HYDRAULIC REPORT

NORTHFORD ROAD OVER MUDDY RIVER

Town of Wallingford

July 2020

Prepared for:

Town of Wallingford
45 South Main Street
Wallingford, CT 06492

Prepared by:

Wengell, McDonnell & Costello, Inc.
Consulting Engineers
Newington, CT 06111
(860) 667-9624

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Project Overview

Wengell, McDonnell & Costello Consulting Engineers (WMC) has been retained by the Town of Wallingford (Town), Connecticut to perform design and permitting services for replacement of the Northford Road bridge over the Muddy River (Bridge No. 04832). The current structure was built circa 1938. An inspection of the bridge by ConnDOT in 2015 found the structural condition of the bridge to only meet the minimal design requirements.

Northford Road is a paved, two-lane rural major collector located in eastern Wallingford. Northford Road runs generally in a north-south direction, connecting Anderson Road (south end) and East Center Street (north end). The bridge is approximately 1,250 feet south of the intersection of Northford Road with East Center Street, adjacent to the entrance to Town recreation areas and just downstream of MacKenzie Reservoir.

The Muddy River has been studied by FEMA and has a regulatory floodway and floodplain. Flow rates for the Muddy River have been taken from the New Haven County Flood Insurance Study (FIS). The drainage area at the bridge is approximately 8.88 square miles. According to the ConnDOT Drainage Manual, this is an Intermediate Class structure. An Intermediate structure should pass the design event with one foot of underclearance. The design event for a structure with this sized drainage area is the 100-year (1% annual probability) flood event.

This Hydraulic Report has been prepared as supporting documentation for the project design and permitting. The report is comprehensive, as it is the only hydraulic report required for the project. This report addresses regulatory and design hydraulic modeling results; temporary conditions during construction, as well as DEEP Inland Fisheries interests. The proposed structure will increase the flow capacity under the bridge.

Hydrologic Summary

The drainage area upstream of Northford Road is found to be 8.88 MI^2, which places the crossing in the Intermediate Class structure category, according to the 2000 ConnDOT *Drainage Manual* (Drainage Area between 1 MI^2 and 10 MI^2). The design frequency for Intermediate structures is the 100-year (1% annual probability) flood event, with a goal of passing the design flood with one foot underclearance while also having a minimum of 1 foot of roadway freeboard. According to the New Haven County Flood Insurance Study (FIS), the bridge is located within a numbered FEMA flood zone. There is also a regulatory Floodway for the Muddy River.

The previous Town of Wallingford FIS adopted flow rates for the Muddy River based on studies done by the USDA Soil Conservation Service (now Natural Resource Conservation Service, NRCS). The agency used their TR-20 computer software application to estimate flow rates for flood events, and to route them through the reservoir, to incorporate the attenuation the reservoir provides.

Regulatory hydraulic model hydrology is based on the current New Haven County FIS, dated May 16, 2017. For Muddy River, the FIS flow rates are listed in the table below. The regulatory hydraulic models use the FIS flow rates for the full modeled reach, as in the FIS.

Table 1: FIS Flow Rates

Return Frequency (Years)	Flow Rate (CFS)
10	1,560
50	2,490
100	2,980
500	4,030

For the design models, StreamStats flow rates are used. StreamStats does not consider the attenuating effects of reservoirs and dams, so the predicted rates from StreamStats can be considered conservative. Flow rates used in the design models also address the local hydraulic condition. The main spillway of MacKenzie Reservoir discharges along the main stem of the Muddy River. Refer to Figure 1 below. The auxiliary spillway is west of the main spillway, with a ridge separating the spillways. Flow out of the auxiliary spillway runs under Northford Road in a culvert and channel until intercepting an unnamed tributary of the river, which flows roughly eastward to a confluence with the Muddy River just downstream of the Northford Road bridge. Hydraulically, the close proximity of the combined tributary flow plus flow over the auxiliary spillway entering the river affects the hydraulic conditions at the bridge. This condition is accounted for by

adding the flow from the tributary at the cross section just downstream of the bridge. The design flow rates are presented in Table 2.

Table 2: Design Flow Rates

Return Frequency (Years)	Flow Rates (CFS)	
	Upstream	Downstream
2	402	436
3	498	555
5	603	700
10	742	918
25	917	1,190
50	1,067	1,410
100	1,216	1,650
200	1,371	1,870
500	1,488	2,120

Hydraulics

HYDRAULIC MODEL DEVELOPMENT

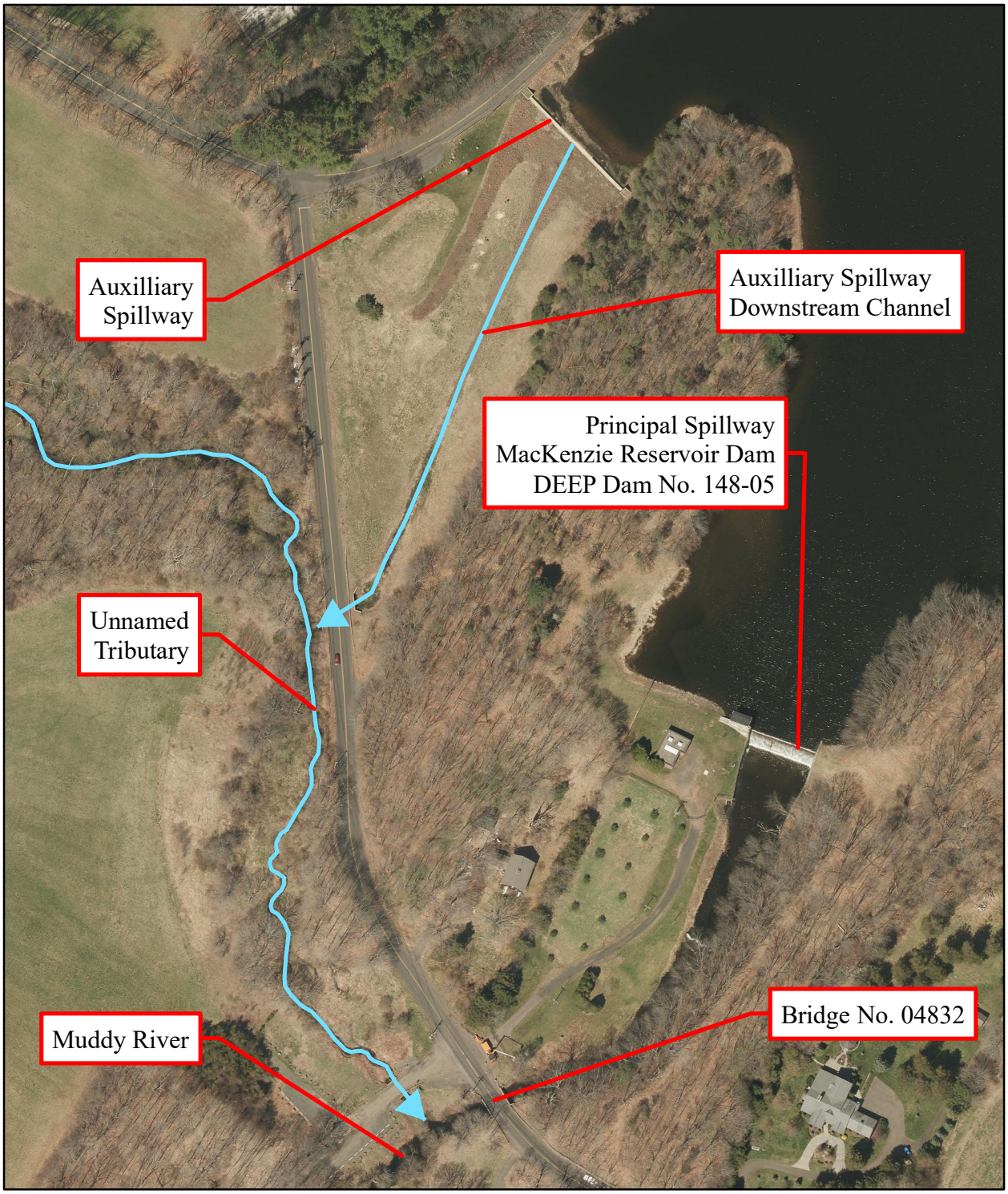
FEMA Models

FIS Regulatory: The current New Haven County FIS reports that the Muddy River was studied in 1977 using the SCS WSP2 software to obtain water surface profiles. WMC requested backup data from FEMA for the Muddy River, but no information was available. Modeling geometry for this project is based on survey data acquired for the project, augmented by LIDAR data.

Existing Structures

The existing bridge consists of a concrete deck slab supported on concrete abutments. The abutment foundations are unknown but WMC suspects they would likely be shallow spread footings. The 2017 bridge inspection report lists the NBIS Item 113 rating as 5 which is classified as scour susceptible. The bridge has solid concrete parapets which are approximately 3 feet high and would be a notable hydraulic obstruction for any flood event which overtops the roadway in the area of the bridge. The roadway low point is located ±70 feet to the northwest of the bridge centerline, near the centerline of the access road leading to the dam. The bridge has wingwalls which are flared less than 20 degrees and a hydraulic clear span length of 22 feet.

Figure 1 - Site Hydraulic Layout, 2016 Aerial



0 100 200 400 Feet

1:2,400

1 inch equals 200 feet

N
W E
S

WMC Consulting Engineers
Newington, CT 06111
(860)667-9624

Existing Condition Models

The Existing Condition model consists of 13 cross sections, 7 upstream and 6 downstream the bridge. Refer to the cross-section location plan in Appendix C. Manning's roughness and expansion and contraction coefficients were estimated based on field observations.

Existing Design Model: Model runs were performed for the 2-, 3-, 5-, 10-, 25-, 50-, 100-, 200-, and 500-year flood events.

Design analysis is run in the mixed flow regime; HEC-RAS calculates subcritical and supercritical profiles and selects the best alternative at each cross section. Starting water surface elevations for the design models utilize the Critical Depth condition as starting water surface elevations at both ends of the model. The ends of the model reach are set far enough away from the bridge to allow for the water surface profile to merge to a true depth before approaching the bridge.

Existing Regulatory Model: Geometry for the Floodway model is identical to the Design model. Floodway widths for published cross sections are according to the Floodway Table included in the FIS, which also correspond to the Floodway widths observed in the FIRM mapping. Intermediate cross section Floodway widths are based on scaling of the Floodway boundary on the FIRM maps.

Regulatory analysis is run in the subcritical flow regime; HEC-RAS calculates subcritical profiles only. For the initial calibration run the downstream end of the model is set to the published water surface elevations in the Floodway Table. For the other water surface elevations, the flood profile is used to estimate the 10-yr, 50-yr, and 500-yr water surface elevations at the downstream end of the model.

Proposed Structures

The proposed structure is edited from the Existing Condition model. The proposed structure has a 40-foot hydraulic opening and an out-to-out 32.5-foot width. The new parapets have a tube railing design that will aid flow over the bridge deck in an extreme flooding event. The 40-foot opening was selected as the maximum opening feasible for the natural channel width of the river. The roadway profile is also raised in the vicinity of the bridge.

Proposed Condition Models

The bridge geometry of the existing model was changed to reflect the new design. The flow characteristics used in the models do not need to be altered.

Proposed Design Model: The geometry edits are made to the model. Design analysis is again run in the mixed flow regime; HEC-RAS calculates subcritical and supercritical profiles and selects the best alternative at each cross section. Flow elevations and

velocities from this model can be found in Table 5 for the 10-year storm and Table 7 for the 100-year storm.

Proposed Floodway Model: The Proposed Condition hydraulic model is re-run, with the same encroachment stations as for the Existing Condition model. Floodway analysis is again run in the subcritical flow regime; HEC-RAS calculates subcritical profiles only. The model of the encroached condition showed decreases in upstream water elevation between zero and two feet for the 10-year flood event and between zero and one feet for the 100-year flood. This can be seen in tables 4 and 6, respectively.

Natural Condition Hydraulic Model

A Natural Condition model is provided. For the Natural Condition, all manmade effects are eliminated from the model, to identify how the manmade impacts affect water surface elevations. For the Natural Condition model, expansion and contraction coefficients are adjusted to the natural stream values. Ineffective flow areas associated with the removed structures are also omitted. DEEP hydraulic guidance wishes for the Proposed Condition to be within one foot of the Natural Condition.

Table 8 on page 16 compares the Natural Condition to the Proposed Condition and the effects of the proposed bridge on the Natural Condition. The Proposed Condition water surface elevations are within one foot of the Natural Condition for the reach of the river affected by the Proposed Condition.

TEMPORARY CONDITIONS

Refer to the plans for details of the temporary condition. In summary, temporary cofferdams will be installed on both sides of the river 3 feet from the existing abutments. In normal conditions, the average flow can be handled by the temporary conditions without any difficulty. This condition was modeled and only a slight increase in surface elevation occurs.

TEMPORARY CONDITION ANALYSIS

Following the procedure described in Section 6, Appendix F of the *Drainage Manual*, it was estimated that for an expected in-stream construction duration of ±2 weeks, the temporary design frequency is the Spring Day flood event. In accordance with Section 6.15 of the ConnDOT *Drainage Manual*, the water handling plan was developed to provide guidance for the Construction Contractor. Installing cofferdams to an elevation below the recommended height or providing a hydraulic opening less than recommended width will provide reduced protection of the Contractor's work.

The hydraulic analyses indicate that the temporary condition will cause little change to the Spring Day water surface profile from existing conditions upstream of the bridge. Changes in the temporary condition are confined to the inlet reach just upstream of the proposed repairs. As there are no structures located near the bridge, the increase is not considered to present an impact to existing structures.

The top of cofferdam elevation is recommended to be one foot above the inlet elevation, which leaves significant freeboard for the design event. The top of the cofferdams is well below the adjacent roadways, and no impacts are anticipated due to the relatively brief temporary condition.

Summary of Design Consistency

INLAND FISHERIES

DEEP Inland Fisheries reviewed this project. CT DEEP Inland Fisheries had some requested actions to be included in the design. The design should include a line of rounded boulders along the edges of the channel, to provide refuge for small aquatic organisms. In addition, a rock vane is to be added at the outlet of the tributary just downstream of the bridge, to provide some preservation of the different thermal zones occurring at the confluence. The standard TOY restriction (June 1 to September 30) is recommended for unconfined work in the stream. However, unconfined work is not proposed. WMC has incorporated the recommendations from Inland Fisheries in the design.

Summary of Regulatory Consistency

The following Regulatory criteria are applicable to the proposed structure:

10-Year Flood Encroached Event Analysis

The hydraulic analyses indicate that for the 10-year flow rate, the water surface profile upstream of the proposed structure will be lowered between the existing and proposed conditions. Refer to Table 4 on page 12 for a comparison of existing and proposed water surface elevations.

100-Year Flood Encroached Event Analysis

The hydraulic analyses indicate that for the 100-year flow rate, the proposed water surface profile upstream of the proposed bridge will be lowered ±0.5 foot between existing and proposed conditions. Refer to Table 5 on page 13 for a comparison of existing and proposed water surface elevations.

Summary of Scour Analysis

GENERAL BACKGROUND

Scour depths are typically estimated following the procedures outlined in the latest April 2012 edition of FHWA publication HEC-18 - *Evaluating Scour at Bridges*.

In accordance with HEC-18 and the CT DOT *Drainage Manual*, scour is evaluated for the following scour conditions:

1. Long-Term Channel Degradation and Aggradation: Normal velocities for the river are low to moderate, and the river does not tend to transport and deposit materials. It is assumed that some isolated locations may have aggradation or degradation. The bridge area shows some minor scour. In addition, in flood events there may be some ephemeral effects. Long-term scour is predicted to be 0.15 feet.

2. Lateral Contraction Scour (HEC-18, Sections 6.1-6.4): This bridge component is only applicable to non-pressure flow conditions. For this evaluation, pressure flow conditions occur for larger floods. For the smaller floods not experiencing pressure flow, the flood remains mostly in the channel, and only minor scour occurs.

3. Pressure Flow (Vertical) Contraction Scour (HEC-18, Section 6.10): For pressure flow conditions, the vertical component of scour is added to the lateral contraction scour. As stated above, pressure flow conditions occur at this site for floods greater than the 50-year event. Pressure flow computations are performed for the 100-year and 200-year events.

4. DOT Amended Froehlich's Local Abutment Scour (DOT *Drainage Manual*, Page 9.B-2) - The *Drainage Manual* recommends using an amended form of Froehlich's equation to estimate local abutment scour for Connecticut bridges. As is for contraction scour, there is minor overbank flow that enters the bridge opening, causing some abutment scour.

5. Total scour (NCHRP 24-20): The National Cooperative Highway Research Program report *Estimation of Scour Depth at Bridge Abutments*, NCHRP 24-20 (2010) presents a procedure for estimating total scour based on a series of laboratory flume experiments. For this project, the major scour design events have pressure flow. Overtopping conditions were not analyzed as part of this study - there was not a bridge deck used in the laboratory experiments, and the procedure is not applicable for this project.

PROJECT BACKGROUND

This project proposes to replace the existing bridge at Northford Road for a larger, open bottomed bridge structure.

Flood events of ±50-year overtop the river embankments in the proposed condition, which has a channel width approximately 20 feet wider than the existing condition. More significant flood events have overtopping floods that spread to cover the larger floodplain, but usually only to shallow depths. In the design condition, all floods return to the channel and are passed by the bridge. Models using the regulatory flows have overtopping conditions at the bridge.

SCOUR COMPUTATIONS

Scour computations for the proposed project find that the conditions at the site are not favorable for the development of scour. Refer to Table 3 below. Flow leaves the channel

onto the floodplain in proximity to the Northford Road bridge then returns to be passed in the bridge opening.

There is no history of significant scour at this location. Recent field investigations found that the channel bed under the bridge showed minor scour for the smaller existing bridge, which has been in use for 80 years.

Table 3: Scour Analysis Summary

Table 3.a: 10-Year Flood Event					
	Estimated Scour Depths, Feet				
Abutment	Long Term	Contraction	Pressure	Abutment	**Total**
#1 (Left)	0.15	0.00	N	0.00	0.15
#2 (Right)				0.47	0.62
Table 3.b: 50-Year Flood Event					
	Estimated Scour Depths, Feet				
Abutment	Long Term	Contraction	Pressure	Abutment	Total
#1 (Left)	0.15	0.00	N	0.02	0.17
#2 (Right)				1.77	1.92
Table 3.c: 100-Year Flood Event					
	Estimated Scour Depths, Feet				
Abutment	Long Term	Contraction	Pressure	Abutment	Total
#1 (Left)	0.15	0.00	Y	0.16	0.31
#2 (Right)				3.86	4.01
Table 3.d: 200-Year Flood Event (Maximum Scour)					
	Estimated Scour Depths, Feet				
Abutment	Long Term	Contraction	Pressure	Abutment	Total
#1 (Left)	0.15	0.00	Y	0.19	0.34
#2 (Right)				4.37	4.52

It is anticipated that the abutment footings for the proposed bridge are to be founded on mico-piles. Top of footing elevations must address frost depth, so at a minimum, the footings should be below the predicted scour depths.

MITIGATION

Analysis of hydraulic conditions at the proposed bridge finds that there is no condition that would cause erosion of the embankments. It is suggested some rounded riprap be placed under the bridge on the sloping embankments and to carry the riprap out of the bridge opening and around the abutments.

Table 4: Comparison, 10-Year Regulatory Flood Event, Existing versus Proposed, Encroached & Unencroached Condition Elevations

Station ID	FIS ID	CWSEL					
		Encroached			Unencroached		
		(1)	(2)	(2)-(1)	(3)	(4)	(4)-(3)
		Existing	Proposed	Δ	Existing	Proposed	Δ
3123	BM	177.78	176.97	- 0.81	177.03	176.83	- 0.20
3045	BL	177.53	176.51	- 1.02	176.73	176.47	- 0.26
2859		177.43	176.31	- 1.12	176.53	176.23	- 0.30
2670		177.35	176.15	- 1.20	176.42	176.07	- 0.35
2614	BK	177.11	175.60	- 1.51	176.15	175.69	- 0.46
2558		177.12	175.63	- 1.49	176.15	175.69	- 0.46
2531		177.01	175.28	- 1.73	176.04	175.53	- 0.51
2515.5	**Northford Road Bridge**						
2499		175.00	175.00	0.00	174.27	174.27	0.00
2475		175.04	175.04	0.00	174.28	174.28	0.00
2390	BJ	174.79	174.79	0.00	172.73	172.73	0.00
2256	BI	174.52	174.52	0.00	172.85	172.85	0.00
2193		173.90	173.90	0.00	172.29	172.29	0.00
1000	BH	170.20	170.20	0.00	170.20	170.20	0.00

Table 5: Comparison; 10-Year Design Flood Event, Existing versus Proposed

Station ID	FIS ID	Condition				Comparison		
		Existing		Proposed				
		(1)	(2)	(3)	(4)	(3) - (1)	(4) - (2)	(4/2)-1
		WSEL (FT)	Velocity (FT/S)	WSEL (FT)	Velocity (FT/S)	WSEL (FT)	Velocity (FT/S)	Vel. Change (%)
3123	BM	175.08	2.83	175.06	2.85	- 0.02	0.02	0.7
3045	BL	174.47	5.73	174.28	6.45	- 0.19	0.72	12.6
2859		174.30	3.39	174.09	3.57	- 0.21	0.18	5.3
2670		174.11	3.55	173.85	3.83	- 0.26	0.28	7.9
2614	BK	173.77	4.90	173.40	5.53	- 0.37	0.63	12.9
2558		173.76	3.31	173.37	3.65	- 0.39	0.34	10.3
2531		173.64	3.94	173.22	4.37	- 0.42	0.43	10.9
2515.5	**Northford Road Bridge**							
2499		172.98	4.61	172.98	4.61	0.00	0.00	0.0
2475		172.95	3.93	172.95	3.93	0.00	0.00	0.0
2390	BJ	172.58	4.34	172.58	4.34	0.00	0.00	0.0
2256	BI	172.53	2.62	172.53	2.62	0.00	0.00	0.0
2193		172.36	4.13	172.36	4.13	0.00	0.00	0.0
1000	BH	167.49	7.51	167.49	7.51	0.00	0.00	0.0

Table 6: Comparison, 100-Year Regulatory Flood Event, Existing versus Proposed, Encroached & Unencroached Condition Elevations

Station ID	FIS ID	CWSEL					
		Encroached			Unencroached		
		(1)	(2)	(2)-(1)	(3)	(4)	(4)-(3)
		Existing	Proposed	Δ	Existing	Proposed	Δ
3123	BM	180.91	180.52	- 0.39	179.03	179.33	0.30
3045	BL	180.63	180.19	- 0.44	178.71	179.06	0.35
2859		180.54	180.08	- 0.46	178.44	178.85	0.41
2670		180.47	180.00	- 0.47	178.38	178.81	0.43
2614	BK	180.18	179.66	- 0.52	178.03	178.54	0.51
2558		180.21	179.69	- 0.52	178.00	178.52	0.52
2531		180.02	179.47	- 0.55	177.85	178.40	0.55
2515.5	**Northford Road Bridge**						
2499		177.68	177.68	0.00	176.25	176.25	0.00
2475		177.68	177.68	0.00	176.12	176.12	0.00
2390	BJ	177.50	177.50	0.00	174.68	174.68	0.00
2256	BI	177.01	177.01	0.00	174.66	174.66	0.00
2193		176.05	176.05	0.00	174.08	174.08	0.00
1000	BH	172.50	172.50	0.00	171.50	171.50	0.00

Table 7: Comparison; 100-Year Design Flood Event, Existing versus Proposed

		Condition				Comparison		
		Existing		Proposed				
		(1)	(2)	(3)	(4)	(3) - (1)	(4) - (2)	(4/2)-1
c	FIS ID	WSEL (FT)	Velocity (FT/S)	WSEL (FT)	Velocity (FT/S)	WSEL (FT)	Velocity (FT/S)	Vel. Change (%)
3123	BM	176.46	3.14	176.38	3.20	- 0.08	0.06	1.9
3045	BL	176.19	4.53	176.08	4.69	- 0.11	0.16	3.5
2859		176.02	3.81	175.90	3.91	- 0.12	0.10	2.6
2670		175.91	3.64	175.77	3.77	- 0.14	0.13	3.6
2614	BK	175.69	4.58	175.52	4.81	- 0.17	0.23	5.0
2558		175.69	3.42	175.52	3.55	- 0.17	0.13	3.8
2531		175.60	3.95	175.30	4.64	- 0.30	0.69	17.5
2514.5	**Northford Road Bridge**							
2499		174.24	5.62	174.24	5.62	0.00	0.00	0.0
2475		174.25	4.56	174.25	4.56	0.00	0.00	0.0
2390	BJ	173.97	4.35	173.97	4.35	0.00	0.00	0.0
2256	BI	173.85	3.54	173.85	3.54	0.00	0.00	0.0
2193		173.63	5.24	173.63	5.24	0.00	0.00	0.0
1000	BH	168.12	9.20	168.12	9.20	0.00	0.00	0.0

Table 8: Comparison, 100-Year Design Flood Event, Natural versus Proposed

Station ID	FIS ID	Condition				Comparison		
		Natural		Proposed				
		(1)	(2)	(3)	(4)	(3) - (1)	(4) - (2)	(4/2)-1
		WSEL (FT)	Velocity (FT/S)	WSEL (FT)	Velocity (FT/S)	WSEL (FT)	Velocity (FT/S)	Vel. Change (%)
3123	BM	176.06	3.46	176.38	3.20	0.32	- 0.26	- 7.5
3045	BL	175.60	5.52	176.08	4.69	0.48	- 0.83	- 15.0
2859		175.33	4.38	175.90	3.91	0.57	- 0.47	- 10.7
2670		175.10	4.53	175.77	3.77	0.67	- 0.76	- 16.8
2614	BK	174.56	6.39	175.52	4.81	0.96	- 1.58	- 24.7
2558		174.47	5.51	175.52	3.55	1.05	- 1.96	- 35.6
2531		174.44	5.28	175.30	4.64	0.86	- 0.64	- 12.1
2515.5	**Northford Road Bridge**							
2499		174.37	4.97	174.24	5.62	- 0.13	0.65	13.1
2475		174.25	4.35	174.25	4.56	0.00	- 0.72	4.8
2390	BJ	173.97	3.54	173.97	4.35	0.00	0.81	22.9
2256	BI	173.85	5.24	173.85	3.54	0.00	- 1.70	- 32.4
2193		173.63	9.20	173.63	5.24	0.00	- 3.96	- 43.0
1000	BH	168.12	4.97	168.12	9.20	0.00	4.23	85.1

Table 9: Comparison; Spring Day Temporary Condition, Existing v. Temporary

Station ID	Condition		Comparison
	Existing	Temporary	
	(1)	(2)	(2) - (1)
	WSEL (FT)	WSEL (FT)	WSEL (FT)
3123	172.55	172.55	0.00
3045	172.35	172.35	0.00
2859	170.23	170.23	0.00
2670	170.20	170.20	0.00
2614	170.07	170.07	0.00
2558	169.47	169.47	0.00
2531	169.46	169.46	0.00
2515.5	Northford Road over Muddy River		
2499	169.46	169.46	0.00
2475	169.46	169.46	0.00
2390	169.32	169.32	0.00
2256	168.46	168.46	0.00
2193	168.44	168.44	0.00
1000	164.84	164.84	0.00

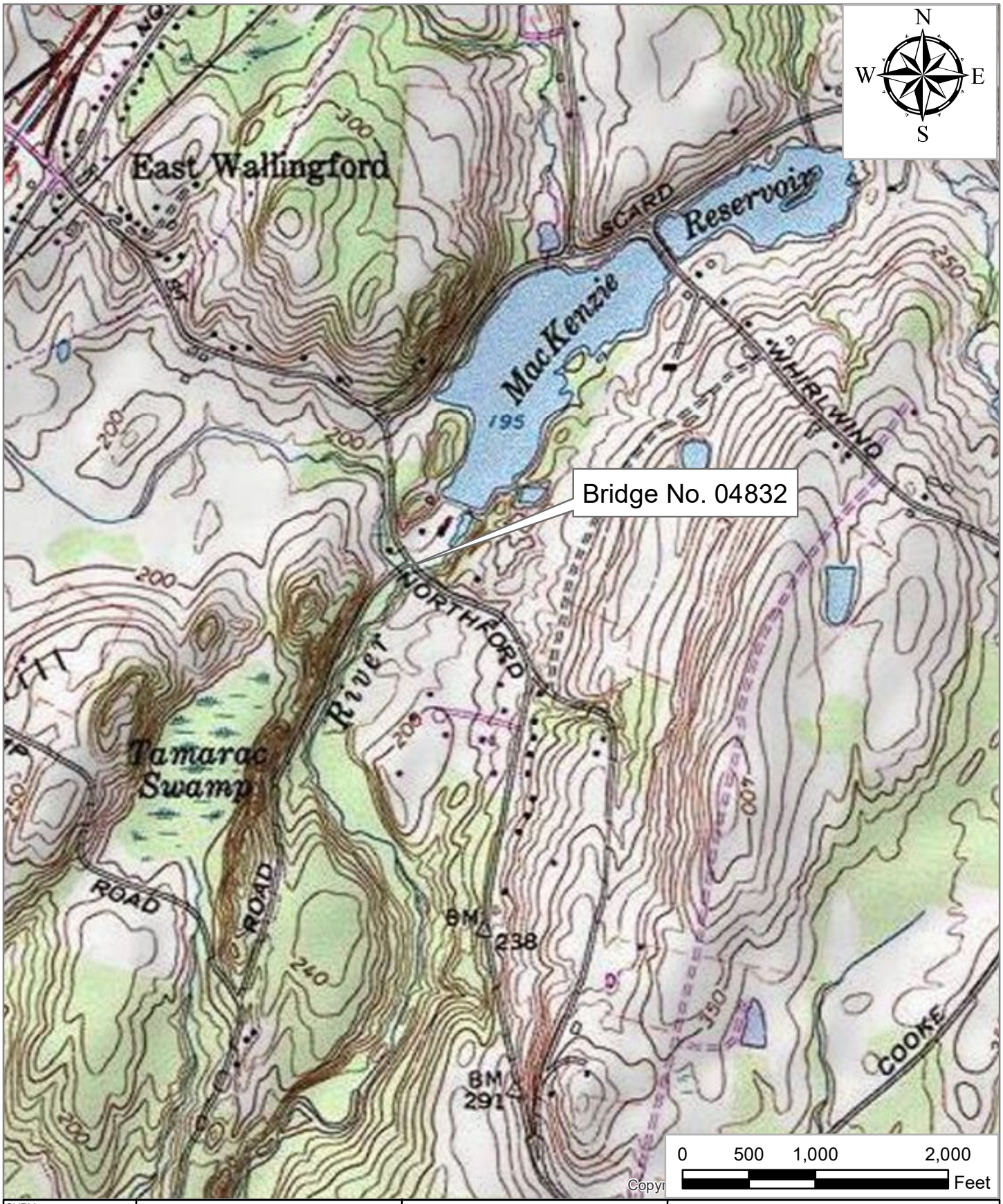
Appendix A - Plans (Under Separate Cover)

WMC Consulting Engineers
Newington, CT
(860) 667-9624

Appendix B - Maps

WMC Consulting Engineers
Newington, CT
(860) 667-9624

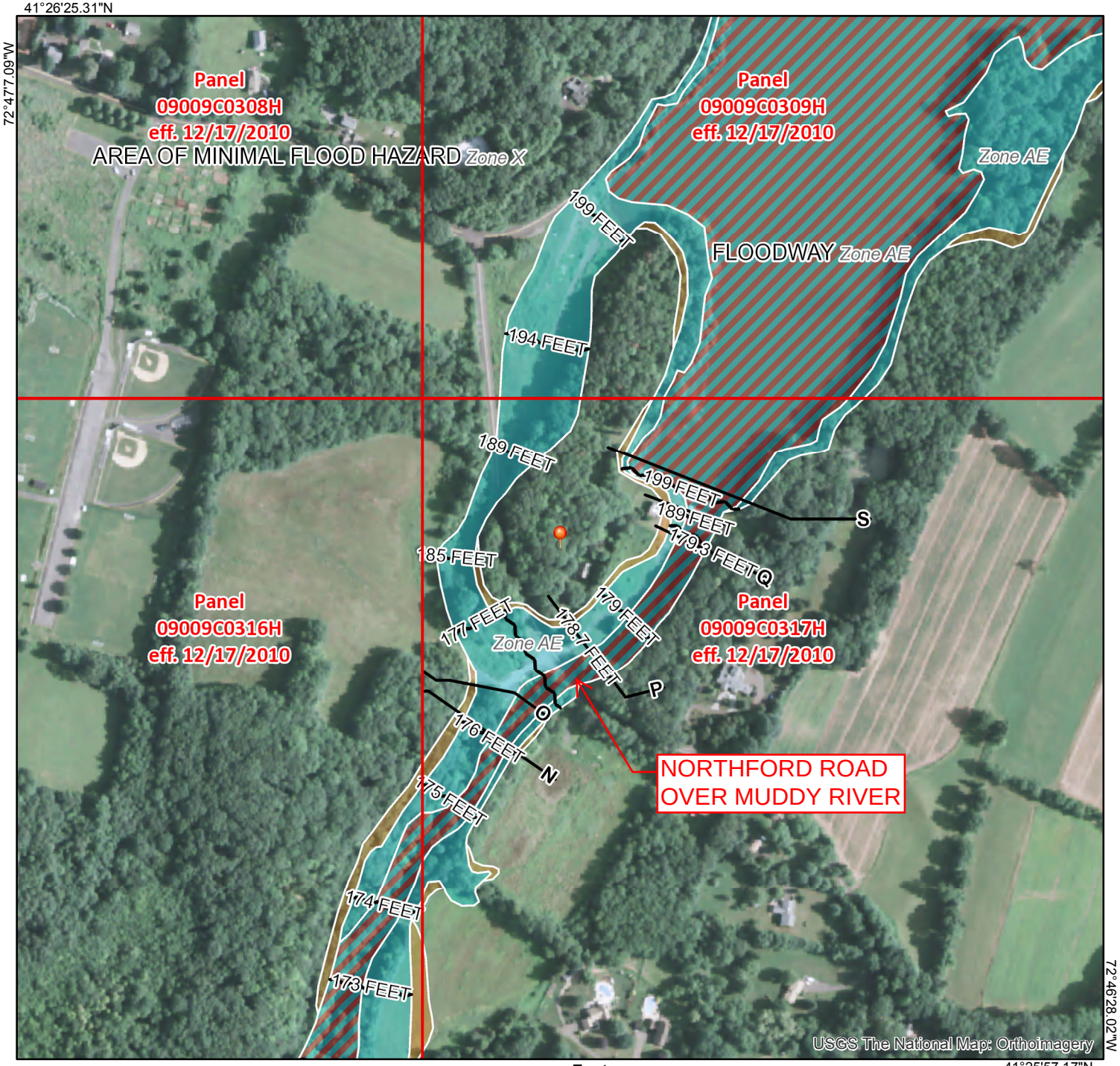
Appendix B Contents



SUPV. JAC DESIGN DRAWN CMB CHECKED MEF DATE July 9, 2020	WMC CONSULTING ENGINEERS WENGELL, McDONNELL & COSTELLO 87 HOLMES ROAD NEWINGTON, CT 06111 (860) 667-9624	**PREPARED FOR:** TOWN OF WALLINGFORD 45 SOUTH MAIN STREET WALLINGFORD, CT 06492	LOCATION MAP NORTHFORD RD OVER MUDDY RIVER WALLINGFORD, CT NORTHFORD RD LOCATION MAP 16022 --	SHEET 1 OF 1

PROJECT FILE NAME NUMBER REV.

National Flood Hazard Layer FIRMette



Legend

- Cross-Sections
- Base Flood Elevations

Flood Hazard Zones

- 1% Annual Chance Flood
- Regulatory Floodway
- Special Floodway
- Area of Undetermined Flood Hazard
- 0.2% Annual Chance Flood
- Future Conditions 1% Annual Chance Flood Hazard
- Area with Reduced Risk Due to Levee

LOMRs

- Effective

Map Panels

- Digital Data
- Unmodernized Maps
- Unmapped

This map complies with FEMA's standards for the use of digital flood maps. The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. The base map shown complies with FEMA's base map accuracy standards.

The NFHL is a living database, updated daily, and this map represents a snapshot of information at a specific time.

Flood risks are dynamic and can change frequently due to a variety of factors, including weather patterns, erosion, and new development. FEMA flood maps are continually updated through a variety of processes. Users should always verify through the Map Service Center (http://msc.fema.gov) or the Community Map Repository that they have the current effective information.

NFHL maps should not be created for unmapped or unmodernized areas.

FEMA

Date: 9/27/2016 Time: 10:40:46 AM

SUPV.	JAC
DESIGN	
DRAWN	CMB
CHECKED	MEF
DATE	JULY 9, 2020

WMC
CONSULTING ENGINEERS
WENGELL, McDONNELL & COSTELLO
87 HOLMES ROAD
NEWINGTON, CT 06111
(860) 667-9624

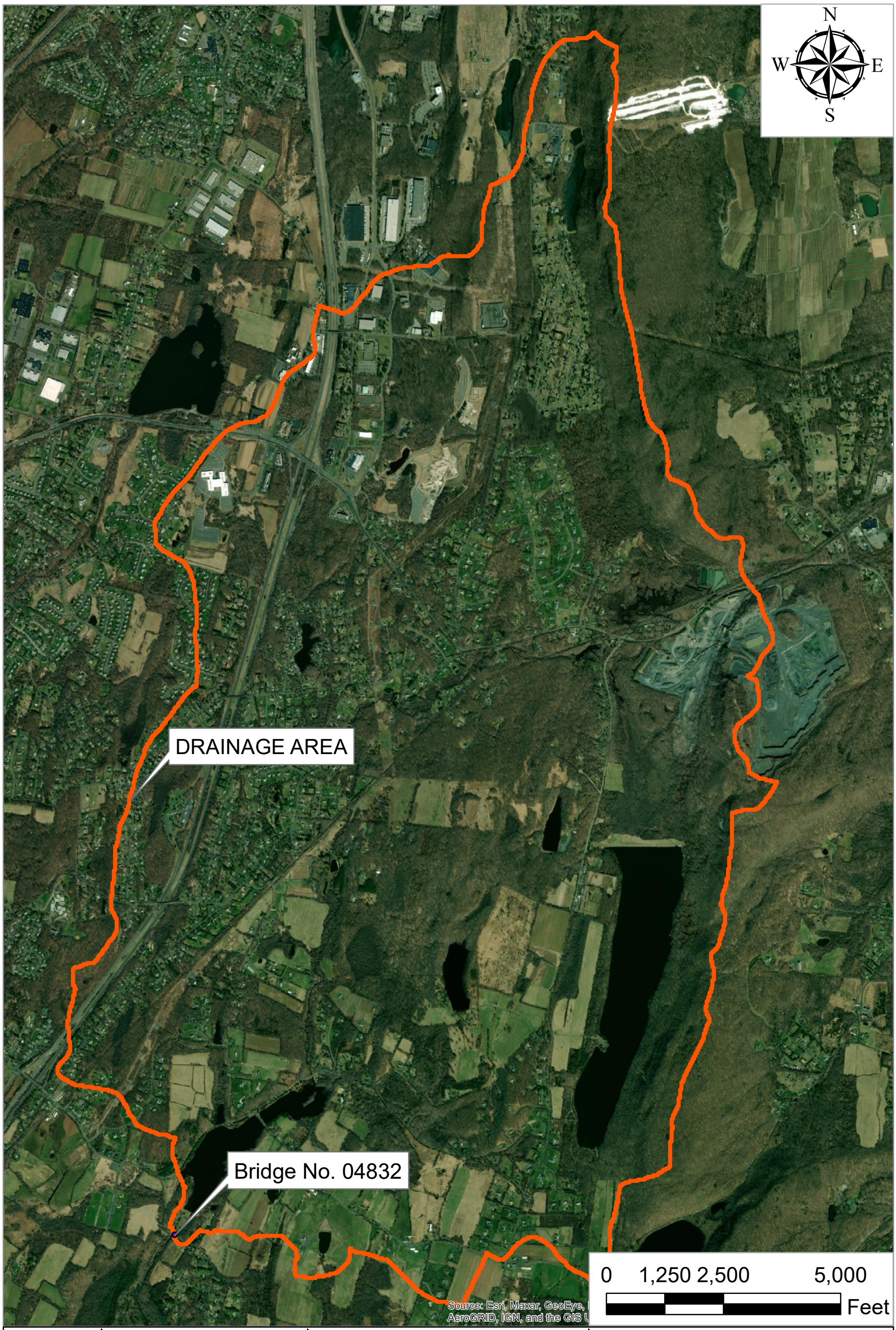
PREPARED FOR:

TOWN OF WALLINGFORD
45 SOUTH MAIN STREET
WALLINGFORD, CT 06492

AERIAL MAP

NORTHFORD RD OVER MUDDY RIVER
WALLINGFORD, CT

PROJECT	FILE NAME	NUMBER	REV.	SHEET	OF
NORTHFORD RD	AERIAL MAP	16022		1	1



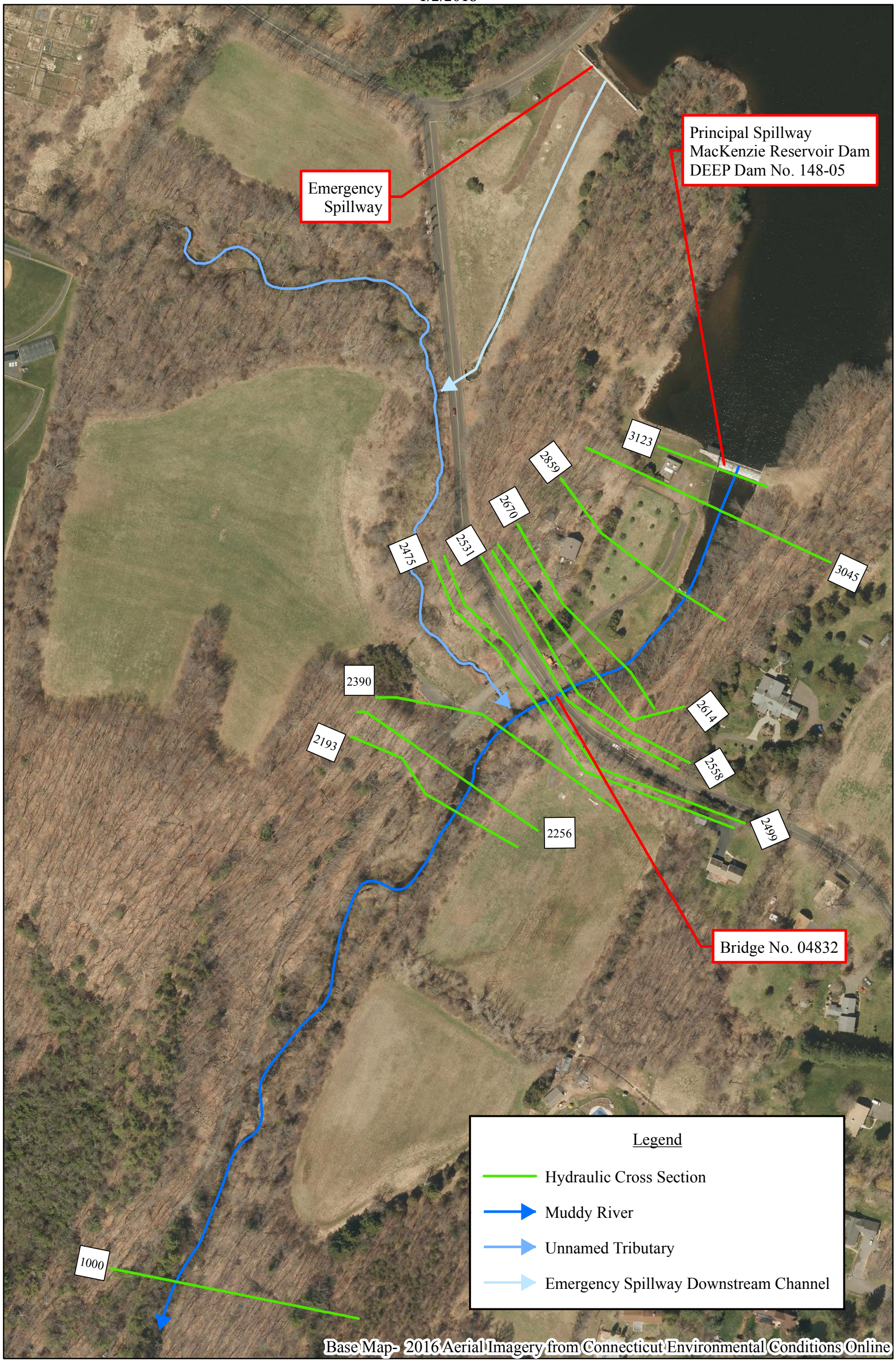
SUPV. JAC DESIGN DRAWN CMB CHECKED MEF DATE JULY 9, 2020	WMC CONSULTING ENGINEERS WENGELL, McDONNELL & COSTELLO 87 HOLMES ROAD NEWINGTON, CT 06111 (860) 667-9624	**PREPARED FOR:** TOWN OF WALLINGFORD 45 SOUTH MAIN STREET WALLINGFORD, CT, 06492	**DRAINAGE AREA MAP** NORTHFORD RD OVER MUDDY RIVER WALLINGFORD, CT NORTHFORD RD PROJECT / DRAINAGE AREA FILE NAME / 16022 NUMBER / SHEET 1 OF 1

Appendix C - Hydraulic Data

WMC Consulting Engineers
Newington, CT
(860) 667-9624

Appendix C - Contents

Hydraulic Cross Section Location Plan
1/2/2018



0 100 200 400 Feet

1:2,400

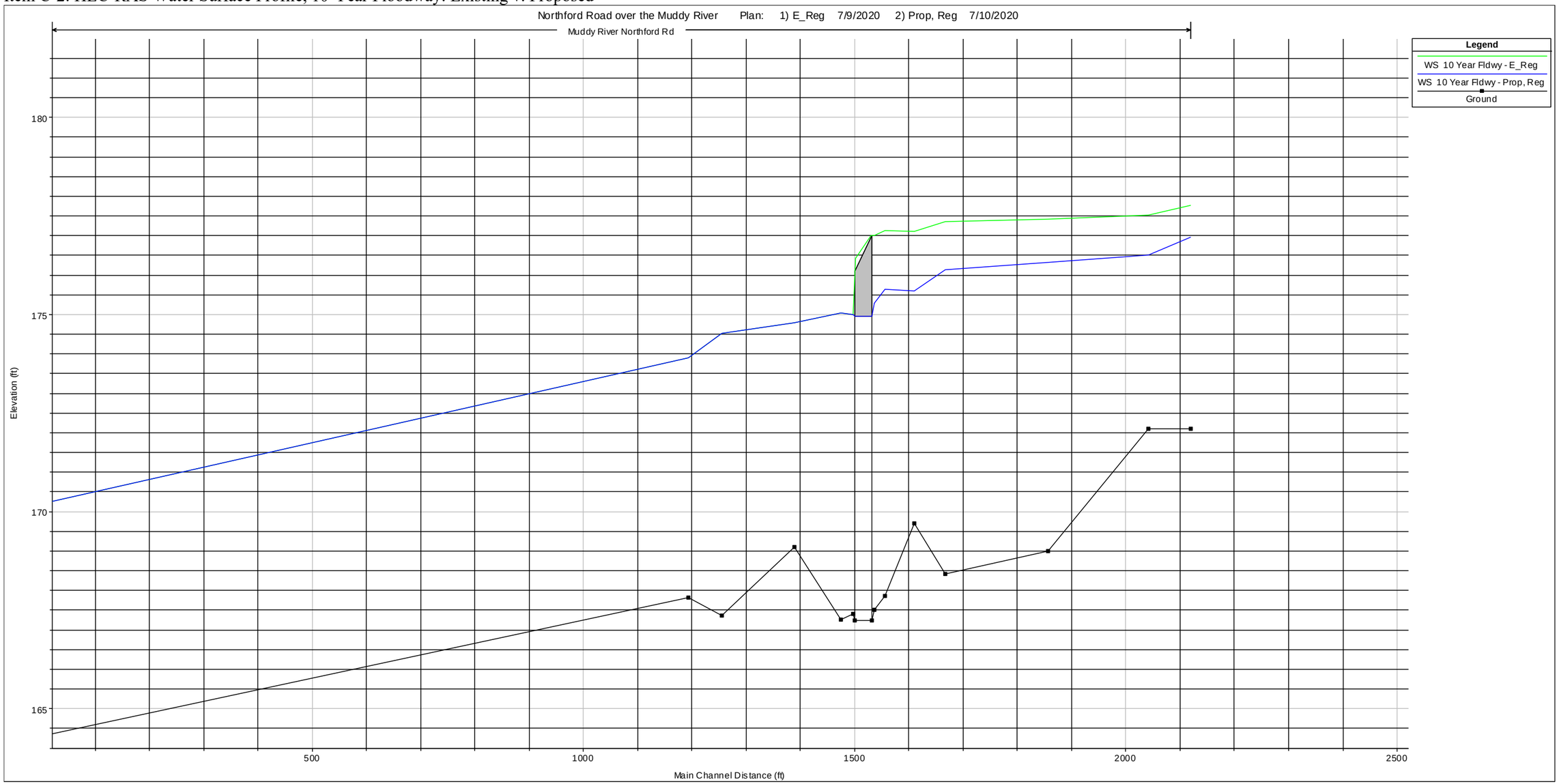
1 inch equals 200 feet

N
W E
S

WMC Consulting Engineers
Newington, CT 06111
(860)667-9624

REGULATORY HYDRAULIC MODELS

Item C-2: HEC-RAS Water Surface Profile, 10-Year Floodway: Existing v. Proposed



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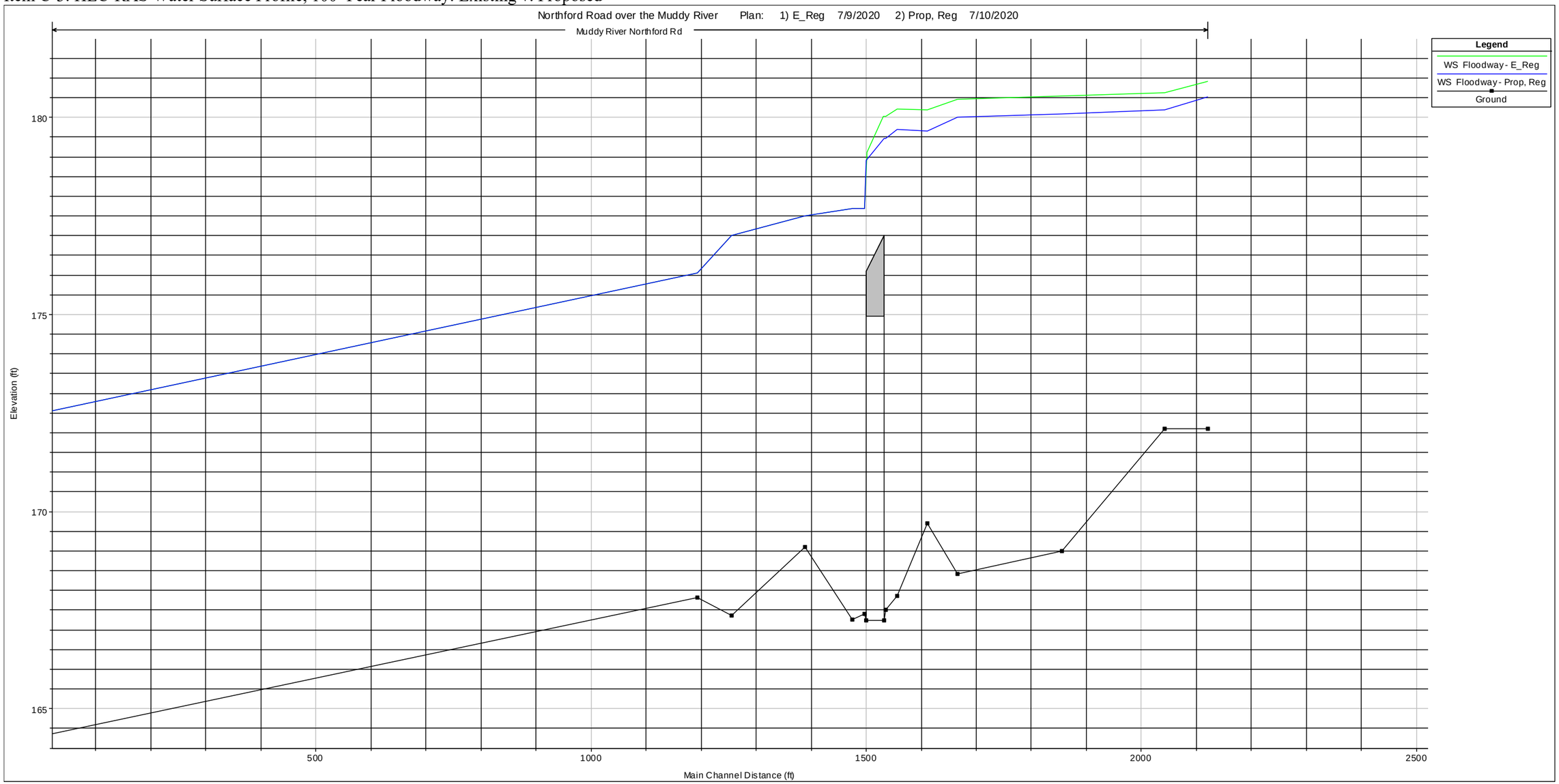
Item C-3: HEC-RAS Water Surface Profile, 100-Year Floodway: Existing v. Proposed



