HYDROLOGY REPORT

The West Branch Mattawamkeag River watershed at the Iron Bridge (#2403) in Island Falls, Maine is 265.3 mi^2 and has wetlands comprising 3.88% of the watershed area. The Maine Department of Transportation (MDOT) provided the above watershed characteristics and estimated the peak discharge-frequency relationship using the USGS WRIR 99-4008 Full Regression Method for Ungaged, Unregulated Streams in Rural Drainage Basins. The design discharges for the Iron Bridge over West Branch Mattawamkeag River are summarized below. The average peak flows were used in the hydraulic model.

SUMMARY

Ordinary High Water ($Q_{1.1}$) = 4,607.5cfs
2-Year Flood (Q_2) = 8,833.4 cfs
5-Year Flood (Q_5) = 13,260.0 cfs
10-Year Flood (Q_{10}) = 16,510.2 cfs
25-Year Flood (Q_{25}) = 20,716.4 cfs
Design Discharge (Q_{50}) = 23,996.1 cfs
Check Discharge (Q_{100}) = 27,411.0 cfs
500-Year Flood (Q_{500}) = 35,925.6cfs

The project area is part of the flood insurance study for the Town of Island Falls, effective May 2, 1991, conducted by the Federal Emergency Management Agency (FEMA). West Branch Mattawamkeag River is part of a detailed study area with a delineated floodway; therefore, FEMA will not allow any increase in the 100-year water surface elevation without requiring a Conditional Letter of Map Revision (CLOMR). FEMA's published 100-year regulatory base flow of 25,400 cfs will be included in the hydraulic model, in addition to the flows listed above, to demonstrate that federal requirements are satisfied and that a CLOMR is not required for the project.

HYDRAULIC REPORT

The Iron Bridge is 216 ft long with four spans of 54 ft. The bridge is 31.7 ft wide with a sidewalk along the downstream side, and the approach roadway width is 24 ft. The hydraulic opening of the bridge is 2,713 ft^2 The bridge crosses West Branch Mattawamkeag River at a 90° skew. The existing structure is a reinforced concrete T-beam bridge on mass concrete abutments and piers. The piers are 4 ft wide at the top and approximately 5 ft wide at the base.

The U.S. Army Corp of Engineers HEC-RAS Version 4.0 was used to model the hydraulics at Iron Bridge. The existing conditions were modeled using MDOT's survey data of the channel, floodplain, and existing bridge and the flow data presented in the Hydrology Report. Manning's n values were estimated based on photographs and channel bottom description. The channel bottom is uneven with many areas of exposed ledge and some sizable stones; the channel Manning's n was estimated at 0.050. The floodplain has thick woods with some undergrowth and a Manning's n of 0.1 was selected. These values are consistent with the flood insurance study, which used Manning's n values of 0.045-0.060 for the channel and 0.078-0.100 for the overbank areas for West Branch Mattawamkeag River

The survey information provided by MDOT includes 900 ft of channel and floodplain information along West Branch Mattawamkeag River. An island in the river divides channel flow just downstream of the Iron Bridge. The remnants of an old dam and power house are located on the island and in the left half of the channel (looking downstream). The remnants of the dam were not included in the hydraulic model because it does not appear to have been included in the FEMA study and a large amount of flow is carried by the other half of the divided channel, which is completely unobstructed.

The slope of the channel is irregular, particularly downstream of the bridge, creating difficulty in the selection of a downstream boundary condition. However, the extents of the model are such that the selected boundary condition has very little effect on the water

surface elevation at the bridge. The existing conditions analysis was performed using the mixed flow regime and a slope of 0.001 ft/ft was assumed for the upstream and downstream normal depth boundary conditions. Energy and momentum were both chosen for the low flow bridge modeling approach and the program selected the highest energy answer. Energy was selected for the high flow bridge modeling approach. The resulting water surface profiles show that all flows are conveyed through the existing bridge opening with 1.36 ft and 0.16 ft of freeboard over the 50-year and 100-year flood events, respectively.

The low chord elevation for the existing bridge is 453.23 ft and 455.25 ft at the Begin and End abutments, respectively. Local testimony indicated that the stream did not overtop the road or bridge during spring of 2008, which was determined to be a 100-year return period event for West Branch Mattawamkeag River. The existing conditions hydraulic model agrees with the local testimony.

