

Condition Ratings

Bridge No. 02315 is inspected by the Department biennially and condition ratings are prepared in accordance with FHWA Report No. FHWA-PD-96-001, "Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges," (FHWA 1995). Some of the condition ratings more pertinent to the evaluation of this project are summarized below. These ratings are based on an inspection that was performed on July 13, 2009.

Condition Rating Category	Rating from Recent Bridge Inspection Report	Condition Observed in Field	Potential Impact of Increased Discharge	Probable Action Required by Increased Discharge
Substructure (Item 60)	NA (Not applicable. Culvert)	Consistent with Bridge Inspection Report	Minor	Minor
Channel and Channel Protection (Item 61)	7 (Minor Damage)	Consistent with Bridge Inspection Report	Minor	Probable More Frequent Maintenance Required, debris clean-up
Structure Evaluation (Item 67)	7 (Present Minimum Criteria)	Consistent with Bridge Inspection Report	Minor	Probable More Frequent Maintenance Required
Waterway Adequacy (Item 71)	7 (Better than present minimum criteria)	Consistent with Bridge Inspection Report	Minor	Probable More Frequent Maintenance Required
Scour Critical Bridges (Item 113)	8 (Foundation stable)	Consistent with Bridge Inspection Report	Minor	Minor

Roadway

This portion of Route 44 is classified as a “Rural Principal Arterial” consisting of two lanes in the vicinity of the structure. The roadway width approaching the structure is approximately 37-feet and the 2007 ADT is 8,600. The posted speed limit for Route 44 in the vicinity of the structure is 50 mph.

The bridge database indicates a 4 mile long detour would be required to bypass Br. No. 02315 in the event of closure/failure and this section of Route 44 becomes impassible.

Flood History/Designation

Flood History

There is no documented flood history specific to this site; however, based on generalized mapping of major flood events in the State, the structure may have experienced a 100-350 year event in August 1955.

FEMA Flood Zone Designation

The structure is not located in a FEMA Flood Hazard Zone. However, flows from this structure discharges to Morgan Brook, which is located within Hazard Zone A5.

Hydrology

Description

A 1.48 square mile (948 acre) drainage area discharges to the structure. Aerial photos indicate the majority of the drainage area is residential structures with the majority of woodlands. USGS quadrangle mapping indicates the brook flows through about 8% areas of swampy land. Natural Resource Conservation Service, NRCS, (formerly SCS) unit hydrograph methodology, with the 24-hour, Type III rainfall distribution, was used to estimate the peak discharges at this structure. The drainage area was evaluated as single basin in the hydrologic model.

Methodology/Parameters

Methodology: SCS Method

Drainage Area: 948 acres (1.48 mi²)

Time of Concentration: 81 minutes

Composite CN: 58

Adjustment Factor (Fp) for Ponds and Wetland Areas: 0.72

The following precipitation data from the Drainage Manual, which is based on TP-40, were used as a baseline in the calculations:

Return Frequency (Year)	2	10	25	50	100
24 Hour Precipitation (inches)	3.2	4.7	5.5	6.2	7.0

Results

The following Peak Discharges were estimated based on the TP-40 precipitation data

Return Frequency (Year)	2	10	25	50	100	500**
Peak Discharge from Watershed (cfs)	52	211	326	438	576	970

** 500-yr. discharge estimated by Straight Line Log-Probability plot interpolation

Due to the drainage area is greater than one square mile, Br. No. 02315 is classified as an “Intermediate Structure” per the Drainage Manual criteria. Intermediate structures are designed to pass a 100-year frequency discharge. To demonstrate the sensitivity of the design discharge calculation to increases in the precipitation parameter, the current 24 hour, 100-year baseline precipitation of 7.0 inches was increased in ½ inch increments, up to a 4 inch increase, and the peak discharges associated with the increased precipitation were calculated. The results are presented in the following table:

Peak Discharge from Watershed Resulting From Increase in Precipitation									
Precipitation Increase (inches)	0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
Precipitation Increase (%)	0	7.1	14.3	21.4	28.6	35.7	42.9	50.0	57.1
100-yr Discharge (cfs)	576	668	762	858	957	1057	1159	1263	1367
Increase in Discharge (cfs)	0	92	186	282	381	481	583	687	791
Increase in Discharge (%)	0	16.0	32.3	49.0	66.1	83.5	101.2	119.3	137.3

A plot (rating curve) of the “Increase in 100-Yr Precipitation Vs. Increase in 100-Yr Peak Discharge” is included in the attachments following the narrative.