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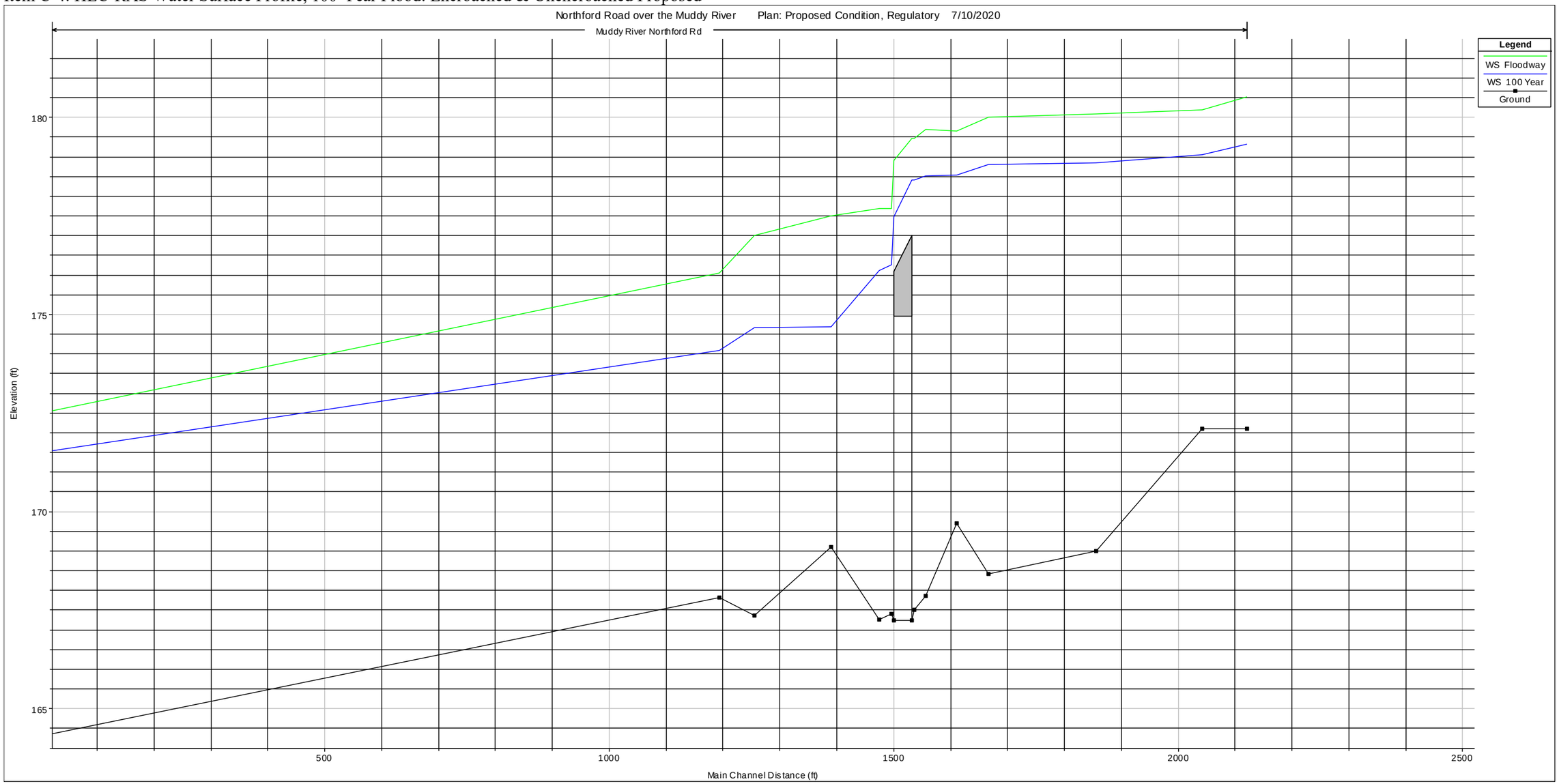
Item C-4: HEC-RAS Water Surface Profile, 100-Year Flood: Encroached & Unencroached Proposed



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Item C-5: HEC-RAS Std. Summary Table 1, 10-Year Floodway: Existing and Proposed Condition

HEC-RAS River: Muddy River Reach: Northford Rd Profile: 10 Year Fldwy

Reach	River Sta	Profile	Plan	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Northford Rd	3123 BM	10 Year Fldwy	E_Reg	1560.00	172.10	177.78	174.30	177.94	0.000627	3.21	491.24	89.00	0.24
Northford Rd	3123 BM	10 Year Fldwy	Prop, Reg	1560.00	172.10	176.97	174.30	177.19	0.001041	3.75	419.15	89.00	0.30
Northford Rd	3045 BL	10 Year Fldwy	E_Reg	1560.00	172.10	177.53	175.13	177.85	0.001517	4.61	352.93	73.00	0.37
Northford Rd	3045 BL	10 Year Fldwy	Prop, Reg	1560.00	172.10	176.51	175.13	177.03	0.003229	5.83	278.58	73.00	0.52
Northford Rd	2859	10 Year Fldwy	E_Reg	1560.00	169.00	177.43	173.08	177.64	0.000651	3.87	487.10	83.16	0.25
Northford Rd	2859	10 Year Fldwy	Prop, Reg	1560.00	169.00	176.31	173.08	176.63	0.001144	4.67	394.44	83.16	0.33
Northford Rd	2670	10 Year Fldwy	E_Reg	1560.00	168.42	177.35	173.22	177.50	0.000646	3.66	616.64	99.26	0.23
Northford Rd	2670	10 Year Fldwy	Prop, Reg	1560.00	168.42	176.15	173.22	176.38	0.001223	4.51	497.34	99.26	0.31
Northford Rd	2614 BK (Approach)	10 Year Fldwy	E_Reg	1560.00	169.70	177.11	173.84	177.43	0.001630	4.84	395.03	77.00	0.33
Northford Rd	2614 BK (Approach)	10 Year Fldwy	Prop, Reg	1560.00	169.70	175.60	173.84	176.23	0.004107	6.63	278.64	77.00	0.51
Northford Rd	2558	10 Year Fldwy	E_Reg	1560.00	167.86	177.12	172.51	177.31	0.000654	3.56	516.79	88.25	0.23
Northford Rd	2558	10 Year Fldwy	Prop, Reg	1560.00	167.86	175.63	172.51	175.95	0.001468	4.60	385.04	88.25	0.33
Northford Rd	2531	10 Year Fldwy	E_Reg	1560.00	167.50	177.01	172.71	177.27	0.000957	4.25	434.63	74.65	0.27
Northford Rd	2531	10 Year Fldwy	Prop, Reg	1560.00	167.50	175.28	172.71	175.83	0.002632	5.98	260.88	74.65	0.43
Northford Rd	2515.5 BN04832			Bridge									
Northford Rd	2499	10 Year Fldwy	E_Reg	1560.00	167.40	175.00	172.62	175.60	0.003816	6.25	249.77	73.00	0.46
Northford Rd	2499	10 Year Fldwy	Prop, Reg	1560.00	167.40	175.00	172.62	175.60	0.003816	6.25	249.77	73.00	0.46
Northford Rd	2475	10 Year Fldwy	E_Reg	1560.00	167.26	175.04	172.30	175.42	0.002866	4.95	323.34	77.65	0.39
Northford Rd	2475	10 Year Fldwy	Prop, Reg	1560.00	167.26	175.04	172.30	175.42	0.002866	4.95	323.34	77.65	0.39
Northford Rd	2390 BJ (Exit)	10 Year Fldwy	E_Reg	1560.00	169.10	174.79	172.55	175.16	0.003083	4.84	322.09	71.42	0.40
Northford Rd	2390 BJ (Exit)	10 Year Fldwy	Prop, Reg	1560.00	169.10	174.79	172.55	175.16	0.003083	4.84	322.09	71.42	0.40
Northford Rd	2256 BI	10 Year Fldwy	E_Reg	1560.00	167.52	174.52	170.92	174.86	0.001632	4.65	335.49	50.00	0.32
Northford Rd	2256 BI	10 Year Fldwy	Prop, Reg	1560.00	167.52	174.52	170.92	174.86	0.001632	4.65	335.49	50.00	0.32
Northford Rd	2193	10 Year Fldwy	E_Reg	1560.00	167.82	173.90	172.22	174.65	0.005160	7.63	287.69	57.83	0.55
Northford Rd	2193	10 Year Fldwy	Prop, Reg	1560.00	167.82	173.90	172.22	174.65	0.005160	7.63	287.69	57.83	0.55
Northford Rd	1000 BH	10 Year Fldwy	E_Reg	1560.00	164.30	170.20	168.51	170.51	0.002410	5.75	570.83	150.61	0.43
Northford Rd	1000 BH	10 Year Fldwy	Prop, Reg	1560.00	164.30	170.20	168.51	170.51	0.002410	5.75	570.83	150.61	0.43

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Item C-6: HEC-RAS Std. Summary Table 1, 100-Year Floodway: Existing and Proposed Condition

HEC-RAS River: Muddy River Reach: Northford Rd Profile: Floodway

Reach	River Sta	Profile	Plan	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Northford Rd	3123 BM	Floodway	E_Reg	2980.00	172.10	180.91	175.47	181.15	0.000547	3.93	770.11	89.00	0.23
Northford Rd	3123 BM	Floodway	Prop, Reg	2980.00	172.10	180.52	175.47	180.78	0.000634	4.12	735.23	89.00	0.25
Northford Rd	3045 BL	Floodway	E_Reg	2980.00	172.10	180.63	176.48	181.07	0.001150	5.41	579.32	73.00	0.34
Northford Rd	3045 BL	Floodway	Prop, Reg	2980.00	172.10	180.19	176.48	180.69	0.001373	5.72	547.58	73.00	0.37
Northford Rd	2859	Floodway	E_Reg	2980.00	169.00	180.54	174.85	180.87	0.000726	4.95	745.68	83.16	0.27
Northford Rd	2859	Floodway	Prop, Reg	2980.00	169.00	180.08	174.85	180.46	0.000841	5.20	708.03	83.16	0.29
Northford Rd	2670	Floodway	E_Reg	2980.00	168.42	180.47	174.73	180.71	0.000681	4.68	926.68	99.26	0.25
Northford Rd	2670	Floodway	Prop, Reg	2980.00	168.42	180.00	174.73	180.27	0.000797	4.92	880.28	99.26	0.27
Northford Rd	2614 BK (Approach)	Floodway	E_Reg	2980.00	169.70	180.18	175.86	180.64	0.001588	5.88	631.88	77.00	0.33
Northford Rd	2614 BK (Approach)	Floodway	Prop, Reg	2980.00	169.70	179.66	175.86	180.18	0.001914	6.27	591.86	77.00	0.36
Northford Rd	2558	Floodway	E_Reg	2980.00	167.86	180.21	174.32	180.50	0.000695	4.61	788.86	88.25	0.25
Northford Rd	2558	Floodway	Prop, Reg	2980.00	167.86	179.69	174.32	180.02	0.000830	4.88	743.28	88.25	0.27
Northford Rd	2531	Floodway	E_Reg	2980.00	167.50	180.02	174.58	180.45	0.001045	5.55	659.33	74.65	0.30
Northford Rd	2531	Floodway	Prop, Reg	2980.00	167.50	179.47	174.58	179.96	0.001262	5.89	618.59	74.65	0.33
Northford Rd	2515.5 BN04832			Bridge									
Northford Rd	2499	Floodway	E_Reg	2980.00	167.40	177.68	174.54	178.36	0.003347	6.74	483.53	73.00	0.43
Northford Rd	2499	Floodway	Prop, Reg	2980.00	167.40	177.68	174.54	178.36	0.003347	6.74	483.53	73.00	0.43
Northford Rd	2475	Floodway	E_Reg	2980.00	167.26	177.68	174.19	178.22	0.002533	6.01	534.09	77.65	0.38
Northford Rd	2475	Floodway	Prop, Reg	2980.00	167.26	177.68	174.19	178.22	0.002533	6.01	534.09	77.65	0.38
Northford Rd	2390 BJ (Exit)	Floodway	E_Reg	2980.00	169.10	177.50	173.99	177.99	0.002390	5.66	549.21	85.00	0.37
Northford Rd	2390 BJ (Exit)	Floodway	Prop, Reg	2980.00	169.10	177.50	173.99	177.99	0.002390	5.66	549.21	85.00	0.37
Northford Rd	2256 BI	Floodway	E_Reg	2980.00	167.52	177.01	172.61	177.66	0.002311	6.48	459.76	50.00	0.38
Northford Rd	2256 BI	Floodway	Prop, Reg	2980.00	167.52	177.01	172.61	177.66	0.002311	6.48	459.76	50.00	0.38
Northford Rd	2193	Floodway	E_Reg	2980.00	167.82	176.05	174.07	177.36	0.006761	10.28	411.93	57.83	0.64
Northford Rd	2193	Floodway	Prop, Reg	2980.00	167.82	176.05	174.07	177.36	0.006761	10.28	411.93	57.83	0.64
Northford Rd	1000 BH	Floodway	E_Reg	2980.00	164.30	172.50	169.70	172.91	0.002191	6.89	921.19	154.00	0.43
Northford Rd	1000 BH	Floodway	Prop, Reg	2980.00	164.30	172.50	169.70	172.91	0.002191	6.89	921.19	154.00	0.43

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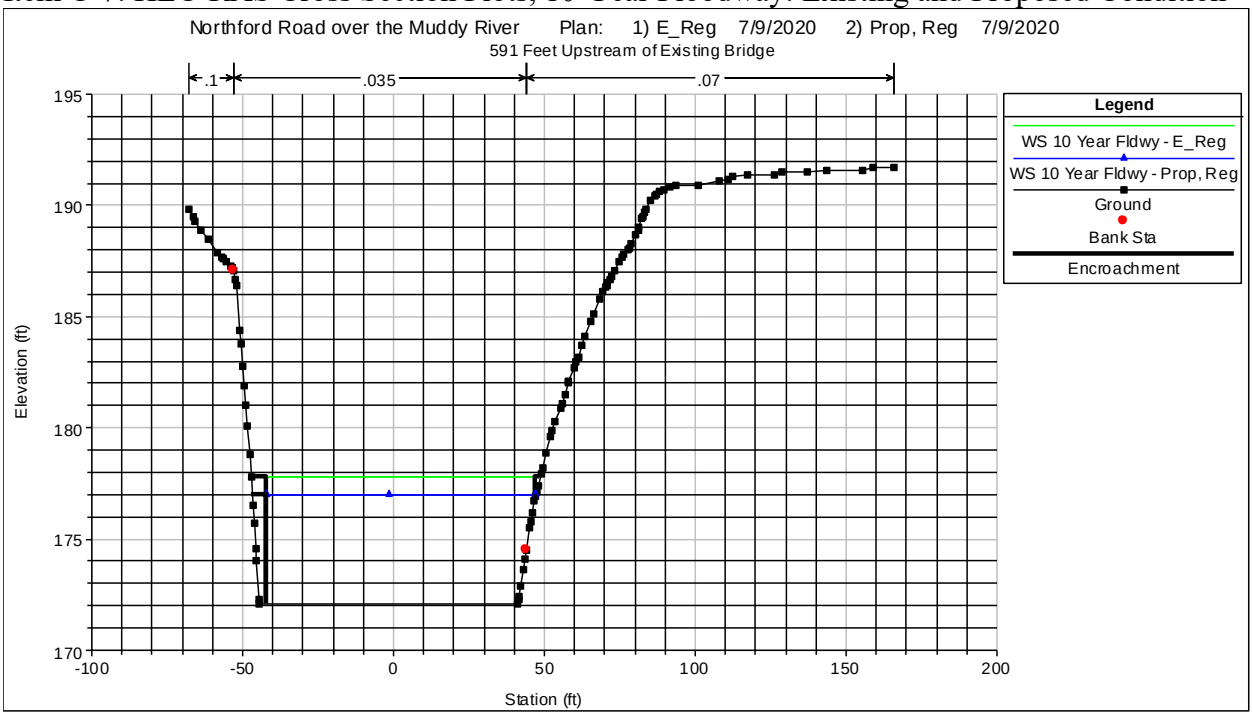
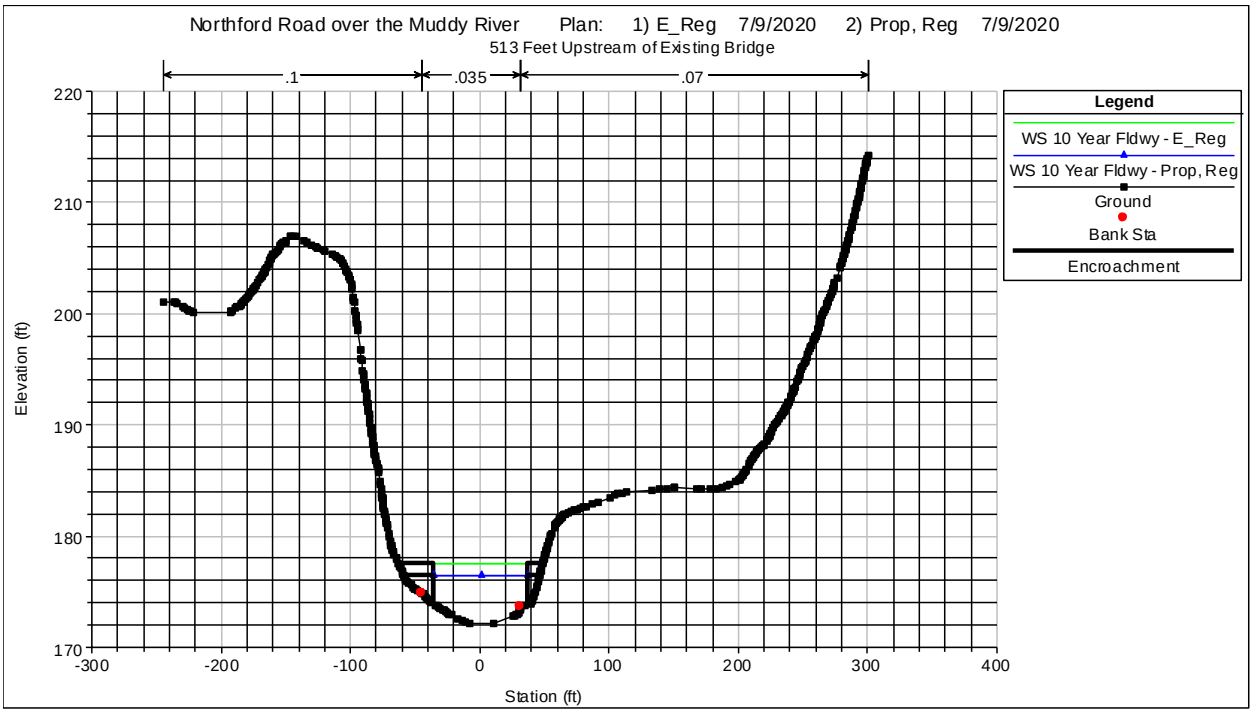
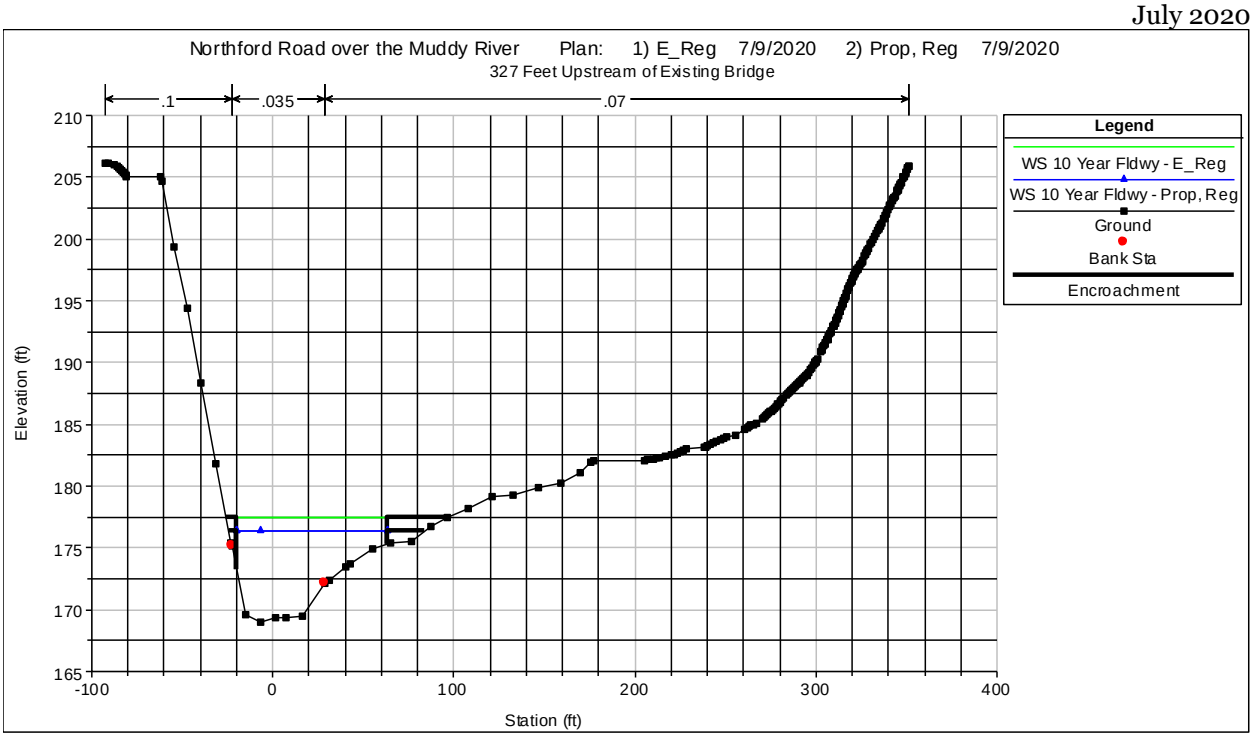
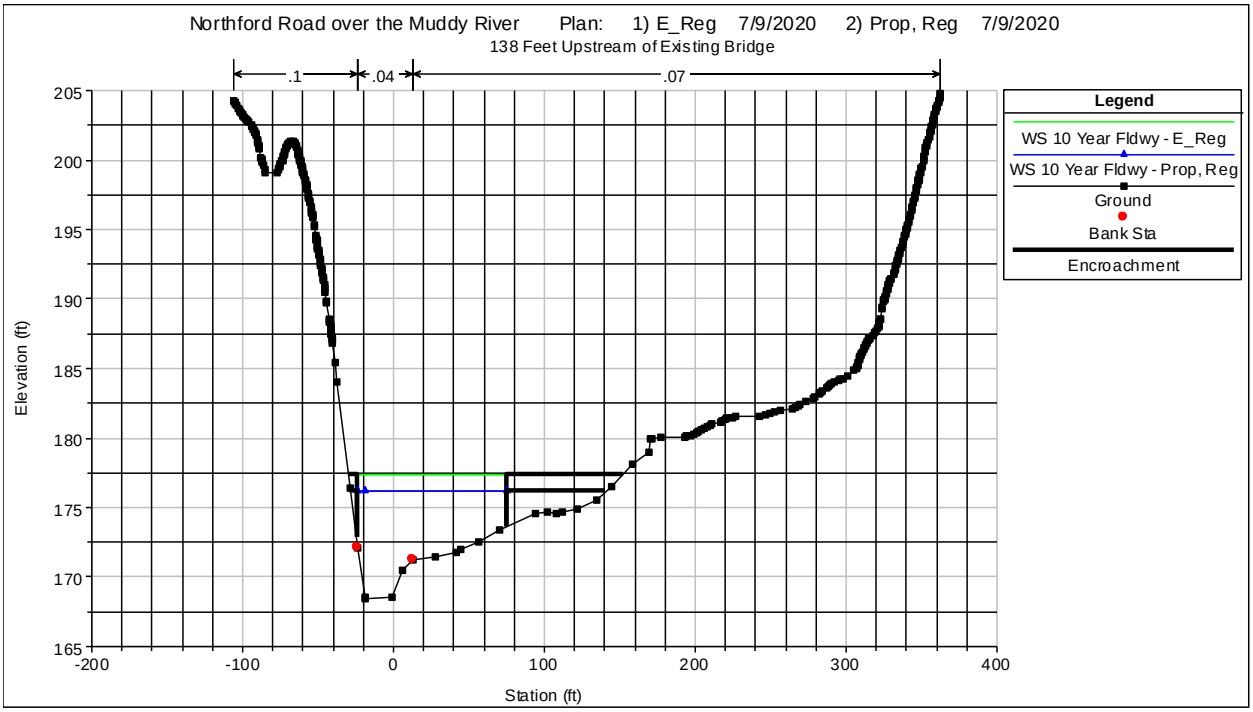
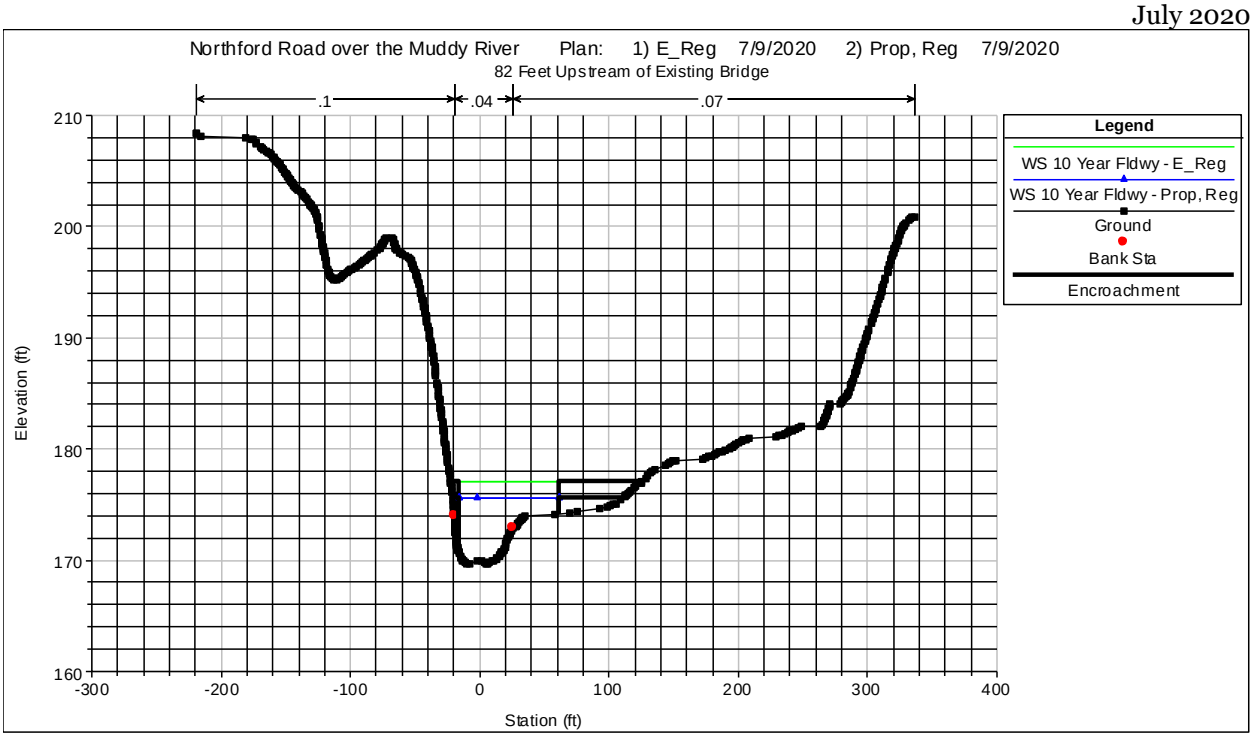
Item C-7: HEC-RAS Cross Section Plots, 10-Year Floodway: Existing and Proposed Condition

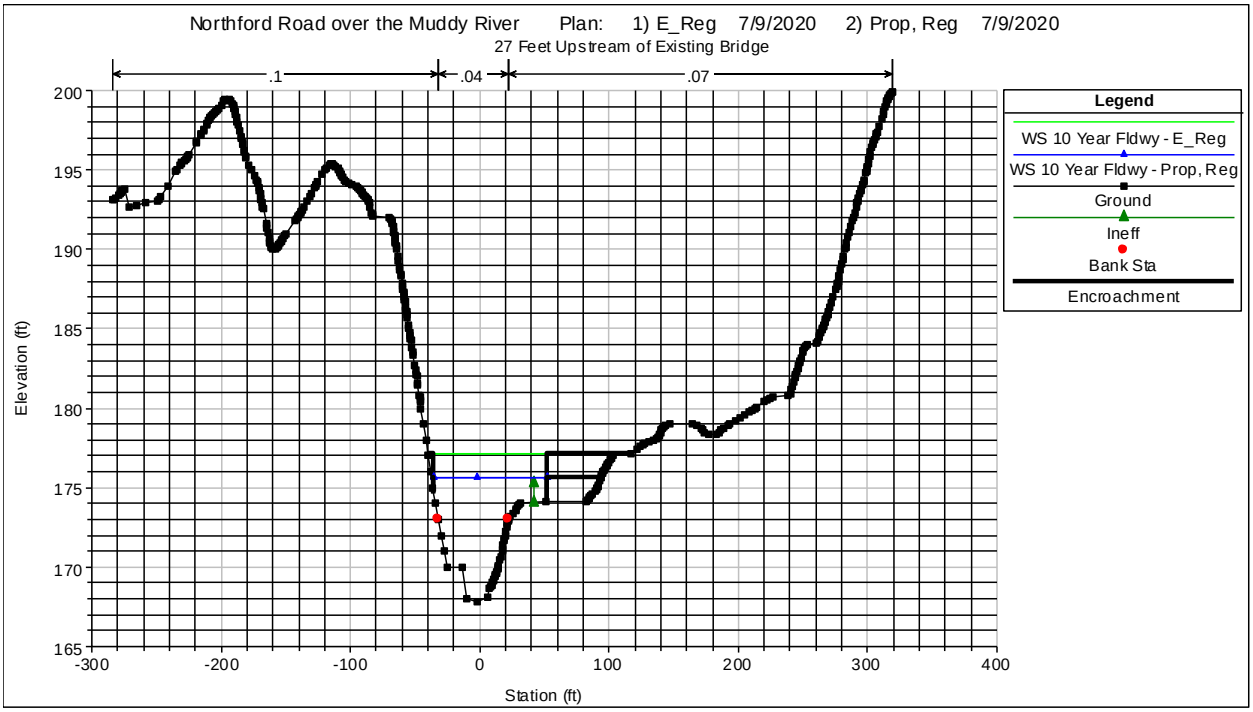


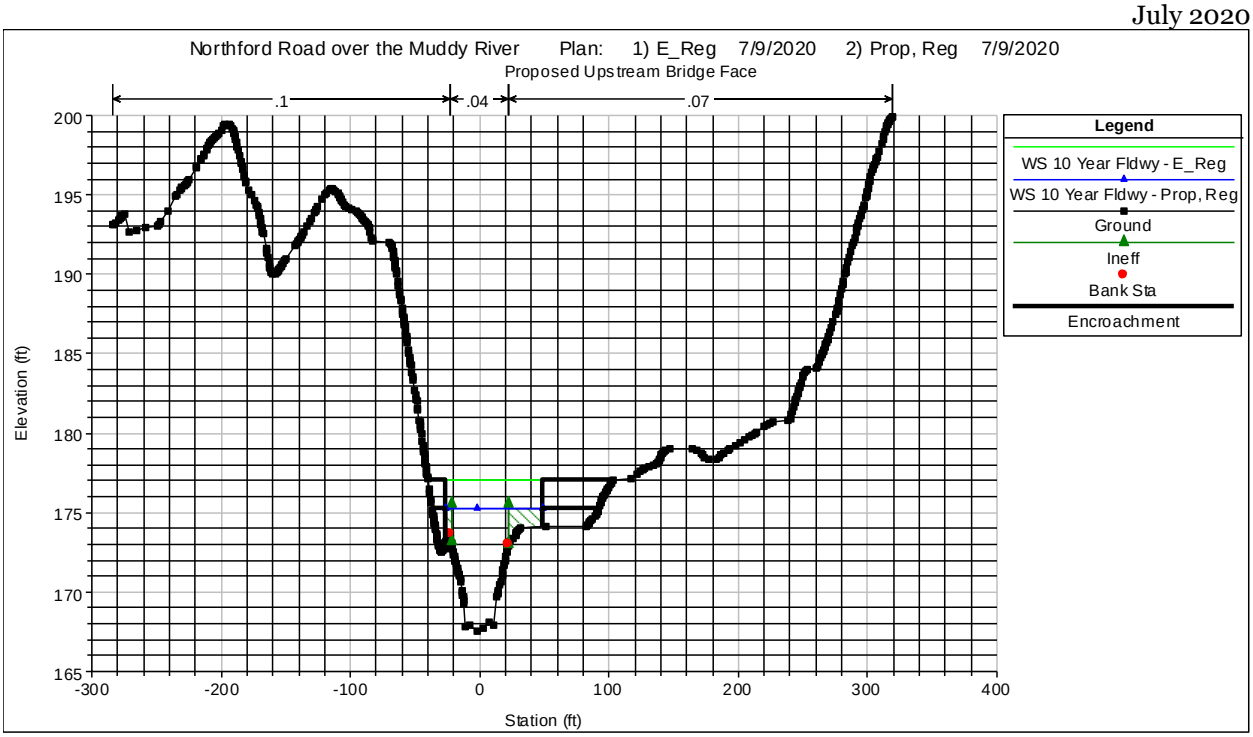


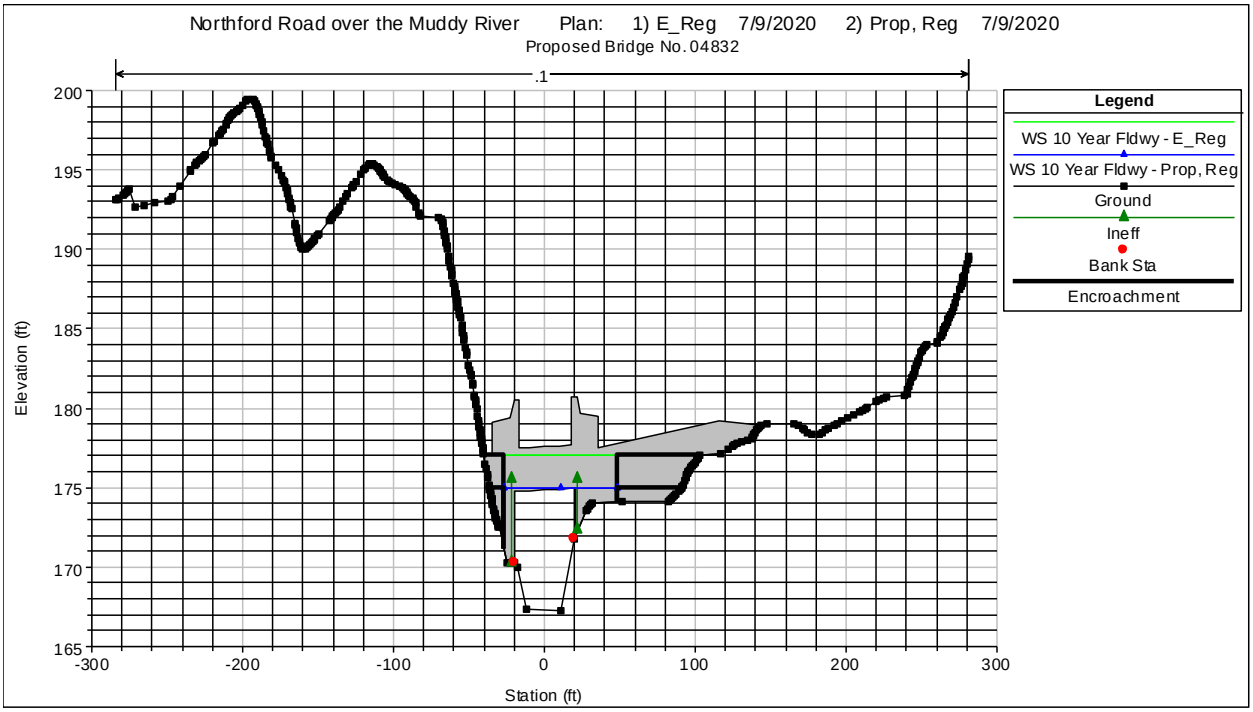

Northford Road over the Muddy River Plan: 1) E_Reg 7/9/2020 2) Prop, Reg 7/9/2020
327 Feet Upstream of Existing Bridge
.1
.035
.07
Elevation (ft)
Station (ft)
Legend
WS 10 Year Fldwy - E_Reg
WS 10 Year Fldwy - Prop, Reg
Ground
Bank Sta
Encroachment

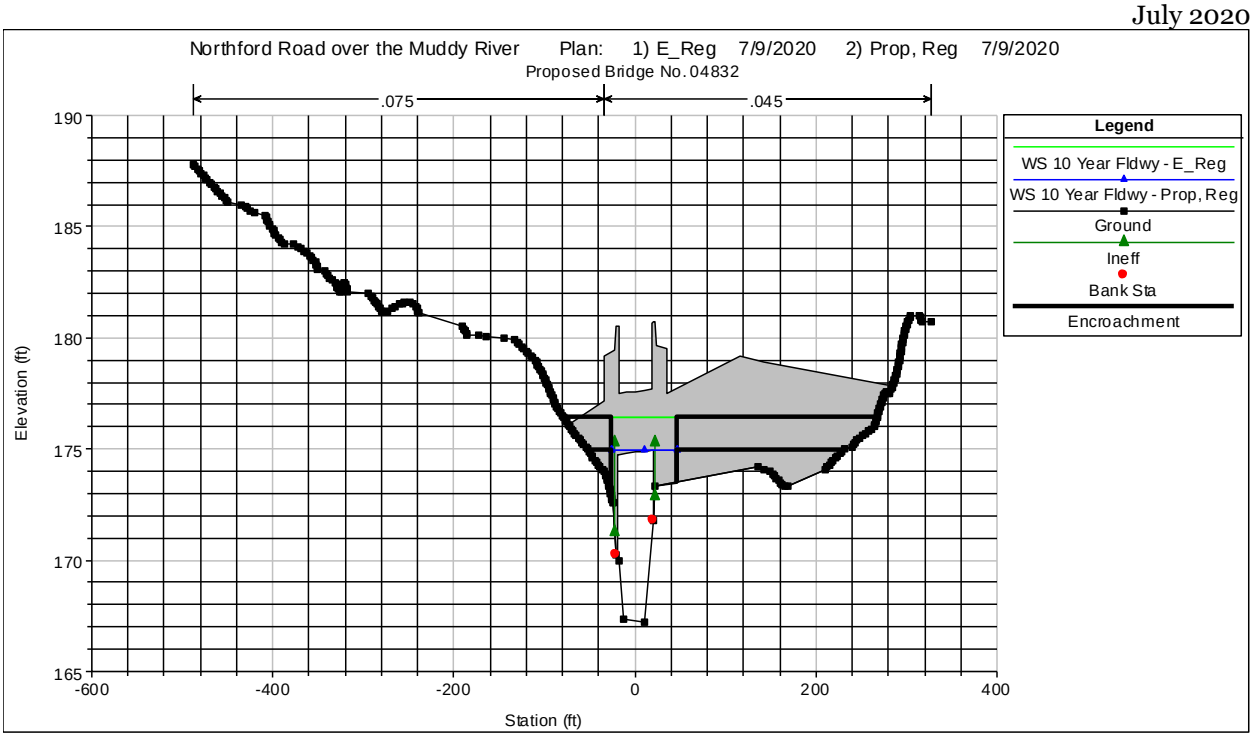

Northford Road over the Muddy River Plan: 1) E_Reg 7/9/2020 2) Prop, Reg 7/9/2020
138 Feet Upstream of Existing Bridge
.1
.04
.07
Elevation (ft)
Station (ft)
Legend
WS 10 Year Fldwy - E_Reg
WS 10 Year Fldwy - Prop, Reg
Ground
Bank Sta
Encroachment

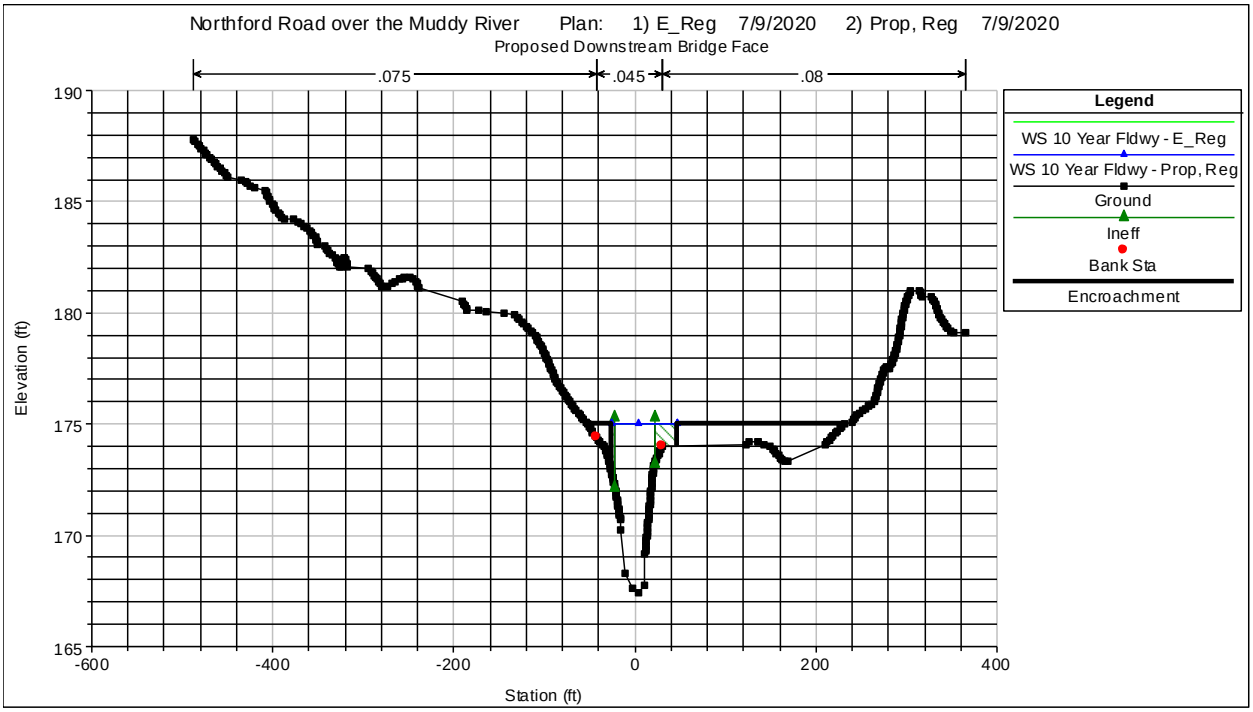

Northford Road over the Muddy River Plan: 1) E_Reg 7/9/2020 2) Prop, Reg 7/9/2020
82 Feet Upstream of Existing Bridge
.1
.04
.07
Elevation (ft)
Station (ft)
Legend
WS 10 Year Fldwy - E_Reg
WS 10 Year Fldwy - Prop, Reg
Ground
Bank Sta
Encroachment

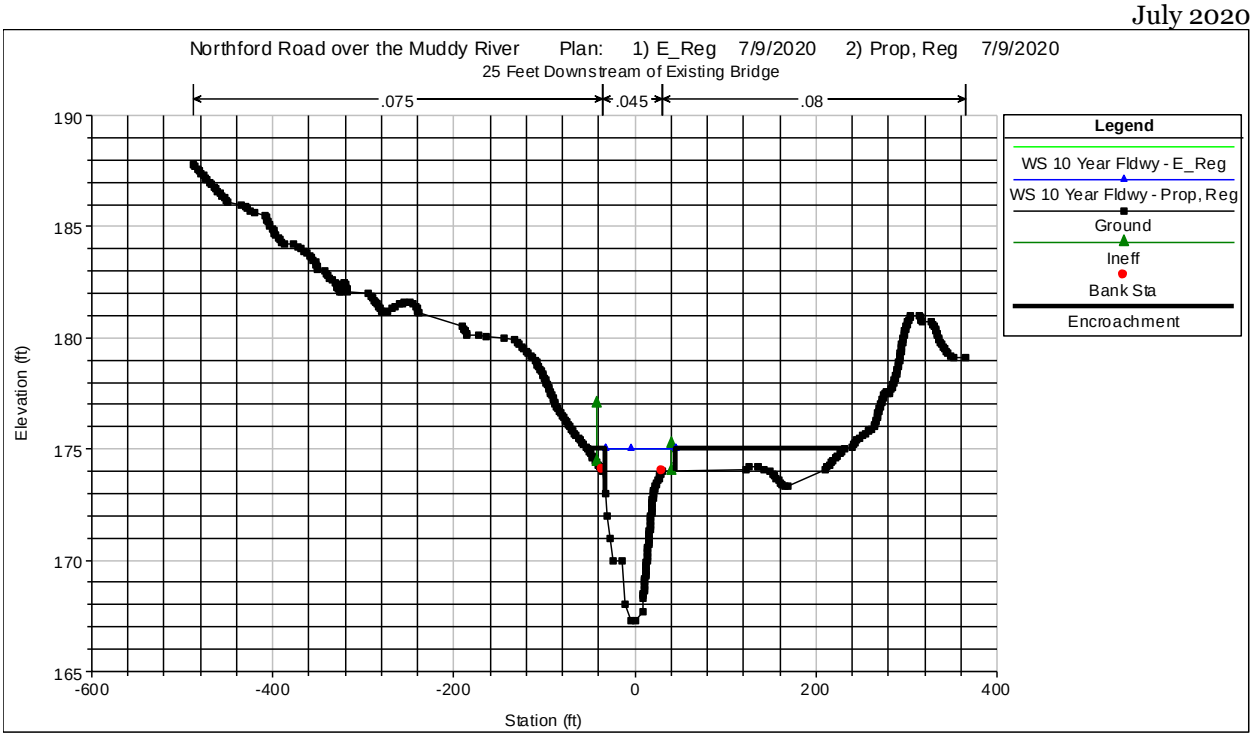

Northford Road over the Muddy River Plan: 1) E_Reg 7/9/2020 2) Prop, Reg 7/9/2020
27 Feet Upstream of Existing Bridge
.1
.04
.07
Elevation (ft)
Station (ft)
Legend
WS 10 Year Fldwy - E_Reg
WS 10 Year Fldwy - Prop, Reg
Ground
Ineff
Bank Sta
Encroachment

