

HYDROLOGY REPORT

The USGS Streamstats Application (StreamStats), Version 4.3, was used to develop the peak discharges for the River Road crossing of Colley Wright Brook which references the methods published in the United State Geological Survey (USGS) Scientific Investigations Report 2015-5049. Based on a review of the available information, the methods represent the most recent regression equations for an ungaged stream and the watershed parameters were found to be within the acceptable range. Supporting information can be found in Appendix E.

Summary		
Drainage Area	7.40	mi ²
Q1.1	70.4	ft ³ /s
Q10	496.0	ft ³ /s
Q25	652.0	ft ³ /s
Q50	764.0	ft ³ /s
Q100	896.0	ft ³ /s
Q500	1210.0	ft ³ /s

Reported by: Mather, Olin
Date: March 7, 2019

HYDRAULIC REPORT

ANALYSIS

A hydraulic analysis was developed for the River Road crossing of Colley Wright Brook (Doles Bridge #5061) to quantify water surface elevations (WSE) and velocities at the bridge, to evaluate scour potential and to ensure that the proposed countermeasures are adequately sized. For the purposes of the analysis all elevations are referenced to NAVD88 and the substructure labeling convention defines left and right looking downstream.

The existing structure consists of a 16 feet (span) by 12.5 feet (rise) concrete box with U-type wingwalls, that is embedded approximately 0.5 feet in the natural channel. Based on a review of the available information, the existing structure has a low chord elevation of 81.0 feet and a minimum roadway (overtopping) elevation of 84.0 feet. The proposed alternative consists of a 67.5 feet (span) bridge with sloping embankments. The bridge has a minimum low chord elevation of 81.9 feet (Left Abutment) and a minimum roadway (overtopping) elevation of 86.0 feet (Left Approach). Since the channel will be reestablished to match the slope of the upstream and downstream channel, the proposed alternative has an invert elevation of 69.0 feet.

Section 2.3.10 of the Bridge Manual requires at least 2.0 feet of freeboard (maximum water surface elevation to low chord) be provided during the design (50-year) flood event. Additionally, in order to minimize significant damage to the structure, roadway, and adjacent property, the Bridge Manual also recommends at least 1.0 feet of freeboard be provided during the check (100-year) flood event.

CHA developed a hydraulic model for the existing and proposed conditions using the Army Corps of Engineers (ACOE) HEC-RAS software (version 5.0.6). The geometry was generated from a 2013 Light Detection and Ranging (LiDAR) dataset using the HEC-GeoRAS extension for ArcMap and when possible, supplemented with survey data collected by MaineDOT in the vicinity of the crossing. The hydraulic results presented in this report are based on the assumption of unobstructed flow through the bridge section. The flood elevations established by the HEC-RAS model are thus considered valid if the hydraulic cross-sections and bridge remain relatively free and clear of debris.

Given the minimal slope of Colley Wright Brook and the proximity of the Presumpscot River (approximately 1.0 mile downstream) to the River Road Crossing, the existing and proposed hydraulics were evaluated based on a normal depth (no tailwater) and known water surface (tailwater) downstream boundary. The normal depth slope was calculated to be 0.001 feet/feet based on channel lengths measured from the most recent aerial imagery in ArcMap and channel inverts from the project survey and FEMA Flood Insurance Study (FIS). Although a

downstream railroad bridge (constriction) may ultimately limit the tailwater impacts from the Presumpscot River, the known water surface elevation was conservatively referenced from information published in the FIS. According to the water surface elevation profiles, the 50- and 100-year water surface elevations at the confluence with Colley Wright Brook (FIS Cross Section 'K') were estimated to be 79.8 feet and 80.8 feet, respectively. All elevations referenced from the FIS were converted to the North American Vertical Datum of 1988 (NAVD88 = NGVD29 – 0.67 feet).

As the water surface on Colley Wright Brook and the Presumpscot River are not expected to peak at the same time, the Joint Probability Analysis for Coincidental Peak Guidance published by the Vermont Agency of Transportation (VTrans) was used to establish a reasonable tailwater condition. According to StreamStats, Colley Wright Brook (riverine) has a drainage area of 7.4 square miles (AT) and the Presumpscot River (tailwater) has a drainage area of 515 square miles (AM). Therefore, the hydraulics at the crossing were evaluated based on an Area Ratio (AR) of 70 ($10 \leq AR < 100$). According to the Joint Probability Guidance, the controlling design 50-year water surface elevation was determined based on a 25-year event on Colley Wright Brook and a 50-year event on the Presumpscot River. Similarly, the controlling check 100-year water surface elevation is based on a 50-year event on Colley Wright Brook and a 100-year event on the Presumpscot River. The model results and supporting information is located in Appendix E.