The “Precip.net” precipitation estimates were evaluated for this structure. The 100-year 24-hour precipitation estimate at this site is 8.7 inches. This is an approximately 1.7 inch or 24.3% increase over the TP-40, 100-year precipitation estimate. The “Precip.net” 500-year 24-hour precipitation estimate is 12.3 inches, equivalent to a 5.3 inch increase over the TP-40, 100-year 24-hour precipitation estimate. The peak discharge increases associated with the “Precip.net” 100- and 500-year precipitation estimates can be determined using the rating curve at 1.7 inches and 5.3 inches, respectively, over the baseline precipitation of 7.0 inches and peak discharge of

576 cfs. The resulting peak discharges for the “Precip.net” 50- and 100-year precipitation estimates are 895 cfs and 1620 cfs, respectively.

Hydraulics

Methodology

The FHWA’s Culvert Analysis Program HY-8 was used to evaluate the culvert hydraulics for the various precipitation scenarios. Elevations in the analysis are based on an assumed datum with the Route 44 roadway elevation set at 100.0-ft. Based on the assumed datum, the inlet invert elevation is approximately 89.8-ft. Freeboard is measured from the Route 44 roadway elevation to the headwater elevation.

Design Criteria

Due to the greater than 1 square mile drainage area, Br. No. 02315 is classified as an “Intermediate Structure” per the Drainage Manual criteria. Intermediate structures are designed to pass a 100-year frequency discharge (Design Frequency) and the effects of a discharge equal to the 500-year flood (Check Frequency) passing through the structure are investigated. A minimum freeboard of one foot is required for the design frequency.

Results

The results of the hydraulic evaluations are presented in the following comparison table:

Peak Discharge Description	Peak Discharge (cfs)	Headwater Elevation* (ft)	Headwater Depth (ft.)	Freeboard (ft.)	Pressure Flow Condition	Outlet Velocity (fps)
100-Year Discharge (TP-40)	576	99.46	9.66	0.54	no	21.99
500-Year Discharge (TP-40)	970	overtopping	overtopping	overtopping	overtopping	overtopping
100-Year Discharge (Precip.net)	895	overtopping	overtopping	overtopping	overtopping	overtopping
500-Year Discharge (Precip.net)	1620	overtopping	overtopping	overtopping	overtopping	overtopping
Submerged Inlet	450	97.8	8	2.2	no	21
@ 1-Ft Freeboard	542	99	9.2	1.00	no	21.7
Overtopping Begins	614	100	10.2	0	no	22.7
*Based on assumed datum – Roadway = Elev. 100-ft.						

The hydraulic evaluation indicates that the structure cannot convey the estimated Precip.net 100-yr frequency design event flows. The structure overtops at a discharge of 614 cfs, less than Precip.net 100-year discharge of 895cfs. The inlet begins to submerge at a discharge of approximately 450 cfs.

Outlet velocities associated with the 100-yr frequency design event flow is approximately 21.99-ft/s, which are considered in the very high range. The field review indicated there was a 4' drop at the outlet creating a scour hole.