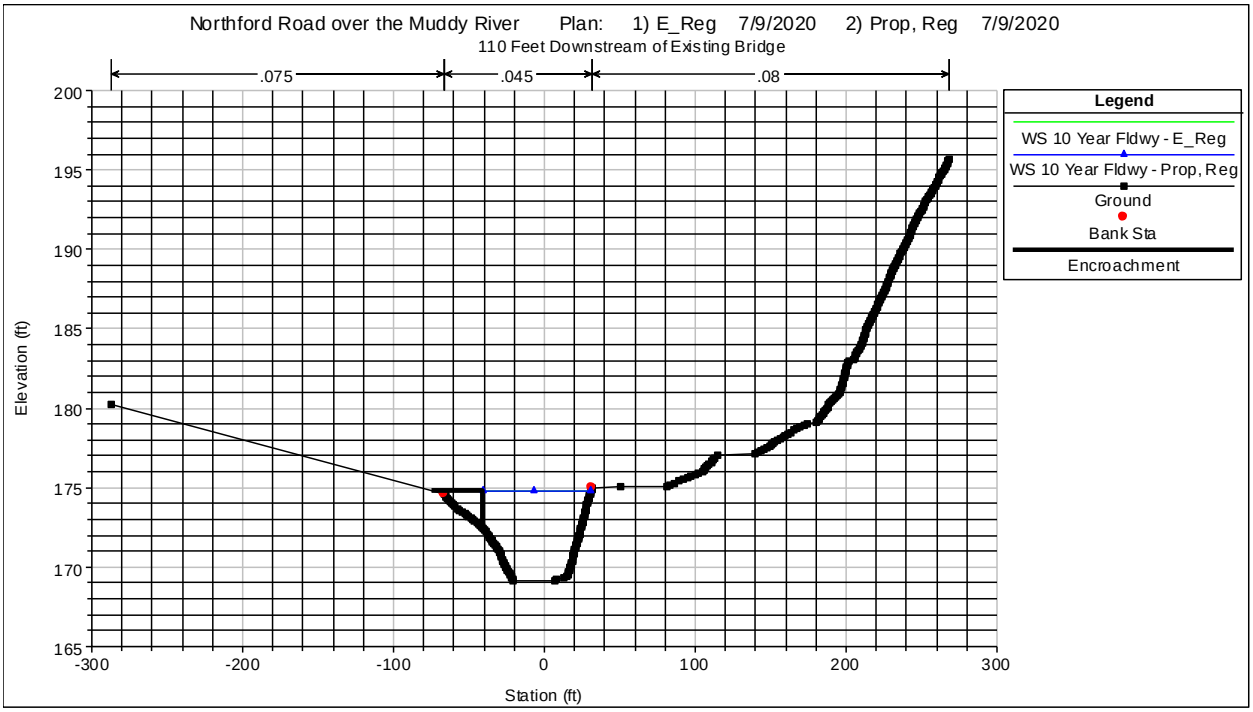

Northford Road over the Muddy River Plan: 1) E_Reg 7/9/2020 2) Prop, Reg 7/9/2020
Proposed Upstream Bridge Face
.1
.04
.07
Elevation (ft)
Station (ft)
Legend
WS 10 Year Fldwy - E_Reg
WS 10 Year Fldwy - Prop, Reg
Ground
Ineff
Bank Sta
Encroachment

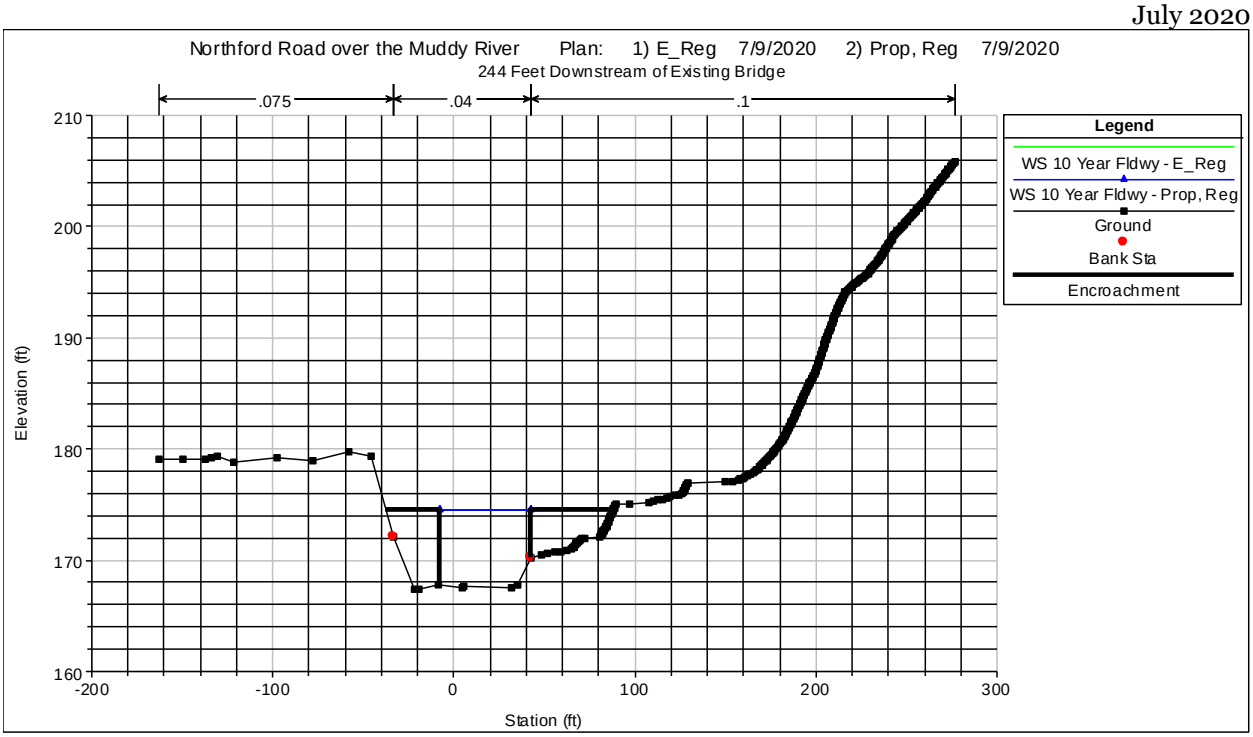

Northford Road over the Muddy River Plan: 1) E_Reg 7/9/2020 2) Prop, Reg 7/9/2020
Proposed Bridge No. 04832
.1
Elevation (ft)
Station (ft)
Legend
WS 10 Year Fldwy - E_Reg
WS 10 Year Fldwy - Prop, Reg
Ground
Ineff
Bank Sta
Encroachment


Northford Road over the Muddy River Plan: 1) E_Reg 7/9/2020 2) Prop, Reg 7/9/2020
Proposed Bridge No. 04832
.075
.045
Legend
WS 10 Year Fldwy - E_Reg
WS 10 Year Fldwy - Prop, Reg
Ground
Ineff
Bank Sta
Encroachment
Elevation (ft)
Station (ft)
190
185
180
175
170
165
-600
-400
-200
0
200
400


Northford Road over the Muddy River Plan: 1) E_Reg 7/9/2020 2) Prop, Reg 7/9/2020
Proposed Downstream Bridge Face
.075
.045
.08
Legend
WS 10 Year Fldwy - E_Reg
WS 10 Year Fldwy - Prop, Reg
Ground
Ineff
Bank Sta
Encroachment
Elevation (ft)
Station (ft)
190
185
180
175
170
165
-600
-400
-200
0
200
400


Northford Road over the Muddy River Plan: 1) E_Reg 7/9/2020 2) Prop, Reg 7/9/2020
25 Feet Downstream of Existing Bridge
.075
.045
.08
Legend
WS 10 Year Fldwy - E_Reg
WS 10 Year Fldwy - Prop, Reg
Ground
Ineff
Bank Sta
Encroachment
Elevation (ft)
Station (ft)
190
185
180
175
170
165
-600
-400
-200
0
200
400


Northford Road over the Muddy River Plan: 1) E_Reg 7/9/2020 2) Prop, Reg 7/9/2020
110 Feet Downstream of Existing Bridge
.075
.045
.08
Legend
WS 10 Year Fldwy - E_Reg
WS 10 Year Fldwy - Prop, Reg
Ground
Bank Sta
Encroachment
Elevation (ft)
Station (ft)
200
195
190
185
180
175
170
165
-300
-200
-100
0
100
200
300


Northford Road over the Muddy River Plan: 1) E_Reg 7/9/2020 2) Prop, Reg 7/9/2020
244 Feet Downstream of Existing Bridge
.075
.04
.1
Legend
WS 10 Year Fldwy - E_Reg
WS 10 Year Fldwy - Prop, Reg
Ground
Bank Sta
Encroachment
Elevation (ft)
Station (ft)
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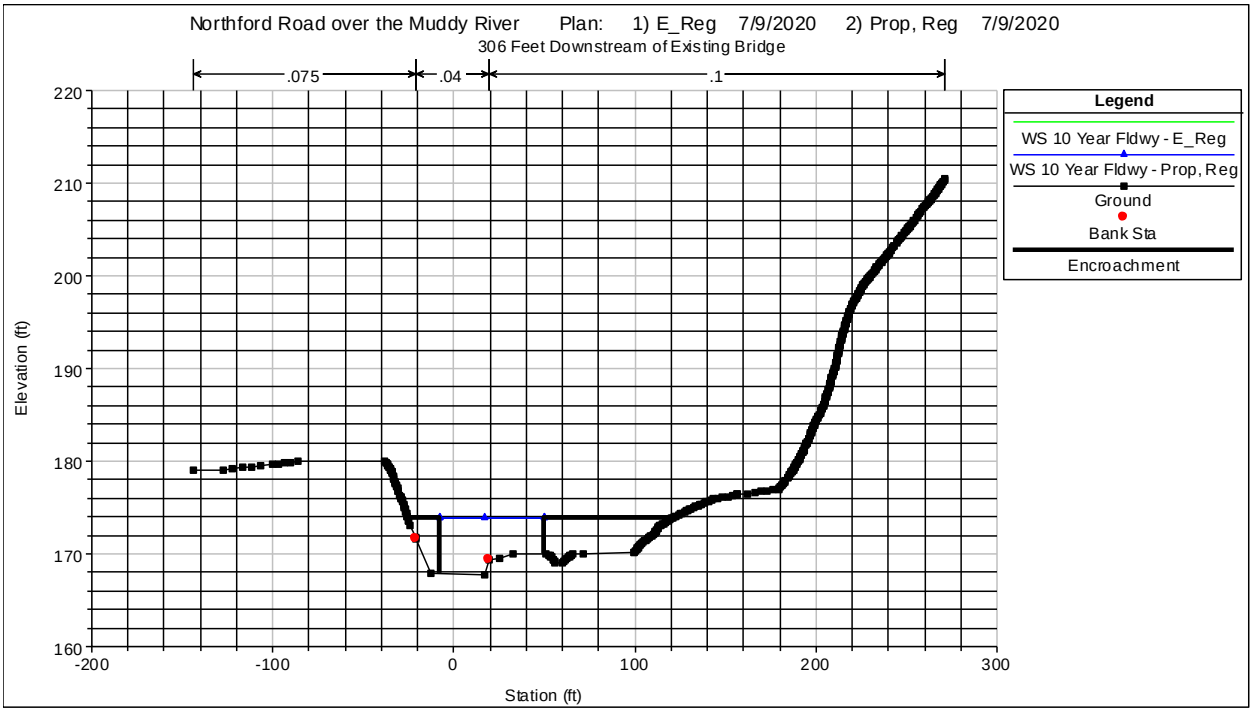
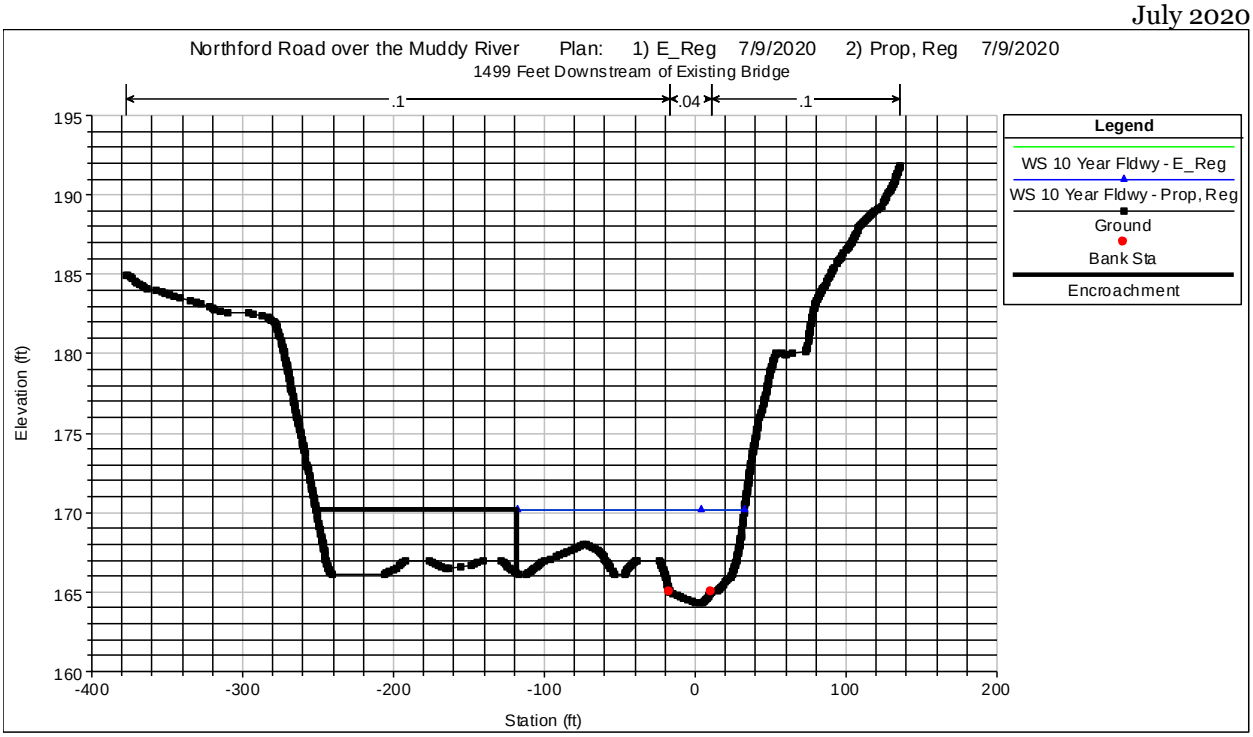
200
190
180
170
160
-200
-100
0
100
200
300


Northford Road over the Muddy River Plan: 1) E_Reg 7/9/2020 2) Prop, Reg 7/9/2020
306 Feet Downstream of Existing Bridge
.075
.04
.1
Legend
WS 10 Year Fldwy - E_Reg
WS 10 Year Fldwy - Prop, Reg
Ground
Bank Sta
Encroachment
Elevation (ft)
Station (ft)
220
210
200
190
180
170
160
-200
-100
0
100
200
300



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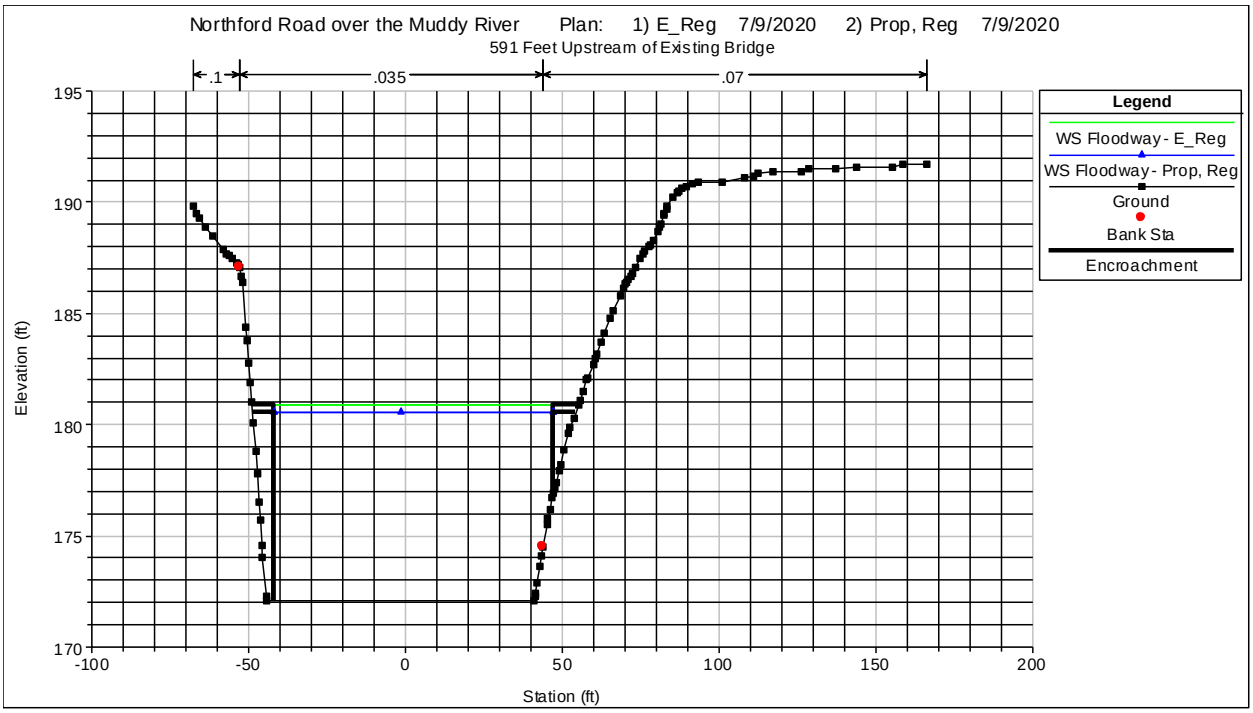
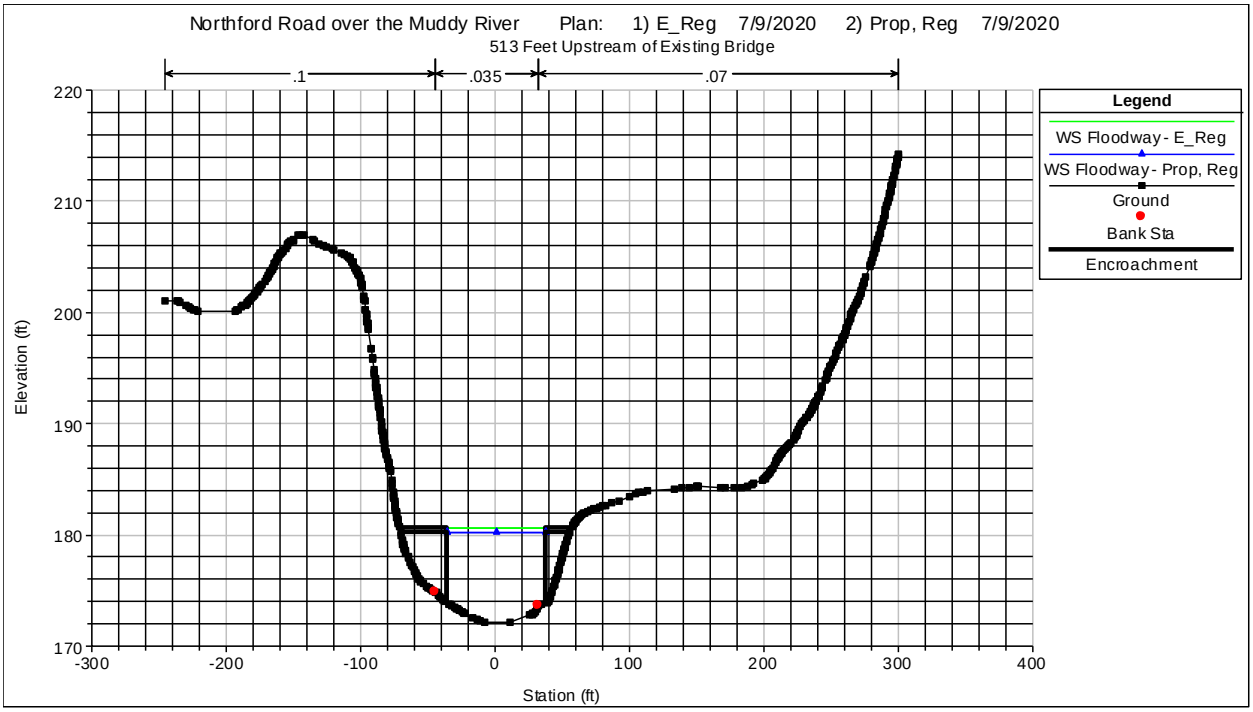
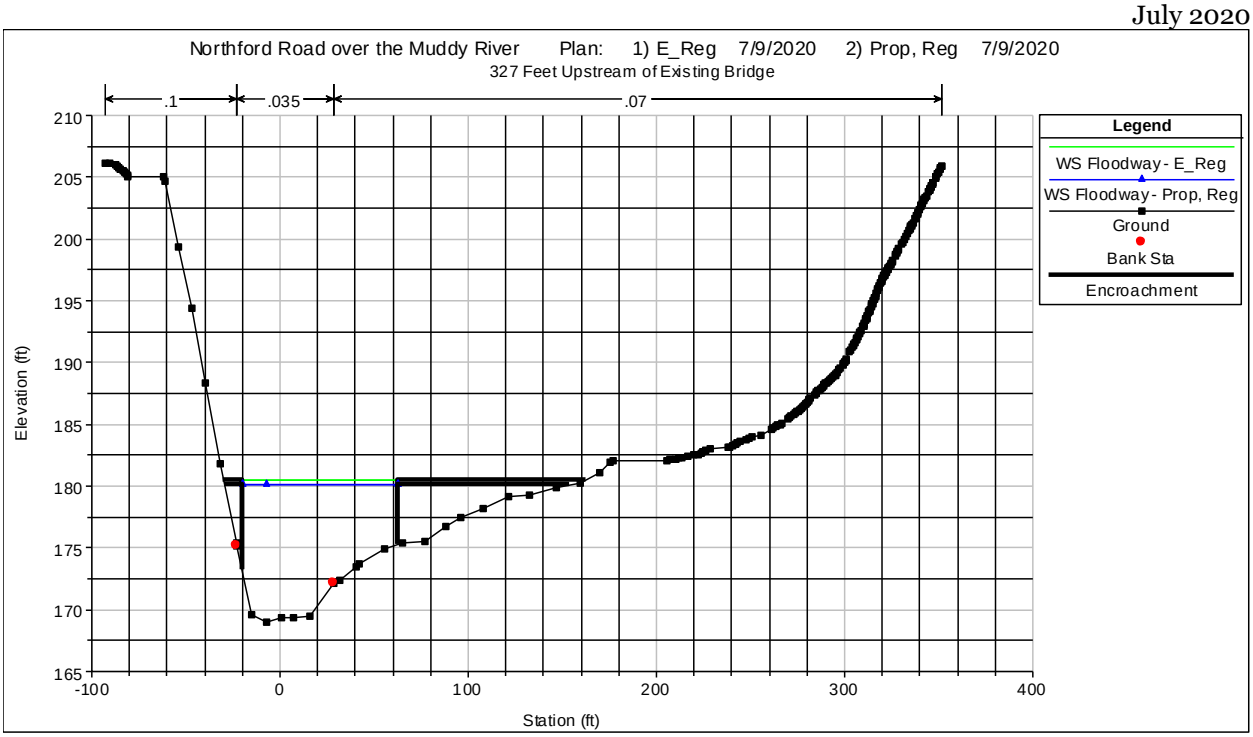
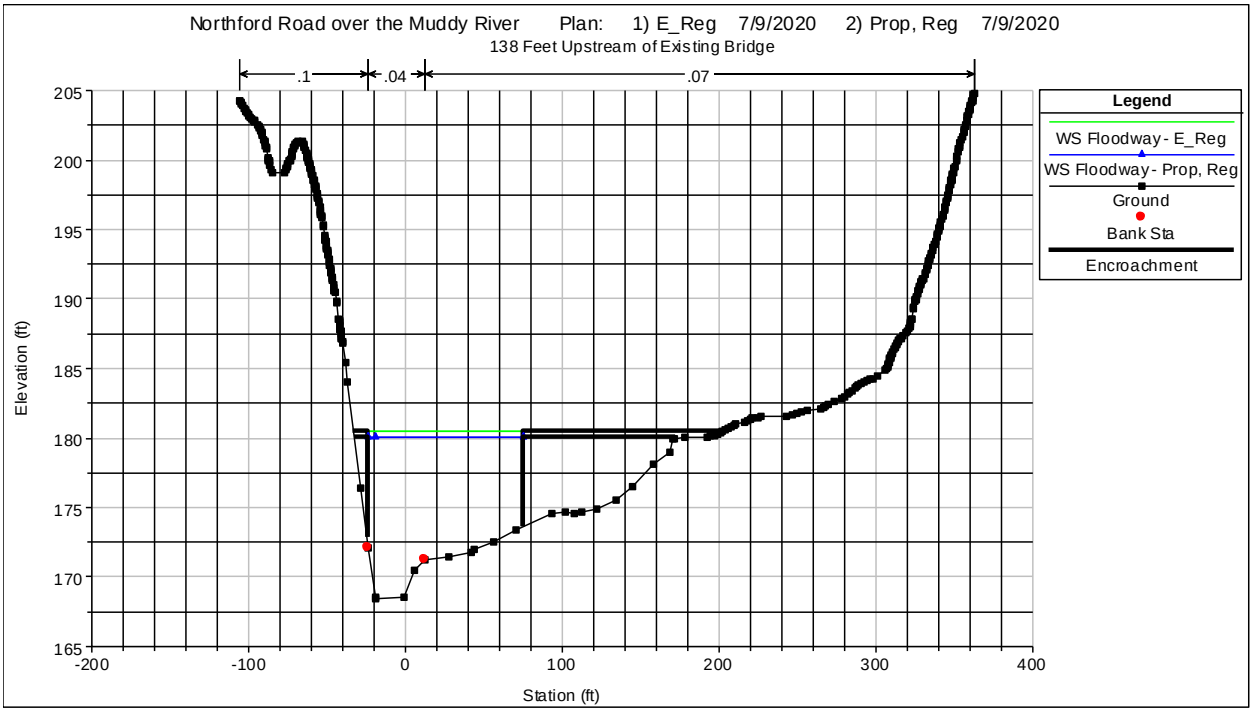
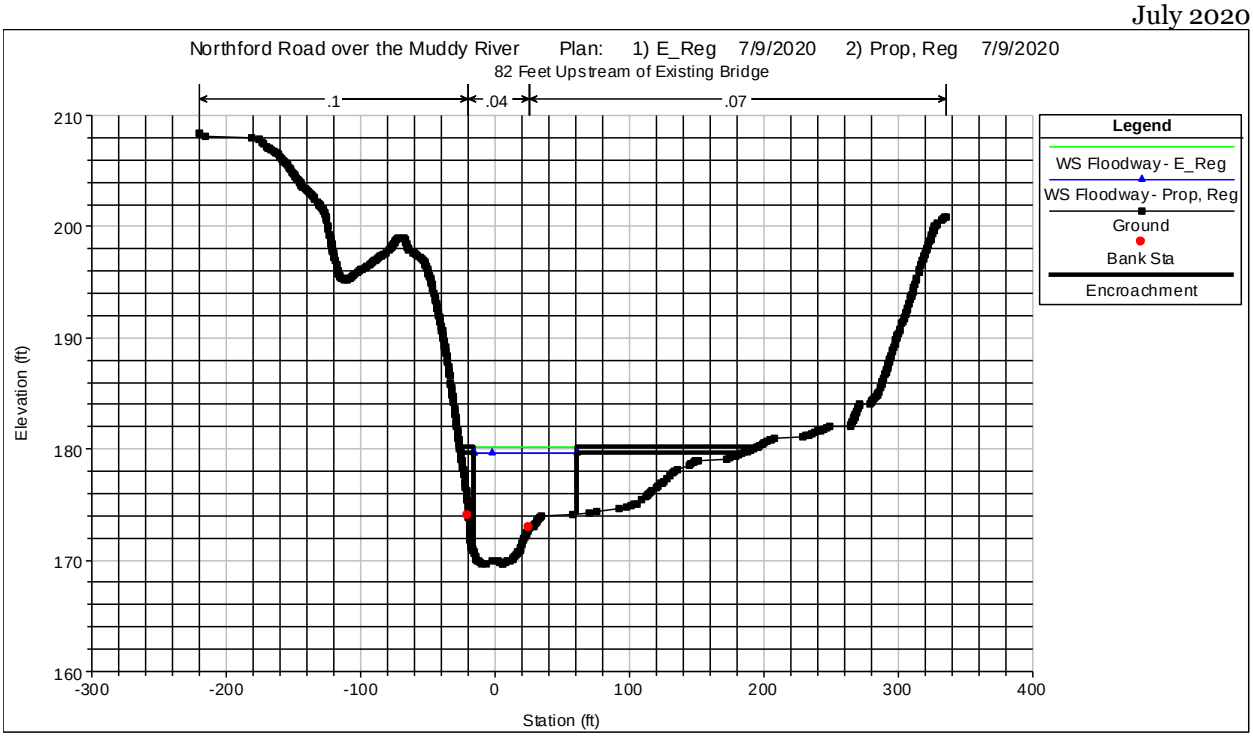
Item C-8: HEC-RAS Cross Section Plots, 100-Year Floodway: Existing and Proposed Condition

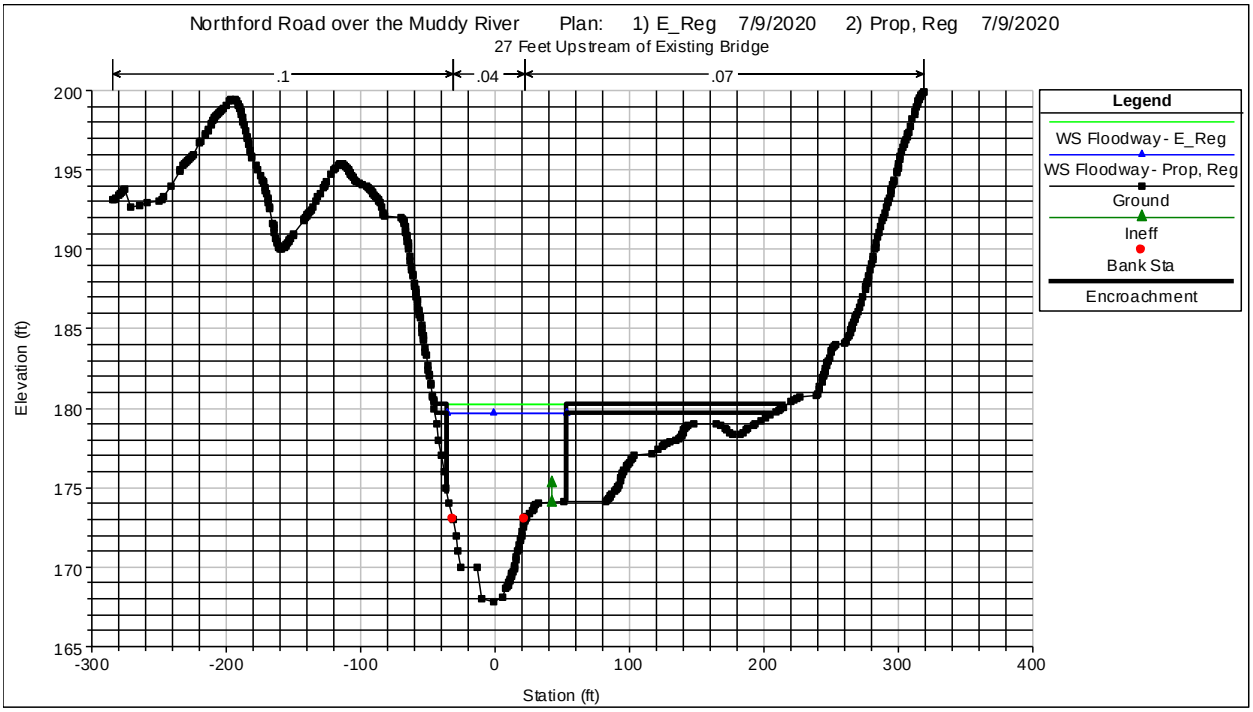


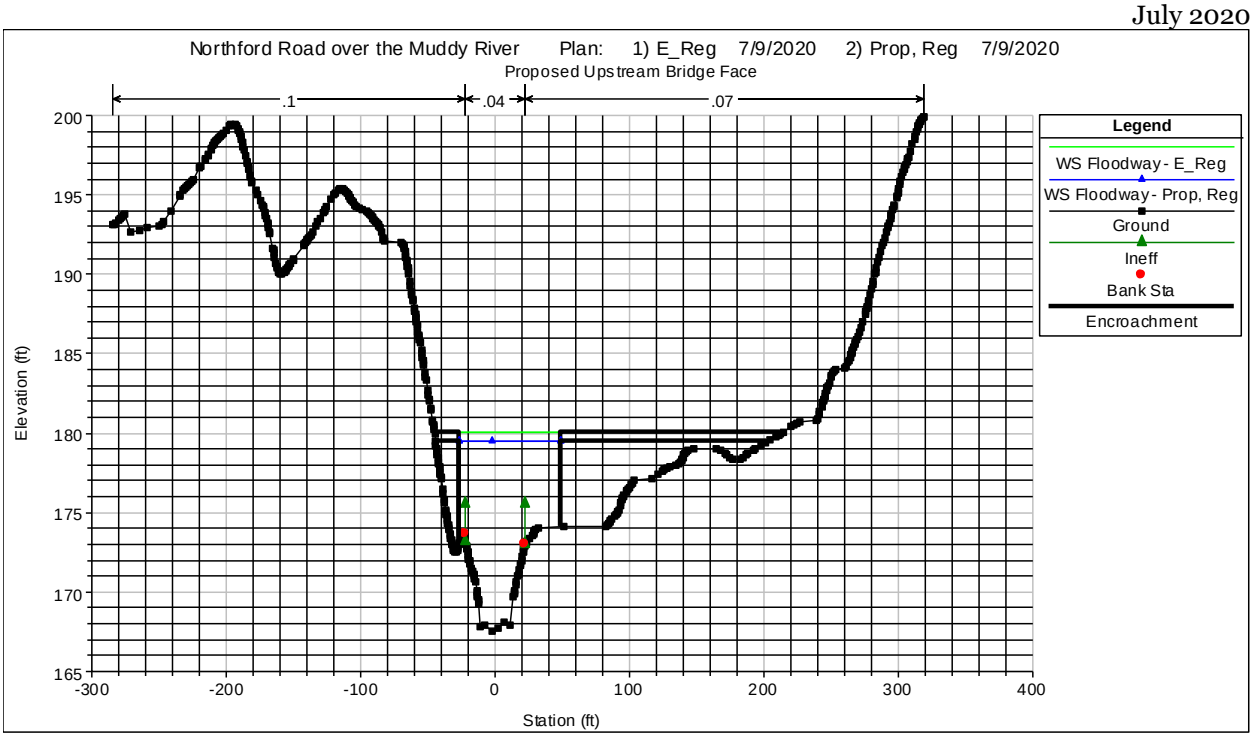


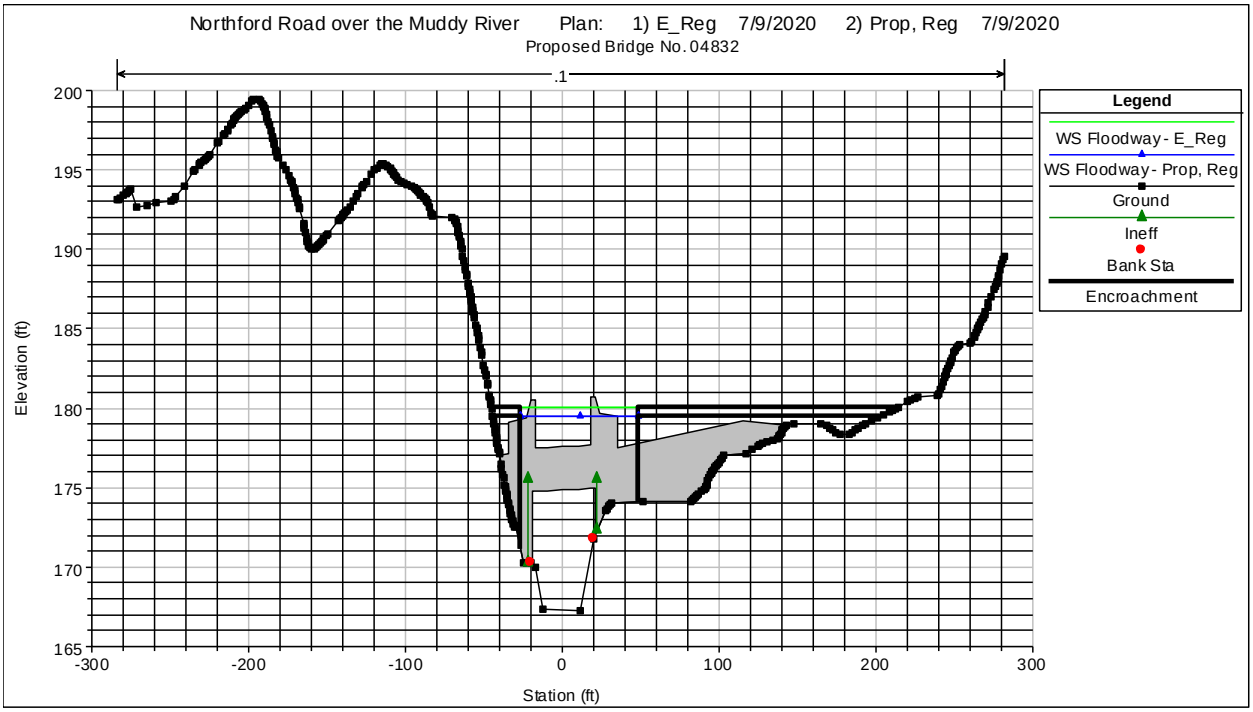

Northford Road over the Muddy River Plan: 1) E_Reg 7/9/2020 2) Prop, Reg 7/9/2020
327 Feet Upstream of Existing Bridge
.1
.035
.07
Legend
WS Floodway - E_Reg
WS Floodway - Prop, Reg
Ground
Bank Sta
Encroachment
Elevation (ft)
Station (ft)
210
205
200
195
190
185
180
175
170
165
-100
0
100
200
300
400

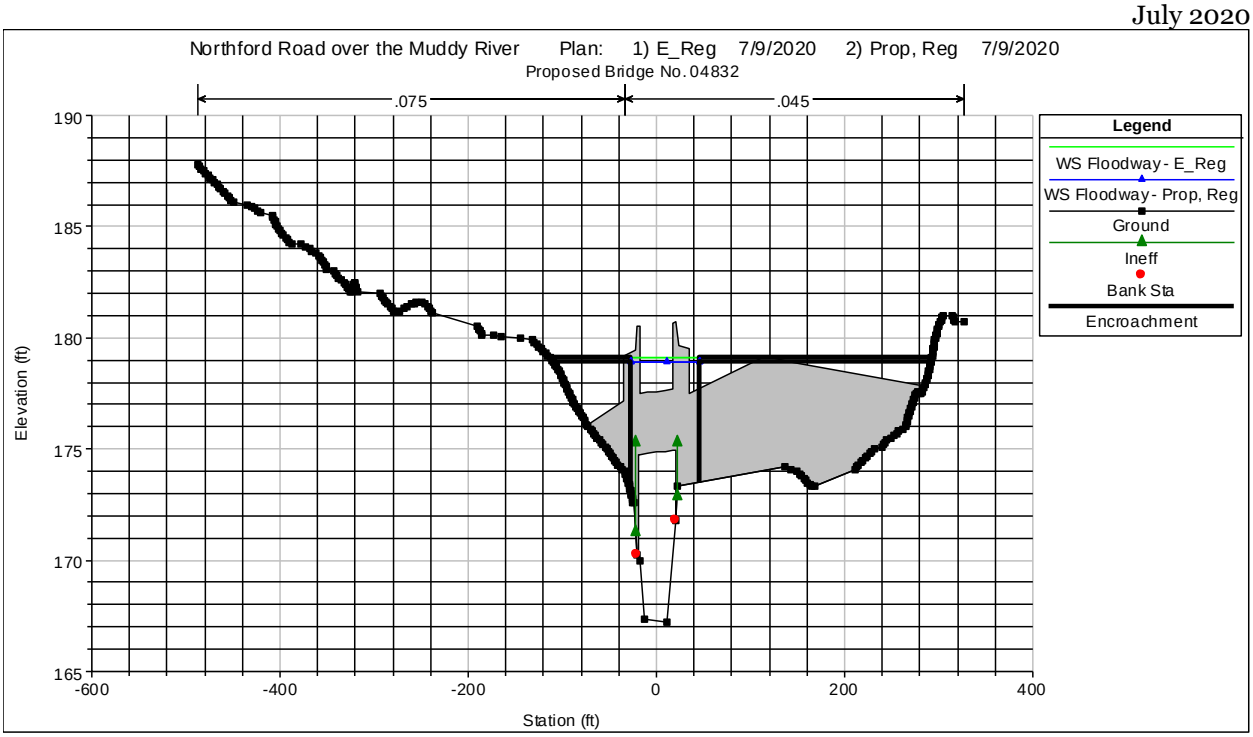

Northford Road over the Muddy River Plan: 1) E_Reg 7/9/2020 2) Prop, Reg 7/9/2020
138 Feet Upstream of Existing Bridge
.1
.04
.07
Legend
WS Floodway - E_Reg
WS Floodway - Prop, Reg
Ground
Bank Sta
Encroachment
Elevation (ft)
Station (ft)
205
200
195
190
185
180
175
170
165
-200
-100
0
100
200
300
400

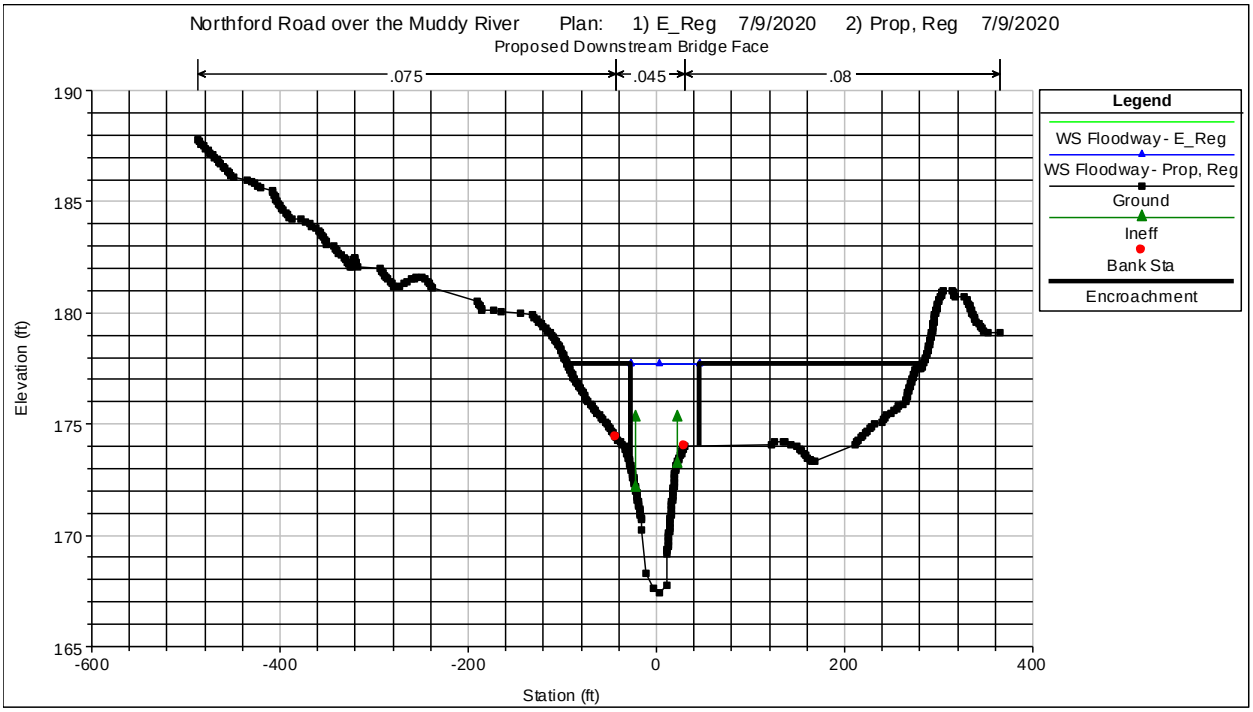

Northford Road over the Muddy River Plan: 1) E_Reg 7/9/2020 2) Prop, Reg 7/9/2020
82 Feet Upstream of Existing Bridge
.1
.04
.07
Legend
WS Floodway - E_Reg
WS Floodway - Prop, Reg
Ground
Bank Sta
Encroachment
Elevation (ft)
Station (ft)
210
200
190
180
170
160
-300
-200
-100
0
100
200
300
400

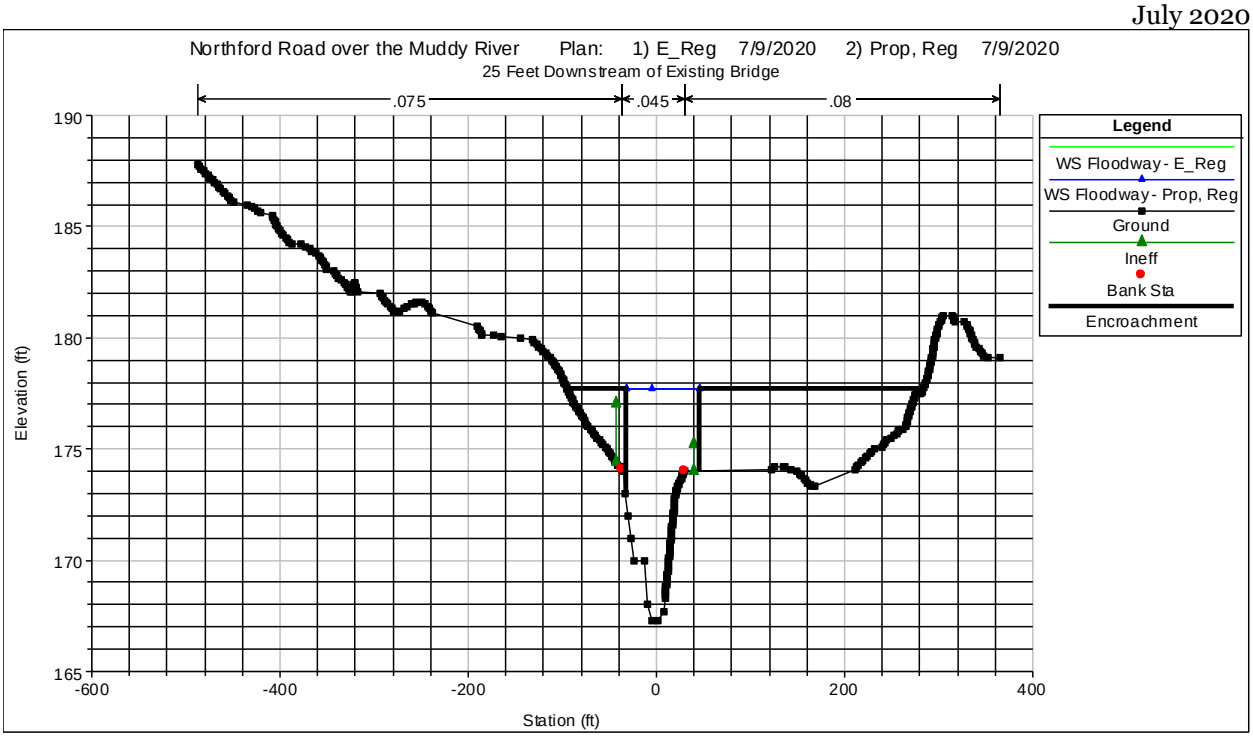

Northford Road over the Muddy River Plan: 1) E_Reg 7/9/2020 2) Prop, Reg 7/9/2020
27 Feet Upstream of Existing Bridge
.1
.04
.07
Legend
WS Floodway - E_Reg
WS Floodway - Prop, Reg
Ground
Ineff
Bank Sta
Encroachment
Elevation (ft)
Station (ft)
200
195
190
185
180
175
170
165
-300
-200
-100
0
100
200
300
400

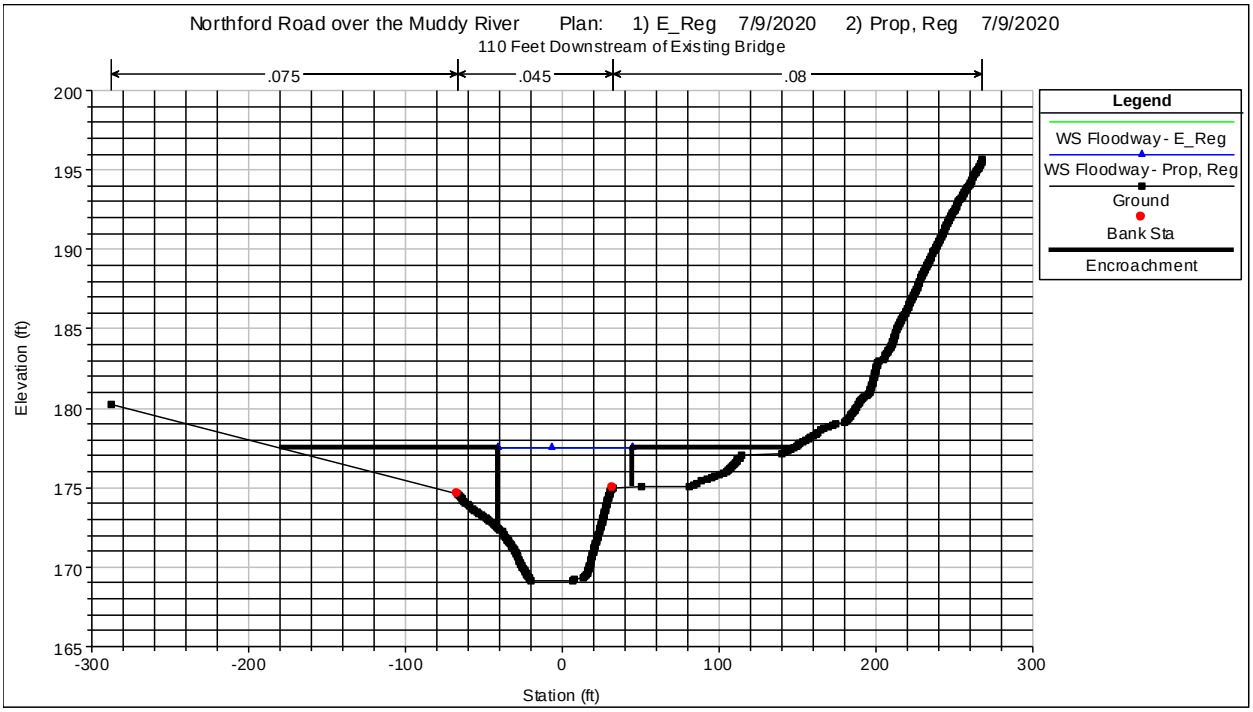

Northford Road over the Muddy River Plan: 1) E_Reg 7/9/2020 2) Prop, Reg 7/9/2020
Proposed Upstream Bridge Face
.1
.04
.07
Legend
WS Floodway - E_Reg
WS Floodway - Prop, Reg
Ground
Ineff
Bank Sta
Encroachment
Elevation (ft)
Station (ft)