RESULTS

Based on the results of the hydraulic analysis, the proposed alternative provides the necessary 2.0 feet of freeboard during the design (50-year) flood event while maintaining or reducing the headwater elevations. Since the proposed alternative provides an additional 409.0 square feet of hydraulic opening, the velocity through the bridge is reduced during both tailwater scenarios. Finally, the proposed alternative provides the recommended 1.0 feet of freeboard during the check (100-year) flood event and is not expected to overtop the roadway approaches. A summary of the results of the hydraulic analysis is provided in the table on the following page and supporting calculations are included in Appendix E.

Summary of Hydraulic Analysis

		Existing (16' Span C.I.P Slab)		Preferred Alternative (67.5' Span with Integral Abutments)	
		Normal Depth ¹	Tailwater ²	Normal Depth ¹	Tailwater ²
Total Area of Waterway Opening	ft ²	189	189	605	605
Headwater elevation @ Q _{1.1}	ft	71.8	-	71.8	-
Headwater elevation @ Q ₁₀	ft	76.8	-	76.7	-
Headwater elevation @ Q ₂₅	ft	77.4	-	77.2	-
Headwater elevation @ Q ₅₀	ft	77.8	80.0	77.5	79.9
Headwater elevation @ Q ₁₀₀	ft	78.3	81.0	77.8	80.9
Headwater elevation @ Q ₅₀₀	ft	79.3	-	78.5	-
Freeboard @ Q ₅₀	ft	3.2	1.0	4.4	2.0
Freeboard @ Q ₁₀₀	ft	2.7	0.0	4.1	1.0
Flood of Record (Unknown) Elevation (Unknown)					
Outlet Velocity @ Q _{1.1}	ft/s	1.7	-	0.9	-
Outlet Velocity @ Q ₁₀	ft/s	4.2	-	1.8	-
Outlet Velocity @ Q ₂₅	ft/s	5.2	-	2.2	-
Outlet Velocity @ Q ₅₀	ft/s	5.9	3.9	2.4	1.5
Outlet Velocity @ Q ₁₀₀	ft/s	6.7	4.2	2.7	1.5
Outlet Velocity @ Q ₅₀₀	ft/s	8.6	-	3.3	-