Adaptive Capacity

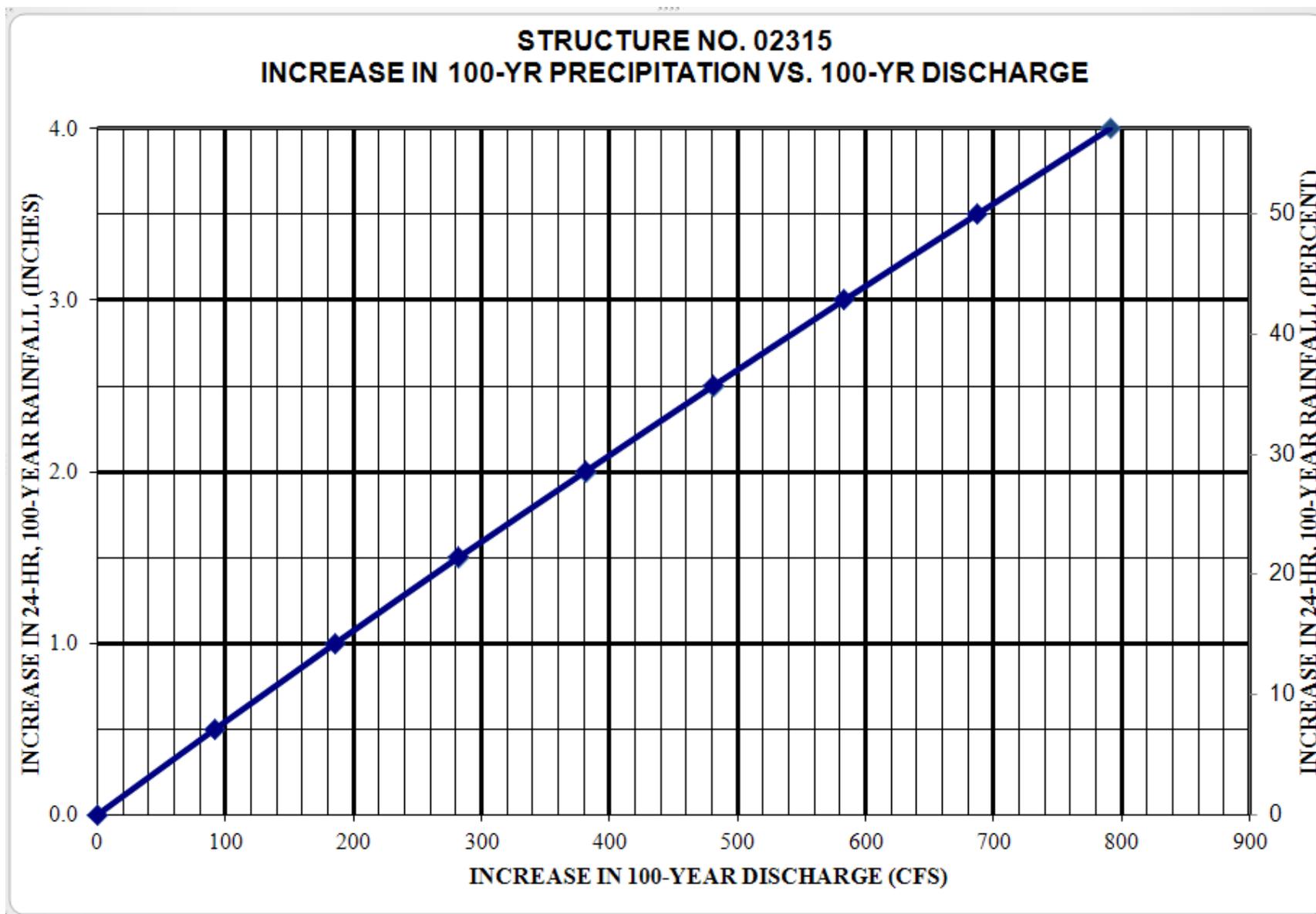
As a part of the assessment of the adaptive capacity of the subject structure and the current hydraulic design criteria, the degree to which increases in the design precipitation could change the design discharge was examined in relation to “key points” in the hydraulic performance of the structure. The following results are noted:

- The inlet begins to submerge at a flow of 450 cfs. The calculated flow for the TP-40 based 100-year storm event is 576 cfs. According to the analysis, the structure is able to handle the TP-40 based 100-year storm event without the one foot freeboard.
- The structure overtops at a discharge of 614 cfs prior to reaching the Precip.net 100-year discharge of 895cfs.
- This structure does not have the capacity to handle additional flows beyond the TP-40 based 100-year storm event.