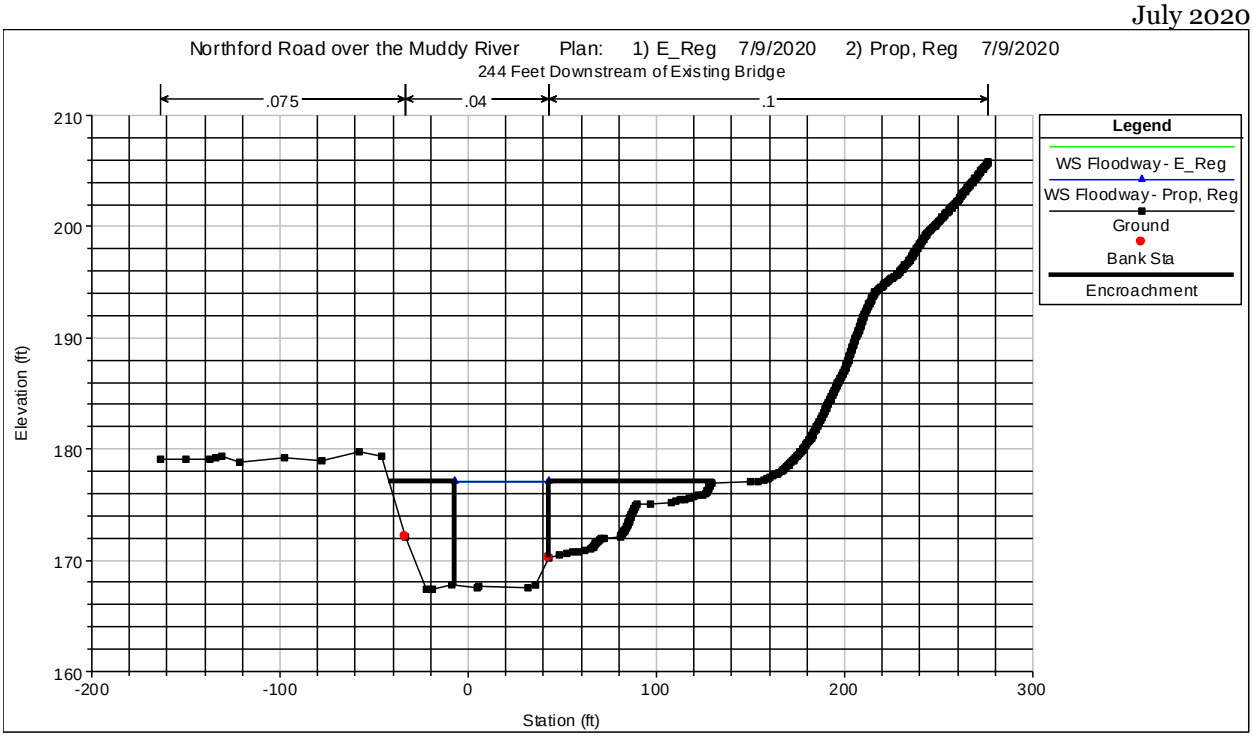

Northford Road over the Muddy River Plan: 1) E_Reg 7/9/2020 2) Prop, Reg 7/9/2020
Proposed Bridge No. 04832
.1
Legend
WS Floodway - E_Reg
WS Floodway - Prop, Reg
Ground
Ineff
Bank Sta
Encroachment
Elevation (ft)
Station (ft)

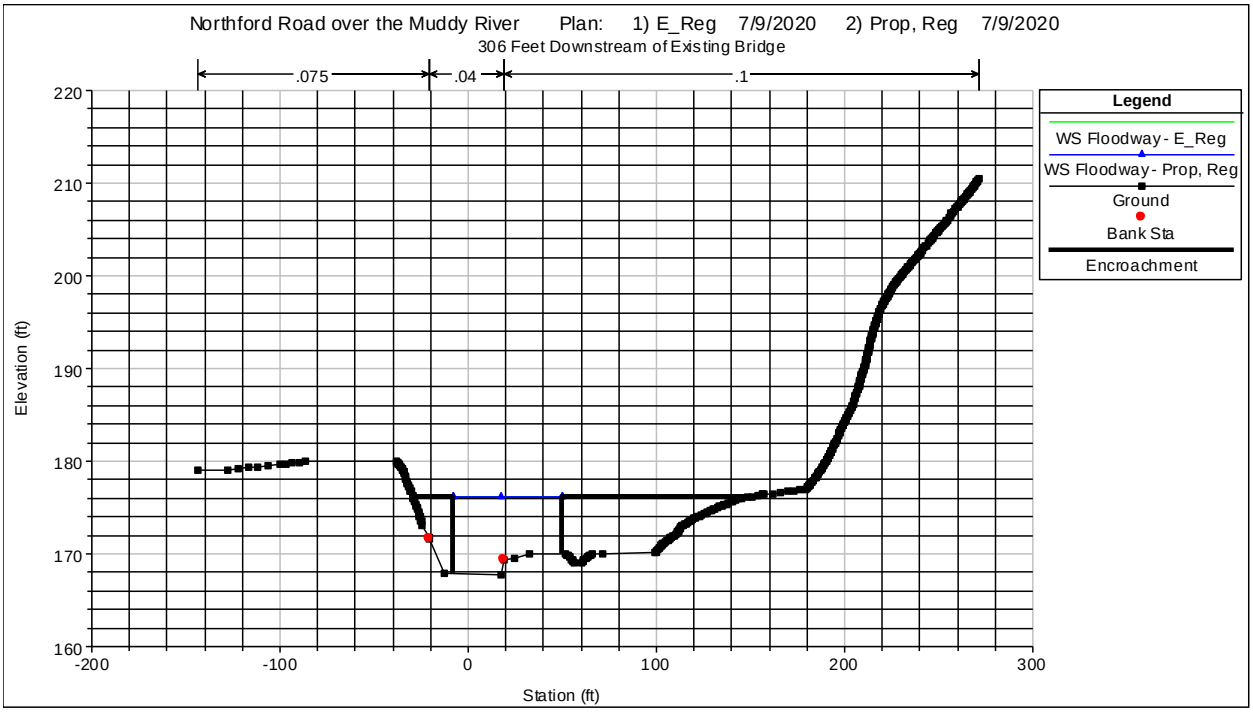

Northford Road over the Muddy River Plan: 1) E_Reg 7/9/2020 2) Prop, Reg 7/9/2020
Proposed Bridge No. 04832
.075
.045
Legend
WS Floodway - E_Reg
WS Floodway - Prop, Reg
Ground
Ineff
Bank Sta
Encroachment
Elevation (ft)
Station (ft)
190
185
180
175
170
165
-600
-400
-200
0
200
400

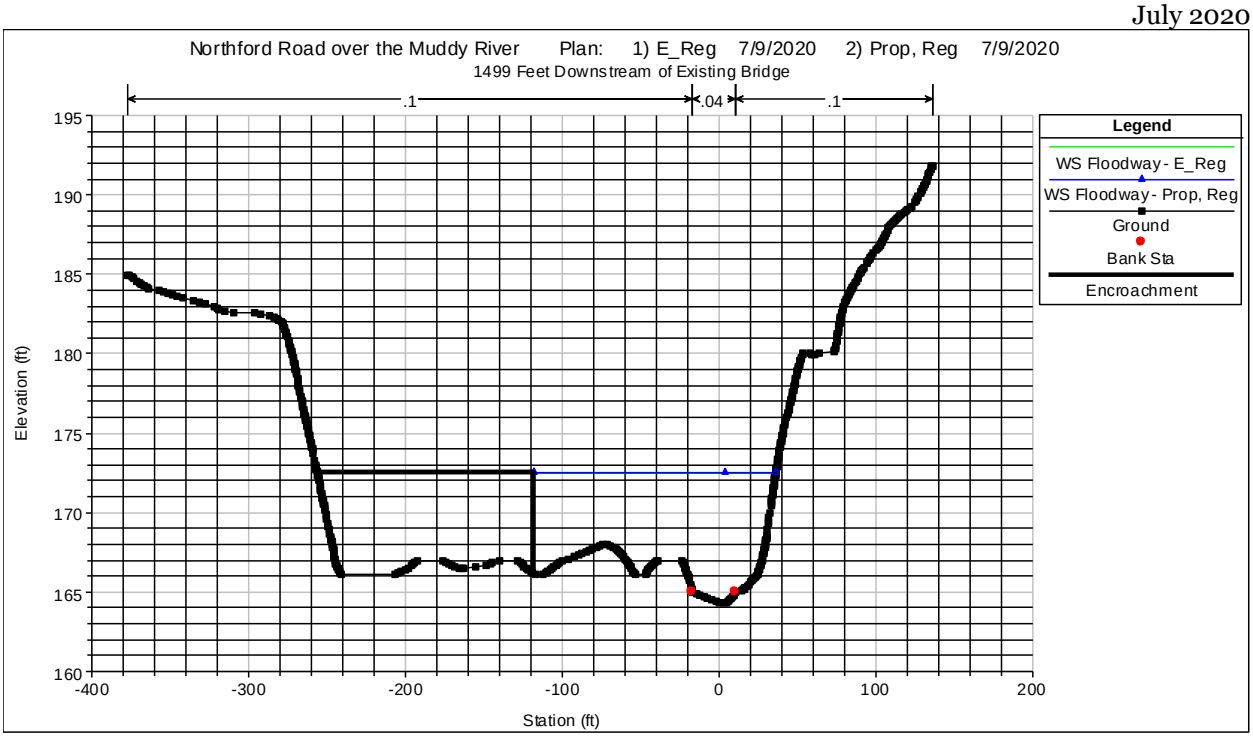

Northford Road over the Muddy River Plan: 1) E_Reg 7/9/2020 2) Prop, Reg 7/9/2020
Proposed Downstream Bridge Face
.075
.045
.08
Legend
WS Floodway - E_Reg
WS Floodway - Prop, Reg
Ground
Ineff
Bank Sta
Encroachment
Elevation (ft)
Station (ft)
190
185
180
175
170
165
-600
-400
-200
0
200
400


Northford Road over the Muddy River Plan: 1) E_Reg 7/9/2020 2) Prop, Reg 7/9/2020
25 Feet Downstream of Existing Bridge
.075
.045
.08
Elevation (ft)
Station (ft)
190
185
180
175
170
165
-600
-400
-200
0
200
400
Legend
WS Floodway - E_Reg
WS Floodway - Prop, Reg
Ground
Ineff
Bank Sta
Encroachment


Northford Road over the Muddy River Plan: 1) E_Reg 7/9/2020 2) Prop, Reg 7/9/2020
110 Feet Downstream of Existing Bridge
.075
.045
.08
Elevation (ft)
Station (ft)
200
195
190
185
180
175
170
165
-300
-200
-100
0
100
200
300
Legend
WS Floodway - E_Reg
WS Floodway - Prop, Reg
Ground
Bank Sta
Encroachment


Northford Road over the Muddy River Plan: 1) E_Reg 7/9/2020 2) Prop, Reg 7/9/2020
244 Feet Downstream of Existing Bridge
.075
.04
.1
Legend
WS Floodway - E_Reg
WS Floodway - Prop, Reg
Ground
Bank Sta
Encroachment
Elevation (ft)
Station (ft)
210
200
190
180
170
160
-200
-100
0
100
200
300


Northford Road over the Muddy River Plan: 1) E_Reg 7/9/2020 2) Prop, Reg 7/9/2020
306 Feet Downstream of Existing Bridge
.075
.04
.1
Legend
WS Floodway - E_Reg
WS Floodway - Prop, Reg
Ground
Bank Sta
Encroachment
Elevation (ft)
Station (ft)
220
210
200
190
180
170
160
-200
-100
0
100
200
300



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Item C-9: HEC-RAS Input Data - Proposed Regulatory Conditions Analysis

HEC-RAS 5.0.7 March 2019
U.S. Army Corps of Engineers
Hydrologic Engineering Center
609 Second Street

```
X      X  XXXXXX   XXXX          XXXX       XX      XXXX
X      X  X       X    X        X    X    X  X    X
X      X  X       X             X    X    X    X  X
XXXXXXX   XXXX    X        XXX  XXXX     XXXXXX   XXXX
X      X  X       X             X  X     X      X      X
X      X  X       X    X        X   X    X      X      X
X      X  XXXXXX   XXXX          X    X   X      X   XXXXX
```

PROJECT DATA
Project Title: Northford Road over the Muddy River
Project File: Wallingford_40ftSpan.prj
Run Date and Time: 7/10/2020 7:58:33 AM

Project in English units

Project Description:
Northford Road over the Muddy River, Wallingford
Bridge No. 04832
Cross sections conventionally oriented looking downstream
Vertical Datum- NAVD88 Horizontal Datum- NAD83

PLAN DATA

Plan Title: Proposed Condition, Regulatory
Plan File: p:\Projects\16022 Wallingford - Northford Rd Bridge Design\Hydraulics & Drainage\Hydraulics Drainage\Wallingford 40 ft Span-Ali\Wallingford Hec-Ras\Wallingford_40ftSpan.p05

Geometry Title: Proposed Condition
Geometry File : p:\Projects\16022 Wallingford - Northford Rd Bridge Design\Hydraulics & Drainage\Hydraulics Drainage\Wallingford 40 ft Span-Ali\Wallingford Hec-Ras\Wallingford_40ftSpan.g05

Flow Title : FIS Regulatory Discharges
Flow File : p:\Projects\16022 Wallingford - Northford Rd Bridge Design\Hydraulics & Drainage\Hydraulics Drainage\Wallingford 40 ft Span-Ali\Wallingford Hec-Ras\Wallingford_40ftSpan.f01

Plan Description:
Proposed Condition, Regulatory Discharges

Plan Summary Information:
Number of: Cross Sections = 13 Multiple Openings = 0
Culverts = 0 Inline Structures = 0
Bridges = 1 Lateral Structures = 0

Computational Information
Water surface calculation tolerance = 0.01
Critical depth calculation tolerance = 0.01
Maximum number of iterations = 20
Maximum difference tolerance = 0.33
Flow tolerance factor = 0.001

Computation Options
Critical depth computed at all cross sections
Conveyance Calculation Method: At breaks in n values only
Friction Slope Method: Average Conveyance
Computational Flow Regime: Subcritical Flow

Encroachment Data
Equal Conveyance = False
Left Offset = 0
Right Offset = 0

River = Muddy River Reach = Northford Rd

RS	Profile	Method	Value1	Value2
3123	Floodway	1	-42.065	46.935
3045	Floodway	1	-35.195	37.805
2859	Floodway	1	-20.1	63.06
2670	Floodway	1	-24.25	75.01
2614	Floodway	1	-15.67	61.33
2558	Floodway	1	-35.43	52.82
2531	Floodway	1	-26.3	48.35
2499	Floodway	1	-26.24	46.76
2475	Floodway	1	-32.34	45.31
2390	Floodway	1	-40.525	44.475
2256	Floodway	1	-7.355	42.645
2193	Floodway	1	-8.01	49.82
1000	Floodway	1	-118	36

FLOW DATA

Flow Title: FIS Regulatory Discharges

Flow File : p:\Projects\16022 Wallingford - Northford Rd Bridge Design\Hydraulics & Drainage\Hydraulics Drainage\Wallingford 40 ft Span-Ali\Wallingford Hec-Ras\Wallingford_40ftSpan.f01

Flow Data (cfs)

River	Reach	RS	10 Year	50 Year	100 Year	500 Year	Floodway	10 Year Fldwy
Muddy River	Northford Rd	3123	1560	2490	2980	4030	2980	1560

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
Muddy River	Northford Rd	10 Year		Known WS = 170.2
Muddy River	Northford Rd	50 Year	Known WS = 171.2	
Muddy River	Northford Rd	100 Year	Known WS = 171.5	
Muddy River	Northford Rd	500 Year	Known WS = 178.5	
Muddy River	Northford Rd	Floodway	Known WS = 172.5	
Muddy River	Northford Rd	10 Year Fldwy	Known WS = 170.2	

GEOMETRY DATA

Geometry Title: Proposed Condition
Geometry File : p:\Projects\16022 Wallingford - Northford Rd Bridge Design\Hydraulics & Drainage\Hydraulics Drainage\Wallingford 40 ft Span-Ali\Wallingford Hec-Ras\Wallingford_40ftSpan.g05

CROSS SECTION

RIVER: Muddy River
REACH: Northford Rd RS: 3123

INPUT
Description: 591 Feet Upstream of Existing Bridge
FEMA Cross Section "BM"
Geometry based one foot 2011 Lidar contours
Station Elevation Data num= 100

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-67.59	189.8	-66.56	189.5	-65.8	189.3	-63.7	188.9	-61.43	188.5
-58.22	187.9	-57.01	187.7	-56.3	187.6	-55.21	187.5	-53.96	187.3
-53.42	187.2	-52.97	187.1	-52.33	186.7	-51.95	186.4	-50.88	184.4
-50.52	183.8	-49.92	182.8	-49.41	181.9	-48.88	181	-48.38	180.1

-47.69 178.8 -47.2 177.8 -46.61 176.5 -46.23 175.7 -45.75 174.6
-45.51 174 -44.51 172.3 -44.35 172.1 41.02 172.1 41.46 172.3
41.66 172.44 42.14 172.9 42.89 173.6 43.48 174.1 43.91 174.5
45.03 175.5 45.34 175.8 46.01 176.2 46.75 176.7 47.17 176.9
47.47 177.1 47.97 177.4 48.91 177.9 49.38 178.2 50.31 178.9
51.77 179.6 52.54 179.9 53.62 180.3 55.34 180.9 55.85 181.1
56.81 181.5 57.7 182 57.96 182.1 59.78 182.7 60.63 183
61.14 183.2 62.28 183.7 63.29 184.1 65.27 184.8 66.16 185.1
68.34 185.8 69.33 186.1 70.21 186.3 70.56 186.4 71.01 186.5
71.75 186.7 72.21 186.8 73.43 187.1 74.76 187.5 75.69 187.7
76.27 187.8 77.53 188 78.1 188.1 78.9 188.3 80.41 188.7
81.06 188.9 81.33 189 82.2 189.4 82.46 189.5 83.12 189.7
83.5 189.8 85.37 190.2 86.5 190.4 87.3 190.5 88.2 190.6
89.57 190.7 91.52 190.8 93.38 190.9 101.17 190.9 108.06 191.1
111.06 191.2 112.46 191.3 117.31 191.4 126.32 191.4 128.52 191.5
137.03 191.5 143.74 191.6 155.39 191.6 158.72 191.7 165.98 191.7

Manning's n Values num= 3
Sta n Val Sta n Val Sta n Val
-67.59 .1 -52.97 .035 43.91 .07

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
-52.97 43.91 83.14 78.37 75.19 .1 .3

CROSS SECTION

RIVER: Muddy River
REACH: Northford Rd RS: 3045

INPUT
Description: 513 Feet Upstream of Existing Bridge
FEMA Cross Section
"BL"
Geometry based one foot 2011 Lidar contours
Station Elevation Data num= 494
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
-245.04 201.1 -236.27 201.1 -235.44 201 -233.97 200.9 -229.47 200.6
-227.92 200.5 -226.46 200.4 -224.85 200.3 -223.3 200.2 -221.63 200.1
-193.01 200.1 -192.04 200.2 -190.96 200.3 -188.95 200.5 -187.62 200.6
-185.97 200.7 -184.98 200.8 -184.17 200.9 -183.38 201 -182.61 201.1
-181.9 201.2 -181.21 201.3 -179.88 201.5 -179.17 201.6 -178.49 201.7
-177.04 201.9 -176.4 202 -175.8 202.1 -175.24 202.2 -174.47 202.3
-173.97 202.4 -173.28 202.5 -171.59 202.8 -170.45 203 -169.4 203.2
-168.38 203.4 -167.86 203.5 -167.38 203.6 -166.88 203.7 -166.42 203.8
-165.98 203.9 -165.52 204 -164.7 204.2 -163.9 204.4 -163.11 204.6

-162.27 204.8 -161.84 204.9 -161.44 205 -160.93 205.1 -160.3 205.2
-159.75 205.3 -158.78 205.4 -157.89 205.5 -157.28 205.6 -156.09 205.8
-154.83 206 -154.19 206.1 -153 206.3 -151.81 206.4 -150 206.49
-149.73 206.5 -146.77 206.9 -146.01 207 -143.76 207 -142.01 206.9
-135.52 206.5 -133.89 206.4 -130.65 206.2 -127.23 206 -125.21 205.9
-121.45 205.7 -119.56 205.6 -113.93 205.3 -111.97 205.2 -110.13 205.1
-108.44 205 -107.77 204.9 -107.26 204.8 -106.38 204.6 -105.95 204.5
-105.14 204.3 -103.91 204 -103.46 203.9 -102.99 203.8 -102.54 203.7
-101.81 203.5 -101.42 203.4 -101.06 203.3 -100.4 203.1 -100.13 203
-99.45 202.6 -99.29 202.5 -98.99 202.3 -98.83 202.2 -97.78 201.5
-97.64 201.4 -97.34 201.2 -97.07 201 -96.3 200.3 -96.2 200.2
-95.87 199.9 -95.75 199.8 -95.31 199.4 -95.1 199.2 -94.9 199
-94.46 198.6 -94.36 198.5 -92.49 196.8 -92.39 196.7 -91.51 195.9
-91.41 195.8 -90.42 194.9 -90.03 194.6 -89.91 194.5 -89.26 194
-88.78 193.6 -88.65 193.5 -88.41 193.3 -88.28 193.2 -87.92 192.9
-87.81 192.8 -87.45 192.5 -87.22 192.3 -86.89 192 -86.79 191.9
-86.55 191.7 -86.44 191.6 -86.31 191.5 -86.07 191.3 -85.94 191.2
-85.71 191 -85.16 190.5 -84.79 190.2 -84.35 189.8 -84.23 189.7
-83.9 189.4 -83.66 189.2 -83.4 189 -83.26 188.9 -82.86 188.6
-82.42 188.3 -82.14 188.1 -81.84 187.9 -81.7 187.8 -81.25 187.5
-81.11 187.4 -80.81 187.2 -80.49 187 -80.08 186.8 -79.43 186.5
-79.24 186.4 -78.64 186.1 -78.46 186 -78.3 185.9 -78.04 185.7
-77.08 184.9 -76.83 184.7 -76.18 184.2 -75.82 183.9 -75.59 183.7
-75.37 183.5 -75.25 183.4 -75.15 183.3 -74.82 183 -74.61 182.8
-74.41 182.6 -74.3 182.5 -73.99 182.2 -73.88 182.1 -73.71 182
-73.52 181.9 -72.92 181.6 -72.48 181.4 -72.28 181.3 -71.9 181.1
-71.72 181 -71.38 180.8 -70.42 180.2 -69.92 179.9 -69.39 179.6
-68.97 179.4 -68.54 179.2 -68.31 179.1 -67.8 178.9 -67.49 178.8
-66.85 178.6 -66.18 178.4 -64.86 178 -64.46 177.9 -62.82 177.5
-62.02 177.3 -61.25 177.1 -60.08 176.8 -59.68 176.7 -59.3 176.6
-58.95 176.5 -58.18 176.3 -57.48 176.1 -56.9 176 -56.01 175.9
-55.07 175.8 -53.12 175.6 -51.14 175.4 -50.02 175.29 -49.14 175.2
-48.15 175.1 -46.2 175 -44.68 174.9 -43.84 174.8 -42.27 174.6
-41.44 174.5 -39.87 174.3 -39.05 174.2 -38.26 174.1 -37.43 174
-34.68 173.8 -33.28 173.7 -31.73 173.6 -30.54 173.5 -29.01 173.4
-27.74 173.3 -26.26 173.2 -24.93 173.1 -23.55 173 -21.78 172.9
-16.6 172.6 -13.18 172.4 -11.48 172.3 -8.1 172.1 11.26 172.1
26.07 172.8 27.42 172.86 28.32 172.9 29.2 173 29.99 173.1
30.68 173.3 30.96 173.4 31.32 173.5 32.04 173.6 33 173.7
34.55 173.8 39.18 173.9 39.53 174 40.2 174.2 40.95 174.4
41.3 174.5 41.63 174.6 42.24 174.8 42.72 175 43.72 175.4
43.98 175.5 44.98 175.9 45.46 176.1 45.69 176.2 46.18 176.4
46.64 176.6 47.04 176.8 47.25 176.9 48.05 177.3 48.49 177.5
48.72 177.6 48.97 177.7 49.45 177.9 49.95 178.1 50.41 178.3
50.84 178.5 51.07 178.6 51.51 178.8 51.75 178.9 52.26 179.1
52.49 179.2 52.97 179.4 53.48 179.6 54.21 179.9 54.48 180

54.84 180.1 55.22 180.2 57.62 180.8 58.06 180.9 58.52 181
59.09 181.1 59.76 181.2 60.49 181.3 61.25 181.4 61.99 181.5
62.69 181.6 63.44 181.7 64.24 181.8 65.02 181.9 66.39 182
68.65 182.1 70.96 182.2 73.34 182.3 75.76 182.4 78.12 182.5
80.34 182.6 82.58 182.7 86.98 182.9 91.73 183.1 100.39 183.5
104.73 183.7 107.07 183.8 109.81 183.9 113.75 184 133.36 184.1
139.41 184.2 144.91 184.3 150 184.39 150.37 184.4 151.01 184.4
167.75 184.3 171.22 184.2 178.07 184.2 183.32 184.3 187.53 184.4
190.58 184.5 192.69 184.6 198.35 184.9 200.05 185 200.88 185.1
201.53 185.2 202.2 185.3 203.49 185.5 204.08 185.6 204.7 185.7
205.84 185.9 206.39 186 207.7 186.3 208.56 186.5 209 186.6
209.86 186.8 210.37 186.9 210.95 187 211.44 187.1 212.01 187.2
212.62 187.3 213.28 187.4 213.8 187.5 214.37 187.6 215.03 187.7
215.62 187.8 216.42 187.9 217.32 188 218.39 188.1 219.39 188.2
220.21 188.3 221.84 188.6 222.39 188.7 222.89 188.8 223.45 188.9
223.91 189 224.33 189.1 224.73 189.2 225.1 189.3 225.9 189.5
226.65 189.7 227.12 189.8 228.17 190 228.74 190.1 229.9 190.3
231.04 190.5 231.74 190.6 232.95 190.8 233.49 190.9 234.15 191
234.7 191.1 235.15 191.2 235.49 191.3 235.95 191.4 236.52 191.5
236.94 191.6 237.41 191.7 237.83 191.8 238.29 191.9 238.77 192
239.12 192.1 240.32 192.4 240.75 192.5 241.13 192.6 241.72 192.8
242.37 193 242.72 193.1 243.09 193.2 243.44 193.3 243.81 193.4
245.61 193.9 246.24 194.1 246.53 194.2 247.09 194.4 247.64 194.6
247.93 194.7 248.83 195 249.21 195.1 249.93 195.3 250.8 195.5
251.61 195.7 251.96 195.8 253.05 196.1 253.72 196.3 254.61 196.6
255.59 196.9 255.97 197 256.7 197.2 258 197.5 258.42 197.6
258.78 197.7 259.18 197.8 259.61 197.9 259.98 198 260.27 198.1
260.82 198.3 261.34 198.5 261.59 198.6 262.13 198.8 262.68 199
263.17 199.2 263.95 199.5 264.22 199.6 264.71 199.8 264.97 199.9
265.27 200 265.59 200.1 266.32 200.3 266.76 200.4 268.02 200.7
268.43 200.8 268.87 200.9 269.64 201.1 270 201.2 270.7 201.4
271.04 201.5 271.67 201.7 272.28 201.9 272.55 202 273.05 202.2
273.53 202.4 274.05 202.6 274.33 202.7 274.63 202.8 275.87 203.2
278.57 204.1 279.19 204.3 279.82 204.5 280.09 204.6 280.34 204.7
280.98 205 281.44 205.2 281.68 205.3 282.19 205.5 282.74 205.7
283.04 205.8 283.32 205.9 283.85 206.1 284.37 206.3 284.84 206.5
285.3 206.7 285.78 206.9 286.22 207.1 287.06 207.5 287.67 207.8
287.89 207.9 288.52 208.2 288.93 208.4 289.5 208.7 289.86 208.9
290.46 209.2 291.09 209.5 291.52 209.7 291.97 209.9 292.39 210.1
292.79 210.3 293.17 210.5 293.58 210.7 293.94 210.9 294.13 211
294.47 211.2 294.83 211.4 295 211.5 295.36 211.7 295.93 212
296.33 212.2 296.75 212.4 297.32 212.7 297.68 212.9 298.06 213.1
298.4 213.3 298.56 213.4 298.74 213.5 298.96 213.6 299.2 213.7
299.41 213.8 299.86 214 300.26 214.2 300.31 214.22

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-245.04	.1	-44.68	.035	32.04	.07

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
-44.68 32.04 190.22 185.87 181.39 .1 .3

CROSS SECTION

RIVER: Muddy River
REACH: Northford Rd RS: 2859

INPUT
Description: 327 Feet Upstream of Existing Bridge
Geometry based on project
survey supplemented with one foot 2011 Lidar contours in far
overbank areas
Station Elevation Data num= 222

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-92.93	206.1	-90.85	206.1	-87.62	206	-86.21	205.9	-85.46	205.8
-84.7	205.7	-83.22	205.5	-82.49	205.4	-81.84	205.3	-81.21	205.2
-80.65	205.1	-62.06	205	-61.37	204.62	-54.23	199.36	-47.14	194.38
-39.69	188.32	-31.87	181.82	-23.06	175.38	-22.82	175.2	-14.98	169.54
-6.75	169	1.09	169.38	7.44	169.4	16.13	169.42	28.52	172.08
31.44	172.43	40.14	173.47	42.44	173.74	55.47	174.88	65	175.46
76.68	175.56	87.7	176.68	96.41	177.42	107.73	178.2	121.09	179.14
132.35	179.22	146.98	179.84	159.47	180.3	170.07	181.08	175.21	181.9
177.03	182	205.17	182.1	207.07	182.14	210.1	182.2	211.82	182.25
213.77	182.3	216.77	182.4	219.76	182.5	221.86	182.6	223.43	182.7
224.99	182.8	226.56	182.9	228.61	183	238.11	183.1	239.12	183.2
240.21	183.3	241.69	183.4	243.21	183.5	244.65	183.6	247.51	183.8
248.91	183.9	251.04	184	255.62	184.1	260.87	184.6	261.96	184.7
263.12	184.8	264.17	184.9	265.61	185	266.89	185.1	270.13	185.5
270.98	185.6	271.78	185.7	272.8	185.8	273.73	185.9	274.82	186
275.56	186.1	276.27	186.2	276.97	186.3	277.68	186.4	278.38	186.5
279.04	186.6	279.65	186.7	280.23	186.8	280.77	186.9	281.32	187
281.95	187.1	283.9	187.4	284.56	187.5	285.21	187.6	285.85	187.7
286.51	187.8	287.14	187.9	287.8	188	288.51	188.1	289.25	188.2
290	188.3	290.71	188.4	291.49	188.5	292.19	188.6	292.98	188.7
293.67	188.8	294.38	188.9	295.04	189	295.55	189.1	296.04	189.2
296.98	189.4	297.44	189.5	298.85	189.8	299.31	189.9	299.74	190
300.12	190.1	300.45	190.2	300.79	190.3	302.77	190.9	303.11	191
303.81	191.2	304.53	191.4	304.88	191.5	305.24	191.6	306.04	191.8
306.43	191.9	306.72	192	307.02	192.1	307.71	192.3	308.33	192.5
308.65	192.6	309.64	192.9	309.96	193	310.23	193.1	310.49	193.2
311.03	193.4	311.31	193.5	311.58	193.6	311.86	193.7	312.13	193.8

312.69 194 312.96 194.1 313.24 194.2 313.51 194.3 314.07 194.5
314.34 194.6 314.62 194.7 314.88 194.8 315.34 195 315.59 195.1
315.87 195.2 316.08 195.3 316.3 195.4 316.76 195.6 317.51 195.9
317.78 196 318.06 196.1 318.36 196.2 318.98 196.4 319.28 196.5
319.59 196.6 319.91 196.7 320.21 196.8 320.49 196.9 320.79 197
321.12 197.1 321.46 197.2 321.84 197.3 322.23 197.4 322.63 197.5
323.02 197.6 323.4 197.7 323.8 197.8 324.21 197.9 324.64 198
325.4 198.2 325.72 198.3 326.71 198.6 327.05 198.7 327.69 198.9
328.03 199 328.39 199.1 328.78 199.2 330.26 199.6 330.64 199.7
331.38 199.9 332.46 200.2 333.51 200.5 334.23 200.7 334.58 200.8
334.94 200.9 335.28 201 335.63 201.1 335.99 201.2 336.34 201.3
337.36 201.6 337.71 201.7 338.43 201.9 338.74 202 339.06 202.1
339.96 202.4 340.5 202.6 340.79 202.7 341.41 202.9 342.01 203.1
342.4 203.2 342.78 203.3 343.12 203.4 343.49 203.5 344.54 203.8
344.93 203.9 345.25 204 345.58 204.1 345.92 204.2 346.25 204.3
346.56 204.4 346.85 204.5 347.13 204.6 348.06 204.9 348.36 205
348.67 205.1 349.31 205.3 349.62 205.4 350.58 205.7 350.89 205.8
351.21 205.9 351.35 205.94

Manning's n Values num= 3
Sta n Val Sta n Val Sta n Val
-92.93 .1 -22.82 .035 28.52 .07

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
-22.82 28.52 198.12 189.7 181.78 .1 .3

CROSS SECTION

RIVER: Muddy River
REACH: Northford Rd RS: 2670

INPUT
Description: 138 Feet Upstream of Existing Bridge
Geometry based on project
survey supplemented with one foot 2011 Lidar contours in far
overbank areas
Station Elevation Data num= 343
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
-105.69 204.2 -105.67 204.2 -105.07 204.1 -104.48 204 -103.93 203.9
-102.85 203.7 -102.29 203.6 -101.71 203.5 -101.07 203.4 -100.34 203.3
-99.62 203.2 -98.89 203.1 -98.14 203 -97.27 202.9 -96.59 202.8
-95.79 202.7 -94.21 202.5 -93.66 202.4 -93.1 202.3 -92.61 202.2
-92.14 202.1 -91.77 202 -91.46 201.9 -91.17 201.8 -90.17 201.4
-89.91 201.3 -89.66 201.2 -89.2 201 -89 200.9 -88.82 200.8
-87.8 200.2 -87.62 200.1 -87.38 200 -87.12 199.9 -86.87 199.8

-86.27 199.6 -85.4 199.3 -84.8 199.1 -77.37 199.1 -76.47 199.3
-76.03 199.4 -75.62 199.5 -75.24 199.6 -74.85 199.7 -74.09 199.9
-73.75 200 -73.43 200.1 -72.83 200.3 -72.54 200.4 -72.24 200.5
-71.95 200.6 -71.34 200.8 -71.02 200.9 -70.67 201 -70.3 201.1
-69.62 201.2 -68.46 201.3 -66.19 201.3 -65.59 201.2 -65.1 201.1
-64.63 201 -64.31 200.9 -63.75 200.7 -63.23 200.5 -62.99 200.4
-62.72 200.3 -62.46 200.2 -62.19 200.1 -61.93 200 -61.75 199.9
-61.55 199.8 -61.28 199.7 -61 199.6 -60.75 199.5 -60.56 199.4
-60.38 199.3 -60.18 199.2 -59.97 199.1 -59.75 199 -59.52 198.9
-58.79 198.6 -58.54 198.5 -58.28 198.4 -57.8 198.2 -57.57 198.1
-57.33 198 -57.12 197.9 -56.57 197.6 -56.38 197.5 -56.2 197.4
-56.03 197.3 -55.49 197 -55.3 196.9 -54.76 196.6 -54.42 196.4
-54.24 196.3 -54.07 196.2 -53.89 196.1 -53.72 196 -53.56 195.9
-52.66 195.3 -52.5 195.2 -51.6 194.6 -51.46 194.5 -51.3 194.4
-51.15 194.3 -50.99 194.2 -50.84 194.1 -50.36 193.8 -50.19 193.7
-50.03 193.6 -49.86 193.5 -49.7 193.4 -49.53 193.3 -49.37 193.2
-48.86 192.9 -48.7 192.8 -48.41 192.6 -48.11 192.4 -47.83 192.2
-47.68 192.1 -47.51 192 -47.35 191.9 -46.84 191.6 -46.66 191.5
-46.49 191.4 -46.31 191.3 -45.8 191 -45.5 190.8 -45.24 190.6
-45.1 190.5 -44.19 189.8 -44.07 189.7 -42.64 188.6 -42.36 188.4
-42.23 188.3 -41.95 188.1 -41.82 188 -41.54 187.8 -41.41 187.7
-41.27 187.6 -41.14 187.5 -40.86 187.3 -40.73 187.2 -40.59 187.1
-40.35 186.9 -40.22 186.8 -38.54 185.4 -37.61 184.08 -28.57 176.38
-23.39 172.11 -19.06 168.55 -18.9 168.42 -1.19 168.56 5.56 170.48
12.7 171.26 27.68 171.42 41.49 171.8 44.24 171.94 56.52 172.58
70.07 173.4 93.59 174.56 101.74 174.68 107.89 174.54 112.02 174.66
122.04 174.84 134.51 175.52 144.89 176.52 158.38 178.08 168.82 178.94
170 179.9 171.21 180 177.69 180.03 192.7 180.1 194.31 180.14
197.28 180.2 199.08 180.3 200.61 180.4 202.26 180.5 203.9 180.6
205.75 180.7 207.93 180.8 209.43 180.9 210.59 181 216.56 181.1
218.04 181.2 219.55 181.3 221.27 181.4 224.73 181.5 226.32 181.6
242.59 181.6 246.59 181.7 249.71 181.8 252.84 181.9 256.22 182
264.66 182.1 266.35 182.2 268.02 182.3 269.7 182.4 273.02 182.6
278.03 182.9 279.68 183 282.02 183.2 283.17 183.3 284.33 183.4
286.67 183.6 287.86 183.7 289.03 183.8 290.23 183.9 292.57 184
294.63 184.1 296.37 184.2 298.33 184.3 301.07 184.5 305.27 184.9
306.65 185 307.23 185.1 307.63 185.2 307.91 185.3 308.14 185.4
308.64 185.6 308.87 185.7 309.14 185.8 309.39 185.9 309.69 186
310.22 186.1 310.73 186.2 311.8 186.4 312.23 186.5 312.68 186.6
313.19 186.7 313.64 186.8 314.17 186.9 314.63 187 315.24 187.1
315.98 187.2 317.41 187.4 318.86 187.6 319.57 187.7 320.91 187.9
321.45 188 321.69 188.1 321.98 188.2 322.23 188.3 322.67 188.5
322.88 188.6 324 189.3 324.17 189.4 324.81 189.8 325.01 189.9
325.28 190 325.58 190.1 325.86 190.2 326.36 190.4 326.93 190.6
327.26 190.7 327.56 190.8 327.87 190.9 328.19 191 328.5 191.1
328.82 191.2 329.2 191.3 329.61 191.4 330.06 191.5 331.22 191.8

331.63 191.9 332.25 192.1 332.52 192.2 332.99 192.4 333.25 192.5
333.75 192.7 334.29 192.9 334.55 193 335.09 193.2 335.37 193.3
335.95 193.5 336.55 193.7 337.13 193.9 337.69 194.1 338.73 194.5
339 194.6 339.25 194.7 339.77 194.9 340.01 195 340.27 195.1
340.52 195.2 340.75 195.3 341.23 195.5 341.98 195.8 342.46 196
342.71 196.1 343.44 196.4 343.69 196.5 343.95 196.6 344.7 196.9
344.93 197 345.58 197.3 345.78 197.4 345.99 197.5 346.6 197.8
346.81 197.9 347.01 198 347.37 198.2 347.75 198.4 347.95 198.5
348.16 198.6 348.35 198.7 348.75 198.9 348.96 199 349.16 199.1
349.8 199.4 350.02 199.5 351.02 200 351.21 200.1 351.61 200.3
352.24 200.6 352.65 200.8 352.88 200.9 353.13 201 353.65 201.2
354.18 201.4 354.99 201.7 355.77 202 356.02 202.1 356.25 202.2
356.7 202.4 356.94 202.5 357.63 202.8 357.85 202.9 358.31 203.1
358.55 203.2 358.81 203.3 359.35 203.5 359.61 203.6 359.88 203.7
360.14 203.8 360.41 203.9 360.97 204.1 361.21 204.2 361.44 204.3
361.92 204.5 362.34 204.7 362.46 204.76

Manning's n Values num= 3
Sta n Val Sta n Val Sta n Val
-105.69 .1 -23.39 .04 12.7 .07

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
-23.39 12.7 57.97 55.73 48.78 .1 .3

CROSS SECTION

RIVER: Muddy River
REACH: Northford Rd RS: 2614

INPUT
Description: 82 Feet Upstream of Existing Bridge
FEMA Cross Section
"BK"
Assumed Approach Cross Section
Geometry based on project
survey supplemented with one foot 2011 Lidar contours in far
overbank areas
Station Elevation Data num= 494
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
-219.69 208.4 -219.54 208.4 -215.15 208.1 -181.55 208 -176.05 207.9
-175.07 207.8 -173.28 207.6 -172.4 207.5 -169.73 207.2 -168.85 207.1
-167.99 207 -166.71 206.9 -165 206.8 -163.39 206.7 -162.32 206.6
-161.45 206.5 -160.14 206.3 -159.51 206.2 -158.87 206.1 -158.12 206
-157.3 205.9 -156.41 205.8 -155.32 205.7 -154.61 205.6 -154.01 205.5
-153.09 205.3 -152.64 205.2 -152.17 205.1 -151.08 204.9 -150 204.74

-149.71 204.7 -149 204.6 -148.34 204.5 -147.71 204.4 -146.51 204.2
-145.92 204.1 -145.38 204 -144.86 203.9 -144.42 203.8 -143.95 203.7
-143.04 203.6 -141.25 203.4 -140.33 203.3 -138.43 203.1 -137.53 203
-136.74 202.9 -136.06 202.8 -134.76 202.6 -134.12 202.5 -132.17 202.2
-131.48 202.1 -130.81 202 -130.23 201.9 -129.7 201.8 -129.19 201.7
-128.22 201.5 -127.72 201.4 -126.78 201.2 -126.36 201.1 -125.89 200.9
-125.65 200.8 -125.42 200.7 -125.25 200.6 -124.45 200.1 -124.3 200
-123.98 199.8 -123.15 199.3 -122.99 199.2 -122.65 199 -122.49 198.9
-121.81 198.5 -121.63 198.4 -121.29 198.2 -121.11 198.1 -120.77 197.9
-120.59 197.8 -120.25 197.6 -119.88 197.4 -119.52 197.2 -119.15 197
-118.31 196.6 -118.11 196.5 -117.35 196.1 -117.17 196 -116.88 195.9
-116.55 195.8 -116.28 195.7 -115.77 195.6 -115.02 195.5 -114.15 195.4
-113.4 195.3 -112.46 195.2 -110 195.2 -108.83 195.3 -107.74 195.4
-106.63 195.5 -105.57 195.6 -104.45 195.7 -102.27 195.9 -101.32 196
-99.92 196.1 -98.5 196.2 -97.09 196.3 -95.67 196.4 -93.14 196.6
-91.96 196.7 -90.66 196.8 -89.63 196.9 -88.52 197 -87.65 197.1
-86.5 197.2 -85.47 197.3 -84.47 197.4 -83.42 197.5 -81.38 197.7
-79.33 197.9 -77.57 198 -76.75 198.2 -76.32 198.3 -75.79 198.4
-75.32 198.5 -74.71 198.6 -73.92 198.7 -73.6 198.8 -73.2 198.9
-72.56 199 -67.59 199 -66.83 198.9 -66.13 198.6 -65.89 198.5
-65.2 198.2 -64.96 198.1 -64.71 198 -63.94 197.9 -61.52 197.7
-60.33 197.6 -59.16 197.5 -57.94 197.4 -55.63 197.2 -54.44 197.1
-53.3 197 -52.63 196.8 -52.33 196.7 -52.02 196.6 -51.42 196.4
-51.11 196.3 -50.39 196.1 -49.78 195.9 -49.5 195.8 -48.97 195.6
-48.7 195.5 -48.19 195.3 -47.91 195.2 -47.42 195 -46.98 194.8
-46.14 194.4 -45.34 194 -44.58 193.6 -44.4 193.5 -44.02 193.3
-43.48 193 -43.13 192.8 -42.96 192.7 -42.78 192.6 -42.26 192.3
-42.1 192.2 -41.75 192 -41.37 191.8 -41.19 191.7 -40.85 191.5
-40.69 191.4 -40.01 191 -39.85 190.9 -39.51 190.7 -39.35 190.6
-38.67 190.2 -38.52 190.1 -38.4 190 -38.01 189.7 -37.73 189.5
-37.43 189.3 -37.27 189.2 -37.13 189.1 -36.53 188.7 -36.39 188.6
-35.94 188.3 -35.52 188 -35.25 187.8 -34.73 187.4 -34.62 187.3
-34.26 187 -34.15 186.9 -33.91 186.7 -33.8 186.6 -32.96 185.9
-32.85 185.8 -32.49 185.5 -32.27 185.3 -31.67 184.8 -31.54 184.7
-31.3 184.5 -31.17 184.4 -30.94 184.2 -30.29 183.7 -30.01 183.5
-29.75 183.3 -29.64 183.2 -29.52 183.1 -29.19 182.8 -28.73 182.4
-28.61 182.3 -28.5 182.2 -28.41 182.1 -28.01 181.7 -27.9 181.6
-27.7 181.4 -27.26 181 -27.17 180.9 -26.97 180.7 -26.86 180.6
-26.65 180.4 -26.53 180.3 -26.2 180 -25.96 179.8 -25.82 179.7
-25.56 179.5 -25.42 179.4 -25.02 179.1 -24.75 178.9 -24.63 178.8
-23.98 178.3 -23.71 178.1 -23.56 178 -23.3 177.8 -23.19 177.71
-23.18 177.7 -22.68 177.3 -22.42 177.1 -22.3 177 -22.17 176.9
-21.8 176.6 -21.67 176.5 -21.43 176.3 -21.18 176.1 -20.96 175.9
-20.68 175.5 -20.6 175.4 -20.53 175.3 -20.3 175 -20.23 174.9
-19.91 174.5 -19.78 174.3 -19.6 174 -19.55 173.9 -19.43 173.7
-19.32 173.5 -19.22 173.3 -19.16 173.2 -19 172.9 -18.94 172.8

-18.84 172.6 -18.78 172.5 -18.68 172.3 -18.62 172.2 -18.47 171.9
-18.4 171.8 -18.32 171.7 -18.22 171.6 -17.91 171.4 -17.7 171.3
-17.47 171.2 -17.3 171.1 -16.97 171 -16.54 170.9 -16.06 170.7
-15.81 170.6 -15 170.3 -14.69 170.2 -14.06 170.1 -13.53 170
-12.03 169.9 -10.87 169.8 -9.81 169.7 -7.21 169.7 -2.09 169.9
2.03 169.9 3.59 169.8 5.43 169.7 5.7 169.7 7.65 169.8
9.01 169.9 10.85 170 13.03 170.1 13.5 170.2 14.89 170.4
15.52 170.5 16.25 170.6 16.96 170.7 17.62 170.8 18.36 170.9
18.96 171 19.41 171.1 20.25 171.4 20.52 171.5 21.36 171.8
21.66 171.9 22.3 172.1 22.93 172.3 23.28 172.4 23.64 172.5
24.31 172.7 24.91 172.8 25.68 172.9 27.88 173 28.56 173.1
29.17 173.2 29.75 173.3 30.93 173.5 31.53 173.6 32.14 173.7
32.48 173.75 32.78 173.8 33.57 173.9 34.45 174 58.21 174.1
69.59 174.3 75.27 174.4 92.34 174.7 98.02 174.8 101.24 174.9
103.57 175 105.62 175.1 108.78 175.4 112.05 175.7 112.92 175.8
113.63 175.9 114.6 176 115.61 176.1 116.56 176.2 119.56 176.5
120.57 176.6 123.57 176.9 124.55 177 125.46 177.1 128.11 177.4
129.88 177.6 132.55 177.9 133.49 178 135.21 178.1 144.01 178.6
145.8 178.7 147.58 178.8 149.31 178.9 150 178.93 151.36 179
172 179.1 174.34 179.2 176.67 179.3 178.95 179.4 181.16 179.5
183.39 179.6 185.59 179.7 187.78 179.8 189.98 179.9 192.72 180
194.68 180.1 195.64 180.2 196.49 180.3 198.37 180.4 199.81 180.5
202.71 180.7 204.15 180.8 205.6 180.9 207.69 181 228.78 181.1
231.04 181.2 233.22 181.3 235.45 181.4 237.73 181.5 239.96 181.6
242.13 181.7 244.25 181.8 246.34 181.9 248.55 182 264.17 182.1
264.57 182.2 265.55 182.4 265.96 182.5 266.34 182.6 266.7 182.7
267.08 182.8 267.49 182.9 267.88 183 268.24 183.1 268.69 183.2
269.21 183.4 269.71 183.6 270.23 183.8 270.61 183.9 271.18 184
278.77 184.1 279.59 184.2 280.29 184.3 281.09 184.4 282.65 184.6
283.33 184.7 283.93 184.8 284.45 184.9 284.84 185 285.52 185.2
286.42 185.5 286.73 185.6 287.31 185.8 287.92 186 288.24 186.1
288.84 186.3 290.16 186.7 290.51 186.8 290.82 186.9 291.1 187
291.34 187.1 291.81 187.3 292.27 187.5 292.71 187.7 292.94 187.8
293.41 188 293.66 188.1 294.14 188.3 294.4 188.4 295.4 188.8
295.66 188.9 296.51 189.2 297.38 189.5 297.99 189.7 298.28 189.8
298.83 190 299.09 190.1 299.39 190.2 300.01 190.4 300.61 190.6
301.22 190.8 302.77 191.3 303.09 191.4 304.02 191.7 304.62 191.9
305.18 192.1 305.45 192.2 306.23 192.5 306.5 192.6 307.54 193
307.79 193.1 308.83 193.5 309.37 193.7 309.65 193.8 309.91 193.9
310.72 194.2 311 194.3 311.53 194.5 312.37 194.8 313.45 195.2
313.7 195.3 315.26 195.9 315.51 196 316.06 196.2 316.84 196.5
317.08 196.6 317.87 196.9 318.12 197 318.38 197.1 319.2 197.4
319.46 197.5 320 197.7 320.56 197.9 320.86 198 321.17 198.1
321.83 198.3 322.57 198.5 323.24 198.7 323.94 198.9 324.27 199
324.83 199.2 325.36 199.4 325.94 199.6 326.21 199.7 326.46 199.8
326.73 199.9 327.22 200 327.85 200.1 328.58 200.2 329.36 200.3