The FEMA Flood Insurance Study shows 100-year base flood elevations of 461 ft (NGVD29) just upstream of the Iron Bridge. When converted to the NAVD 88 Datum, FEMA's published water surface elevation is 460.45 ft, which is 6.06 ft higher than the 100-year water surface elevation due to FEMA's flow in the existing conditions model for the project. According to FEMA's water surface elevation, the bridge and roadway would be overtopped during a 100-year storm. This does not agree with flooding history at the bridge and local testimony. Some of the differences between FEMA's model and the existing model for the project can be attributed to updated survey information and updated hydraulic modeling software. The FEMA study used the Soil Conservation Service's WSP-2 program and the current model for the project used HEC-RAS 4.0.

The proposed replacement structure will be located along the same horizontal alignment as the existing structure. The vertical profile will be raised slightly through the site. The proposed structure will be 214 ft long, 40.33 ft wide, have two clear spans of 103 ft, a 4 ft wide pier, and a total hydraulic opening of 2,740 ft^2. The superstructure will consist of 47.24 in. deep bulb-tee beams with a reinforced concrete deck slab. All three existing

piers will be demolished and the proposed pier will be reinforced concrete. The existing abutments will be reconstructed and widened to support the proposed structure. The low chord elevation for the proposed bridge is 453.03 ft and 454.86 ft at the Begin and End abutments, respectively. The low chord of the proposed structure is slightly lower than the low chord of the existing structure to accommodate the superstructure depth required for a two span bridge. However, since two piers will be eliminated, the proposed hydraulic opening will be larger than the existing and will aid in the passage of flow and debris through the structure.

The proposed hydraulic model was analyzed using the same assumptions for Manning's n values, downstream boundary condition, flow regime, and bridge modeling approach as the existing hydraulic model.

The results from the proposed conditions model shows that the water surface elevations for all flow events are lower than existing conditions. The hydraulic analysis summary from the existing and proposed hydraulic models is shown on the following page.

HYDRAULIC ANALYSIS SUMMARY

	Existing Bridge	Proposed Bridge
Opening Area, ft^2	2,713	2,740
Minimum Low Chord Elevation, ft	453.23	453.03
Headwater Elevation @ $Q_{1.1}$, ft	445.13	444.94
Headwater Elevation @ Q_2, ft	447.72	447.47
Headwater Elevation @ Q_5, ft	449.85	449.56
Headwater Elevation @ Q_{10}, ft	451.16	450.85
Headwater Elevation @ Q_{25}, ft	452.73	452.40
Headwater Elevation @ Q_{50}, ft	453.89	453.55
Headwater Elevation @ Q_{100}, ft	455.09	454.76
Headwater Elevation @ Q_{500}, ft	456.78	456.77
Velocity @ $Q_{1.1}$, ft/s	4.77	4.97
Velocity @ Q_2, ft/s	5.85	6.06
Velocity @ Q_5, ft/s	6.72	6.94
Velocity @ Q_{10}, ft/s	7.29	7.52
Velocity @ Q_{25}, ft/s	7.93	8.16
Velocity @ Q_{50}, ft/s	8.36	8.59
Velocity @ Q_{100}, ft/s	8.73	8.95
Velocity @ Q_{500}, ft/s	10.21	10.22
Maximum Freeboard @ Q_{50}, ft	1.36	1.31
Maximum Freeboard @ Q_{100}, ft	0.16	0.10

The headwater elevation and velocity information was taken from Section 1613.924 in the hydraulic models for the existing and proposed bridges, which is the upstream bounding bridge cross section for both structures. The maximum freeboard for the design 50-year and check 100-year events was determined by subtracting the water surface elevation from the low chord elevation at the End Abutment, which is higher than the minimum low chord elevation at the Begin Abutment.

The hydraulic analysis summary shows that the proposed structure will lower headwater elevations upstream of the Iron Bridge; therefore, the proposed bridge improves hydraulic conditions at the site and the project will not require a CLOMR from FEMA. The low chord elevation of the proposed bridge is slightly lower than the existing low chord elevation, which reduces the amount of freeboard. However, the overall hydraulic efficiency of the structure is increased due to the removal of two piers. The existing abutments and piers are founded on ledge and there is no evidence of scour issues at the site. Similarly, the proposed abutments and pier will be founded on ledge so no scour analysis is required for the project.