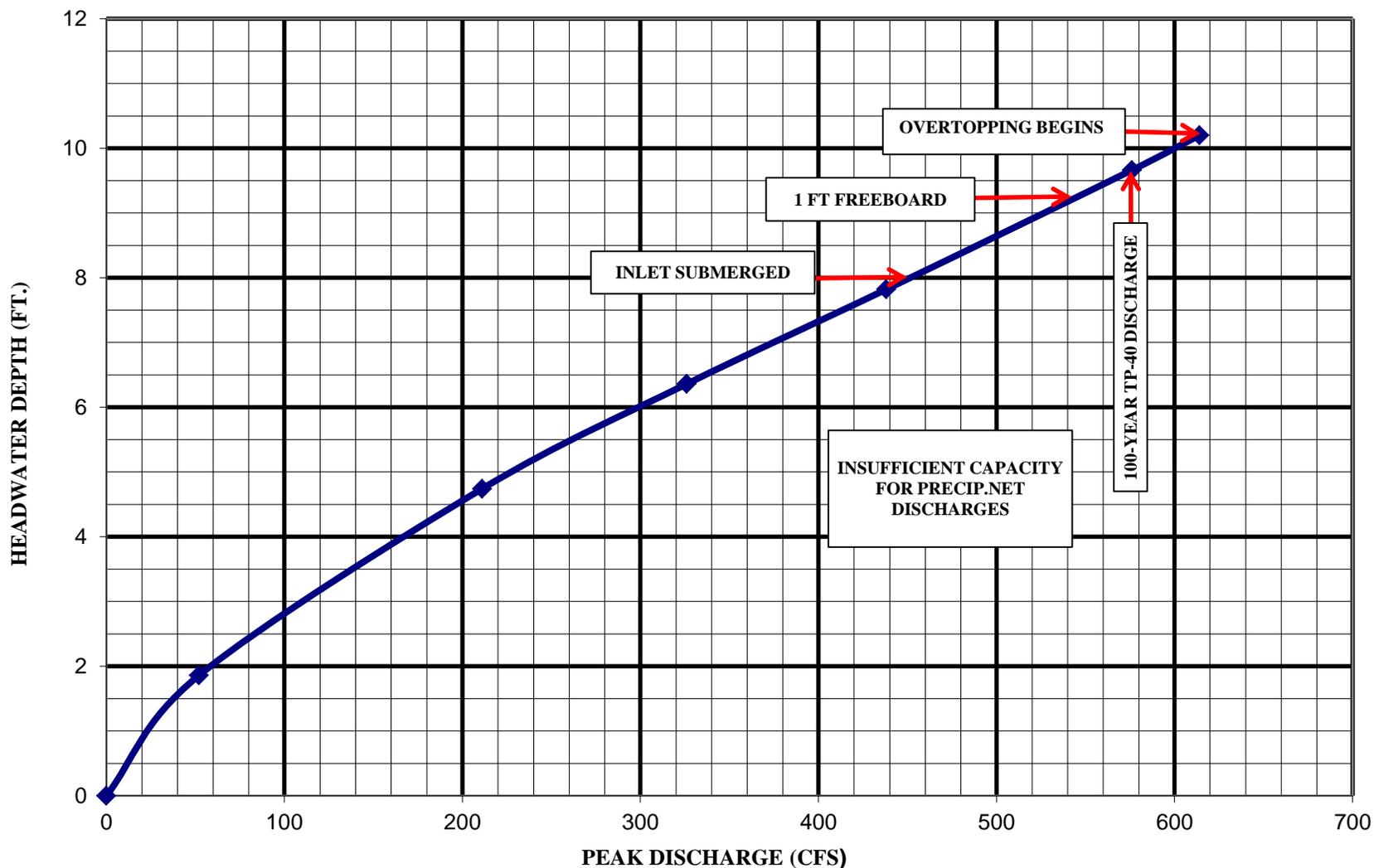
In regard to water surface elevation design criteria, the results of the hydraulic evaluation indicate that the structure does not have additional hydraulic capacity to convey flows greater than TP-40 based 100-year discharge. The structure does not have the capacity to convey the Precip.net 100-year frequency discharge. The structure is hydraulically inadequate. There is no adaptive capacity for this structure. The outlet velocity is in the high range.