331.76 200.6 333.13 200.7 334.7 200.8 336.07 200.9

Manning's n Values num= 3
Sta n Val Sta n Val Sta n Val
-219.69 .1 -19.6 .04 25.68 .07

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
-19.6 25.68 50.75 55.06 50.46 .3 .5

CROSS SECTION

RIVER: Muddy River
REACH: Northford Rd RS: 2558

INPUT
Description: 27 Feet Upstream of Existing Bridge
Proposed geometry
Station Elevation Data num= 412
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
-283.97 193.1 -283.04 193.1 -281.69 193.2 -279.62 193.4 -278.34 193.5
-277.35 193.6 -276.62 193.7 -275.08 193.8 -271.49 192.7 -264.9 192.8
-258.65 192.9 -249.57 193 -247.9 193.1 -246.41 193.3 -241.39 194
-235 194.9 -234.27 195 -231.86 195.3 -231.07 195.4 -230.24 195.5
-228.96 195.6 -227.39 195.7 -226.34 195.8 -225.5 195.9 -224.71 196
-219.6 196.7 -218.86 196.8 -215.94 197.2 -215.19 197.3 -213.67 197.5
-212.92 197.6 -211.38 197.8 -210.64 197.9 -209.65 198.1 -209.09 198.2
-208.59 198.3 -207.7 198.4 -206.62 198.5 -205.48 198.6 -204.36 198.7
-203.26 198.8 -202.19 198.9 -200.08 199.1 -197.89 199.3 -196.68 199.4
-193.17 199.4 -192.13 199.3 -191.28 199.2 -190.64 199.1 -190.22 199
-189.93 198.9 -189.27 198.7 -188.74 198.5 -188.22 198.3 -187.38 198
-186.83 197.8 -185.95 197.5 -184.83 197.1 -184.56 197 -183.77 196.7
-183.52 196.6 -182.48 196.2 -182.16 196.1 -181.55 195.9 -181.16 195.8
-178.21 195.3 -176.43 195 -174.04 194.6 -172.87 194.4 -172.34 194.3
-172.03 194.2 -171.15 193.9 -170.6 193.7 -170.04 193.5 -169.26 193.2
-168.99 193.1 -168.47 192.9 -167.97 192.7 -167.71 192.6 -165.21 191.6
-164.97 191.5 -164.47 191.3 -164.02 191.1 -163.06 190.7 -162.56 190.5
-162.32 190.4 -161.61 190.2 -161.28 190.1 -160.47 190 -158.38 190
-156.96 190.1 -155.99 190.2 -155.15 190.3 -154.38 190.4 -153.67 190.48
-152.8 190.6 -152.1 190.7 -150.54 190.9 -149.73 191 -142.53 191.8
-141.73 191.9 -140.98 192 -140.29 192.1 -139.63 192.2 -138.83 192.3
-137.99 192.4 -137.03 192.5 -135.7 192.7 -133.74 193 -131.76 193.3
-130.45 193.5 -127.87 193.9 -127.21 194 -126.5 194.1 -125.04 194.3
-122.08 194.7 -119.83 195 -118.53 195.1 -116.45 195.3 -115.56 195.4
-113.88 195.4 -112.42 195.3 -111.23 195.2 -109.95 195.1 -109.06 195
-108.47 194.9 -107.91 194.8 -107.25 194.7 -106.53 194.6 -105.47 194.5

-104.45 194.4 -103.15 194.3 -101.16 194.2 -98.68 194.1 -96.02 194
-94.42 193.9 -93 193.8 -91.99 193.7 -91.3 193.6 -90.8 193.5
-90.2 193.4 -88.76 193.3 -87.6 193.2 -86.72 193.1 -86.2 193
-85.49 192.9 -84.75 192.7 -83.45 192.3 -83.15 192.2 -82.52 192.1
-70.12 192 -68.77 191.9 -68.14 191.8 -67.81 191.7 -67.54 191.6
-67.11 191.4 -66.6 191.2 -66.37 191.1 -65.93 190.9 -65.73 190.8
-65.19 190.5 -65 190.4 -64.64 190.2 -64.27 190 -63.58 189.6
-63.03 189.3 -62.27 188.9 -61.82 188.7 -61.16 188.4 -60.93 188.3
-60.07 187.9 -59.69 187.7 -59.33 187.5 -58.95 187.3 -58.78 187.2
-58.4 187 -58.04 186.8 -57.85 186.7 -57.25 186.4 -56.87 186.2
-56.69 186.1 -56.31 185.9 -55.92 185.7 -54.92 185.2 -54.55 185
-54.17 184.8 -53.77 184.6 -53.39 184.4 -53.21 184.3 -52.26 183.8
-51.67 183.5 -51.29 183.3 -50.12 182.7 -49.53 182.4 -48.95 182.1
-48.75 182 -48 181.6 -47.82 181.5 -46.49 180.8 -46.29 180.7
-45.91 180.5 -45.71 180.4 -45.49 180 -43.54 179 -41.69 178
-39.84 177 -38.11 176 -36.2 175 -34.25 174 -31.66 173
-29.42 172 -27.41 171 -25.4 170 -13 170 -9.6 168
-1.66 167.86 5.79 168.12 7.74 168.7 8.65 168.8 9.49 168.9
10.08 169 10.56 169.1 11 169.2 11.84 169.4 12.27 169.5
12.68 169.6 13.11 169.7 13.95 169.9 14.34 170 14.65 170.1
15.77 170.5 16.03 170.6 17.1 171 17.35 171.1 18.08 171.4
18.82 171.7 19.06 171.8 19.57 172 20.07 172.2 20.85 172.5
21.35 172.7 21.62 172.8 21.91 172.9 22.22 173 22.39 173.03
22.85 173.1 23.82 173.2 25.65 173.4 27.54 173.6 28.5 173.7
29.39 173.8 30.36 173.9 31.69 174 51.02 174.1 82.19 174.1
83.12 174.2 84.11 174.3 85.04 174.4 86.03 174.5 86.96 174.6
89 174.8 90.11 174.9 90.99 175 91.58 175.1 91.99 175.2
92.83 175.4 93.6 175.6 94.41 175.8 94.79 175.9 95.31 176
96.06 176.1 97.47 176.3 98.23 176.4 98.89 176.5 99.67 176.6
101.1 176.8 101.83 176.9 103.19 177 116.96 177.1 121.37 177.4
124.32 177.6 125.81 177.7 127.54 177.8 130.32 177.9 134.37 178
137.16 178.1 137.81 178.2 138.4 178.3 138.94 178.4 139.57 178.5
140.46 178.6 141.14 178.7 142.17 178.8 143.25 178.9 147.41 179
164.87 179 168.15 178.9 170.87 178.7 172.25 178.6 173.9 178.5
176.9 178.4 182.6 178.4 184.64 178.5 186.55 178.6 188.3 178.7
191.84 178.9 193.64 179 197.35 179.2 201.1 179.4 204.87 179.6
208.66 179.8 210.57 179.9 212.46 180 214.32 180.1 219.87 180.4
221.89 180.5 224.3 180.6 226.59 180.7 238.86 180.8 240.38 180.91
240.86 181.2 241.65 181.4 242.89 181.7 243.81 181.9 244.23 182
244.57 182.1 245.14 182.3 245.81 182.5 246.54 182.7 247.17 182.9
247.54 183 248.45 183.2 249.69 183.5 250.19 183.6 251.41 183.8
252.04 183.9 253.72 184 260.29 184.1 260.87 184.2 262.46 184.5
263.03 184.6 264.08 184.8 264.65 184.9 265.17 185 265.62 185.1
265.99 185.2 266.89 185.4 267.73 185.6 268.19 185.7 269.06 185.9
269.88 186.1 271.03 186.4 271.81 186.6 273.44 187 275.34 187.5
276.09 187.7 276.81 187.9 277.13 188 277.7 188.2 277.97 188.3

279.01 188.7 280.09 189.1 280.93 189.4 281.47 189.6 282.61 190
282.94 190.1 283.75 190.4 284.95 190.8 285.87 191.1 286.83 191.4
288.14 191.8 288.76 192 289.8 192.3 291.2 192.7 291.93 192.9
292.33 193 292.96 193.2 294 193.5 294.68 193.7 294.99 193.8
295.96 194.1 296.7 194.3 297.1 194.4 298.64 194.8 299.01 194.9
299.6 195.1 299.88 195.2 300.38 195.4 301.1 195.7 301.62 195.9
302.24 196.1 303.4 196.4 304.22 196.6 304.59 196.7 305.45 196.9
306.24 197.1 307.01 197.3 307.41 197.4 308.57 197.7 310.53 198.2
311.68 198.5 312.46 198.7 313.6 199 314.34 199.2 314.74 199.3
315.18 199.4 315.68 199.5 316.32 199.6 317.16 199.7 317.94 199.8
318.67 199.9 319.29 199.9

Manning's n Values num= 3
Sta n Val Sta n Val Sta n Val
-283.97 .1 -31.66 .04 22.22 .07

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
-31.66 22.22 19.07 20 20.11 .3 .5
Ineffective Flow num= 1
Sta L Sta R Elev Permanent
42 319.29 175.25 F

CROSS SECTION

RIVER: Muddy River
REACH: Northford Rd RS: 2531

INPUT
Description: Proposed Upstream Bridge Face
Proposed geometry
Station Elevation Data num= 474
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
-283.97 193.1 -283.04 193.1 -281.69 193.2 -279.62 193.4 -278.34 193.5
-277.35 193.6 -276.62 193.7 -275.08 193.8 -271.49 192.7 -264.9 192.8
-258.65 192.9 -249.57 193 -247.9 193.1 -246.41 193.3 -241.39 194
-235 194.9 -234.27 195 -231.86 195.3 -231.07 195.4 -230.24 195.5
-228.96 195.6 -227.39 195.7 -226.34 195.8 -225.5 195.9 -224.71 196
-219.6 196.7 -218.86 196.8 -215.94 197.2 -215.19 197.3 -213.67 197.5
-212.92 197.6 -211.38 197.8 -210.64 197.9 -209.65 198.1 -209.09 198.2
-208.59 198.3 -207.7 198.4 -206.62 198.5 -205.48 198.6 -204.36 198.7
-203.26 198.8 -202.19 198.9 -200.08 199.1 -197.89 199.3 -196.68 199.4
-193.17 199.4 -192.13 199.3 -191.28 199.2 -190.64 199.1 -190.22 199
-189.93 198.9 -189.27 198.7 -188.74 198.5 -188.22 198.3 -187.38 198
-186.83 197.8 -185.95 197.5 -184.83 197.1 -184.56 197 -183.77 196.7
-183.52 196.6 -182.48 196.2 -182.16 196.1 -181.55 195.9 -181.16 195.8

-178.21 195.3 -176.43 195 -174.04 194.6 -172.87 194.4 -172.34 194.3
-172.03 194.2 -171.15 193.9 -170.6 193.7 -170.04 193.5 -169.26 193.2
-168.99 193.1 -168.47 192.9 -167.97 192.7 -167.71 192.6 -165.21 191.6
-164.97 191.5 -164.47 191.3 -164.02 191.1 -163.06 190.7 -162.56 190.5
-162.32 190.4 -161.61 190.2 -161.28 190.1 -160.47 190 -158.38 190
-156.96 190.1 -155.99 190.2 -155.15 190.3 -154.38 190.4 -153.67 190.48
-152.8 190.6 -152.1 190.7 -150.54 190.9 -149.73 191 -142.53 191.8
-141.73 191.9 -140.98 192 -140.29 192.1 -139.63 192.2 -138.83 192.3
-137.99 192.4 -137.03 192.5 -135.7 192.7 -133.74 193 -131.76 193.3
-130.45 193.5 -127.87 193.9 -127.21 194 -126.5 194.1 -125.04 194.3
-122.08 194.7 -119.83 195 -118.53 195.1 -116.45 195.3 -115.56 195.4
-113.88 195.4 -112.42 195.3 -111.23 195.2 -109.95 195.1 -109.06 195
-108.47 194.9 -107.91 194.8 -107.25 194.7 -106.53 194.6 -105.47 194.5
-104.45 194.4 -103.15 194.3 -101.16 194.2 -98.68 194.1 -96.02 194
-94.42 193.9 -93 193.8 -91.99 193.7 -91.3 193.6 -90.8 193.5
-90.2 193.4 -88.76 193.3 -87.6 193.2 -86.72 193.1 -86.2 193
-85.49 192.9 -84.75 192.7 -83.45 192.3 -83.15 192.2 -82.52 192.1
-70.12 192 -68.77 191.9 -68.14 191.8 -67.81 191.7 -67.54 191.6
-67.11 191.4 -66.6 191.2 -66.37 191.1 -65.93 190.9 -65.73 190.8
-65.19 190.5 -65 190.4 -64.64 190.2 -64.27 190 -63.58 189.6
-63.03 189.3 -62.27 188.9 -61.82 188.7 -61.16 188.4 -60.93 188.3
-60.07 187.9 -59.69 187.7 -59.33 187.5 -58.95 187.3 -58.78 187.2
-58.4 187 -58.04 186.8 -57.85 186.7 -57.25 186.4 -56.87 186.2
-56.69 186.1 -56.31 185.9 -55.92 185.7 -54.92 185.2 -54.55 185
-54.17 184.8 -53.77 184.6 -53.39 184.4 -53.21 184.3 -52.26 183.8
-51.67 183.5 -51.29 183.3 -50.12 182.7 -49.53 182.4 -48.95 182.1
-48.75 182 -48 181.6 -47.82 181.5 -46.49 180.8 -46.29 180.7
-45.91 180.5 -45.71 180.4 -45.33 180.2 -44.94 180 -44.29 179.5
-43.92 179.2 -43.65 179 -43.28 178.8 -42.92 178.6 -42.73 178.5
-42.19 178.2 -42 178.1 -41.64 177.9 -41.45 177.8 -40.91 177.5
-40.72 177.4 -40.36 177.2 -40.17 177.1 -39.15 176.5 -38.66 176.2
-37.94 175.8 -37.55 175.6 -36.79 175.2 -36.59 175.1 -36.21 174.9
-36.01 174.8 -35.63 174.6 -35.45 174.5 -35.07 174.3 -34.86 174.2
-34.42 174 -34.19 173.9 -33.71 173.7 -33.46 173.6 -32.93 173.4
-32.68 173.3 -32.23 173.1 -31.93 173 -31.59 172.9 -30.96 172.7
-30.63 172.6 -30.28 172.5 -29.28 172.5 -28.26 172.6 -27.79 172.7
-27.46 172.8 -26.78 173 -26.43 173.1 -26.05 173.2 -25.25 173.4
-24.83 173.5 -24.07 173.6 -23.22 173.7 -22.77 173.7 -22.7 173.653
-22.32 173.4 -22.26 173.36 -21.84 173.1 -21.51 172.9 -21.32 172.8
-21.04 172.7 -20.54 172.5 -20.05 172.3 -19.78 172.2 -19.45 172.1
-19.09 172 -18.78 171.92 -18.4 171.8 -17.38 171.5 -16.67 171.3
-15.97 171.1 -15.66 171 -15.16 170.8 -14.68 170.6 -13.53 170.1
-13.36 170 -13.08 169.8 -12.95 169.7 -12.67 169.5 -12.54 169.4
-12.26 169.2 -11 167.84 -7.7 167.92 -2.12 167.5 2.72 167.76
7.12 168.12 11 167.96 13.11 169.7 13.95 169.9 14.34 170
14.65 170.1 15.77 170.5 16.03 170.6 17.1 171 17.35 171.1

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 18.08   171.4   18.82   171.7   19.06   171.8   19.57     172   20.07   172.2
 20.84   172.5   20.85   172.5   21.35   172.7   21.62   172.8   21.91   172.9
 22.22     173   22.85   173.1   23.82   173.2   25.65   173.4   27.54   173.6
  28.5   173.7   28.55 173.706   29.39   173.8   30.36   173.9   31.69     174
 51.02   174.1   82.19   174.1   83.12   174.2   84.11   174.3   85.04   174.4
 86.03   174.5   86.96   174.6      89   174.8   90.11   174.9   90.99     175
 91.58   175.1   91.99   175.2   92.83   175.4    93.6   175.6   94.41   175.8
 94.79   175.9   95.31     176   96.06   176.1   97.47   176.3   98.23   176.4
 98.89   176.5   99.67   176.6   101.1   176.8  101.83   176.9  103.19     177
116.96   177.1  121.37   177.4  124.32   177.6  125.81   177.7  127.54   177.8
130.32   177.9  134.37     178  137.16   178.1  137.81   178.2   138.4   178.3
138.94   178.4  139.57   178.5  140.46   178.6  141.14   178.7  142.17   178.8
143.25   178.9  147.41     179  164.87     179  168.15   178.9  170.87   178.7
172.25   178.6   173.9   178.5   176.9   178.4   182.6   178.4  184.64   178.5
186.55   178.6   188.3   178.7  191.84   178.9  193.64     179  197.35   179.2
 201.1   179.4  204.87   179.6  208.66   179.8  210.57   179.9  212.46     180
214.32   180.1  219.87   180.4  221.89   180.5   224.3   180.6  226.59   180.7
238.86   180.8  240.38  180.91  240.86   181.2  241.65   181.4  242.89   181.7
243.81   181.9  244.23     182  244.57   182.1  245.14   182.3  245.81   182.5
246.54   182.7  247.17   182.9  247.54     183  248.45   183.2  249.69   183.5
250.19   183.6  251.41   183.8  252.04   183.9  253.72     184  260.29   184.1
260.87   184.2  262.46   184.5  263.03   184.6  264.08   184.8  264.65   184.9
265.17     185  265.62   185.1  265.99   185.2  266.89   185.4  267.73   185.6
268.19   185.7  269.06   185.9  269.88   186.1  271.03   186.4  271.81   186.6
273.44     187  275.34   187.5  276.09   187.7  276.81   187.9  277.13     188
 277.7   188.2  277.97   188.3  279.01   188.7  280.09   189.1  280.93   189.4
281.47   189.6  282.61     190  282.94   190.1  283.75   190.4  284.95   190.8
285.87   191.1  286.83   191.4  288.14   191.8  288.76     192   289.8   192.3
 291.2   192.7  291.93   192.9  292.33     193  292.96   193.2     294   193.5
294.68   193.7  294.99   193.8  295.96   194.1   296.7   194.3   297.1   194.4
298.64   194.8  299.01   194.9   299.6   195.1  299.88   195.2  300.38   195.4
 301.1   195.7  301.62   195.9  302.24   196.1   303.4   196.4  304.22   196.6
304.59   196.7  305.45   196.9  306.24   197.1  307.01   197.3  307.41   197.4
308.57   197.7  310.53   198.2  311.68   198.5  312.46   198.7   313.6     199
314.34   199.2  314.74   199.3  315.18   199.4  315.68   199.5  316.32   199.6
317.16   199.7  317.94   199.8  318.67   199.9  319.29   199.9

Manning's n Values        num=       3
    Sta   n Val     Sta   n Val     Sta   n Val
-283.97      .1  -22.77     .04   22.22     .07

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
      -22.77   22.22           39.11   39.11   39.11            .3      .5
Ineffective Flow     num=       2
  Sta L   Sta R    Elev  Permanent
-283.97     -22   175.5       F
```

22.22 319.29 175.5 F

BRIDGE

RIVER: Muddy River
REACH: Northford Rd RS: 2515.5

INPUT
Description: Proposed Bridge No. 04832
Northford Road over the Muddy River
Distance from Upstream XS = 3.31
Deck/Roadway Width = 32.5
Weir Coefficient = 2.6
Upstream Deck/Roadway Coordinates
num= 24
Sta Hi Cord Lo Cord Sta Hi Cord Lo Cord Sta Hi Cord Lo Cord
-194.77 177.76 -128.73 176.5 -89 175.68
-34.54 177.15 -34.54 179.15 -22.85 179.43
-20.23 180.5 -19.42 180.5 0 -19.42 180.5 174.75
-16.92 180.513 174.763 -16.92 177.513 174.763 -10 177.547 174.81
0 177.597 174.85 10 177.647 174.9 18.08 177.688 174.938
18.08 180.688 174.938 20.58 180.7 174.95 20.58 180.7 0
21.36 180.7 23.99 179.66 35.65 179.5
35.65 177.5 115.53 179.19 143.25 178.9

Upstream Bridge Cross Section Data
Station Elevation Data num= 366
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
-283.97 193.1 -283.04 193.1 -281.69 193.2 -279.62 193.4 -278.34 193.5
-277.35 193.6 -276.62 193.7 -275.08 193.8 -271.49 192.7 -264.9 192.8
-258.65 192.9 -249.57 193 -247.9 193.1 -246.41 193.3 -241.39 194
-235 194.9 -234.27 195 -231.86 195.3 -231.07 195.4 -230.24 195.5
-228.96 195.6 -227.39 195.7 -226.34 195.8 -225.5 195.9 -224.71 196
-219.6 196.7 -218.86 196.8 -215.94 197.2 -215.19 197.3 -213.67 197.5
-212.92 197.6 -211.38 197.8 -210.64 197.9 -209.65 198.1 -209.09 198.2
-208.59 198.3 -207.7 198.4 -206.62 198.5 -205.48 198.6 -204.36 198.7
-203.26 198.8 -202.19 198.9 -200.08 199.1 -197.89 199.3 -196.68 199.4
-193.17 199.4 -192.13 199.3 -191.28 199.2 -190.64 199.1 -190.22 199
-189.93 198.9 -189.27 198.7 -188.74 198.5 -188.22 198.3 -187.38 198
-186.83 197.8 -185.95 197.5 -184.83 197.1 -184.56 197 -183.77 196.7
-183.52 196.6 -182.48 196.2 -182.16 196.1 -181.55 195.9 -181.16 195.8
-178.21 195.3 -176.43 195 -174.04 194.6 -172.87 194.4 -172.34 194.3
-172.03 194.2 -171.15 193.9 -170.6 193.7 -170.04 193.5 -169.26 193.2
-168.99 193.1 -168.47 192.9 -167.97 192.7 -167.71 192.6 -165.21 191.6
-164.97 191.5 -164.47 191.3 -164.02 191.1 -163.06 190.7 -162.56 190.5

-162.32 190.4 -161.61 190.2 -161.28 190.1 -160.47 190 -158.38 190
-156.96 190.1 -155.99 190.2 -155.15 190.3 -154.38 190.4 -153.67 190.48
-152.8 190.6 -152.1 190.7 -150.54 190.9 -149.73 191 -142.53 191.8
-141.73 191.9 -140.98 192 -140.29 192.1 -139.63 192.2 -138.83 192.3
-137.99 192.4 -137.03 192.5 -135.7 192.7 -133.74 193 -131.76 193.3
-130.45 193.5 -127.87 193.9 -127.21 194 -126.5 194.1 -125.04 194.3
-122.08 194.7 -119.83 195 -118.53 195.1 -116.45 195.3 -115.56 195.4
-113.88 195.4 -112.42 195.3 -111.23 195.2 -109.95 195.1 -109.06 195
-108.47 194.9 -107.91 194.8 -107.25 194.7 -106.53 194.6 -105.47 194.5
-104.45 194.4 -103.15 194.3 -101.16 194.2 -98.68 194.1 -96.02 194
-94.42 193.9 -93 193.8 -91.99 193.7 -91.3 193.6 -90.8 193.5
-90.2 193.4 -88.76 193.3 -87.6 193.2 -86.72 193.1 -86.2 193
-85.49 192.9 -84.75 192.7 -83.45 192.3 -83.15 192.2 -82.52 192.1
-70.12 192 -68.77 191.9 -68.14 191.8 -67.81 191.7 -67.54 191.6
-67.11 191.4 -66.6 191.2 -66.37 191.1 -65.93 190.9 -65.73 190.8
-65.19 190.5 -65 190.4 -64.64 190.2 -64.27 190 -63.58 189.6
-63.03 189.3 -62.27 188.9 -61.82 188.7 -61.16 188.4 -60.93 188.3
-60.07 187.9 -59.69 187.7 -59.33 187.5 -58.95 187.3 -58.78 187.2
-58.4 187 -58.04 186.8 -57.85 186.7 -57.25 186.4 -56.87 186.2
-56.69 186.1 -56.31 185.9 -55.92 185.7 -54.92 185.2 -54.55 185
-54.17 184.8 -53.77 184.6 -53.39 184.4 -53.21 184.3 -52.26 183.8
-51.67 183.5 -51.29 183.3 -50.12 182.7 -49.53 182.4 -48.95 182.1
-48.75 182 -48 181.6 -47.82 181.5 -46.49 180.8 -46.29 180.7
-45.91 180.5 -45.71 180.4 -45.33 180.2 -44.94 180 -44.29 179.5
-43.92 179.2 -43.65 179 -43.28 178.8 -42.92 178.6 -42.73 178.5
-42.19 178.2 -42 178.1 -41.64 177.9 -41.45 177.8 -40.91 177.5
-40.72 177.4 -40.36 177.2 -40.17 177.1 -39.15 176.5 -38.66 176.2
-37.94 175.8 -37.55 175.6 -36.79 175.2 -36.59 175.1 -36.21 174.9
-36.01 174.8 -35.63 174.6 -35.45 174.5 -35.07 174.3 -34.86 174.2
-34.42 174 -34.19 173.9 -33.71 173.7 -33.46 173.6 -32.93 173.4
-32.68 173.3 -32.23 173.1 -31.93 173 -31.59 172.9 -30.96 172.7
-30.63 172.6 -30.28 172.5 -29.28 172.5 -24.5 170.25 -22.5 170.25
-20 170.25 -17.5 170 -12.16 167.33 11 167.25 20 171.79
27.54 173.6 28.5 173.7 29.39 173.8 30.36 173.9 31.69 174
51.02 174.1 82.19 174.1 83.12 174.2 84.11 174.3 85.04 174.4
86.03 174.5 86.96 174.6 89 174.8 90.11 174.9 90.99 175
91.58 175.1 91.99 175.2 92.83 175.4 93.6 175.6 94.41 175.8
94.79 175.9 95.31 176 96.06 176.1 97.47 176.3 98.23 176.4
98.89 176.5 99.67 176.6 101.1 176.8 101.83 176.9 103.19 177
116.96 177.1 121.37 177.4 124.32 177.6 125.81 177.7 127.54 177.8
130.32 177.9 134.37 178 137.16 178.1 137.81 178.2 138.4 178.3
138.94 178.4 139.57 178.5 140.46 178.6 141.14 178.7 142.17 178.8
143.25 178.9 147.41 179 164.87 179 168.15 178.9 170.87 178.7
172.25 178.6 173.9 178.5 176.9 178.4 182.6 178.4 184.64 178.5
186.55 178.6 188.3 178.7 191.84 178.9 193.64 179 197.35 179.2
201.1 179.4 204.87 179.6 208.66 179.8 210.57 179.9 212.46 180

```
 214.32   180.1  219.87   180.4  221.89   180.5   224.3   180.6  226.59   180.7
 238.86   180.8  240.38  180.91  240.86   181.2  241.65   181.4  242.89   181.7
 243.81   181.9  244.23    182  244.57   182.1  245.14   182.3  245.81   182.5
 246.54   182.7  247.17   182.9  247.54    183  248.45   183.2  249.69   183.5
 250.19   183.6  251.41   183.8  252.04   183.9  253.72    184  260.29   184.1
 260.87   184.2  262.46   184.5  263.03   184.6  264.08   184.8  264.65   184.9
 265.17    185  265.62   185.1  265.99   185.2  266.89   185.4  267.73   185.6
 268.19   185.7  269.06   185.9  269.88   186.1  271.03   186.4  271.81   186.6
 273.44    187  275.34   187.5  276.09   187.7  276.81   187.9  277.13    188
  277.7   188.2  277.97   188.3  279.01   188.7  280.09   189.1  280.93   189.4
 281.47   189.6

Manning's n Values       num=      1
   Sta   n Val
-283.97     .1

Bank Sta: Left   Right    Coeff Contr.   Expan.
        -20     20           .3      .5
Ineffective Flow     num=      2
  Sta L   Sta R    Elev  Permanent
-283.97    -22   175.5      F
  22.22  281.47   175.5      F

Downstream  Deck/Roadway Coordinates
   num=     25
    Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
-194.77  177.76        -128.73   176.5           -89  175.68
 -34.54  177.15        -34.54  179.15        -22.85  179.43
 -20.23   180.5        -19.42   180.5      0  -19.42   180.5  174.75
 -16.92 180.513 174.763  -16.92 177.513 174.763     -10 177.547  174.81
      0 177.597  174.85      10 177.647   174.9   18.08 177.688 174.938
  18.08 180.688 174.938   20.58   180.7  174.95   20.58   180.7      0
  21.36   180.7         23.99  179.66         35.65   179.5
  35.65   177.5        115.53  179.19        143.25   178.9
    300  177.75

