

HYDROLOGY REPORT

Main Street Bridge (#2504) carries Main Street over Fall Brook. The watershed of Fall Brook is approximately 32.2 mi². Approximately 0.4 miles downstream from the bridge, Fall River drains into the Kennebec River.

The Maine Department of Transportation (MaineDOT) Environmental Office, Hydrology Section, provided the drainage basin characteristics and flow data for this bridge. The original flow data are based on peak flow calculations using U. S. Geological Survey (USGS) Regression Equations. There is no stream gage on Fall Brook, nor on other waterbodies near the bridge. The hydrology data is included in Appendix E.

The existing bridge has no record of flooding and has not experienced an overtopping event in the recent past. The existing plans for Main Street Bridge over Fall Brook in the Town of Solon Somerset County Survey Plan by Maine Highway Commission Bridge Division dated July 25, 1931 indicate an extreme high-water elevation of 372.0' (NAVD88) from December of 1901. However, there is no flow data for Fall Brook for this event, and at the time, there was a dam immediately downstream that impounded Fall Brook. There is a run-of-the-river dam approximately 300 ft upstream of the bridge.

SUMMARY

Drainage Area	32.2	mi ²
Q1.1	600	ft ³ /s
Q10	2,420	ft ³ /s
Q25	3,110	ft ³ /s
Q50	3,660	ft ³ /s
Q100	4,240	ft ³ /s
Q500	5,700	ft ³ /s

Reported by: Kayla Hampe

Date: September 26, 2019

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

HYDRAULIC REPORT

Hydraulic Modeling:

The existing bridge and proposed structure were analyzed using the Army Corps of Engineers' one-dimensional river hydraulic analysis program, HEC-RAS, version 5.0.3. The hydraulic models were developed using a combination of as-built plans, topographic survey, LiDAR, and other available information. The initial HEC-RAS model of the existing crossing included an approximately 665' long segment of Fall Brook containing 11 cross-sections, six upstream and five downstream. To increase the numerical modeling accuracy of the model in the vicinity of the bridge, interpolated cross-sections at 2' intervals were utilized between the four adjacent cross-sections upstream and two adjacent cross-sections downstream of the bridge.

The existing bridge creates a localized contraction in the stream due to the abutment locations in comparison to the channel upstream of the crossing. A determination of bankfull width (BFW) of 51' was obtained from the Environmental team. However, based on a supplemental memorandum developed by Hoyle, Tanner in April 2019 and subsequent discussions with the project team, the minimum span opening for a new bridge must not be less than the existing bridge (approximately 44' average).

The following parameters and assumptions are made for both the existing and proposed hydraulic models:

- Steady flow
- Manning's "n"
 - Channel = 0.05 upstream & 0.075 downstream
 - Overbanks = 0.08
- The default values for contraction (0.1) and expansion (0.3) were used at all cross-sections except for the following:
 - Values of 0.3 and 0.5 were used for contraction and expansion, respectively, for the cross-section immediately upstream of the bridge and the one immediately downstream of the bridge.
- Mixed flow regime
- Normal depth boundary condition
 - $S = 0.03 \text{ ft./ft.}$
- Ineffective flow areas were defined at cross-sections where the stream "pools" and is outside of the active flow area

Due to the lack of stream gauge data to correlate water surface elevations (WSE) to known discharges, a sensitivity analysis was performed to evaluate the modeling assumptions. For this analysis, the downstream boundary condition was adjusted to see if the water surface elevations converge near the subject crossing. Convergence is considered to occur when a value is adjusted but the solution does not change significantly, either due to roughness changes or downstream boundary conditions. This sensitivity analysis considered the following normal slopes as the downstream boundary conditions: $S = 0.001$ ft/ft, $S = 0.01$ ft/ft, $S = 0.02$ ft/ft, $S = 0.03$ ft/ft (used for bridge analyses), and $S = 0.04$ ft/ft.

Profile plots illustrating results for models with the various normal slope boundary conditions listed above for the Q1.1, Q10, Q50, and Q100 events are included in Appendix E. The results indicate that during all flow events, the water surface elevations converge at the cross-section adjacent to the last downstream cross-section. Therefore, a normal slope boundary condition of $S = 0.03$ ft/ft, as determined from LiDAR topographic data, was used for analysis.

The effective FEMA FIS Flood Map from August 1985 does not provide flow information for the project location because this crossing is in FEMA Zone C, which means it is an area outside the 500-year flood. There is no record of flooding or bridge overtopping in recent history and the existing model results support this.

The design flows were used in HEC-RAS for the existing structure and the proposed structure. The following assumptions were used for modeling the proposed structure:

- Single span structure with 51' clear between abutment faces
- Low chord elevation of 377.29'
- Streambed at/within the structure reflects the proposed channel
- Streambed at all other cross-sections remains the same

Headwater elevations and stream velocities are reported in the table below for the peak flows for both the existing and proposed structures. The HEC-RAS results for the existing conditions and proposed conditions are provided in Appendix E.

SUMMARY

		Existing Structure	Proposed Structure
		44' avg. clear span	51' avg. clear span
Total Area of Waterway Opening	ft ²	500	830
Headwater Elevation @ Q1.1	ft	364.2	363.4
Headwater Elevation @ Q10	ft	368.2	367.1
Headwater Elevation @ Q25	ft	369.4	368.2
Headwater Elevation @ Q50	ft	370.2	369.0
Headwater Elevation @ Q100	ft	371.1	369.8
Headwater Elevation @ Q500	ft	373.2	371.7
Freeboard @ Q50	ft	2.0	8
Freeboard @ Q100	ft	1.1	7.5
Flood of Record - Unknown			
Outlet Velocity @ Q1.1	ft/s	5.8	4.6
Outlet Velocity @ Q10	ft/s	11.4	8.3
Outlet Velocity @ Q25	ft/s	12.8	9.0
Outlet Velocity @ Q50	ft/s	14.1	9.6
Outlet Velocity @ Q100	ft/s	14.8	10.1
Outlet Velocity @ Q500	ft/s	16.4	11.3

Scour:

The streambed is comprised of bedrock and large boulders. The existing structure is founded on bedrock and the proposed structure will be as well. Therefore, scour evaluation was not conducted for the PDR study. During later phases of the project development, the need for scour evaluations may be further considered if geotechnical information indicates the bedrock has erodibility risk.

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