Conclusion

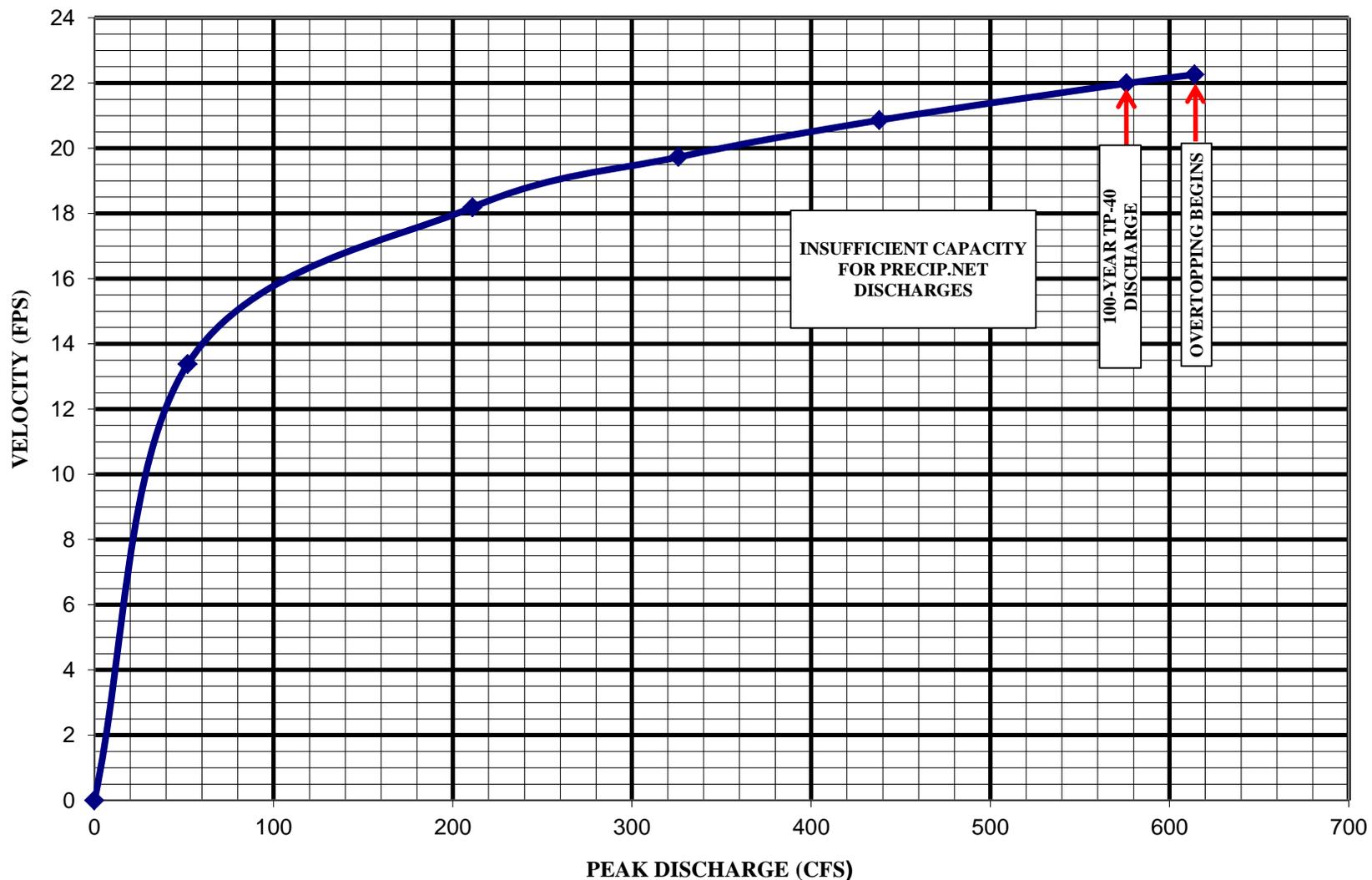
Br. No. 02315 is hydraulically inadequate. The structure has no adaptive capacity. The velocity of the structure is very high.



STRUCTURE NO. 02315 HEADWATER DEPTH VS. PEAK DISCHARGE



STRUCTURE NO. 02315 VELOCITY VS. PEAK DISCHARGE





Bridge No.	02315	Site Review by:	MFK
Town:	Barkhamsted	Site Review by:	PMM
Feature Carried:	Route 44	Date of Review:	10-25-13
Feature Crossed:	Unnamed Brook	Project No.:	170-0374



Photo # 1: Structure Inlet



Photo # 2: Upstream Channel

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Photo # 3: Structure Outlet



Photo # 4: Downstream Channel

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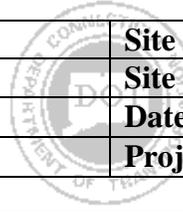


Photo # 5: Roadway Looking West



Photo # 6: : Roadway Looking East



Aerial View of Structure - Connecticut 2004 Orthophotography ("leaf off") & 2000 Contours (LiDAR)