Downstream Bridge Cross Section Data
Station Elevation Data    num=     270
    Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
-487.89  187.79 -485.81   187.7 -483.49   187.6 -481.18   187.5 -478.88   187.4
 -476.6   187.3 -474.35   187.2 -472.13   187.1 -469.81     187 -467.28   186.9
-465.05   186.8 -462.82   186.7 -460.59   186.6 -458.34   186.5 -456.05   186.4
-453.83   186.3 -451.65   186.2 -449.37   186.1  -434.2     186 -430.63   185.9
-427.74   185.8 -424.34   185.7 -420.54   185.6 -408.33   185.5 -407.35   185.4
-406.38   185.3  -405.4   185.2 -404.43   185.1 -403.21     185  -400.9   184.9
-399.44   184.8 -397.98   184.7 -396.31   184.6  -394.4   184.5 -392.36   184.4
```

-390.05 184.3 -387.7 184.2 -377.41 184.2 -372.55 184.1 -369 184
-366.09 183.9 -361.95 183.8 -359.28 183.7 -357.36 183.6 -355.02 183.5
-353.22 183.4 -352.34 183.3 -351.53 183.2 -350.72 183.1 -343.36 183
-341.11 182.9 -339.24 182.8 -337.36 182.7 -334.51 182.6 -331.6 182.5
-330.12 182.4 -328.63 182.3 -327.14 182.2 -325.66 182.1 -323.64 182.1
-323.11 182.2 -322.57 182.3 -322.04 182.4 -321.1 182.5 -320.76 182.5
-319.9 182.4 -319.16 182.3 -318.36 182.2 -317.6 182.1 -294.18 182
-292.23 181.9 -290.44 181.8 -288.65 181.7 -286.87 181.6 -285.08 181.5
-283.29 181.4 -281.47 181.3 -279.54 181.2 -273.15 181.2 -268.58 181.3
-264.38 181.4 -260.19 181.5 -256.96 181.5 -254.8 181.6 -248.85 181.6
-245.59 181.5 -242.69 181.4 -241.06 181.3 -239.52 181.2 -237.99 181.1
-190.27 180.5 -188.67 180.4 -187.37 180.3 -186.33 180.2 -185.41 180.1
-172.71 180.1 -164.61 180.07 -145.2 180 -132.52 179.9 -129.77 179.8
-127.36 179.7 -124.94 179.6 -122.53 179.5 -120.12 179.4 -117.72 179.3
-115.31 179.2 -112.91 179.1 -110.68 179 -108.96 178.9 -107.45 178.8
-105.97 178.7 -104.66 178.6 -103.39 178.5 -102.19 178.4 -101.03 178.3
-99.98 178.2 -98.94 178.1 -97.93 178 -96.86 177.9 -95.72 177.8
-94.56 177.7 -93.56 177.6 -92.58 177.5 -91.47 177.4 -90.46 177.3
-89.63 177.2 -88.66 177.1 -87.7 177 -86.23 176.9 -84.68 176.8
-83.12 176.7 -81.56 176.6 -80.03 176.5 -78.5 176.4 -76.96 176.3
-75.43 176.2 -73.9 176.1 -72.34 176 -70.42 175.9 -68.55 175.8
-66.67 175.7 -64.79 175.6 -62.75 175.5 -60.68 175.4 -58.6 175.3
-56.53 175.2 -54.49 175.1 -52.51 175 -50.98 174.9 -49.48 174.8
-47.98 174.7 -46.47 174.6 -44.65 174.5 -42.73 174.4 -40.57 174.3
-38.36 174.2 -35.92 174.1 -33.62 174 -32.65 173.9 -31.77 173.8
-31.03 173.7 -30.35 173.6 -29.62 173.5 -29.03 173.4 -28.43 173.3
-27.79 173.2 -27.27 173.1 -26.76 173 -26.23 172.9 -25.7 172.8
-25.18 172.7 -24.65 172.6 -24.56 172.58 -20 170.25 -17.5 170
-12.16 167.33 11 167.25 20 171.79 22.74 173.3 135.9 174.2
142.81 174.1 149.64 174 152.36 173.9 154.43 173.8 156.52 173.7
158.71 173.6 161.04 173.5 163.06 173.4 165.09 173.3 168.97 173.3
210.39 174.1 212.38 174.2 214.47 174.3 216.82 174.4 219.24 174.5
221.66 174.6 224.07 174.7 226.49 174.8 228.91 174.9 231.41 175
239.85 175.1 241.25 175.2 242.65 175.3 244.41 175.4 248.55 175.5
252.25 175.6 254.97 175.7 257.31 175.79 257.7 175.8 261.23 175.9
264.37 176 265.4 176.1 266.04 176.2 266.68 176.3 267.32 176.4
267.97 176.5 268.65 176.6 269.32 176.7 269.99 176.8 270.71 176.9
271.47 177 272.31 177.1 273.17 177.2 274.01 177.3 274.83 177.4
275.68 177.5 277.17 177.6 277.42 177.6 279.34 177.5 280.44 177.5
281.96 177.6 283.13 177.7 284.18 177.8 285.18 177.9 286.02 178
286.7 178.1 287.4 178.2 288.11 178.3 288.74 178.4 289.36 178.5
289.98 178.6 290.58 178.7 291.16 178.8 291.74 178.9 292.27 179
292.71 179.1 293.09 179.2 293.48 179.3 293.86 179.4 294.25 179.5
294.63 179.6 295.02 179.7 295.41 179.8 295.83 179.9 296.37 180
296.94 180.1 297.62 180.2 298.31 180.3 299 180.4 299.83 180.5
300.59 180.6 301.62 180.7 302.41 180.8 303.6 180.9 304.87 181

313.58 181 315.14 180.9 316.23 180.8 317.33 180.7 327.52 180.7

Manning's n Values num= 2
Sta n Val Sta n Val
-487.89 .075 -33.62 .045

Bank Sta: Left Right Coeff Contr. Expan.
-20 20 .3 .5
Ineffective Flow num= 2
Sta L Sta R Elev Permanent
-487.89 -22 175.25 F
22 327.52 175.25 F

Upstream Embankment side slope = 0 horiz. to 1.0 vertical
Downstream Embankment side slope = 0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow = .98
Elevation at which weir flow begins =
Energy head used in spillway design =
Spillway height used in design =
Weir crest shape = Broad Crested

Number of Bridge Coefficient Sets = 1

Low Flow Methods and Data
Energy
Selected Low Flow Methods = Energy

High Flow Method
Pressure and Weir flow
Submerged Inlet Cd =
Submerged Inlet + Outlet Cd = .8
Max Low Cord =

Additional Bridge Parameters
Add Friction component to Momentum
Do not add Weight component to Momentum
Class B flow critical depth computations use critical depth
inside the bridge at the upstream end
Criteria to check for pressure flow = Upstream energy grade line

CROSS SECTION

RIVER: Muddy River
REACH: Northford Rd RS: 2499

INPUT
Description: Proposed Downstream Bridge Face
Proposed geometry
Station Elevation Data num= 358

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-487.89	187.79	-485.81	187.7	-483.49	187.6	-481.18	187.5	-478.88	187.4
-476.6	187.3	-474.35	187.2	-472.13	187.1	-469.81	187	-467.28	186.9
-465.05	186.8	-462.82	186.7	-460.59	186.6	-458.34	186.5	-456.05	186.4
-453.83	186.3	-451.65	186.2	-449.37	186.1	-434.2	186	-430.63	185.9
-427.74	185.8	-424.34	185.7	-420.54	185.6	-408.33	185.5	-407.35	185.4
-406.38	185.3	-405.4	185.2	-404.43	185.1	-403.21	185	-400.9	184.9
-399.44	184.8	-397.98	184.7	-396.31	184.6	-394.4	184.5	-392.36	184.4
-390.05	184.3	-387.7	184.2	-377.41	184.2	-372.55	184.1	-369	184
-366.09	183.9	-361.95	183.8	-359.28	183.7	-357.36	183.6	-355.02	183.5
-353.22	183.4	-352.34	183.3	-351.53	183.2	-350.72	183.1	-343.36	183
-341.11	182.9	-339.24	182.8	-337.36	182.7	-334.51	182.6	-331.6	182.5
-330.12	182.4	-328.63	182.3	-327.14	182.2	-325.66	182.1	-323.64	182.1
-323.11	182.2	-322.57	182.3	-322.04	182.4	-321.1	182.5	-320.76	182.5
-319.9	182.4	-319.16	182.3	-318.36	182.2	-317.6	182.1	-294.18	182
-292.23	181.9	-290.44	181.8	-288.65	181.7	-286.87	181.6	-285.08	181.5
-283.29	181.4	-281.47	181.3	-279.54	181.2	-273.15	181.2	-268.58	181.3
-264.38	181.4	-260.19	181.5	-256.96	181.5	-254.8	181.6	-248.85	181.6
-245.59	181.5	-242.69	181.4	-241.06	181.3	-239.52	181.2	-237.99	181.1
-190.27	180.5	-188.67	180.4	-187.37	180.3	-186.33	180.2	-185.41	180.1
-172.71	180.1	-164.61	180.07	-145.2	180	-132.52	179.9	-129.77	179.8
-127.36	179.7	-124.94	179.6	-122.53	179.5	-120.12	179.4	-117.72	179.3
-115.31	179.2	-112.91	179.1	-110.68	179	-108.96	178.9	-107.45	178.8
-105.97	178.7	-104.66	178.6	-103.39	178.5	-102.19	178.4	-101.03	178.3
-99.98	178.2	-98.94	178.1	-97.93	178	-96.86	177.9	-95.72	177.8
-94.56	177.7	-93.56	177.6	-92.58	177.5	-91.47	177.4	-90.46	177.3
-89.63	177.2	-88.66	177.1	-87.7	177	-86.23	176.9	-84.68	176.8
-83.12	176.7	-81.56	176.6	-80.03	176.5	-78.5	176.4	-76.96	176.3
-75.43	176.2	-73.9	176.1	-72.34	176	-70.42	175.9	-68.55	175.8
-66.67	175.7	-64.79	175.6	-62.75	175.5	-60.68	175.4	-58.6	175.3
-56.53	175.2	-54.49	175.1	-52.51	175	-50.98	174.9	-49.48	174.8
-47.98	174.7	-46.47	174.6	-44.65	174.5	-42.73	174.4	-40.57	174.3
-38.36	174.2	-35.92	174.1	-33.62	174	-32.65	173.9	-31.77	173.8
-31.03	173.7	-30.35	173.6	-29.62	173.5	-29.03	173.4	-28.43	173.3
-27.79	173.2	-27.27	173.1	-26.76	173	-26.23	172.9	-25.7	172.8
-25.18	172.7	-24.65	172.6	-24.56	172.58	-24.12	172.5	-23.59	172.4
-23.06	172.3	-22.57	172.2	-22.05	172.1	-21.52	172	-21.13	171.9
-20.76	171.8	-20.34	171.7	-19.96	171.6	-19.56	171.5	-19.02	171.4
-18.51	171.3	-17.99	171.2	-17.48	171.1	-17.1	171	-16.82	170.9
-16.59	170.8	-16.39	170.7	-15.33	170.26	-10.87	168.28	-3.32	167.6
3.46	167.4	10.87	167.78	11.23	169.2	11.46	169.3	11.69	169.4
11.92	169.5	12.15	169.6	12.38	169.7	12.61	169.8	12.84	169.9

13.07 170 13.3 170.1 13.53 170.2 13.77 170.3 14 170.4
14.23 170.5 14.47 170.6 14.7 170.7 14.93 170.8 15.16 170.9
15.4 171 15.64 171.1 15.87 171.2 16.11 171.3 16.35 171.4
16.6 171.5 16.84 171.6 17.08 171.7 17.32 171.8 17.56 171.9
17.8 172 18.04 172.1 18.28 172.2 18.52 172.3 18.75 172.4
18.99 172.5 19.23 172.6 19.47 172.7 19.71 172.8 19.94 172.9
20.37 173 21.02 173.1 21.62 173.17 21.89 173.2 22.74 173.3
23.62 173.4 24.54 173.5 25.44 173.6 26.36 173.7 27.3 173.8
28.22 173.9 29.88 174 122.67 174.1 126.1 174.2 135.71 174.2
135.9 174.2 142.81 174.1 149.64 174 152.36 173.9 154.43 173.8
156.52 173.7 158.71 173.6 161.04 173.5 163.06 173.4 165.09 173.3
168.97 173.3 210.39 174.1 212.38 174.2 214.47 174.3 216.82 174.4
219.24 174.5 221.66 174.6 224.07 174.7 226.49 174.8 228.91 174.9
231.41 175 239.85 175.1 241.25 175.2 242.65 175.3 244.41 175.4
248.55 175.5 252.25 175.6 254.97 175.7 257.31 175.79 257.7 175.8
261.23 175.9 264.37 176 265.4 176.1 266.04 176.2 266.68 176.3
267.32 176.4 267.97 176.5 268.65 176.6 269.32 176.7 269.99 176.8
270.71 176.9 271.47 177 272.31 177.1 273.17 177.2 274.01 177.3
274.83 177.4 275.68 177.5 277.17 177.6 277.42 177.6 279.34 177.5
280.44 177.5 281.96 177.6 283.13 177.7 284.18 177.8 285.18 177.9
286.02 178 286.7 178.1 287.4 178.2 288.11 178.3 288.74 178.4
289.36 178.5 289.98 178.6 290.58 178.7 291.16 178.8 291.74 178.9
292.27 179 292.71 179.1 293.09 179.2 293.48 179.3 293.86 179.4
294.25 179.5 294.63 179.6 295.02 179.7 295.41 179.8 295.83 179.9
296.37 180 296.94 180.1 297.62 180.2 298.31 180.3 299 180.4
299.83 180.5 300.59 180.6 301.62 180.7 302.41 180.8 303.6 180.9
304.87 181 313.58 181 315.14 180.9 316.23 180.8 317.33 180.7
327.52 180.7 329.85 180.6 330.89 180.5 331.73 180.4 332.68 180.3
333.67 180.2 334.61 180.1 335.58 180 336.46 179.9 337.43 179.8
338.45 179.7 339.89 179.6 342.71 179.5 344.3 179.4 346.08 179.3
348.21 179.2 351.81 179.1 365.83 179.1

Manning's n Values num= 3
Sta n Val Sta n Val Sta n Val
-487.89 .075 -42.73 .045 29.88 .08

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
-42.73 29.88 21.88 22.3 22.3 .3 .5
Ineffective Flow num= 2
Sta L Sta R Elev Permanent
-487.89 -22 175.25 F
22 365.83 175.25 F

CROSS SECTION

RIVER: Muddy River
REACH: Northford Rd RS: 2475

INPUT
Description: 25 Feet Downstream of Existing Bridge
Proposed geometry
Station Elevation Data num= 337

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-487.89	187.79	-485.81	187.7	-483.49	187.6	-481.18	187.5	-478.88	187.4
-476.6	187.3	-474.35	187.2	-472.13	187.1	-469.81	187	-467.28	186.9
-465.05	186.8	-462.82	186.7	-460.59	186.6	-458.34	186.5	-456.05	186.4
-453.83	186.3	-451.65	186.2	-449.37	186.1	-434.2	186	-430.63	185.9
-427.74	185.8	-424.34	185.7	-420.54	185.6	-408.33	185.5	-407.35	185.4
-406.38	185.3	-405.4	185.2	-404.43	185.1	-403.21	185	-400.9	184.9
-399.44	184.8	-397.98	184.7	-396.31	184.6	-394.4	184.5	-392.36	184.4
-390.05	184.3	-387.7	184.2	-377.41	184.2	-372.55	184.1	-369	184
-366.09	183.9	-361.95	183.8	-359.28	183.7	-357.36	183.6	-355.02	183.5
-353.22	183.4	-352.34	183.3	-351.53	183.2	-350.72	183.1	-343.36	183
-341.11	182.9	-339.24	182.8	-337.36	182.7	-334.51	182.6	-331.6	182.5
-330.12	182.4	-328.63	182.3	-327.14	182.2	-325.66	182.1	-323.64	182.1
-323.11	182.2	-322.57	182.3	-322.04	182.4	-321.1	182.5	-320.76	182.5
-319.9	182.4	-319.16	182.3	-318.36	182.2	-317.6	182.1	-294.18	182
-292.23	181.9	-290.44	181.8	-288.65	181.7	-286.87	181.6	-285.08	181.5
-283.29	181.4	-281.47	181.3	-279.54	181.2	-273.15	181.2	-268.58	181.3
-264.38	181.4	-260.19	181.5	-256.96	181.5	-254.8	181.6	-248.85	181.6
-245.59	181.5	-242.69	181.4	-241.06	181.3	-239.52	181.2	-237.99	181.1
-190.27	180.5	-188.67	180.4	-187.37	180.3	-186.33	180.2	-185.41	180.1
-172.71	180.1	-164.61	180.07	-145.2	180	-132.52	179.9	-129.77	179.8
-127.36	179.7	-124.94	179.6	-122.53	179.5	-120.12	179.4	-117.72	179.3
-115.31	179.2	-112.91	179.1	-110.68	179	-108.96	178.9	-107.45	178.8
-105.97	178.7	-104.66	178.6	-103.39	178.5	-102.19	178.4	-101.03	178.3
-99.98	178.2	-98.94	178.1	-97.93	178	-96.86	177.9	-95.72	177.8
-94.56	177.7	-93.56	177.6	-92.58	177.5	-91.47	177.4	-90.46	177.3
-89.63	177.2	-88.66	177.1	-87.7	177	-86.23	176.9	-84.68	176.8
-83.12	176.7	-81.56	176.6	-80.03	176.5	-78.5	176.4	-76.96	176.3
-75.43	176.2	-73.9	176.1	-72.34	176	-70.42	175.9	-68.55	175.8
-66.67	175.7	-64.79	175.6	-62.75	175.5	-60.68	175.4	-58.6	175.3
-56.53	175.2	-54.49	175.1	-52.51	175	-50.98	174.9	-49.48	174.8
-47.98	174.7	-46.47	174.6	-44.65	174.5	-42.73	174.4	-40.57	174.3
-38.36	174.2	-35.92	174.1	-35.08	174	-32.72	173	-30.36	172
-27.62	171	-24.55	170	-13.4	170	-10.2	168	-4.52	167.26
.95	167.28	8.25	167.72	9.18	168.3	9.38	168.4	9.58	168.5
9.82	168.6	10.06	168.7	10.3	168.8	10.53	168.9	10.77	169
11	169.1	11.23	169.2	11.46	169.3	11.69	169.4	11.92	169.5
12.15	169.6	12.38	169.7	12.61	169.8	12.84	169.9	13.07	170
13.3	170.1	13.53	170.2	13.77	170.3	14	170.4	14.23	170.5

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  14.47   170.6   14.7   170.7   14.93   170.8   15.16   170.9    15.4    171
  15.64   171.1  15.87   171.2   16.11   171.3   16.35   171.4   16.6   171.5
  16.84   171.6  17.08   171.7   17.32   171.8   17.56   171.9   17.8    172
  18.04   172.1  18.28   172.2   18.52   172.3   18.75   172.4  18.99   172.5
  19.23   172.6  19.47   172.7   19.71   172.8   19.94   172.9  20.37    173
   20.7  173.05  21.02   173.1   21.89   173.2   22.74   173.3  23.62   173.4
  24.54   173.5  25.44   173.6   26.36   173.7    27.3   173.8  28.22   173.9
  29.88    174  122.67   174.1   126.1   174.2  135.71   174.2  135.9   174.2
 142.81   174.1 149.64     174  152.36   173.9  154.43   173.8 156.52   173.7
 158.71   173.6 161.04   173.5  163.06   173.4  165.09   173.3 168.97   173.3
 210.39   174.1 212.38   174.2  214.47   174.3  216.82   174.4 219.24   174.5
 221.66   174.6 224.07   174.7  226.49   174.8  228.91   174.9 231.41    175
 239.85   175.1 241.25   175.2  242.65   175.3  244.41   175.4 248.55   175.5
 252.25   175.6 254.97   175.7  257.31  175.79   257.7   175.8 261.23   175.9
 264.37    176  265.4    176.1  266.04   176.2  266.68   176.3 267.32   176.4
 267.97   176.5 268.65   176.6  269.32   176.7  269.99   176.8 270.71   176.9
 271.47    177  272.31   177.1  273.17   177.2  274.01   177.3 274.83   177.4
 275.68   177.5 277.17   177.6  277.42   177.6  279.34   177.5 280.44   177.5
 281.96   177.6 283.13   177.7  284.18   177.8  285.18   177.9 286.02    178
  286.7   178.1  287.4   178.2  288.11   178.3  288.74   178.4 289.36   178.5
 289.98   178.6 290.58   178.7  291.16   178.8  291.74   178.9 292.27    179
 292.71   179.1 293.09   179.2  293.48   179.3  293.86   179.4 294.25   179.5
 294.63   179.6 295.02   179.7  295.41   179.8  295.83   179.9 296.37    180
 296.94   180.1 297.62   180.2  298.31   180.3    299    180.4 299.83   180.5
 300.59   180.6 301.62   180.7  302.41   180.8   303.6   180.9 304.87    181
 313.58    181  315.14   180.9  316.23   180.8  317.33   180.7 327.52   180.7
 329.85   180.6 330.89   180.5  331.73   180.4  332.68   180.3 333.67   180.2
 334.61   180.1 335.58    180  336.46   179.9  337.43   179.8 338.45   179.7
 339.89   179.6 342.71   179.5   344.3   179.4  346.08   179.3 348.21   179.2
 351.81   179.1 365.83   179.1

Manning's n Values        num=       3
    Sta   n Val     Sta   n Val     Sta   n Val
 -487.89    .075  -35.92    .045   29.88     .08

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
      -35.92   29.88          64.18   84.74   97.07           .3      .5
Ineffective Flow     num=       2
  Sta L   Sta R    Elev  Permanent
 -487.89   -42.4     177       F
    40  365.83  175.23       F

CROSS SECTION


RIVER: Muddy River
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REACH: Northford Rd RS: 2390

INPUT
Description: 110 Feet Downstream of Existing Bridge
FEMA Cross Section
"BJ"
Assumed Exit Cross Section
Geometry based on project survey
supplemented with one foot 2011 Lidar contours in far overbank areas
Station Elevation Data num= 329

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-287.29	180.25	-66.51	174.6	-65.8	174.5	-65	174.4	-64.26	174.3
-63.48	174.2	-62.76	174.1	-61.66	174	-60.32	173.9	-58.98	173.8
-57.52	173.7	-56.03	173.6	-54.51	173.5	-52.89	173.4	-51.52	173.3
-50.21	173.2	-48.89	173.1	-47.57	173	-46.22	172.9	-44.89	172.8
-43.61	172.7	-42.49	172.6	-41.5	172.5	-40.5	172.4	-39.55	172.3
-38.42	172.2	-37.52	172.1	-36.81	172	-36.18	171.9	-35.53	171.8
-34.87	171.7	-34.59	171.66	-34.21	171.6	-33.51	171.5	-32.79	171.4
-32.1	171.3	-31.4	171.2	-30.71	171.1	-30.11	171	-29.55	170.9
-29.15	170.8	-28.77	170.7	-28.34	170.6	-27.88	170.5	-27.37	170.4
-27	170.3	-26.6	170.2	-26.13	170.1	-25.55	170	-24.89	169.9
-24.26	169.8	-23.66	169.7	-23.1	169.6	-22.55	169.5	-21.97	169.4
-21.4	169.3	-20.88	169.2	-20.4	169.1	6.93	169.1	7.7	169.2
12.86	169.3	14.41	169.4	15.54	169.5	15.96	169.6	16.28	169.7
16.59	169.8	16.9	169.9	17.2	170	17.49	170.1	17.78	170.2
18.06	170.3	18.32	170.4	18.56	170.5	18.82	170.6	19.08	170.7
19.34	170.8	19.6	170.9	19.85	171	20.11	171.1	20.4	171.2
20.69	171.3	21.02	171.4	21.36	171.5	21.68	171.6	21.99	171.7
22.31	171.8	22.63	171.9	22.85	171.97	22.96	172	23.27	172.1
23.57	172.2	23.86	172.3	24.16	172.4	24.45	172.5	24.74	172.6
25.03	172.7	25.32	172.8	25.62	172.9	25.88	173	26.14	173.1
26.4	173.2	26.65	173.3	26.9	173.4	27.14	173.5	27.39	173.6
27.64	173.7	27.88	173.8	28.14	173.9	28.41	174	28.69	174.1
29.01	174.2	29.32	174.3	29.64	174.4	29.95	174.5	30.26	174.6
30.59	174.7	30.92	174.8	31.23	174.9	32.17	175	50.7	175.04
81.19	175.1	83.44	175.2	85.8	175.3	88.64	175.4	92.23	175.5
94.86	175.6	97.34	175.7	99.88	175.8	102.44	175.9	104.53	176
105.48	176.1	106.31	176.2	107.17	176.3	108.21	176.4	109.35	176.5
110.42	176.6	111.01	176.7	111.81	176.8	112.96	176.9	114.42	177
140.02	177.1	142.01	177.2	144	177.3	145.99	177.4	147.7	177.5
149.1	177.6	150.4	177.7	151.7	177.8	152.95	177.9	154.83	178
156.74	178.1	158.32	178.2	159.9	178.3	161.49	178.4	163.2	178.5
165.05	178.6	167.07	178.7	169.78	178.8	172.42	178.9	174.51	179
180.27	179.1	181.04	179.2	181.81	179.3	182.58	179.4	183.36	179.5
184.12	179.6	184.87	179.7	185.58	179.8	186.27	179.9	186.97	180

187.8 180.1 188.5 180.2 189.17 180.3 189.93 180.4 190.73 180.5
191.71 180.6 192.85 180.7 193.98 180.8 195.05 180.9 195.8 181
196.16 181.1 196.47 181.2 196.77 181.3 197.09 181.4 197.42 181.5
197.74 181.6 198.07 181.7 198.4 181.8 198.72 181.9 199.02 182
199.26 182.1 199.49 182.2 199.72 182.3 199.94 182.4 200.18 182.5
200.42 182.6 200.64 182.7 200.87 182.8 201.28 182.9 202.01 183
204.96 183.1 205.56 183.2 206.15 183.3 206.75 183.4 207.35 183.5
207.94 183.6 208.54 183.7 209.14 183.8 209.62 183.9 210.22 184
210.55 184.1 210.88 184.2 211.2 184.3 211.51 184.4 211.81 184.5
212.11 184.6 212.41 184.7 212.71 184.8 213.01 184.9 213.37 185
213.87 185.1 214.38 185.2 214.91 185.3 215.45 185.4 215.98 185.5
216.51 185.6 217.04 185.7 217.56 185.8 218.07 185.9 218.58 186
219.13 186.1 219.65 186.2 220.14 186.3 220.64 186.4 221.14 186.5
221.64 186.6 222.14 186.7 222.64 186.8 223.14 186.9 223.63 187
224.1 187.1 224.56 187.2 225 187.3 225.43 187.4 225.86 187.5
226.27 187.6 226.68 187.7 227.08 187.8 227.48 187.9 227.9 188
228.33 188.1 228.78 188.2 229.23 188.3 229.68 188.4 229.71 188.41
230.16 188.5 230.65 188.6 231.12 188.7 231.6 188.8 232.07 188.9
232.56 189 232.65 189.02 233.04 189.1 233.53 189.2 234.01 189.3
234.5 189.4 235 189.5 235.49 189.6 236.06 189.7 236.62 189.8
237.2 189.9 237.78 190 238.36 190.1 238.87 190.2 239.39 190.3
239.87 190.4 240.34 190.5 240.79 190.6 241.22 190.7 241.66 190.8
242.09 190.9 242.52 191 242.96 191.1 243.4 191.2 243.87 191.3
244.34 191.4 244.83 191.5 245.34 191.6 245.85 191.7 246.36 191.8
246.88 191.9 247.39 192 247.91 192.1 248.43 192.2 248.96 192.3
249.48 192.4 250.01 192.5 250.54 192.6 251.08 192.7 251.61 192.8
252.15 192.9 252.72 193 253.4 193.1 254.11 193.2 254.78 193.3
255.43 193.4 256.04 193.5 256.65 193.6 257.24 193.7 257.83 193.8
258.42 193.9 258.99 194 259.56 194.1 260.12 194.2 260.68 194.3
261.24 194.4 261.8 194.5 262.36 194.6 262.95 194.7 263.55 194.8
264.19 194.9 264.92 195 265.55 195.1 265.98 195.2 266.43 195.3
266.86 195.4 267.31 195.5 267.75 195.6 268.01 195.66

Manning's n Values num= 3
Sta n Val Sta n Val Sta n Val
-287.29 .075 -66.51 .045 32.17 .08

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
-66.51 32.17 131.15 133.54 130.56 .1 .3

CROSS SECTION

RIVER: Muddy River
REACH: Northford Rd RS: 2256

INPUT
Description: 244 Feet Downstream of Existing Bridge
FEMA Cross Section
"BI"
Geometry based on project survey supplemented with one foot
2011 Lidar contours in far overbank areas
Station Elevation Data num= 376

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-163.12	179.1	-150.01	179.1	-136.98	179.1	-133.85	179.2	-130.73	179.3
-121.8	178.84	-97.65	179.18	-77.73	178.96	-58.21	179.7	-45.73	179.36
-33.37	172.14	-22	167.36	-19.15	167.44	-8.7	167.74	4.86	167.58
5.47	167.64	31.93	167.52	35.42	167.82	35.54	167.86	42.67	170.2
48.25	170.5	52.04	170.6	55.83	170.7	59.01	170.8	62.1	170.9
65.01	171	65.8	171.1	66.28	171.2	66.77	171.3	67.25	171.4
67.72	171.5	68.3	171.6	68.94	171.7	69.84	171.8	70.83	171.9
72.03	172	80.65	172.1	81.03	172.2	81.39	172.3	81.79	172.4
82.19	172.5	82.59	172.6	82.99	172.7	83.39	172.8	83.78	172.9
84.14	173	84.41	173.1	84.65	173.2	84.89	173.3	85.13	173.4
85.36	173.5	85.58	173.6	85.81	173.7	86.05	173.8	86.28	173.9
86.53	174	86.79	174.1	87.04	174.2	87.31	174.3	87.58	174.4
87.86	174.5	88.12	174.6	88.38	174.7	88.65	174.8	88.99	174.9
89.87	175	96.77	175.1	108.15	175.2	110.62	175.3	112.85	175.4
115.12	175.5	117.39	175.6	119.71	175.7	122.03	175.8	124.32	175.9
126.18	176	126.79	176.1	127.07	176.2	127.33	176.3	127.59	176.4
127.85	176.5	128.11	176.6	128.38	176.7	128.66	176.8	129.02	176.9
129.52	177	149.99	177.08	154.06	177.1	157.21	177.2	158.38	177.3
159.52	177.4	160.68	177.5	161.82	177.6	162.96	177.7	164.09	177.8
165.29	177.9	166.36	178	167.12	178.1	167.76	178.2	168.4	178.3
169.03	178.4	169.63	178.5	170.24	178.6	170.84	178.7	171.43	178.8
172.03	178.9	172.62	179	173.16	179.1	173.7	179.2	174.24	179.3
174.78	179.4	175.3	179.5	175.84	179.6	176.37	179.7	176.87	179.8
177.41	179.9	177.89	180	178.34	180.1	178.77	180.2	179.2	180.3
179.62	180.4	180.05	180.5	180.48	180.6	180.91	180.7	181.33	180.8
181.76	180.9	182.15	181	182.47	181.1	182.79	181.2	183.11	181.3
183.43	181.4	183.71	181.5	183.99	181.6	184.29	181.7	184.61	181.8
184.91	181.9	185.21	182	185.52	182.1	185.83	182.2	186.15	182.3
186.46	182.4	186.78	182.5	187.1	182.6	187.43	182.7	187.75	182.8
188.08	182.9	188.41	183	188.68	183.1	188.96	183.2	189.23	183.3
189.47	183.4	189.74	183.5	190.01	183.6	190.28	183.7	190.56	183.8
190.83	183.9	191.1	184	191.38	184.1	191.65	184.2	191.92	184.3
192.19	184.4	192.48	184.5	192.77	184.6	193.05	184.7	193.33	184.8
193.6	184.9	193.87	185	194.15	185.1	194.42	185.2	194.72	185.3
195	185.4	195.28	185.5	195.55	185.6	195.84	185.7	196.12	185.8
196.41	185.9	196.72	186	197.03	186.1	197.35	186.2	197.68	186.3
198.01	186.4	198.32	186.5	198.64	186.6	198.96	186.7	199.28	186.8
199.56	186.9	199.82	187	200.07	187.1	200.29	187.2	200.51	187.3

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 200.71   187.4  200.92   187.5  201.14   187.6  201.36   187.7  201.57   187.8
 201.79   187.9  201.99    188  202.18   188.1  202.37   188.2  202.56   188.3
 202.75   188.4  202.94   188.5  203.12   188.6  203.31   188.7  203.49   188.8
 203.69   188.9  203.88    189  204.07   189.1  204.28   189.2  204.49   189.3
  204.7   189.4  204.91   189.5  205.12   189.6  205.33   189.7  205.52   189.8
 205.73   189.9  205.95    190  206.17   190.1   206.4   190.2  206.64   190.3