Reported by: Mather, Olin

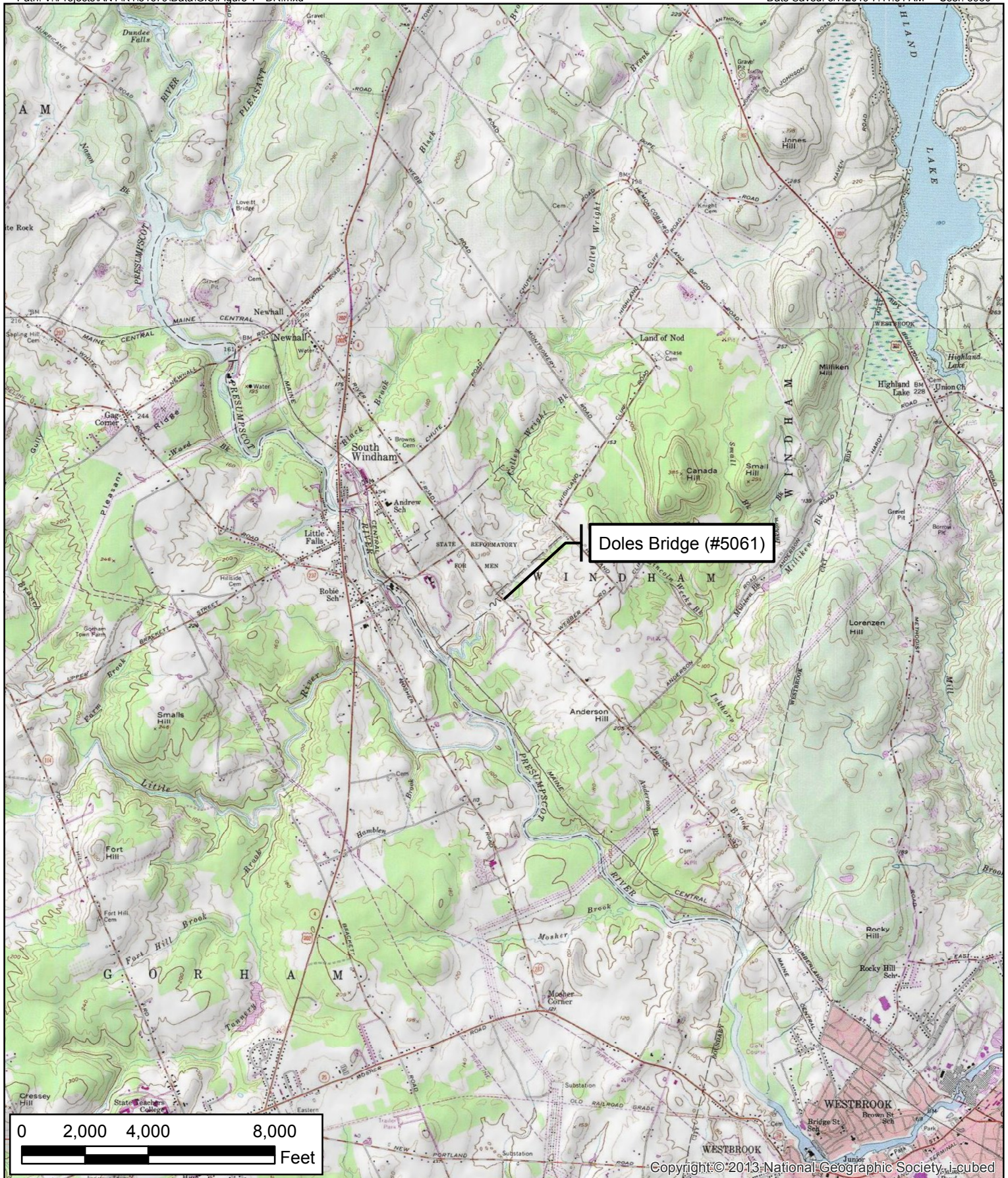
Date: March 7, 2019

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

1. The headwater elevations were taken at the approach cross section (RS 605) and are based on a normal depth downstream boundary (no tailwater scenario).
2. The headwater elevations were taken at the approach cross section (RS 605) and are based on a known water surface elevation from the Presumpscot River (tailwater scenario). Since the Presumpscot River controls the design water surface elevation at the bridge, the headwater and outlet velocity were provided for the 50- and 100-year events. For the purposes of this analysis, the controlling 50-year values reference a 25-year event on Colley Wright Brook and a 50-year event on the Presumpscot River. Similarly, the controlling 100-year values reference a 50-year event on Colley Wright Brook and a 100-year event on the Presumpscot River.

Based on Section 2.3.11 of the Bridge Manual, a new bridge should have a scour design and scour check flood frequency equal to the 100-year and 500-year events, respectively. As such, the proposed alternative was evaluated for scour using the hydraulic model and the guidelines set forth in the 2012 Hydraulic Engineering Circular No. 18, Evaluating Scour at Bridges, Fifth Edition (HEC-18). When using a streambed material of fine sand (D_{50} of 0.2 mm) during the normal depth scenario, the maximum total scour (long term, contraction and local) was calculated to be 1.7 feet and 4.4 feet for the 100-year and 500-year events, respectively. According to the design plans, the sloping abutments will be protected with Stone Fill (Item 610.07) which has a D_{50} of approximately 1.1 feet. Therefore, the adequacy of the abutment protection was evaluated based on the guidelines set forth in the Hydraulic Engineering Circular No. 23, Third Edition, September 2009 (HEC-23). According to Design Guidelines 14, the Stone Fill appears to be adequately sized based on a 100-year depth (6.3 feet) and velocity (2.7 feet per second). Supporting calculations are included in Appendix E.

Figures



1 inch = 4,000 feet

River Road over Colley Wright Brook Location Map

Town of Windham, Cumberland County, Maine

Issue Date: Mar, 2019

Project Number: 31679

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Figure 1



1 inch = 400 feet

River Road over Colley Wright Brook Structure Location Map

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Figure 2