @ Q_{10}	ft	22.72	18.62
Headwater elevation @ Q_{25}	ft	25.52	19.28
Headwater elevation @ Q_{50}	ft	26.02	19.77
Headwater elevation @ Q_{100}	ft	26.25	20.29
Headwater elevation @ Q_{500}	ft	26.63	21.57
HW/D @ Q_{50}	ft	1.92	0.63
HW/D @ Q_{100}	ft	1.96	0.70
Outlet Velocity @ $Q_{1.1}$	ft/s	7.38	1.50
Outlet Velocity @ Q_{10}	ft/s	12.12	4.10
Outlet Velocity @ Q_{25}	ft/s	13.23	4.93
Outlet Velocity @ Q_{50}	ft/s	13.39	5.57
Outlet Velocity @ Q_{100}	ft/s	13.46	6.23
Outlet Velocity @ Q_{500}	ft/s	13.58	7.80

Reported by: Joshua Hasbrouck
Date: October 15, 2014

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