 206.88   190.4  207.13   190.5  207.37   190.6  207.61   190.7  207.84   190.8
 208.05   190.9  208.27    191  208.48   191.1  208.69   191.2  208.89   191.3
 209.09   191.4  209.29   191.5   209.5   191.6  209.71   191.7  209.92   191.8
 210.15   191.9  210.39    192  210.63   192.1  210.88   192.2  211.12   192.3
 211.37   192.4  211.63   192.5  211.91   192.6  212.19   192.7  212.47   192.8
 212.76   192.9  213.06    193  213.36   193.1  213.64   193.2   213.9   193.3
 214.15   193.4  214.39   193.5  214.63   193.6  214.87   193.7  215.12   193.8
 215.48   193.9  215.85    194  216.25   194.1  216.89   194.2  217.58   194.3
 218.26   194.4  218.94   194.5  219.64   194.6  220.33   194.7  220.99   194.8
 221.63   194.9   222.3    195  223.12   195.1  223.89   195.2  224.82   195.3
 225.65   195.4  226.56   195.5  227.42   195.6  228.06   195.7  228.65   195.8
 229.18   195.9  229.66    196  230.13   196.1  230.61   196.2  231.09   196.3
 231.56   196.4  232.04   196.5  232.51   196.6   233.2   196.7  233.82   196.8
 234.39   196.9   234.8    197  235.16   197.1  235.52   197.2  235.87   197.3
 236.21   197.4  236.55   197.5  236.89   197.6  237.23   197.7  237.57   197.8
 237.91   197.9  238.25    198  238.65   198.1  239.05   198.2  239.45   198.3
 239.84   198.4  240.24   198.5  240.65   198.6  241.05   198.7  241.45   198.8
 241.84   198.9  242.24    199  242.64   199.1  243.05   199.2  243.45   199.3
 243.88   199.4  244.35   199.5  244.92   199.6   245.6   199.7  246.29   199.8
 246.94   199.9  247.59    200  248.18   200.1  248.71   200.2  249.24   200.3
 249.78   200.4  250.31   200.5  250.81   200.6  251.32   200.7  251.82   200.8
 252.33   200.9  252.88    201  253.52   201.1  254.14   201.2  254.73   201.3
 255.29   201.4  255.85   201.5  256.41   201.6  256.93   201.7  257.45   201.8
 257.97   201.9  258.49    202  259.01   202.1  259.55   202.2  259.88  202.27
 260.05   202.3  260.48   202.4  260.91   202.5  261.34   202.6  261.77   202.7
  262.2   202.8  262.63   202.9  263.06    203   263.5   203.1  263.94   203.2
 264.41   203.3  264.88   203.4  265.36   203.5  265.83   203.6  266.32   203.7
 266.84   203.8  267.37   203.9  267.89    204  268.37   204.1  268.85   204.2
 269.33   204.3  269.81   204.4  270.28   204.5  270.75   204.6  271.21   204.7
 271.67   204.8  272.12   204.9   272.6    205  273.08   205.1   273.6   205.2
 274.11   205.3  274.63   205.4  275.14   205.5  275.66   205.6  276.17   205.7
 276.51  205.77

Manning's n Values        num=       3
    Sta   n Val     Sta   n Val     Sta   n Val
 -163.12    .075  -33.37     .04   42.67      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
      -33.37   42.67           60.64   62.43   66.72           .1       .3
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CROSS SECTION

RIVER: Muddy River
REACH: Northford Rd RS: 2193

INPUT
Description: 306 Feet Downstream of Existing Bridge
Geometry based on project
survey supplemented with one foot 2011 Lidar contours in far overbank areas
Station Elevation Data num= 440

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-143.58	179.1	-127.51	179.1	-122.26	179.2	-117.01	179.3	-111.76	179.4
-106.37	179.5	-100.3	179.6	-96.61	179.7	-93.3	179.8	-90	179.9
-86.39	180	-38.21	180	-37.71	179.9	-37.29	179.8	-36.94	179.7
-36.61	179.6	-36.26	179.5	-35.92	179.4	-35.6	179.3	-35.29	179.2
-34.97	179.1	-34.68	179	-34.47	178.9	-34.28	178.8	-34.1	178.7
-33.56	178.4	-33.22	178.2	-33.04	178.1	-32.53	177.8	-32.35	177.7
-32.15	177.6	-31.97	177.5	-31.4	177.2	-31.23	177.1	-30.66	176.8
-30.47	176.7	-29.71	176.3	-29.52	176.2	-29.34	176.1	-29.15	176
-28.95	175.9	-28.74	175.8	-28.54	175.7	-27.82	175.3	-27.65	175.2
-27.31	175	-27.13	174.9	-26.45	174.5	-26.29	174.4	-25.81	174.1
-25.65	174	-25.05	173.6	-24.91	173.5	-24.31	173.1	-20.89	171.76
-20.63	171.63	-13.09	167.9	17.31	167.82	19.31	169.4	24.91	169.54
32.93	170	51.21	170	52.7	169.9	53.26	169.8	53.71	169.7
54.2	169.6	54.88	169.4	55.23	169.3	55.61	169.2	56.01	169.1
60.2	169.1	60.8	169.2	61.41	169.3	62.61	169.5	63.21	169.6
63.72	169.7	64.22	169.8	64.71	169.9	65.73	170	71.17	170.02
99.21	170.1	99.62	170.2	100.03	170.3	100.85	170.5	101.26	170.6
101.65	170.7	102.02	170.8	102.44	170.9	102.84	171	103.29	171.1
103.94	171.2	104.74	171.3	105.39	171.4	106.05	171.5	106.77	171.6
107.44	171.7	108.1	171.8	108.78	171.9	109.78	172	110.4	172.1
110.79	172.2	111.12	172.3	111.41	172.4	111.74	172.5	112.09	172.6
112.39	172.7	112.67	172.8	112.99	172.9	113.42	173	114.1	173.1
114.94	173.2	115.78	173.3	116.59	173.4	117.47	173.5	118.3	173.6
119.17	173.7	120.01	173.8	120.85	173.9	121.79	174	122.9	174.1
124.01	174.2	125.13	174.3	126.17	174.4	127.26	174.5	128.23	174.6
129.26	174.7	130.25	174.8	131.23	174.9	132.43	175	133.73	175.1
134.78	175.2	135.86	175.3	137.02	175.4	138.22	175.5	139.48	175.6
140.8	175.7	142.14	175.8	143.51	175.9	145.34	176	148.42	176.1
151.15	176.2	153.66	176.3	156.15	176.4	156.42	176.4	156.78	176.41
162.15	176.5	166.1	176.6	169.49	176.7	172.84	176.8	176.16	176.9
179.24	177	179.86	177.1	180.3	177.2	180.71	177.3	181.12	177.4
181.52	177.5	181.91	177.6	182.31	177.7	182.72	177.8	183.11	177.9
184.25	178.2	184.61	178.3	184.99	178.4	185.36	178.5	185.72	178.6

186.09 178.7 186.48 178.8 186.86 178.9 187.19 179 187.51 179.1
187.8 179.2 188.09 179.3 188.37 179.4 188.66 179.5 188.96 179.6
189.26 179.7 189.55 179.8 189.85 179.9 190.13 180 190.41 180.1
190.68 180.2 190.94 180.3 191.2 180.4 191.47 180.5 191.99 180.7
192.25 180.8 192.51 180.9 192.74 181 192.96 181.1 193.17 181.2
193.37 181.3 193.58 181.4 194.3 181.7 194.53 181.8 194.76 181.9
195 182 195.22 182.1 195.66 182.3 195.87 182.4 196.08 182.5
196.71 182.8 196.93 182.9 197.13 183 197.34 183.1 197.76 183.3
197.98 183.4 198.4 183.6 198.62 183.7 198.83 183.8 199.05 183.9
199.51 184.1 199.75 184.2 199.98 184.3 200.22 184.4 200.47 184.5
200.71 184.6 200.96 184.7 201.21 184.8 201.73 185 202.23 185.2
202.49 185.3 203.01 185.5 203.53 185.7 203.78 185.8 204.02 185.9
204.25 186 204.43 186.1 204.82 186.4 204.96 186.5 205.22 186.7
205.48 186.9 205.64 187 205.82 187.1 206.22 187.3 206.62 187.5
206.98 187.7 207.16 187.8 207.32 187.9 207.47 188 207.6 188.1
207.72 188.2 207.82 188.3 207.92 188.4 208.04 188.5 208.15 188.6
208.26 188.7 208.38 188.8 208.49 188.9 208.62 189 208.74 189.1
208.9 189.2 209.1 189.3 209.32 189.4 209.53 189.5 209.73 189.6
209.89 189.7 210.07 189.8 210.39 190 210.55 190.1 210.7 190.2
210.84 190.3 210.97 190.4 211.08 190.5 211.18 190.6 211.4 190.8
211.5 190.9 211.61 191 211.71 191.1 211.81 191.2 211.91 191.3
212.01 191.4 212.12 191.5 212.22 191.6 212.32 191.7 212.43 191.8
212.53 191.9 212.63 192 212.73 192.1 212.84 192.2 212.94 192.3
213.14 192.5 213.24 192.6 213.6 192.9 213.86 193.1 214 193.2
214.13 193.3 214.27 193.4 214.42 193.5 214.56 193.6 214.71 193.7
214.85 193.8 215 193.9 215.15 194 215.43 194.2 215.58 194.3
215.72 194.4 215.87 194.5 216.02 194.6 216.16 194.7 216.31 194.8
216.47 194.9 216.64 195 216.8 195.1 216.96 195.2 217.12 195.3
217.28 195.4 217.43 195.5 217.59 195.6 217.76 195.7 217.92 195.8
218.09 195.9 218.26 196 218.44 196.1 218.61 196.2 218.79 196.3
218.98 196.4 219.16 196.5 219.56 196.7 219.78 196.8 220.02 196.9
220.27 197 220.53 197.1 220.82 197.2 221.13 197.3 221.75 197.5
222.04 197.6 222.34 197.7 222.64 197.8 222.93 197.9 223.2 198
223.49 198.1 223.79 198.2 224.09 198.3 224.32 198.4 224.54 198.5
224.78 198.6 225.05 198.7 225.63 198.9 225.92 199 226.24 199.1
226.69 199.2 227.13 199.3 227.55 199.4 227.98 199.5 228.4 199.6
228.82 199.7 229.24 199.8 229.65 199.9 230.05 200 230.46 200.1
230.84 200.2 231.23 200.3 231.99 200.5 232.38 200.6 232.76 200.7
233.14 200.8 233.52 200.9 233.91 201 234.77 201.2 235.21 201.3
235.64 201.4 236.08 201.5 236.53 201.6 236.97 201.7 237.44 201.8
237.91 201.9 238.37 202 238.8 202.1 239.24 202.2 239.65 202.3
240.04 202.4 240.41 202.5 240.8 202.6 241.18 202.7 241.58 202.8
242.34 203 243.08 203.2 243.45 203.3 244.56 203.6 244.96 203.7
245.35 203.8 245.73 203.9 246.13 204 246.53 204.1 246.93 204.2
247.34 204.3 247.75 204.4 248.59 204.6 249.01 204.7 249.42 204.8
249.84 204.9 250.26 205 250.69 205.1 251.11 205.2 251.54 205.3

251.96 205.4 252.39 205.5 252.82 205.6 253.26 205.7 253.69 205.8
254.12 205.9 254.53 206 255.49 206.3 256.11 206.5 256.43 206.6
256.74 206.7 257.05 206.8 257.69 207 258.59 207.2 259.05 207.3
259.5 207.4 259.96 207.5 260.41 207.6 260.85 207.7 261.29 207.8
261.73 207.9 262.16 208 262.57 208.1 262.97 208.2 263.37 208.3
263.77 208.4 264.57 208.6 264.97 208.7 265.37 208.8 265.77 208.9
266.16 209 266.54 209.1 266.89 209.2 267.25 209.3 267.61 209.4
267.96 209.5 268.32 209.6 268.67 209.7 269.03 209.8 269.39 209.9
269.75 210 270.1 210.1 270.45 210.2 270.81 210.3 271.3 210.44

Manning's n Values num= 3
Sta n Val Sta n Val Sta n Val
-143.58 .075 -20.63 .04 19.31 .1

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
-20.63 19.31 1131.06 1193.48 1153.77 .1 .3

CROSS SECTION

RIVER: Muddy River
REACH: Northford Rd RS: 1000

INPUT
Description: 1499 Feet Downstream of Existing Bridge
FEMA Cross Section
"BH"
Geometry based on one foot 2011 Lidar contours
Station Elevation Data num= 494
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
-377.08 184.9 -375.91 184.9 -374.35 184.8 -372.97 184.7 -371.39 184.6
-369.82 184.5 -368.24 184.4 -366.64 184.3 -365.05 184.2 -363.45 184.1
-357.34 184 -353.91 183.9 -351.21 183.8 -348.51 183.7 -345.6 183.6
-342.02 183.5 -334.78 183.3 -331.15 183.2 -327.53 183.1 -321.76 183
-320.06 182.9 -318.92 182.8 -315.16 182.7 -309.71 182.6 -296.06 182.6
-292.8 182.5 -287.05 182.4 -283.53 182.3 -282.19 182.2 -281.03 182.1
-279.27 182 -278.49 181.9 -278.05 181.8 -277.68 181.7 -277.3 181.6
-276.91 181.5 -276.56 181.4 -276.2 181.3 -275.85 181.2 -275.56 181.1
-274.66 180.8 -274.38 180.7 -274.1 180.6 -273.52 180.4 -273.22 180.3
-272.92 180.2 -272.65 180.1 -272.13 179.9 -271.86 179.8 -271.4 179.6
-271.18 179.5 -270.95 179.4 -270.73 179.3 -270.53 179.2 -270.32 179.1
-270.12 179 -269.91 178.9 -269.71 178.8 -269.52 178.7 -268.95 178.4
-268.77 178.3 -268.39 178.1 -268.21 178 -267.83 177.8 -267.62 177.7
-267.4 177.6 -266.71 177.3 -266.5 177.2 -266.06 177 -265.85 176.9
-265.63 176.8 -265.43 176.7 -265.03 176.5 -264.63 176.3 -264.4 176.2
-264.17 176.1 -263.95 176 -263.72 175.9 -263.48 175.8 -263.22 175.7

-262.97 175.6 -262.71 175.5 -262.46 175.4 -261.94 175.2 -261.68 175.1
-261.45 175 -261.24 174.9 -260.61 174.6 -260.21 174.4 -260.02 174.3
-259.82 174.2 -259.63 174.1 -259.43 174 -259.22 173.9 -258.82 173.7
-257.98 173.3 -257.35 173 -257.13 172.9 -256.92 172.8 -256.71 172.7
-256.5 172.6 -255.84 172.3 -255.62 172.2 -255.4 172.1 -255.19 172
-254.75 171.8 -254.54 171.7 -254.12 171.5 -253.92 171.4 -253.5 171.2
-253.3 171.1 -252.88 170.9 -252.68 170.8 -252.47 170.7 -252.27 170.6
-252.06 170.5 -251.86 170.4 -251.65 170.3 -251.45 170.2 -250.82 169.9
-250.6 169.8 -250.18 169.6 -249.52 169.3 -249.08 169.1 -248.64 168.9
-248.2 168.7 -247.76 168.5 -247.55 168.4 -247.33 168.3 -247.12 168.2
-246.92 168.1 -246.73 168 -246.33 167.8 -246.15 167.7 -245.98 167.6
-245.81 167.5 -245.47 167.3 -245.31 167.2 -245.09 167.1 -244.85 167
-244.35 166.8 -244.01 166.7 -243.6 166.6 -243.21 166.5 -242.66 166.4
-242.11 166.3 -241.58 166.2 -240.98 166.1 -206.2 166.1 -204.72 166.2
-203.16 166.3 -199.83 166.4 -198.47 166.5 -196.19 166.7 -195.05 166.8
-193.91 166.9 -192.21 167 -176.57 167 -174.03 166.9 -171.92 166.8
-170.01 166.7 -168.11 166.6 -165.82 166.5 -164.23 166.5 -163.14 166.5
-155.4 166.6 -148.17 166.7 -146.08 166.8 -144.67 166.9 -140.34 167
-128.82 167 -127.08 166.9 -126.15 166.8 -125.22 166.7 -124.29 166.6
-123.22 166.5 -121.85 166.4 -120.18 166.3 -119.05 166.2 -117.32 166.1
-111.99 166.1 -110.58 166.2 -109.16 166.3 -107.9 166.4 -106.79 166.5
-105.35 166.6 -104.24 166.7 -103.21 166.8 -102.1 166.9 -100.39 167
-96.36 167.1 -92.5 167.2 -89.61 167.3 -87.18 167.4 -84.78 167.5
-82.54 167.6 -80.5 167.7 -78.54 167.8 -76.58 167.9 -73.87 168
-71.82 168 -69.96 167.9 -68.03 167.8 -66 167.7 -64.57 167.6
-63.63 167.5 -62.48 167.4 -61.52 167.3 -60.73 167.2 -59.95 167.1
-59.21 167 -58.53 166.9 -57.91 166.8 -57.29 166.7 -56.66 166.6
-56.04 166.5 -54.78 166.3 -54.15 166.2 -53.53 166.1 -46.67 166.1
-46.24 166.2 -45.82 166.3 -45.4 166.4 -44.65 166.5 -43.72 166.6
-42.74 166.7 -41.77 166.8 -40.77 166.9 -39.92 167 -38.68 167
-23.88 167 -23.21 166.9 -22.69 166.8 -22.33 166.7 -21.61 166.5
-21.25 166.4 -20.89 166.3 -20.48 166.2 -20.09 166.1 -19.75 166
-19.43 165.9 -19.15 165.8 -18.88 165.7 -18.34 165.5 -18.08 165.4
-17.83 165.3 -17.56 165.2 -17.28 165.1 -17.01 165 -14.54 164.9
-12.18 164.8 -9.83 164.7 -7.48 164.6 -4.86 164.5 -1.52 164.4
-.01 164.36 2.48 164.3 5.08 164.3 6.07 164.4 6.93 164.5
7.78 164.6 8.64 164.7 9.23 164.8 9.73 164.9 10.81 165
14.42 165.1 15.52 165.2 15.78 165.22 16.61 165.3 17.7 165.4
18.79 165.5 19.88 165.6 20.98 165.7 22.1 165.8 23.27 165.9
24.21 166 24.62 166.1 24.94 166.2 25.23 166.3 25.53 166.4
25.82 166.5 26.1 166.6 26.44 166.7 26.77 166.8 27.11 166.9
27.35 167 27.58 167.1 27.82 167.2 28.05 167.3 28.27 167.4
28.47 167.5 28.68 167.6 28.9 167.7 29.13 167.8 29.3 167.9
29.45 168 29.6 168.1 29.76 168.2 29.91 168.3 30.05 168.4
30.2 168.5 30.34 168.6 30.76 168.9 31.32 169.3 31.47 169.4
31.89 169.7 32.31 170 32.91 170.4 33.05 170.5 33.2 170.6

33.35 170.7 33.5 170.8 33.65 170.9 33.95 171.1 34.1 171.2
34.25 171.3 34.4 171.4 34.7 171.6 34.85 171.7 35 171.8
35.15 171.9 35.31 172 35.47 172.1 35.63 172.2 35.8 172.3
35.96 172.4 36.13 172.5 36.29 172.6 36.46 172.7 36.62 172.8
36.78 172.9 36.94 173 37.11 173.1 37.59 173.4 37.76 173.5
38.08 173.7 38.25 173.8 38.42 173.9 38.78 174.1 38.97 174.2
39.15 174.3 39.34 174.4 39.54 174.5 39.92 174.7 40.11 174.8
40.31 174.9 40.5 175 40.9 175.2 41.1 175.3 41.52 175.5
42.04 175.7 42.88 176 43.44 176.2 43.74 176.3 44.34 176.5
44.62 176.6 45.18 176.8 45.47 176.9 45.73 177 46 177.1
46.26 177.2 46.51 177.3 46.73 177.4 47.13 177.6 47.33 177.7
47.52 177.8 47.92 178 48.12 178.1 48.33 178.2 48.54 178.3
48.76 178.4 49.22 178.6 49.44 178.7 49.67 178.8 49.91 178.9
50.17 179 50.44 179.1 50.72 179.2 51.01 179.3 51.59 179.5
51.89 179.6 52.18 179.7 52.48 179.8 52.98 179.9 53.65 180
57.74 180 59.42 179.9 60.83 179.9 64.19 180 73.34 180.1
73.64 180.2 73.91 180.3 74.1 180.4 74.28 180.5 74.79 180.8
74.96 180.9 75.13 181 75.31 181.1 75.48 181.2 75.66 181.3
75.83 181.4 76.01 181.5 76.18 181.6 76.56 181.8 76.74 181.9
77.12 182.1 77.34 182.2 77.56 182.3 78 182.5 78.23 182.6
78.71 182.8 78.97 182.9 79.29 183 79.69 183.1 80.16 183.2
80.65 183.3 81.14 183.4 81.59 183.5 82.09 183.6 82.53 183.7
82.94 183.8 83.38 183.9 83.86 184 84.39 184.1 85.02 184.2
85.65 184.3 86.91 184.5 87.53 184.6 88.1 184.7 88.63 184.8
89.65 185 90.17 185.1 90.74 185.2 91.33 185.3 91.95 185.4
93.84 185.7 94.47 185.8 95.09 185.9 95.8 186 96.66 186.1
97.49 186.2 98.47 186.3 100.35 186.5 101.09 186.6 101.8 186.7
102.47 186.8 103.13 186.9 103.74 187 104.25 187.1 104.74 187.2
105.22 187.3 105.69 187.4 106.17 187.5 106.64 187.6 107.6 187.8
108.09 187.9 108.63 188 109.59 188.1 110.61 188.2 111.6 188.3
112.58 188.4 113.6 188.5 114.63 188.6 115.65 188.7 116.64 188.8
117.63 188.9 118.82 189 120.34 189.1 122.04 189.2 123.28 189.3
124.82 189.5 125.4 189.6 126.07 189.7 126.56 189.8 127.07 189.9
128.17 190.1 128.8 190.2 129.39 190.3 129.95 190.4 130.46 190.5
130.94 190.6 131.36 190.7 131.77 190.8 132.19 190.9 132.59 191
132.99 191.1 133.39 191.2 133.78 191.3 134.17 191.4 134.91 191.6
135.29 191.7 135.66 191.8 135.77 191.83 135.78 191.83

Manning's n Values num= 3
Sta n Val Sta n Val Sta n Val
-377.08 .1 -17.01 .04 10.81 .1

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
-17.01 10.81 0 0 0 .1 .3

SUMMARY OF MANNING'S N VALUES

River: Muddy River

Reach	River Sta.	n1	n2	n3
Northford Rd	3123	.1	.035	.07
Northford Rd	3045	.1	.035	.07
Northford Rd	2859	.1	.035	.07
Northford Rd	2670	.1	.04	.07
Northford Rd	2614	.1	.04	.07
Northford Rd	2558	.1	.04	.07
Northford Rd	2531	.1	.04	.07
Northford Rd	2515.5	Bridge		
Northford Rd	2499	.075	.045	.08
Northford Rd	2475	.075	.045	.08
Northford Rd	2390	.075	.045	.08
Northford Rd	2256	.075	.04	.1
Northford Rd	2193	.075	.04	.1
Northford Rd	1000	.1	.04	.1

SUMMARY OF REACH LENGTHS

River: Muddy River

Reach	River Sta.	Left	Channel	Right
Northford Rd	3123	83.14	78.37	75.19
Northford Rd	3045	190.22	185.87	181.39
Northford Rd	2859	198.12	189.7	181.78
Northford Rd	2670	57.97	55.73	48.78
Northford Rd	2614	50.75	55.06	50.46
Northford Rd	2558	19.07	20	20.11
Northford Rd	2531	39.11	39.11	39.11
Northford Rd	2515.5	Bridge		
Northford Rd	2499	21.88	22.3	22.3
Northford Rd	2475	64.18	84.74	97.07
Northford Rd	2390	131.15	133.54	130.56
Northford Rd	2256	60.64	62.43	66.72
Northford Rd	2193	1131.06	1193.48	1153.77
Northford Rd	1000	0	0	0

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: Muddy River

Reach	River Sta.	Contr.	Expan.
Northford Rd	3123	.1	.3
Northford Rd	3045	.1	.3
Northford Rd	2859	.1	.3
Northford Rd	2670	.1	.3
Northford Rd	2614	.3	.5
Northford Rd	2558	.3	.5
Northford Rd	2531	.3	.5
Northford Rd	2515.5	Bridge	
Northford Rd	2499	.3	.5
Northford Rd	2475	.3	.5
Northford Rd	2390	.1	.3
Northford Rd	2256	.1	.3
Northford Rd	2193	.1	.3
Northford Rd	1000	.1	.3

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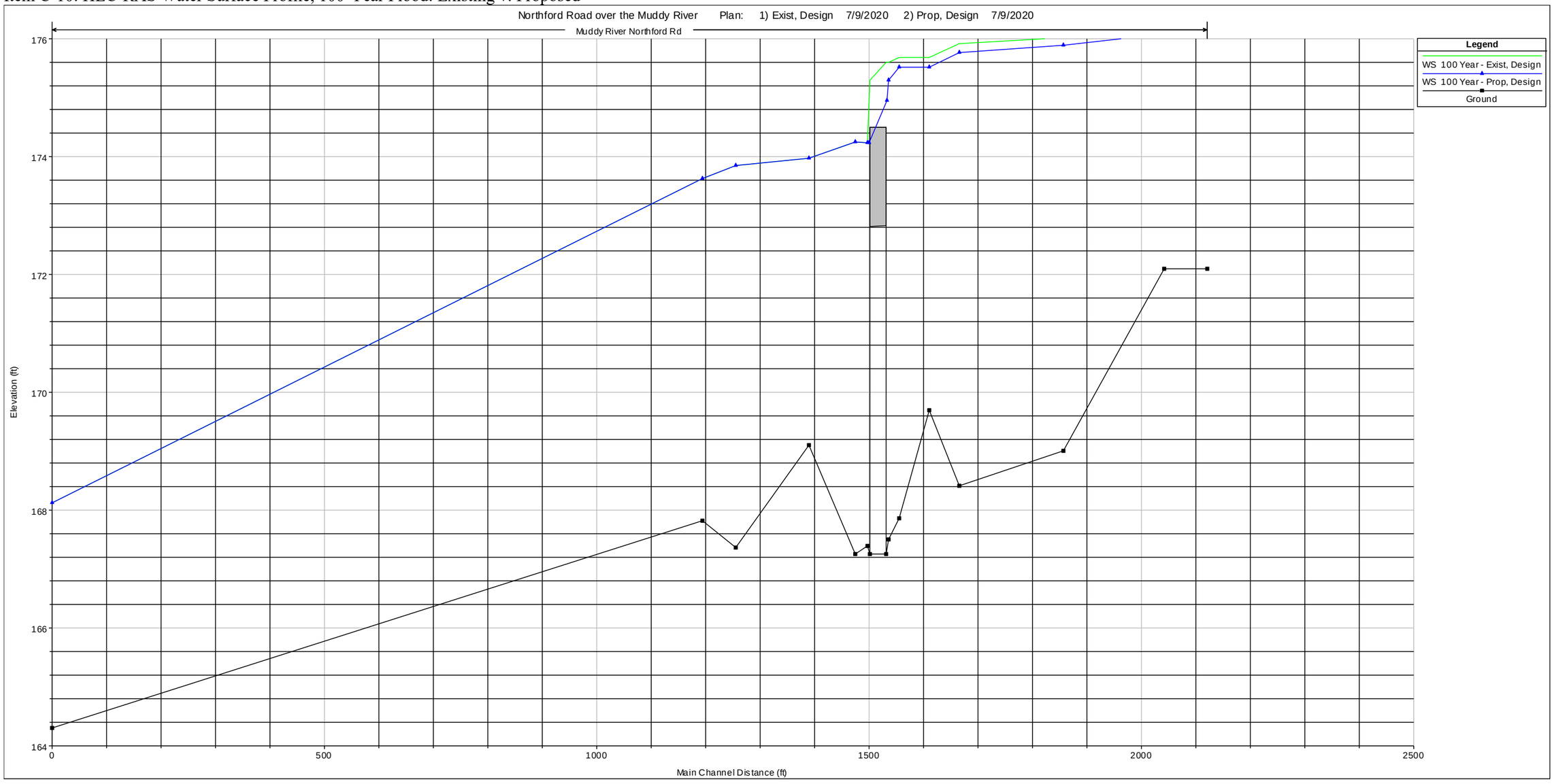
DESIGN HYDRAULIC INFORMATION

Item C-10: HEC-RAS Water Surface Profile, 100-Year Flood: Existing v. Proposed



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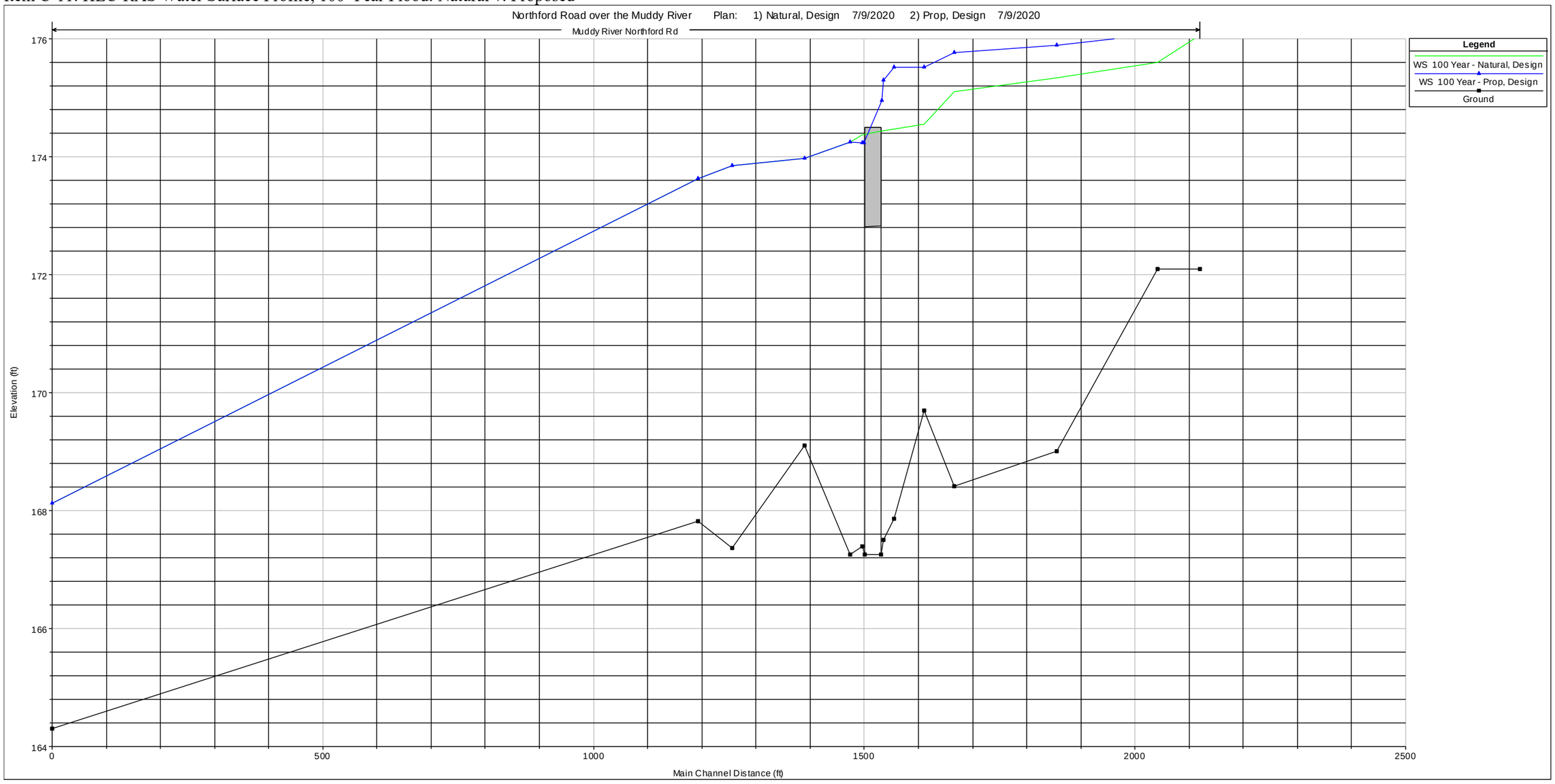
Item C-11: HEC-RAS Water Surface Profile, 100-Year Flood: Natural v. Proposed



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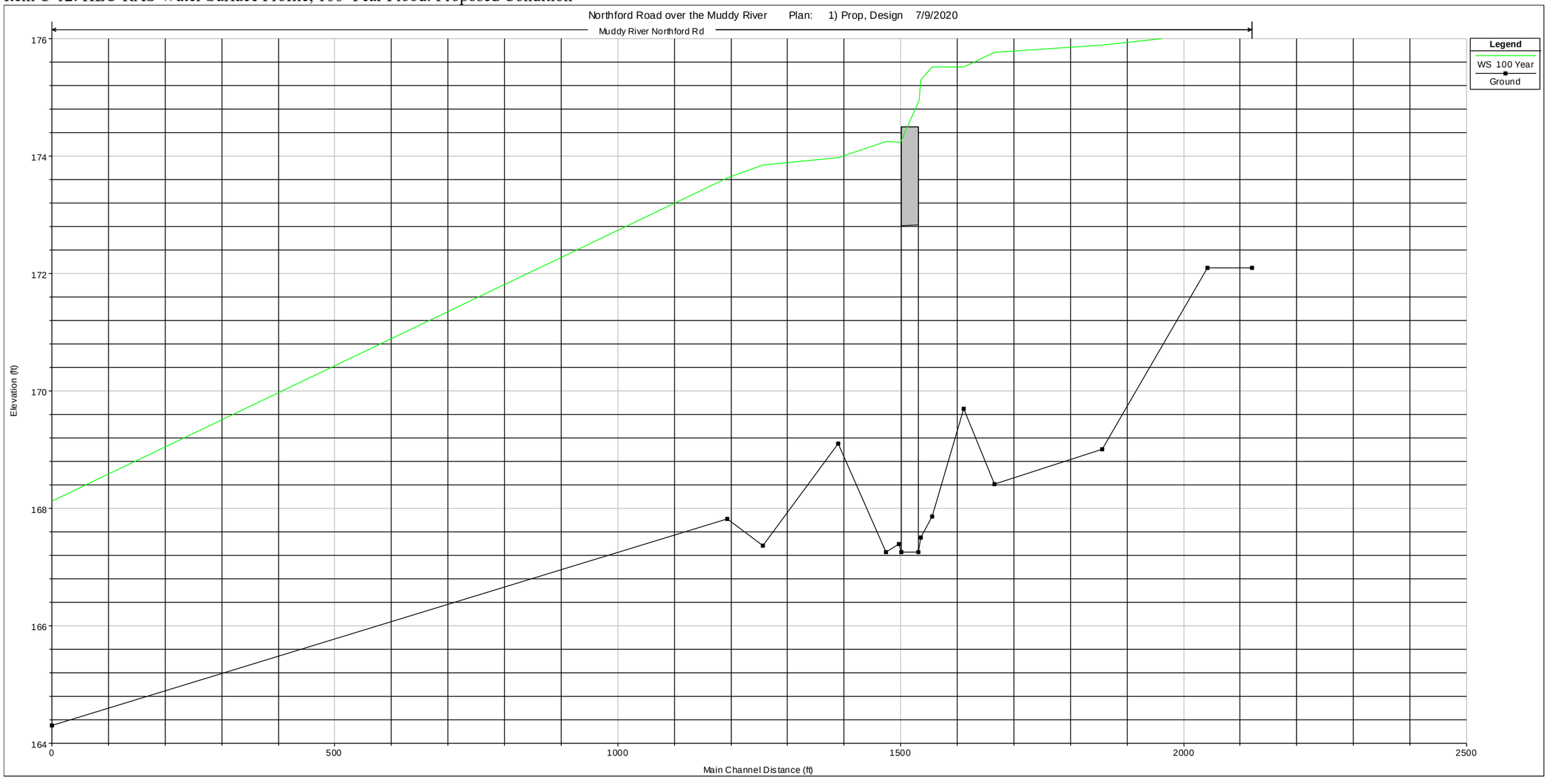
Item C-12: HEC-RAS Water Surface Profile, 100-Year Flood: Proposed Condition



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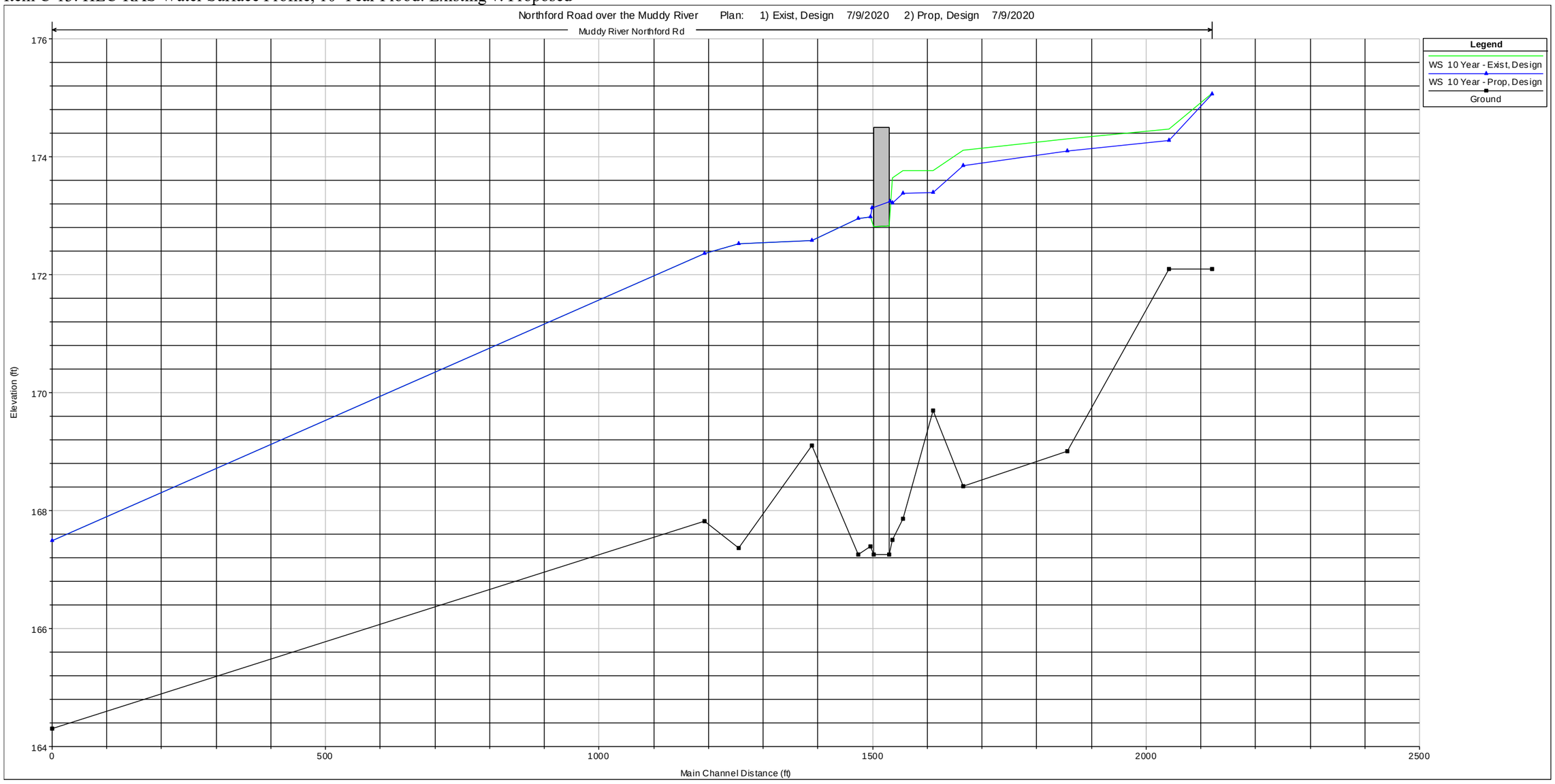
Item C-13: HEC-RAS Water Surface Profile, 10-Year Flood: Existing v. Proposed



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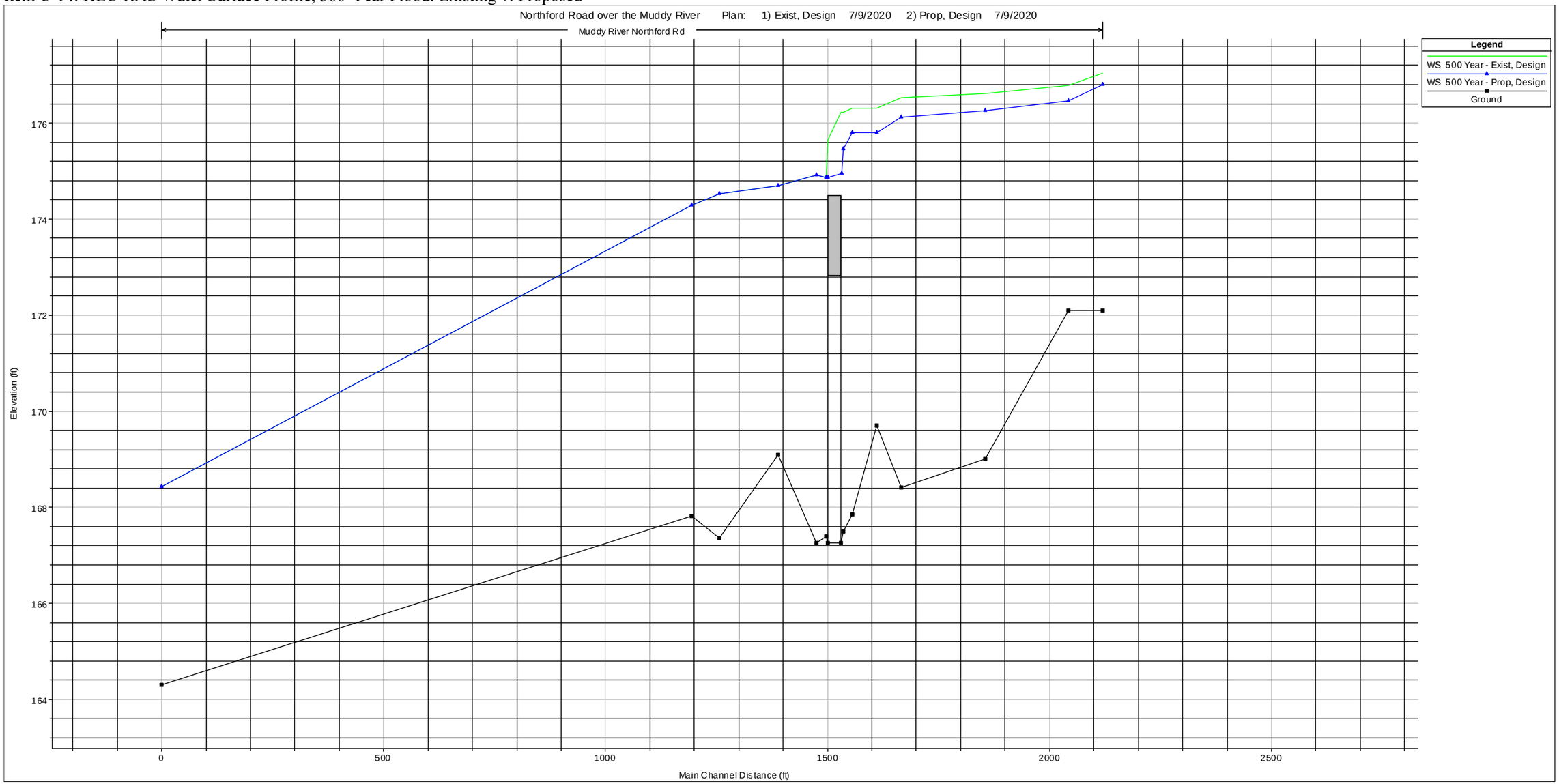
Item C-14: HEC-RAS Water Surface Profile, 500-Year Flood: Existing v. Proposed



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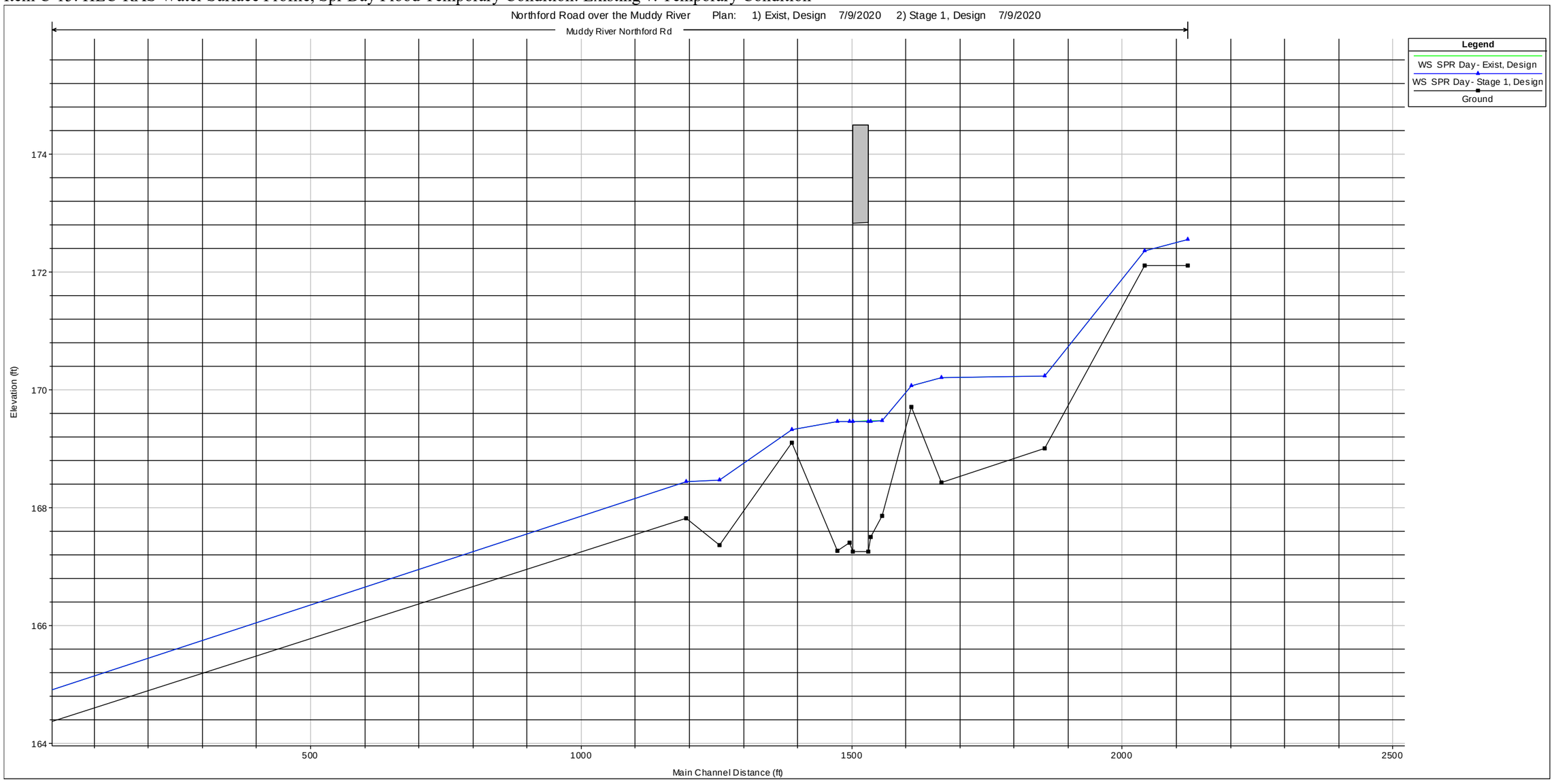
Item C-15: HEC-RAS Water Surface Profile, Spr Day Flood Temporary Condition: Existing v. Temporary Condition



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Item C-16: HEC-RAS Std. Summary Table 1, 2-Year Flood: Existing v. Proposed

HEC-RAS River: Muddy River Reach: Northford Rd Profile: 2 Year

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Northford Rd	3123 BM	2 Year	Exist, Design	402.00	172.10	174.31	172.98	174.38	0.000882	2.08	193.43	89.34	0.25
Northford Rd	3123 BM	2 Year	Prop, Design	402.00	172.10	174.31	172.98	174.38	0.000882	2.08	193.43	89.34	0.25
Northford Rd	3045 BL	2 Year	Exist, Design	402.00	172.10	173.61	173.61	174.15	0.017708	5.89	68.20	63.91	1.01
Northford Rd	3045 BL	2 Year	Prop, Design	402.00	172.10	173.61	173.61	174.15	0.017708	5.89	68.20	63.91	1.01
Northford Rd	2859	2 Year	Exist, Design	402.00	169.00	172.90	170.97	173.02	0.000988	2.74	148.91	55.02	0.28
Northford Rd	2859	2 Year	Prop, Design	402.00	169.00	172.86	170.97	172.98	0.001030	2.78	146.79	54.64	0.28
Northford Rd	2670	2 Year	Exist, Design	402.00	168.42	172.64	170.79	172.78	0.001562	3.14	158.67	81.57	0.31
Northford Rd	2670	2 Year	Prop, Design	402.00	168.42	172.59	170.79	172.73	0.001670	3.21	154.16	80.59	0.32
Northford Rd	2614 BK (Approach)	2 Year	Exist, Design	402.00	169.70	172.25	171.60	172.60	0.006700	4.79	83.86	41.41	0.59
Northford Rd	2614 BK (Approach)	2 Year	Prop, Design	402.00	169.70	172.14	171.60	172.54	0.007958	5.07	79.27	41.00	0.64
Northford Rd	2558	2 Year	Exist, Design	402.00	167.86	172.21	170.41	172.34	0.001503	2.83	142.18	49.99	0.30
Northford Rd	2558	2 Year	Prop, Design	402.00	167.86	172.09	170.41	172.23	0.001703	2.95	136.31	49.43	0.31
Northford Rd	2531	2 Year	Exist, Design	402.00	167.50	172.13	169.95	172.29	0.001797	3.25	123.73	39.43	0.32
Northford Rd	2531	2 Year	Prop, Design	402.00	167.50	172.00	169.95	172.18	0.002004	3.38	118.81	38.67	0.34
Northford Rd	2515.5 BN04832			Bridge									
Northford Rd	2499	2 Year	Exist, Design	402.00	167.40	171.84	169.88	172.03	0.002810	3.50	114.93	38.33	0.36
Northford Rd	2499	2 Year	Prop, Design	402.00	167.40	171.84	169.88	172.03	0.002810	3.50	114.93	38.33	0.36
Northford Rd	2475	2 Year	Exist, Design	402.00	167.26	171.81	169.84	171.95	0.002287	3.05	131.68	47.17	0.32
Northford Rd	2475	2 Year	Prop, Design	402.00	167.26	171.81	169.84	171.95	0.002287	3.05	131.68	47.17	0.32
Northford Rd	2390 BJ (Exit)	2 Year	Exist, Design	402.00	169.10	171.33	170.63	171.60	0.007203	4.15	96.78	53.09	0.54
Northford Rd	2390 BJ (Exit)	2 Year	Prop, Design	402.00	169.10	171.33	170.63	171.60	0.007203	4.15	96.78	53.09	0.54
Northford Rd	2256 BI	2 Year	Exist, Design	436.00	167.36	171.34	168.78	171.39	0.000433	1.72	266.85	98.44	0.17
Northford Rd	2256 BI	2 Year	Prop, Design	436.00	167.36	171.34	168.78	171.39	0.000433	1.72	266.85	98.44	0.17
Northford Rd	2193	2 Year	Exist, Design	436.00	167.82	171.22	169.68	171.33	0.001586	3.03	228.83	123.85	0.31
Northford Rd	2193	2 Year	Prop, Design	436.00	167.82	171.22	169.68	171.33	0.001586	3.03	228.83	123.85	0.31
Northford Rd	1000 BH	2 Year	Exist, Design	436.00	164.30	166.61	166.61	167.20	0.012421	6.61	109.98	140.77	0.82
Northford Rd	1000 BH	2 Year	Prop, Design	436.00	164.30	166.61	166.61	167.20	0.012421	6.61	109.98	140.77	0.82

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Item C-17: HEC-RAS Std. Summary Table 1, 10-Year Flood: Existing v. Proposed

HEC-RAS River: Muddy River Reach: Northford Rd Profile: 10 Year

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Northford Rd	3123 BM	10 Year	Exist, Design	742.00	172.10	175.08	173.42	175.20	0.001106	2.83	262.56	90.52	0.29
Northford Rd	3123 BM	10 Year	Prop, Design	742.00	172.10	175.06	173.42	175.18	0.001133	2.85	260.62	90.48	0.30
Northford Rd	3045 BL	10 Year	Exist, Design	742.00	172.10	174.47	174.18	174.98	0.008667	5.73	133.57	82.42	0.76
Northford Rd	3045 BL	10 Year	Prop, Design	742.00	172.10	174.28	174.18	174.92	0.012450	6.45	117.93	80.20	0.90
Northford Rd	2859	10 Year	Exist, Design	742.00	169.00	174.30	171.74	174.48	0.000959	3.39	236.00	70.43	0.29
Northford Rd	2859	10 Year	Prop, Design	742.00	169.00	174.09	171.74	174.29	0.001126	3.57	221.73	67.78	0.31
Northford Rd	2670	10 Year	Exist, Design	742.00	168.42	174.11	171.85	174.27	0.001223	3.55	298.00	110.18	0.29
Northford Rd	2670	10 Year	Prop, Design	742.00	168.42	173.85	171.85	174.04	0.001531	3.83	270.46	104.67	0.32
Northford Rd	2614 BK (Approach)	10 Year	Exist, Design	742.00	169.70	173.77	172.37	174.14	0.003689	4.90	154.40	52.06	0.47
Northford Rd	2614 BK (Approach)	10 Year	Prop, Design	742.00	169.70	173.40	172.37	173.87	0.005423	5.53	135.53	49.59	0.56
Northford Rd	2558	10 Year	Exist, Design	742.00	167.86	173.76	171.15	173.93	0.001245	3.31	227.25	62.65	0.29
Northford Rd	2558	10 Year	Prop, Design	742.00	167.86	173.37	171.15	173.58	0.001725	3.65	204.04	58.05	0.33
Northford Rd	2531	10 Year	Exist, Design	742.00	167.50	173.64	170.98	173.88	0.001766	3.94	188.27	60.36	0.34
Northford Rd	2531	10 Year	Prop, Design	742.00	167.50	173.22	170.98	173.51	0.002498	4.37	169.67	52.50	0.39
Northford Rd	2515.5 BN04832			Bridge									
Northford Rd	2499	10 Year	Exist, Design	742.00	167.40	172.98	170.90	173.31	0.003542	4.61	161.06	46.90	0.42
Northford Rd	2499	10 Year	Prop, Design	742.00	167.40	172.98	170.90	173.31	0.003542	4.61	161.06	46.90	0.42
Northford Rd	2475	10 Year	Exist, Design	742.00	167.26	172.95	170.87	173.19	0.002736	3.93	188.85	52.77	0.37
Northford Rd	2475	10 Year	Prop, Design	742.00	167.26	172.95	170.87	173.19	0.002736	3.93	188.85	52.77	0.37
Northford Rd	2390 BJ (Exit)	10 Year	Exist, Design	742.00	169.10	172.58	171.32	172.87	0.005013	4.34	171.12	66.93	0.48
Northford Rd	2390 BJ (Exit)	10 Year	Prop, Design	742.00	169.10	172.58	171.32	172.87	0.005013	4.34	171.12	66.93	0.48
Northford Rd	2256 BI	10 Year	Exist, Design	918.00	167.36	172.53	169.52	172.63	0.000692	2.62	393.88	116.34	0.22
Northford Rd	2256 BI	10 Year	Prop, Design	918.00	167.36	172.53	169.52	172.63	0.000692	2.62	393.88	116.34	0.22
Northford Rd	2193	10 Year	Exist, Design	918.00	167.82	172.36	170.80	172.56	0.001970	4.13	375.92	133.69	0.36
Northford Rd	2193	10 Year	Prop, Design	918.00	167.82	172.36	170.80	172.56	0.001970	4.13	375.92	133.69	0.36
Northford Rd	1000 BH	10 Year	Exist, Design	918.00	164.30	167.49	167.49	168.08	0.009897	7.51	293.35	252.86	0.78
Northford Rd	1000 BH	10 Year	Prop, Design	918.00	164.30	167.49	167.49	168.08	0.009897	7.51	293.35	252.86	0.78

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Item C-18: HEC-RAS Std. Summary Table 1, 50-Year Flood: Existing v. Proposed

HEC-RAS River: Muddy River Reach: Northford Rd Profile: 50 Year

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Northford Rd	3123 BM	50 Year	Exist, Design	1067.00	172.10	176.15	173.77	176.28	0.000820	2.97	360.06	92.36	0.26
Northford Rd	3123 BM	50 Year	Prop, Design	1067.00	172.10	175.79	173.77	175.95	0.001122	3.27	326.82	91.59	0.30
Northford Rd	3045 BL	50 Year	Exist, Design	1067.00	172.10	175.87	174.60	176.17	0.002428	4.40	261.78	100.66	0.44
Northford Rd	3045 BL	50 Year	Prop, Design	1067.00	172.10	175.31	174.60	175.76	0.004825	5.43	207.54	93.78	0.60
Northford Rd	2859	50 Year	Exist, Design	1067.00	169.00	175.72	172.32	175.90	0.000750	3.56	352.09	101.72	0.27
Northford Rd	2859	50 Year	Prop, Design	1067.00	169.00	175.07	172.32	175.32	0.001144	4.07	293.98	81.22	0.32
Northford Rd	2670	50 Year	Exist, Design	1067.00	168.42	175.60	172.50	175.74	0.000804	3.46	508.21	163.00	0.24
Northford Rd	2670	50 Year	Prop, Design	1067.00	168.42	174.84	172.50	175.07	0.001472	4.29	388.72	148.61	0.32
Northford Rd	2614 BK (Approach)	50 Year	Exist, Design	1067.00	169.70	175.39	173.00	175.67	0.001741	4.37	316.09	129.30	0.35
Northford Rd	2614 BK (Approach)	50 Year	Prop, Design	1067.00	169.70	174.37	173.00	174.91	0.004325	5.91	196.81	93.63	0.53
Northford Rd	2558	50 Year	Exist, Design	1067.00	167.86	175.40	171.74	175.55	0.000751	3.20	410.80	129.77	0.23
Northford Rd	2558	50 Year	Prop, Design	1067.00	167.86	174.38	171.74	174.64	0.001605	4.12	271.16	119.79	0.33
Northford Rd	2531	50 Year	Exist, Design	1067.00	167.50	175.23	171.76	175.50	0.001267	4.13	258.62	128.95	0.30
Northford Rd	2531	50 Year	Prop, Design	1067.00	167.50	174.16	171.76	174.56	0.002479	5.05	211.47	117.54	0.41
Northford Rd	2515.5 BN04832			Bridge									
Northford Rd	2499	50 Year	Exist, Design	1067.00	167.40	173.88	171.70	174.32	0.003699	5.32	200.74	106.97	0.44
Northford Rd	2499	50 Year	Prop, Design	1067.00	167.40	173.88	171.70	174.32	0.003699	5.32	200.74	106.97	0.44
Northford Rd	2475	50 Year	Exist, Design	1067.00	167.26	173.88	171.49	174.18	0.003109	4.41	242.01	108.69	0.40
Northford Rd	2475	50 Year	Prop, Design	1067.00	167.26	173.88	171.49	174.18	0.003109	4.41	242.01	108.69	0.40
Northford Rd	2390 BJ (Exit)	50 Year	Exist, Design	1067.00	169.10	173.58	171.87	173.87	0.004125	4.34	245.96	83.04	0.44
Northford Rd	2390 BJ (Exit)	50 Year	Prop, Design	1067.00	169.10	173.58	171.87	173.87	0.004125	4.34	245.96	83.04	0.44
Northford Rd	2256 BI	50 Year	Exist, Design	1410.00	167.36	173.48	170.14	173.64	0.000823	3.25	507.31	120.99	0.25
Northford Rd	2256 BI	50 Year	Prop, Design	1410.00	167.36	173.48	170.14	173.64	0.000823	3.25	507.31	120.99	0.25
Northford Rd	2193	50 Year	Exist, Design	1410.00	167.82	173.29	171.38	173.55	0.002087	4.87	503.12	140.26	0.38
Northford Rd	2193	50 Year	Prop, Design	1410.00	167.82	173.29	171.38	173.55	0.002087	4.87	503.12	140.26	0.38
Northford Rd	1000 BH	50 Year	Exist, Design	1410.00	164.30	167.90	167.90	168.65	0.011757	8.93	398.82	269.11	0.87
Northford Rd	1000 BH	50 Year	Prop, Design	1410.00	164.30	167.90	167.90	168.65	0.011757	8.93	398.82	269.11	0.87

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Item C-19: HEC-RAS Std. Summary Table 1, 100-Year Flood: Existing v. Proposed

HEC-RAS River: Muddy River Reach: Northford Rd Profile: 100 Year

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Northford Rd	3123 BM	100 Year	Exist, Design	1216.00	172.10	176.46	173.93	176.61	0.000831	3.14	388.95	92.98	0.27
Northford Rd	3123 BM	100 Year	Prop, Design	1216.00	172.10	176.38	173.93	176.54	0.000886	3.20	381.34	92.82	0.28
Northford Rd	3045 BL	100 Year	Exist, Design	1216.00	172.10	176.19	174.78	176.50	0.002256	4.53	293.88	103.44	0.43
Northford Rd	3045 BL	100 Year	Prop, Design	1216.00	172.10	176.08	174.78	176.41	0.002524	4.69	282.69	102.76	0.46
Northford Rd	2859	100 Year	Exist, Design	1216.00	169.00	176.02	172.56	176.23	0.000798	3.81	383.60	105.14	0.28
Northford Rd	2859	100 Year	Prop, Design	1216.00	169.00	175.90	172.56	176.12	0.000864	3.91	370.67	103.75	0.29
Northford Rd	2670	100 Year	Exist, Design	1216.00	168.42	175.91	172.74	176.06	0.000831	3.64	558.89	166.56	0.25
Northford Rd	2670	100 Year	Prop, Design	1216.00	168.42	175.77	172.74	175.94	0.000920	3.77	535.83	164.95	0.26
Northford Rd	2614 BK (Approach)	100 Year	Exist, Design	1216.00	169.70	175.69	173.26	175.98	0.001770	4.58	354.81	132.74	0.35
Northford Rd	2614 BK (Approach)	100 Year	Prop, Design	1216.00	169.70	175.52	173.26	175.85	0.002035	4.81	332.45	130.77	0.38
Northford Rd	2558	100 Year	Exist, Design	1216.00	167.86	175.69	171.99	175.86	0.000799	3.42	449.20	131.48	0.24
Northford Rd	2558	100 Year	Prop, Design	1216.00	167.86	175.52	171.99	175.70	0.000895	3.55	427.13	130.49	0.26
Northford Rd	2531	100 Year	Exist, Design	1216.00	167.50	175.60	172.07	175.83	0.001088	3.95	415.12	131.17	0.28
Northford Rd	2531	100 Year	Prop, Design	1216.00	167.50	175.30	172.07	175.63	0.001580	4.64	261.80	129.39	0.34
Northford Rd	2515.5 BN04832			Bridge									
Northford Rd	2499	100 Year	Exist, Design	1216.00	167.40	174.24	172.03	174.73	0.003735	5.62	216.49	252.48	0.45
Northford Rd	2499	100 Year	Prop, Design	1216.00	167.40	174.24	172.03	174.73	0.003735	5.62	216.49	252.48	0.45
Northford Rd	2475	100 Year	Exist, Design	1216.00	167.26	174.25	171.75	174.57	0.003117	4.56	268.95	252.81	0.40
Northford Rd	2475	100 Year	Prop, Design	1216.00	167.26	174.25	171.75	174.57	0.003117	4.56	268.95	252.81	0.40
Northford Rd	2390 BJ (Exit)	100 Year	Exist, Design	1216.00	169.10	173.97	172.10	174.26	0.003859	4.35	279.77	89.59	0.43
Northford Rd	2390 BJ (Exit)	100 Year	Prop, Design	1216.00	169.10	173.97	172.10	174.26	0.003859	4.35	279.77	89.59	0.43
Northford Rd	2256 BI	100 Year	Exist, Design	1650.00	167.36	173.85	170.40	174.03	0.000894	3.54	551.78	122.46	0.26
Northford Rd	2256 BI	100 Year	Prop, Design	1650.00	167.36	173.85	170.40	174.03	0.000894	3.54	551.78	122.46	0.26
Northford Rd	2193	100 Year	Exist, Design	1650.00	167.82	173.63	171.63	173.94	0.002216	5.24	552.45	143.70	0.40
Northford Rd	2193	100 Year	Prop, Design	1650.00	167.82	173.63	171.63	173.94	0.002216	5.24	552.45	143.70	0.40
Northford Rd	1000 BH	100 Year	Exist, Design	1650.00	164.30	168.12	168.12	168.87	0.011437	9.20	460.47	276.60	0.86
Northford Rd	1000 BH	100 Year	Prop, Design	1650.00	164.30	168.12	168.12	168.87	0.011437	9.20	460.47	276.60	0.86

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Item C-20: HEC-RAS Std. Summary Table 1, 500-Year Flood: Existing v. Proposed

HEC-RAS River: Muddy River Reach: Northford Rd Profile: 500 Year

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Northford Rd	3123 BM	500 Year	Exist, Design	1488.00	172.10	177.04	174.19	177.22	0.000817	3.38	443.76	94.24	0.27
Northford Rd	3123 BM	500 Year	Prop, Design	1488.00	172.10	176.80	174.19	176.99	0.000971	3.56	420.39	93.69	0.29
Northford Rd	3045 BL	500 Year	Exist, Design	1488.00	172.10	176.79	175.06	177.11	0.001918	4.66	357.26	107.05	0.41
Northford Rd	3045 BL	500 Year	Prop, Design	1488.00	172.10	176.47	175.06	176.86	0.002565	5.09	323.19	105.16	0.47
Northford Rd	2859	500 Year	Exist, Design	1488.00	169.00	176.62	172.98	176.87	0.000829	4.14	448.47	111.84	0.29
Northford Rd	2859	500 Year	Prop, Design	1488.00	169.00	176.25	172.98	176.54	0.001034	4.45	408.06	107.71	0.32
Northford Rd	2670	500 Year	Exist, Design	1488.00	168.42	176.52	173.13	176.68	0.000817	3.83	663.41	173.67	0.25
Northford Rd	2670	500 Year	Prop, Design	1488.00	168.42	176.11	173.13	176.31	0.001078	4.22	592.92	168.92	0.29
Northford Rd	2614 BK (Approach)	500 Year	Exist, Design	1488.00	169.70	176.31	173.70	176.61	0.001648	4.76	438.51	139.05	0.35
Northford Rd	2614 BK (Approach)	500 Year	Prop, Design	1488.00	169.70	175.80	173.70	176.21	0.002431	5.44	369.12	133.77	0.41
Northford Rd	2558	500 Year	Exist, Design	1488.00	167.86	176.30	172.40	176.49	0.000812	3.67	531.00	136.12	0.25
Northford Rd	2558	500 Year	Prop, Design	1488.00	167.86	175.80	172.40	176.03	0.001115	4.08	463.26	132.12	0.29
Northford Rd	2531	500 Year	Exist, Design	1488.00	167.50	176.22	172.59	176.46	0.001091	4.21	496.53	135.56	0.29
Northford Rd	2531	500 Year	Prop, Design	1488.00	167.50	175.46	172.59	175.93	0.002170	5.54	268.69	130.32	0.40
Northford Rd	2515.5 BN04832			Bridge									
Northford Rd	2499	500 Year	Exist, Design	1488.00	167.40	174.87	172.50	175.44	0.003752	6.10	244.04	278.58	0.46
Northford Rd	2499	500 Year	Prop, Design	1488.00	167.40	174.87	172.50	175.44	0.003752	6.10	244.04	278.58	0.46
Northford Rd	2475	500 Year	Exist, Design	1488.00	167.26	174.91	172.19	175.26	0.002780	4.77	323.18	280.24	0.39
Northford Rd	2475	500 Year	Prop, Design	1488.00	167.26	174.91	172.19	175.26	0.002780	4.77	323.18	280.24	0.39
Northford Rd	2390 BJ (Exit)	500 Year	Exist, Design	1488.00	169.10	174.69	172.48	174.98	0.003124	4.28	347.68	100.66	0.40
Northford Rd	2390 BJ (Exit)	500 Year	Prop, Design	1488.00	169.10	174.69	172.48	174.98	0.003124	4.28	347.68	100.66	0.40
Northford Rd	2256 BI	500 Year	Exist, Design	2120.00	167.36	174.53	170.91	174.76	0.000995	4.02	635.95	125.39	0.28
Northford Rd	2256 BI	500 Year	Prop, Design	2120.00	167.36	174.53	170.91	174.76	0.000995	4.02	635.95	125.39	0.28
Northford Rd	2193	500 Year	Exist, Design	2120.00	167.82	174.29	172.06	174.66	0.002374	5.86	648.60	151.10	0.42
Northford Rd	2193	500 Year	Prop, Design	2120.00	167.82	174.29	172.06	174.66	0.002374	5.86	648.60	151.10	0.42
Northford Rd	1000 BH	500 Year	Exist, Design	2120.00	164.30	168.43	168.43	169.26	0.012112	10.01	546.19	277.71	0.90
Northford Rd	1000 BH	500 Year	Prop, Design	2120.00	164.30	168.43	168.43	169.26	0.012112	10.01	546.19	277.71	0.90

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Item C-21: HEC-RAS Std. Summary Table 1, 100-Year Flood: Natural v Proposed

HEC-RAS River: Muddy River Reach: Northford Rd Profile: 100 Year

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Northford Rd	3123 BM	100 Year	Natural, Design	1216.00	172.10	176.06	173.93	176.25	0.001142	3.46	352.41	92.18	0.31
Northford Rd	3123 BM	100 Year	Prop, Design	1216.00	172.10	176.38	173.93	176.54	0.000886	3.20	381.34	92.82	0.28
Northford Rd	3045 BL	100 Year	Natural, Design	1216.00	172.10	175.60	174.78	176.07	0.004321	5.52	235.11	97.39	0.58
Northford Rd	3045 BL	100 Year	Prop, Design	1216.00	172.10	176.08	174.78	176.41	0.002524	4.69	282.69	102.76	0.46
Northford Rd	2859	100 Year	Natural, Design	1216.00	169.00	175.33	172.56	175.62	0.001243	4.38	316.16	85.94	0.34
Northford Rd	2859	100 Year	Prop, Design	1216.00	169.00	175.90	172.56	176.12	0.000864	3.91	370.67	103.75	0.29
Northford Rd	2670	100 Year	Natural, Design	1216.00	168.42	175.10	172.74	175.35	0.001543	4.53	428.23	153.80	0.33
Northford Rd	2670	100 Year	Prop, Design	1216.00	168.42	175.77	172.74	175.94	0.000920	3.77	535.83	164.95	0.26
Northford Rd	2614 BK (Approach)	100 Year	Natural, Design	1216.00	169.70	174.56	173.26	175.18	0.004756	6.39	214.72	104.06	0.55
Northford Rd	2614 BK (Approach)	100 Year	Prop, Design	1216.00	169.70	175.52	173.26	175.85	0.002035	4.81	332.45	130.77	0.38
Northford Rd	2558	100 Year	Natural, Design	1216.00	167.86	174.47	172.41	174.93	0.002906	5.51	259.31	121.09	0.45
Northford Rd	2558	100 Year	Prop, Design	1216.00	167.86	175.52	171.99	175.70	0.000895	3.55	427.13	130.49	0.26
Northford Rd	2531	100 Year	Natural, Design	1216.00	167.50	174.44	172.06	174.86	0.002577	5.28	267.22	120.75	0.42
Northford Rd	2531	100 Year	Prop, Design	1216.00	167.50	175.30	172.07	175.63	0.001580	4.64	261.80	129.39	0.34
Northford Rd	2499	100 Year	Natural, Design	1216.00	167.40	174.37	172.01	174.72	0.003753	4.80	324.10	258.36	0.43
Northford Rd	2499	100 Year	Prop, Design	1216.00	167.40	174.24	172.03	174.73	0.003735	5.62	216.49	252.48	0.45
Northford Rd	2475	100 Year	Natural, Design	1216.00	167.26	174.25	171.90	174.62	0.004071	4.97	296.45	252.90	0.45
Northford Rd	2475	100 Year	Prop, Design	1216.00	167.26	174.25	171.75	174.57	0.003117	4.56	268.95	252.81	0.40
Northford Rd	2390 BJ (Exit)	100 Year	Natural, Design	1216.00	169.10	173.97	172.10	174.26	0.003859	4.35	279.77	89.59	0.43
Northford Rd	2390 BJ (Exit)	100 Year	Prop, Design	1216.00	169.10	173.97	172.10	174.26	0.003859	4.35	279.77	89.59	0.43
Northford Rd	2256 BI	100 Year	Natural, Design	1650.00	167.36	173.85	170.40	174.03	0.000894	3.54	551.78	122.46	0.26
Northford Rd	2256 BI	100 Year	Prop, Design	1650.00	167.36	173.85	170.40	174.03	0.000894	3.54	551.78	122.46	0.26
Northford Rd	2193	100 Year	Natural, Design	1650.00	167.82	173.63	171.63	173.94	0.002216	5.24	552.45	143.70	0.40
Northford Rd	2193	100 Year	Prop, Design	1650.00	167.82	173.63	171.63	173.94	0.002216	5.24	552.45	143.70	0.40
Northford Rd	1000 BH	100 Year	Natural, Design	1650.00	164.30	168.12	168.12	168.87	0.011437	9.20	460.47	276.60	0.86
Northford Rd	1000 BH	100 Year	Prop, Design	1650.00	164.30	168.12	168.12	168.87	0.011437	9.20	460.47	276.60	0.86

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Item C-22: HEC-RAS Std. Summary Table 1, Spring Day Flood, Existing v. Temporary

HEC-RAS River: Muddy River Reach: Northford Rd Profile: SPR Day

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Northford Rd	3123 BM	SPR Day	Exist, Design	16.00	172.10	172.55	172.20	172.55	0.000286	0.42	38.38	86.43	0.11
Northford Rd	3123 BM	SPR Day	Stage 1, Design	16.00	172.10	172.55	172.20	172.55	0.000286	0.42	38.38	86.43	0.11
Northford Rd	3045 BL	SPR Day	Exist, Design	16.00	172.10	172.35	172.35	172.46	0.030336	2.62	6.11	28.99	1.01
Northford Rd	3045 BL	SPR Day	Stage 1, Design	16.00	172.10	172.35	172.35	172.46	0.030336	2.62	6.11	28.99	1.01
Northford Rd	2859	SPR Day	Exist, Design	16.00	169.00	170.23	169.52	170.23	0.000197	0.53	30.25	35.82	0.10
Northford Rd	2859	SPR Day	Stage 1, Design	16.00	169.00	170.23	169.52	170.23	0.000197	0.53	30.25	35.82	0.10
Northford Rd	2670	SPR Day	Exist, Design	16.00	168.42	170.20	168.78	170.21	0.000087	0.43	37.04	25.66	0.06
Northford Rd	2670	SPR Day	Stage 1, Design	16.00	168.42	170.20	168.78	170.21	0.000087	0.43	37.04	25.66	0.06
Northford Rd	2614 BK (Approach)	SPR Day	Exist, Design	16.00	169.70	170.07	170.07	170.18	0.038149	2.70	5.93	26.14	1.00
Northford Rd	2614 BK (Approach)	SPR Day	Stage 1, Design	16.00	169.70	170.07	170.07	170.18	0.038149	2.70	5.93	26.14	1.00
Northford Rd	2558	SPR Day	Exist, Design	16.00	167.86	169.47	168.28	169.47	0.000178	0.55	29.02	24.21	0.09
Northford Rd	2558	SPR Day	Stage 1, Design	16.00	167.86	169.47	168.36	169.47	0.000220	0.58	27.40	24.75	0.10
Northford Rd	2531	SPR Day	Exist, Design	16.00	167.50	169.46	168.07	169.47	0.000075	0.41	38.73	25.45	0.06
Northford Rd	2531	SPR Day	Stage 1, Design	16.00	167.50	169.46	168.08	169.47	0.000159	0.59	27.00	16.00	0.08
Northford Rd	2515.5 BN04832			Bridge									
Northford Rd	2499	SPR Day	Exist, Design	16.00	167.40	169.46	167.88	169.46	0.000082	0.39	40.62	25.36	0.05
Northford Rd	2499	SPR Day	Stage 1, Design	16.00	167.40	169.46	167.89	169.46	0.000148	0.54	29.78	16.00	0.07
Northford Rd	2475	SPR Day	Exist, Design	16.00	167.26	169.46	167.73	169.46	0.000072	0.39	41.21	24.36	0.05
Northford Rd	2475	SPR Day	Stage 1, Design	16.00	167.26	169.46	167.73	169.46	0.000063	0.36	44.10	26.03	0.05
Northford Rd	2390 BJ (Exit)	SPR Day	Exist, Design	16.00	169.10	169.32	169.32	169.41	0.051716	2.46	6.50	34.61	1.00
Northford Rd	2390 BJ (Exit)	SPR Day	Stage 1, Design	16.00	169.10	169.32	169.32	169.41	0.051716	2.46	6.50	34.61	1.00
Northford Rd	2256 BI	SPR Day	Exist, Design	16.00	167.36	168.46	167.73	168.46	0.000089	0.31	51.68	61.99	0.06
Northford Rd	2256 BI	SPR Day	Stage 1, Design	16.00	167.36	168.46	167.73	168.46	0.000089	0.31	51.68	61.99	0.06
Northford Rd	2193	SPR Day	Exist, Design	16.00	167.82	168.44	168.06	168.45	0.001256	0.89	18.04	32.26	0.21
Northford Rd	2193	SPR Day	Stage 1, Design	16.00	167.82	168.44	168.06	168.45	0.001256	0.89	18.04	32.26	0.21
Northford Rd	1000 BH	SPR Day	Exist, Design	16.00	164.30	164.84	164.75	164.91	0.015001	2.16	7.40	22.56	0.67
Northford Rd	1000 BH	SPR Day	Stage 1, Design	16.00	164.30	164.84	164.75	164.91	0.015001	2.16	7.40	22.56	0.67

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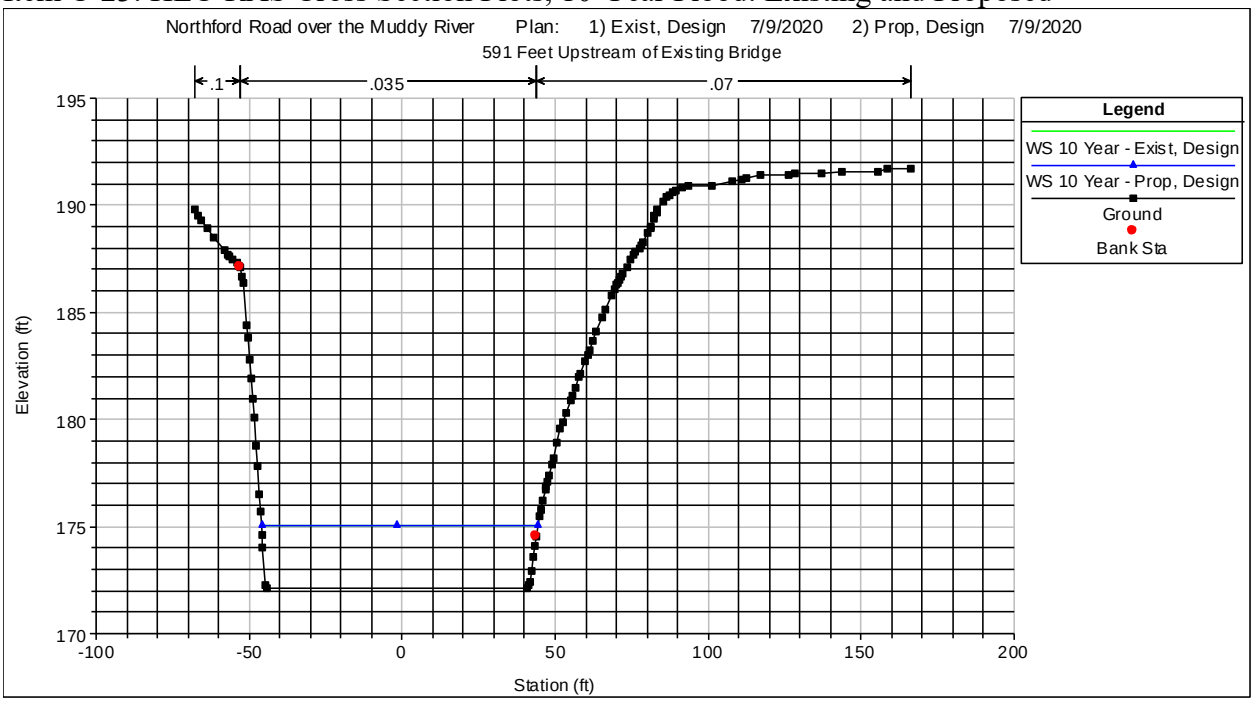
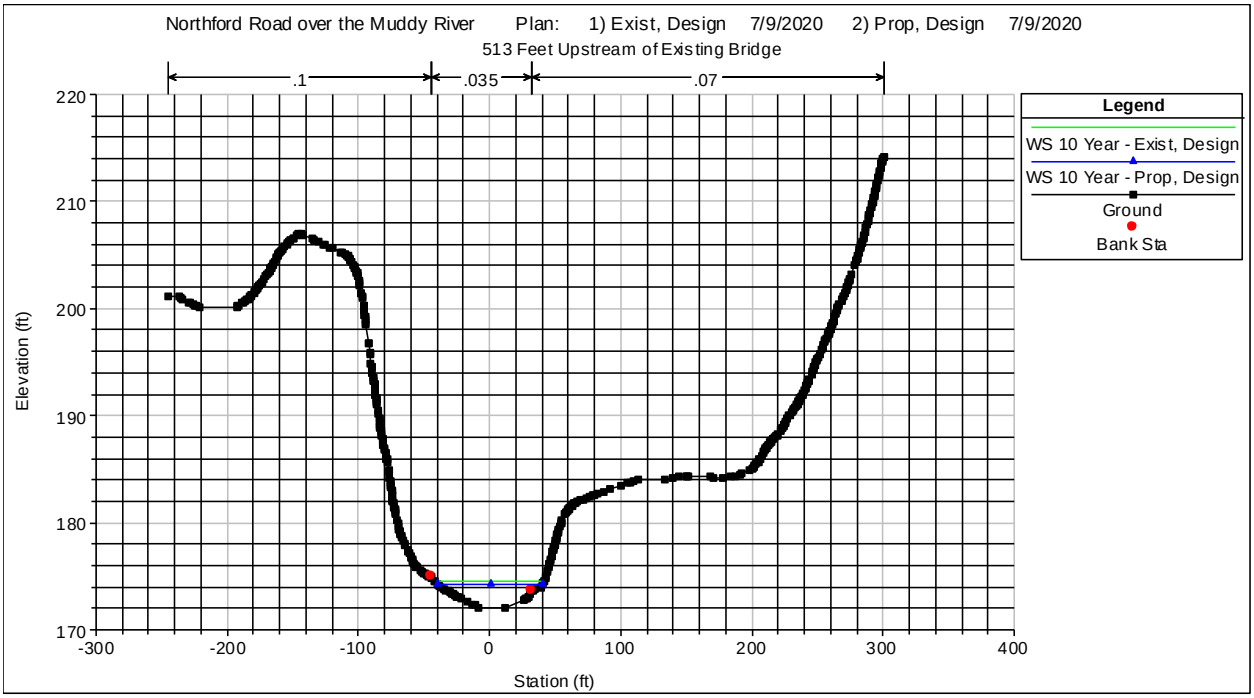
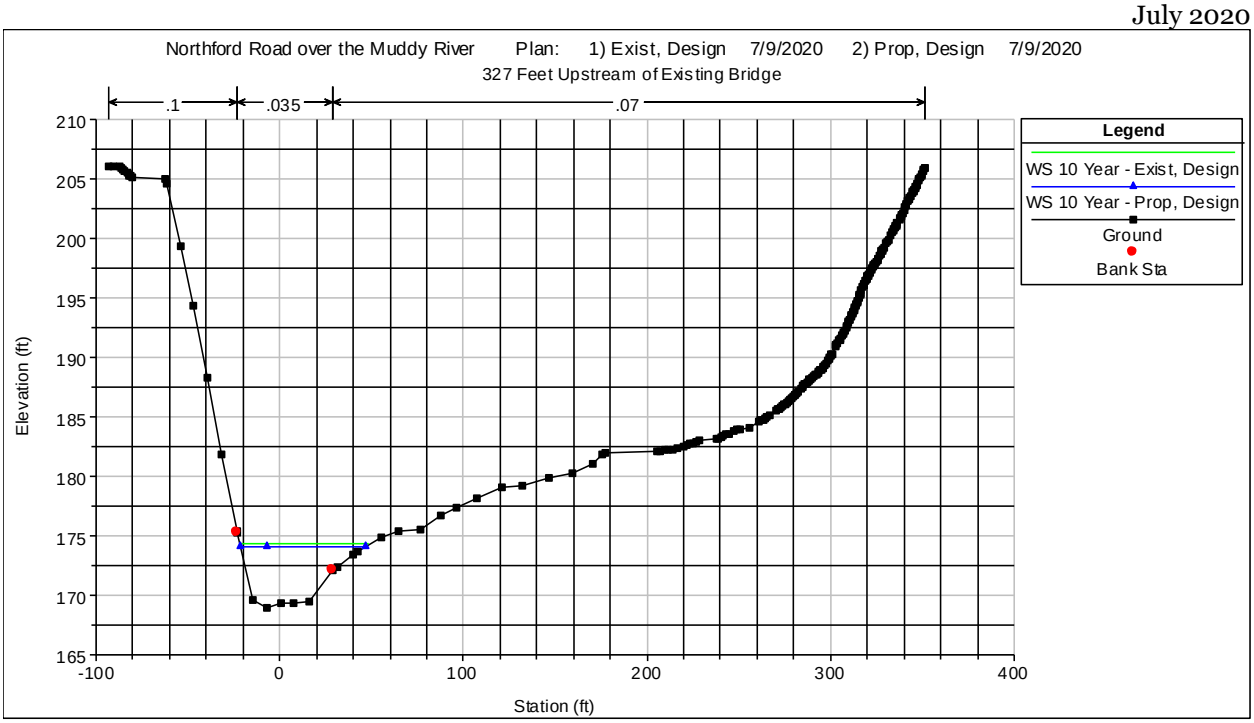
Item C-23: HEC-RAS Cross Section Plots, 10-Year Flood: Existing and Proposed



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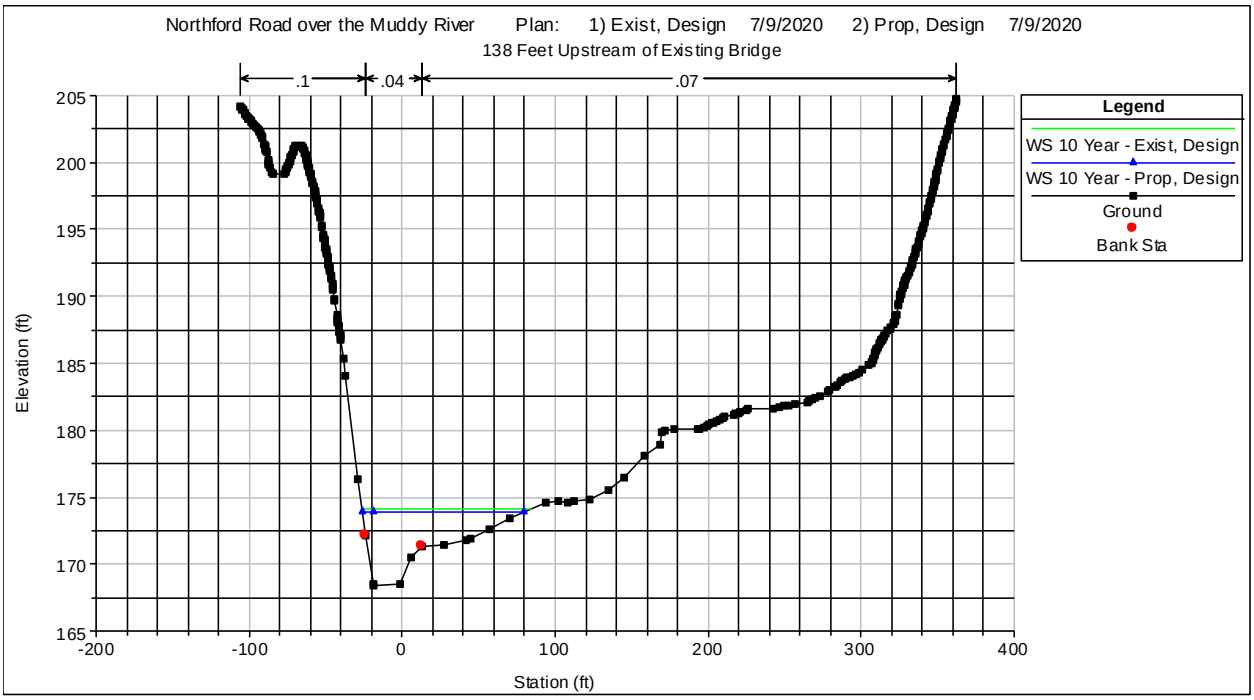
327 Feet Upstream of Existing Bridge
.1
.035
.07
Legend
WS 10 Year - Exist, Design
WS 10 Year - Prop, Design
Ground
Bank Sta
Elevation (ft)
Station (ft)
210
205
200
195
190
185
180
175
170
165
-100
0
100
200
300
400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.04
.07
Legend
WS 10 Year - Exist, Design
WS 10 Year - Prop, Design
Ground
Bank Sta
Elevation (ft)
Station (ft)
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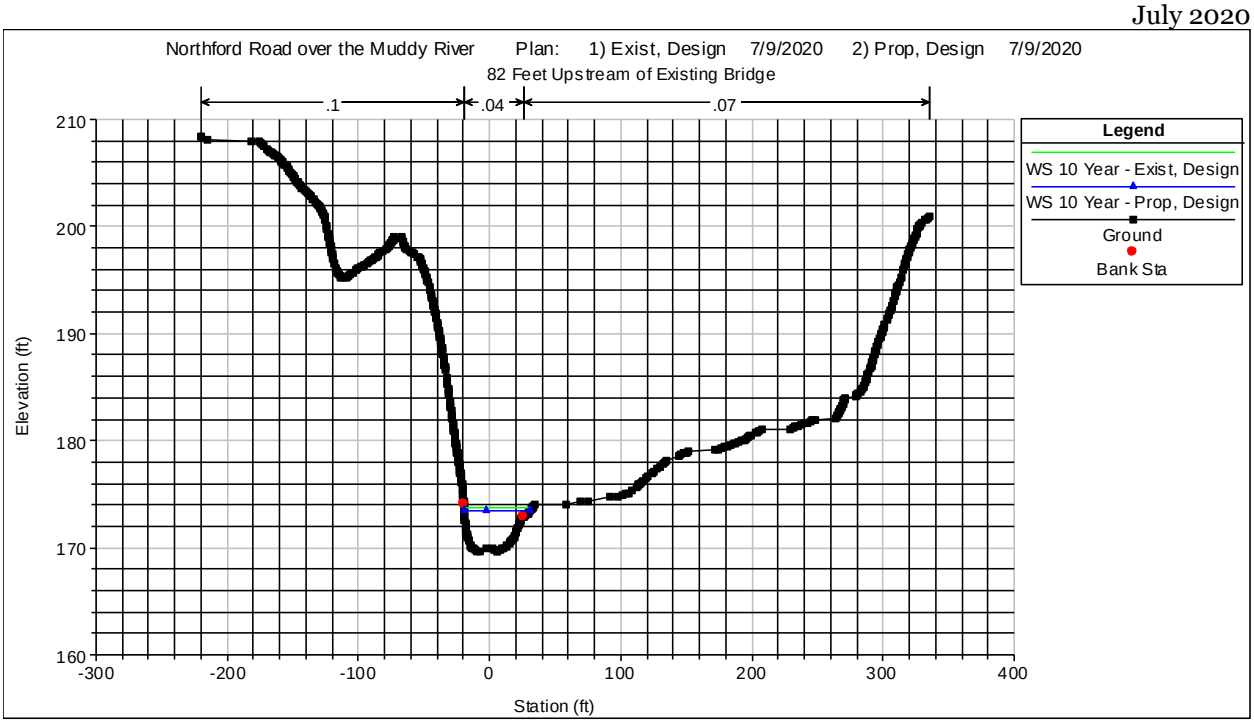
200
195
190
185
180
175
170
165
-200
-100
0
100
200
300
400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82 Feet Upstream of Existing Bridge
.1
.04
.07
Legend
WS 10 Year - Exist, Design
WS 10 Year - Prop, Design
Ground
Bank Sta
Elevation (ft)
Station (ft)
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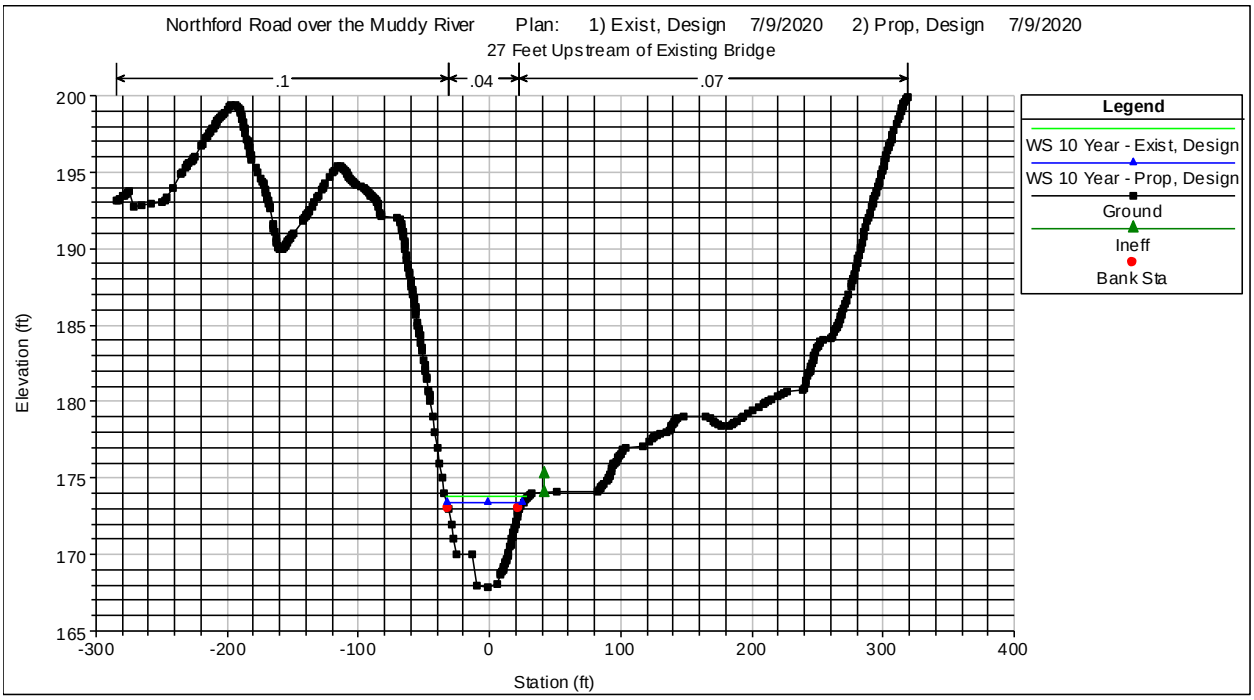
200
190
180
170
160
-300
-200
-100
0
100
200
300
400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27 Feet Upstream of Existing Bridge
.1
.04
.07
Legend
WS 10 Year - Exist, Design
WS 10 Year - Prop, Design
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
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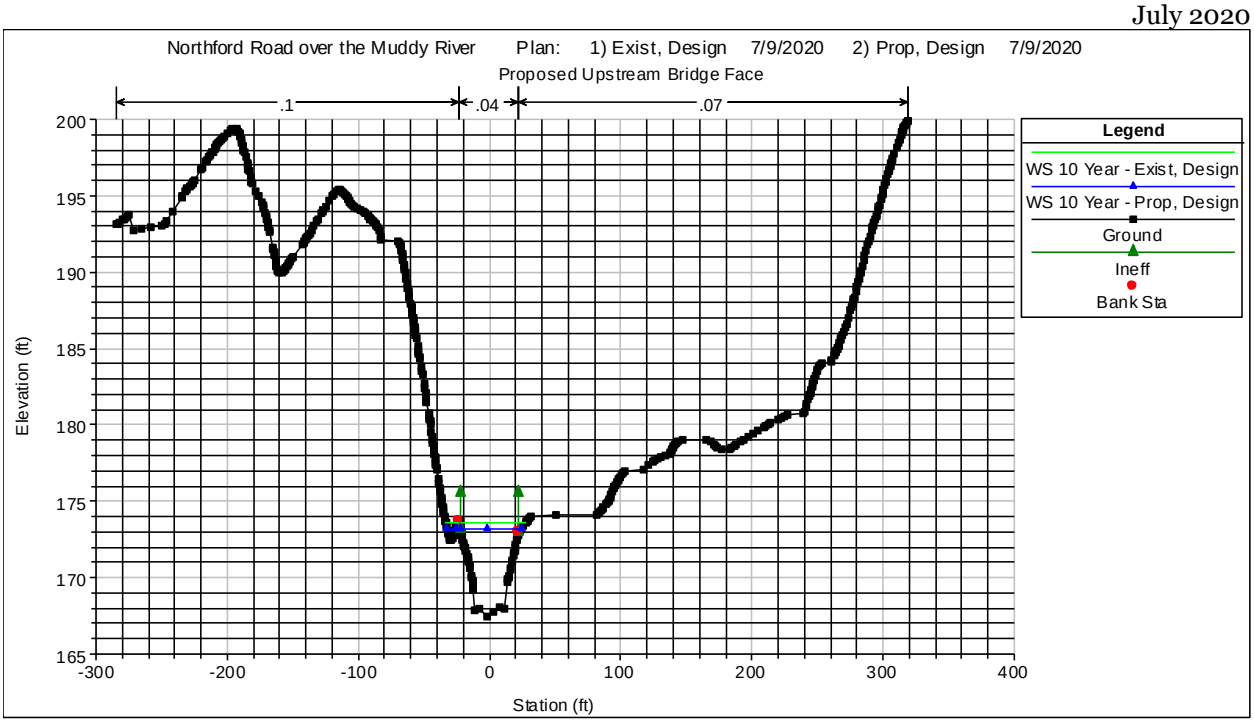
195
190
185
180
175
170
165
-300
-200
-100
0
100
200
300
400


Northford Road over the Muddy River Plan: 1) Exist, Design 7/9/2020 2) Prop, Design 7/9/2020
Proposed Upstream Bridge Face
.1
.04
.07
Legend
WS 10 Year - Exist, Design
WS 10 Year - Prop, Design
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
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195
190
185
180
175
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-200
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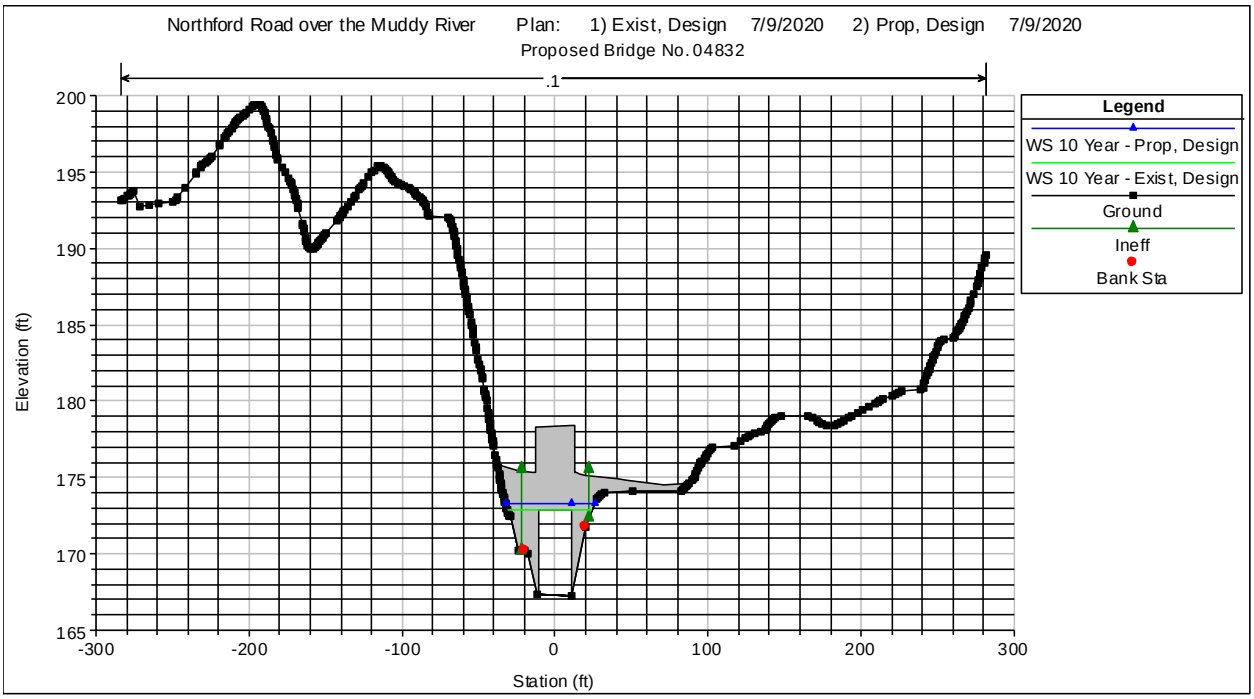
300
400


Northford Road over the Muddy River Plan: 1) Exist, Design 7/9/2020 2) Prop, Design 7/9/2020
Proposed Bridge No. 04832
.1
Legend
WS 10 Year - Prop, Design
WS 10 Year - Exist, Design
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
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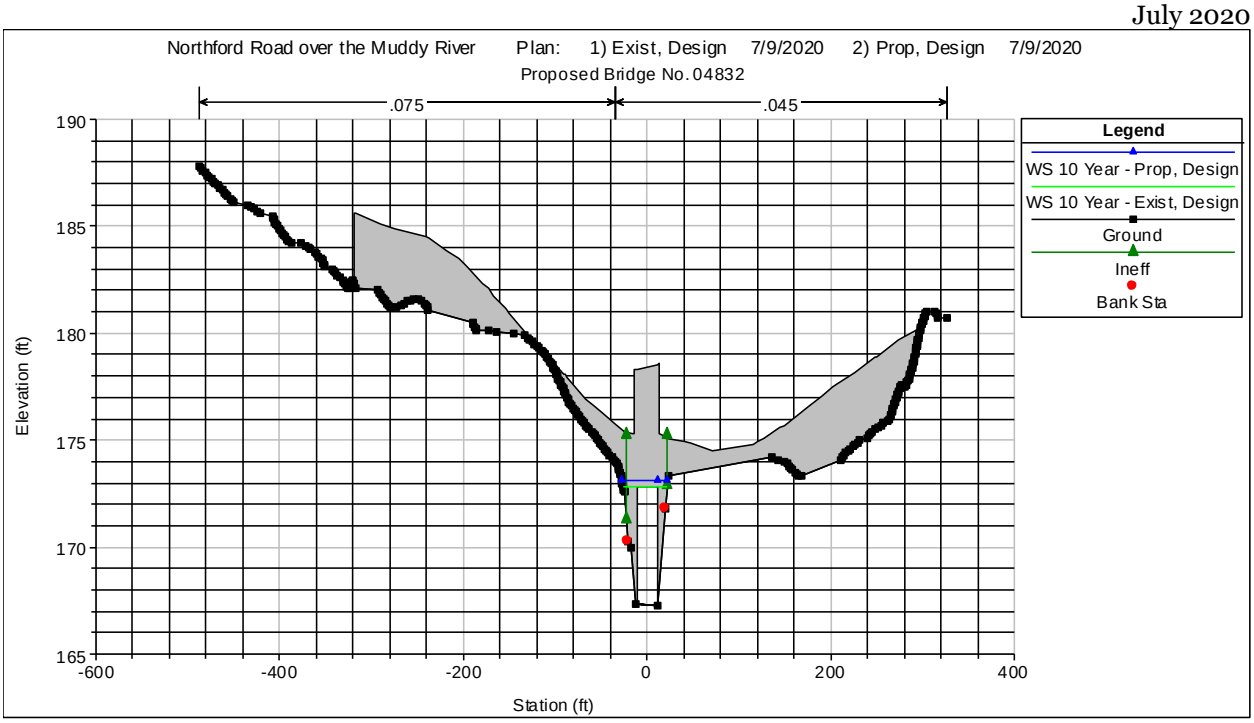
195
190
185
180
175
170
165
-300
-200
-100
0
100
200
300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Proposed Bridge No. 04832
.075
.045
Legend
WS 10 Year - Prop, Design
WS 10 Year - Exist, Design
Ground
Ineff
Bank Sta
Elevation (ft)
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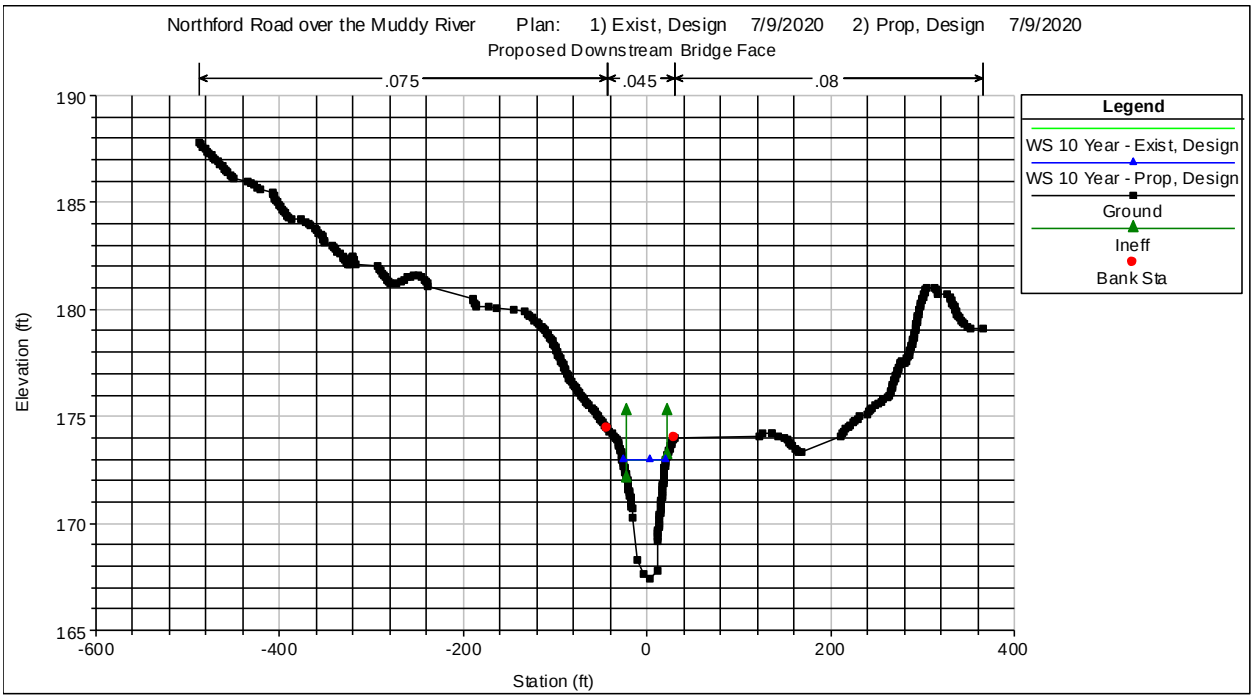
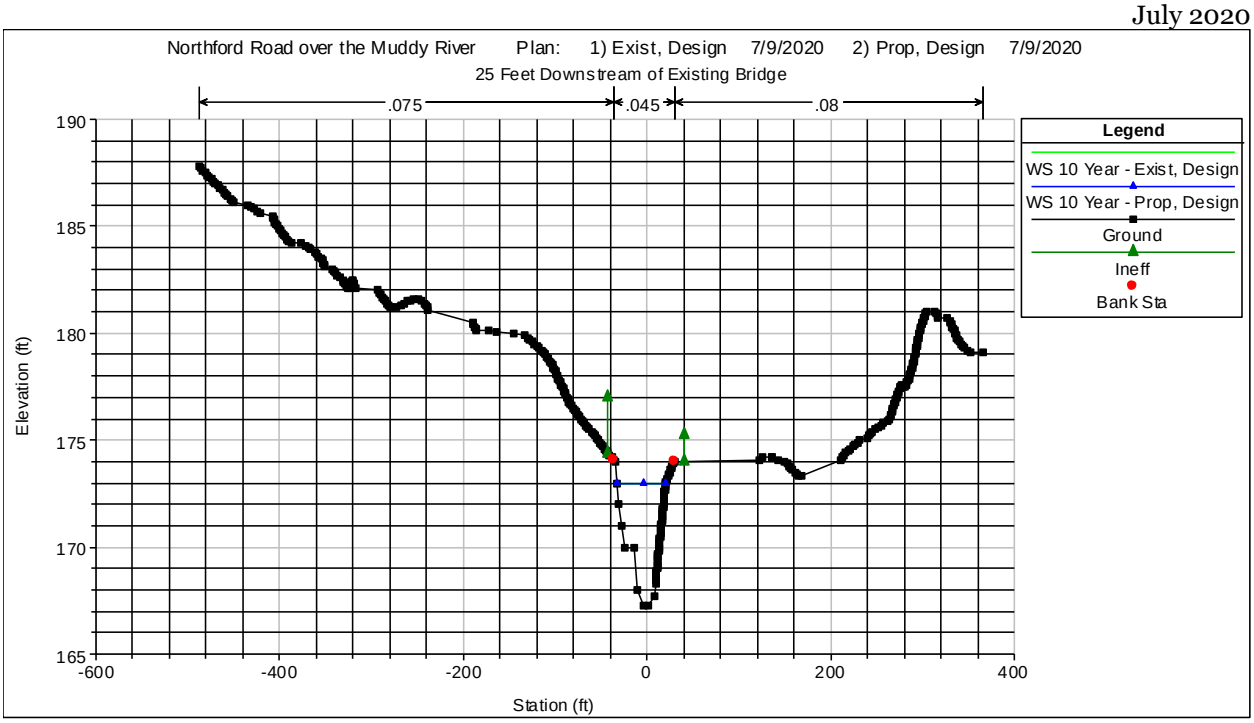
185
180
175
170
165
-600
-400
-200
0
200
400
Station (ft)


Northford Road over the Muddy River Plan: 1) Exist, Design 7/9/2020 2) Prop, Design 7/9/2020
Proposed Downstream Bridge Face
.075
.045
.08
Legend
WS 10 Year - Exist, Design
WS 10 Year - Prop, Design
Ground
Ineff
Bank Sta
Elevation (ft)
190
185
180
175
170
165
-600
-400
-200
0
200
400
Station (ft)


Northford Road over the Muddy River Plan: 1) Exist, Design 7/9/2020 2) Prop, Design 7/9/2020
25 Feet Downstream of Existing Bridge
.075
.045
.08
Legend
WS 10 Year - Exist, Design
WS 10 Year - Prop, Design
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
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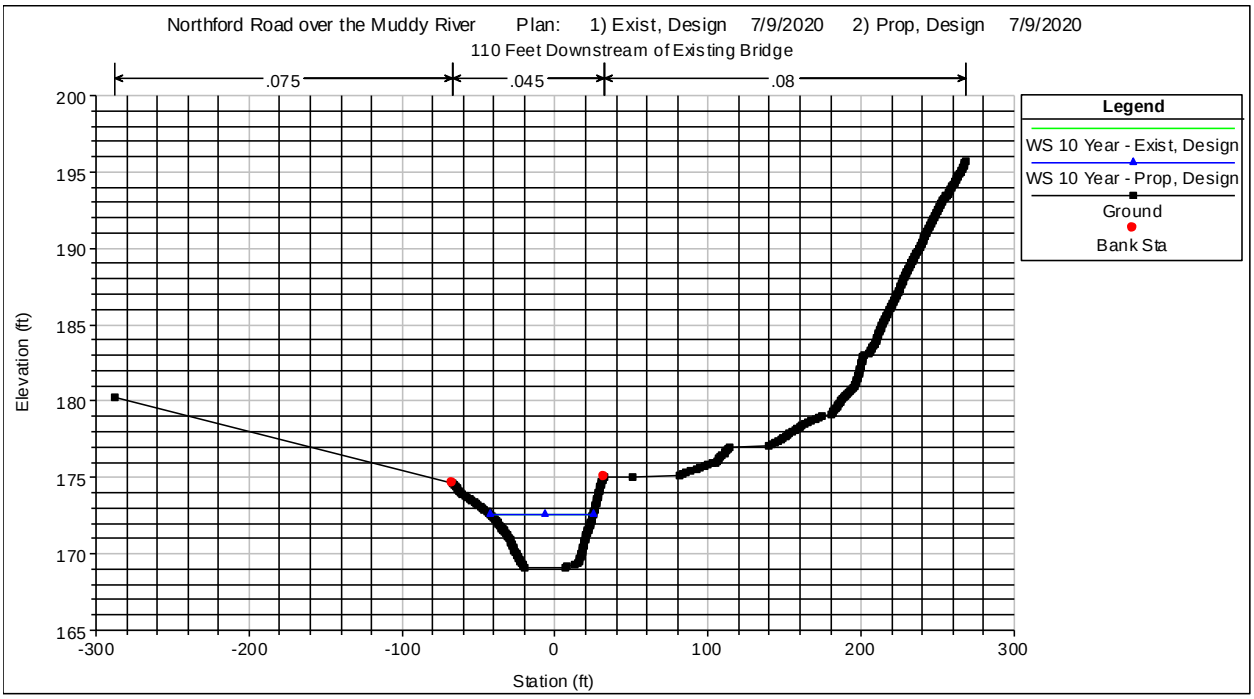
Northford Road over the Muddy River Plan: 1) Exist, Design 7/9/2020 2) Prop, Design 7/9/2020
110 Feet Downstream of Existing Bridge
.075
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Legend
WS 10 Year - Exist, Design
WS 10 Year - Prop, Design
Ground
Bank Sta
Elevation (ft)
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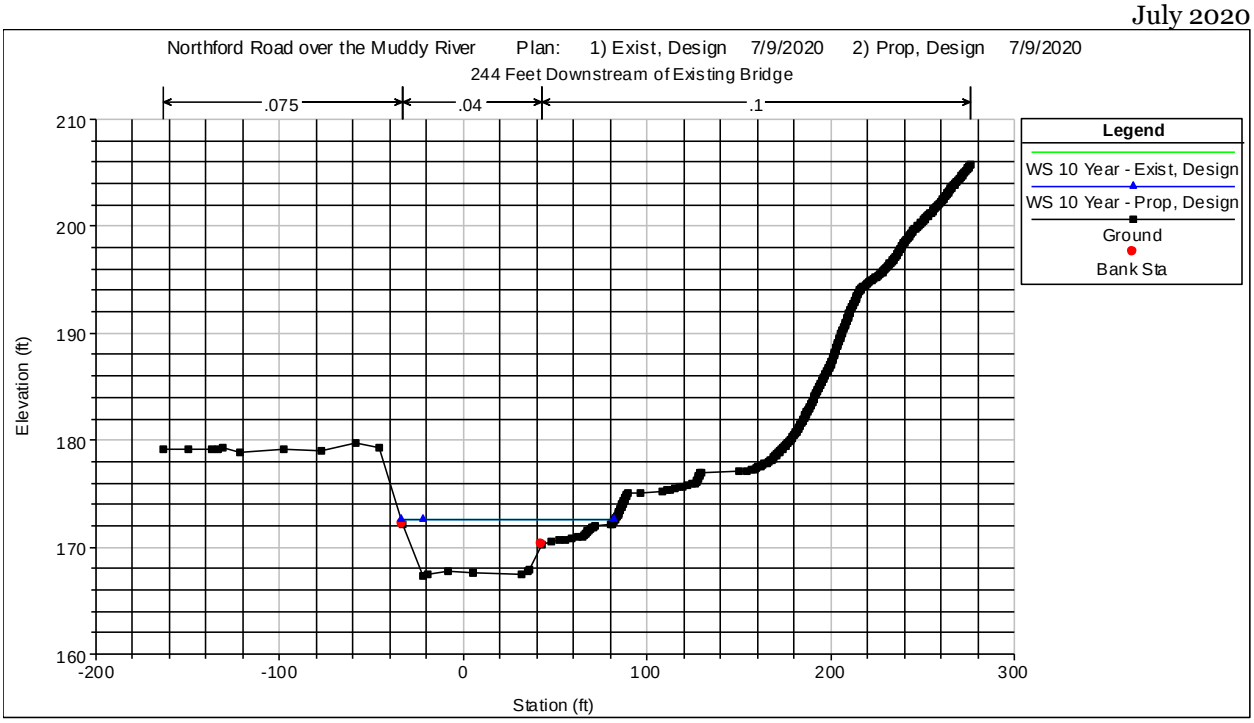
Northford Road over the Muddy River Plan: 1) Exist, Design 7/9/2020 2) Prop, Design 7/9/2020
244 Feet Downstream of Existing Bridge
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Legend
WS 10 Year - Exist, Design
WS 10 Year - Prop, Design
Ground
Bank Sta
Elevation (ft)
Station (ft)
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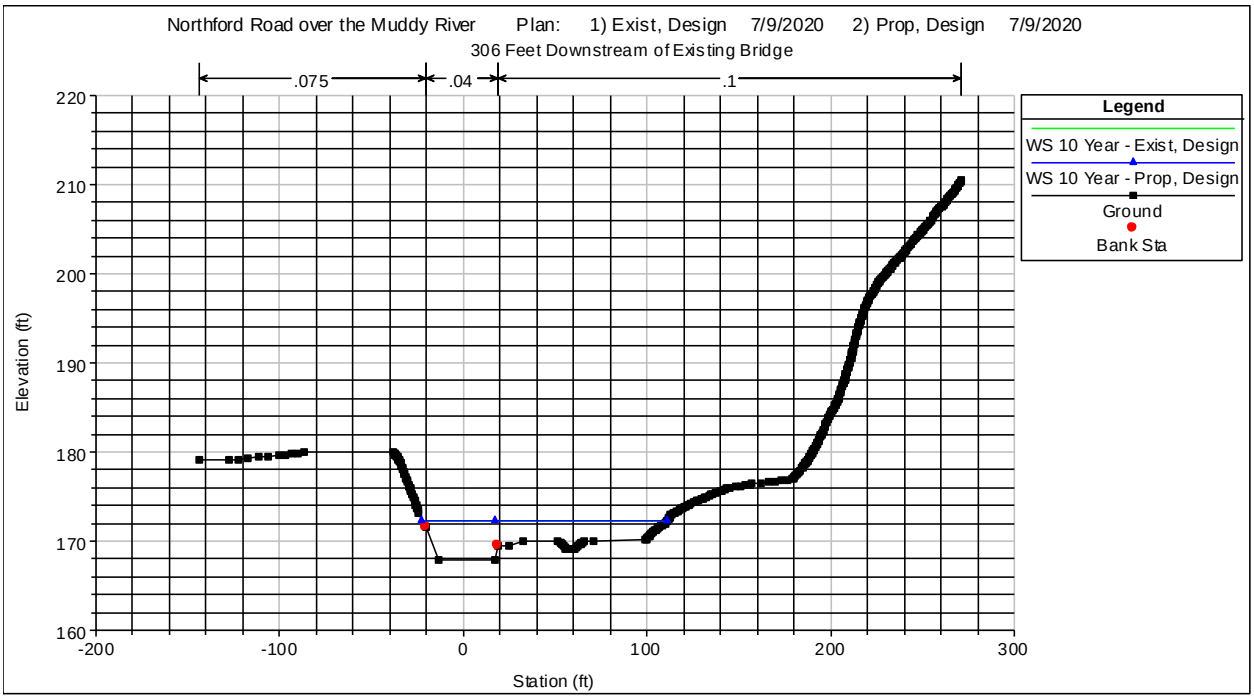
Northford Road over the Muddy River Plan: 1) Exist, Design 7/9/2020 2) Prop, Design 7/9/2020
306 Feet Downstream of Existing Bridge
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Legend
WS 10 Year - Exist, Design
WS 10 Year - Prop, Design
Ground
Bank Sta
Elevation (ft)
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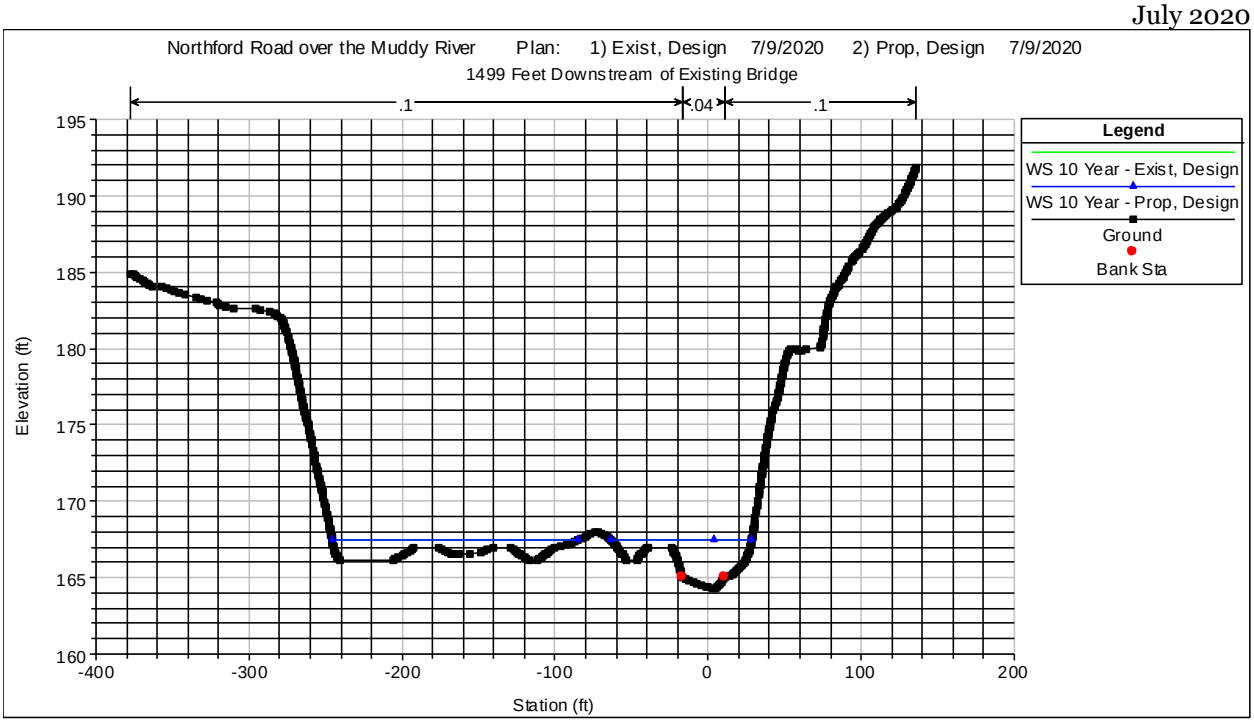

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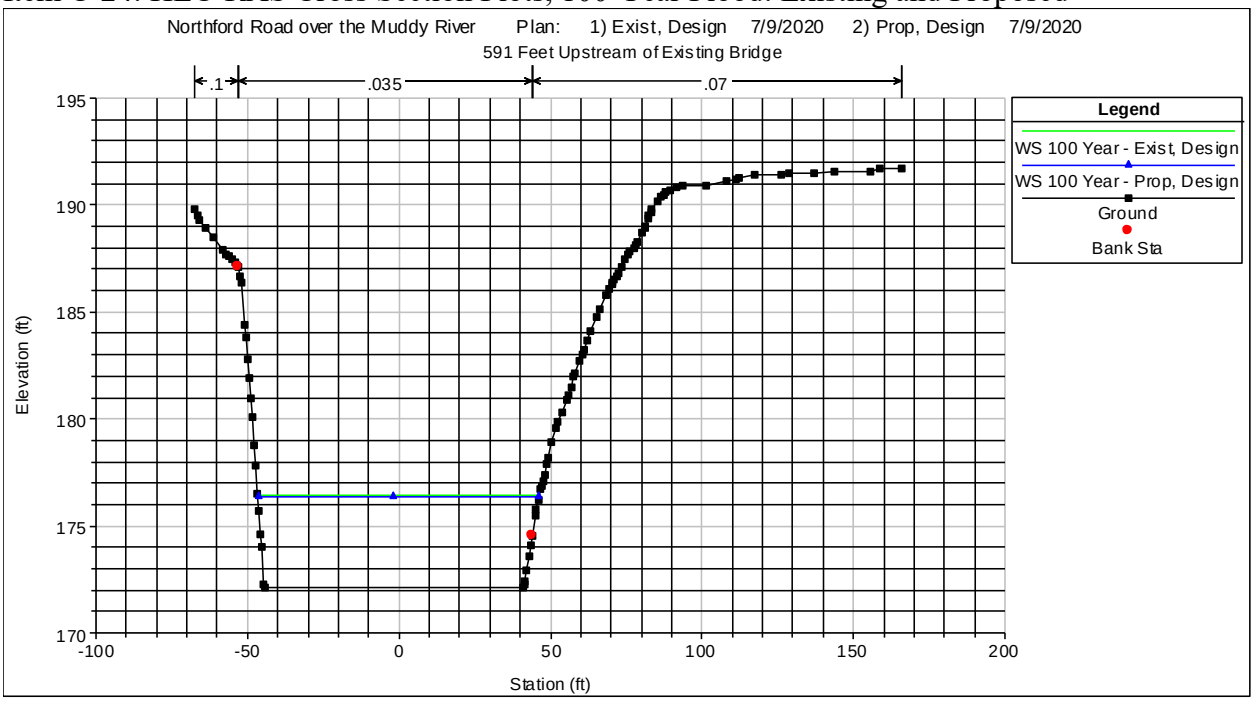
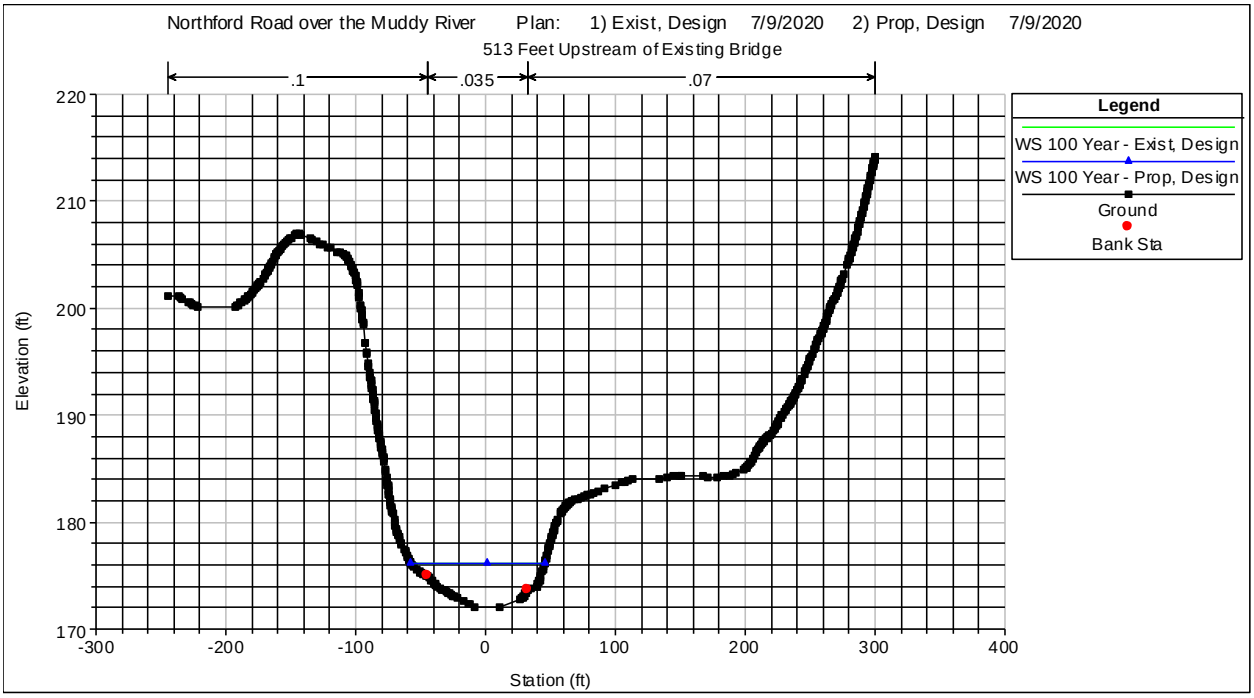
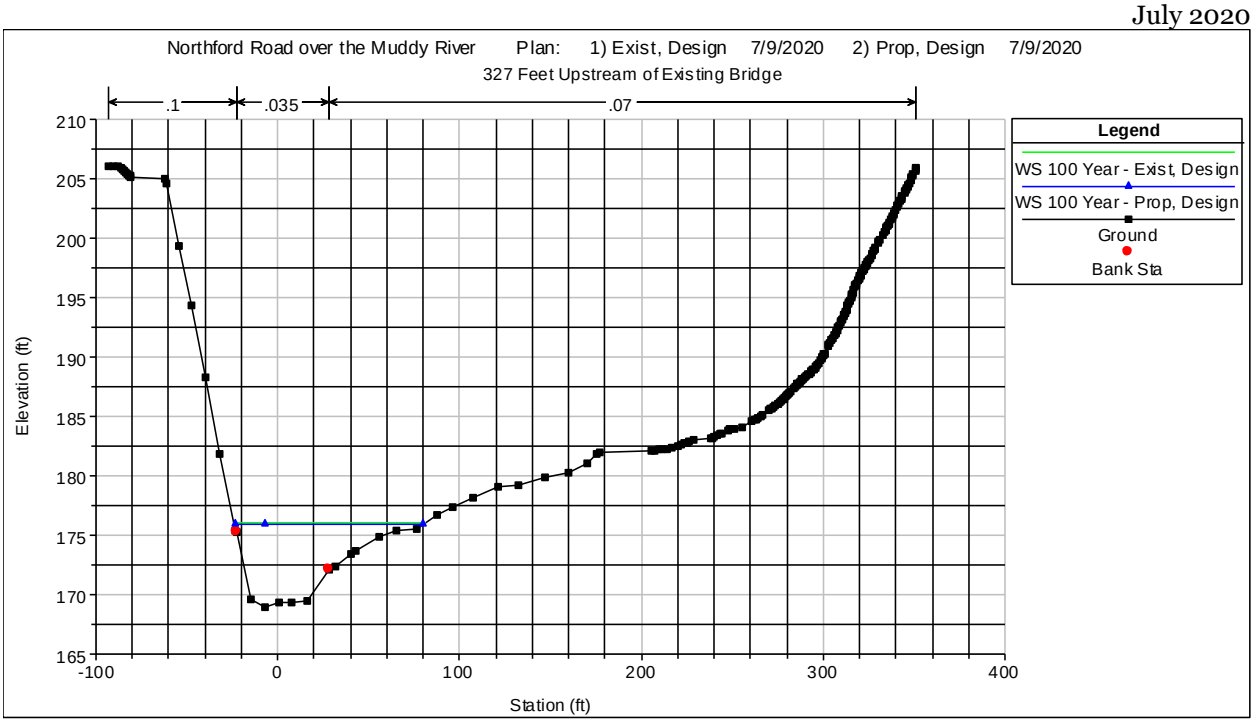
Item C-24: HEC-RAS Cross Section Plots, 100-Year Flood: Existing and Proposed






Northford Road over the Muddy River Plan: 1) Exist, Design 7/9/2020 2) Prop, Design 7/9/2020
327 Feet Upstream of Existing Bridge
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Legend
WS 100 Year - Exist, Design
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Ground
Bank Sta
Elevation (ft)
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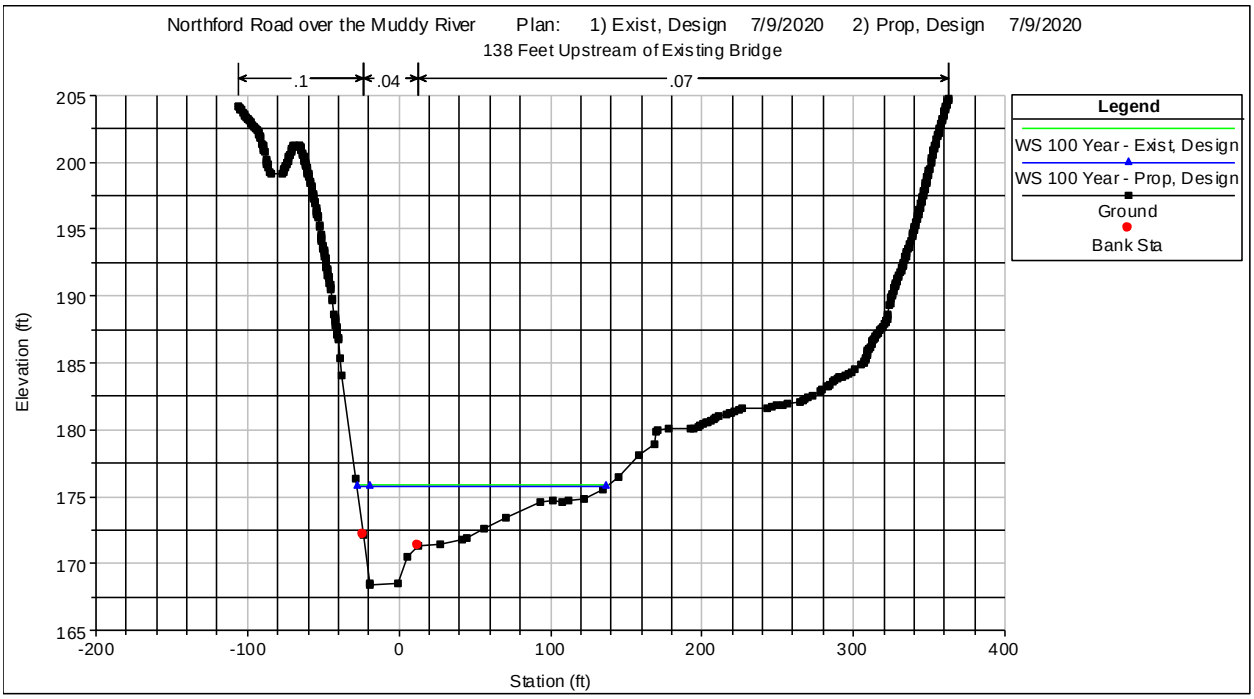
Northford Road over the Muddy River Plan: 1) Exist, Design 7/9/2020 2) Prop, Design 7/9/2020
138 Feet Upstream of Existing Bridge
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Legend
WS 100 Year - Exist, Design
WS 100 Year - Prop, Design
Ground
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Elevation (ft)
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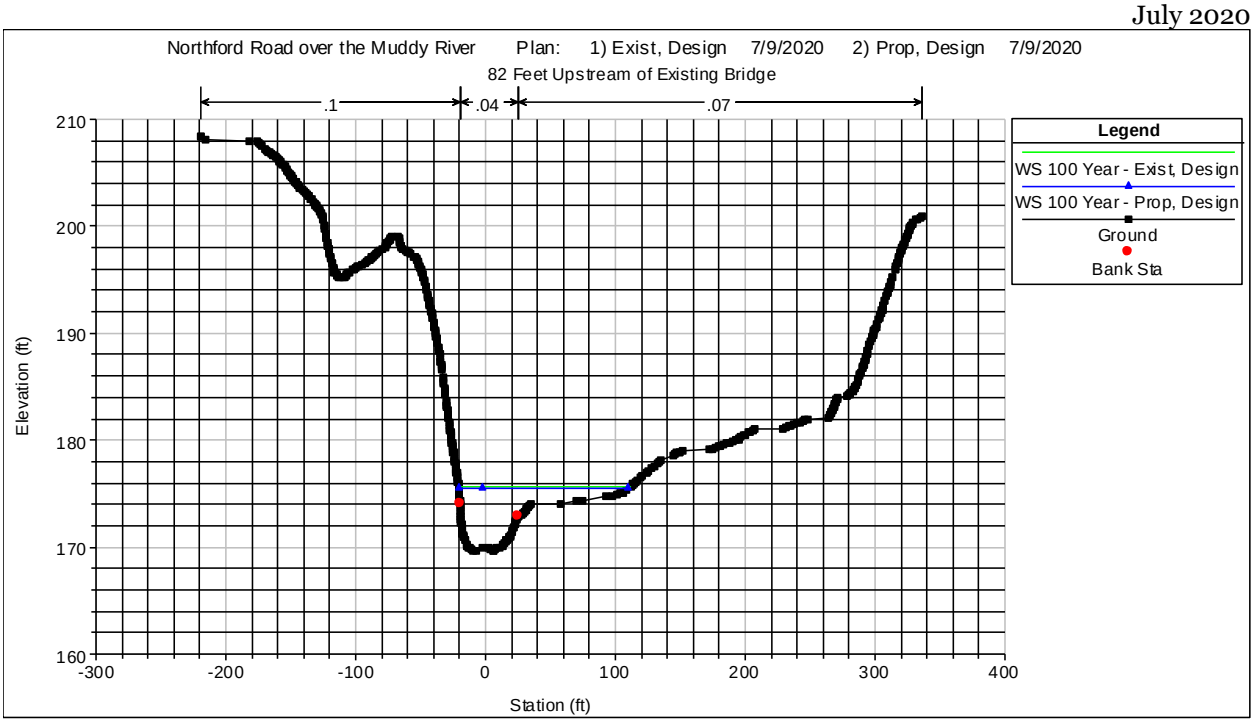
Northford Road over the Muddy River Plan: 1) Exist, Design 7/9/2020 2) Prop, Design 7/9/2020
82 Feet Upstream of Existing Bridge
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Legend
WS 100 Year - Exist, Design
WS 100 Year - Prop, Design
Ground
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Elevation (ft)
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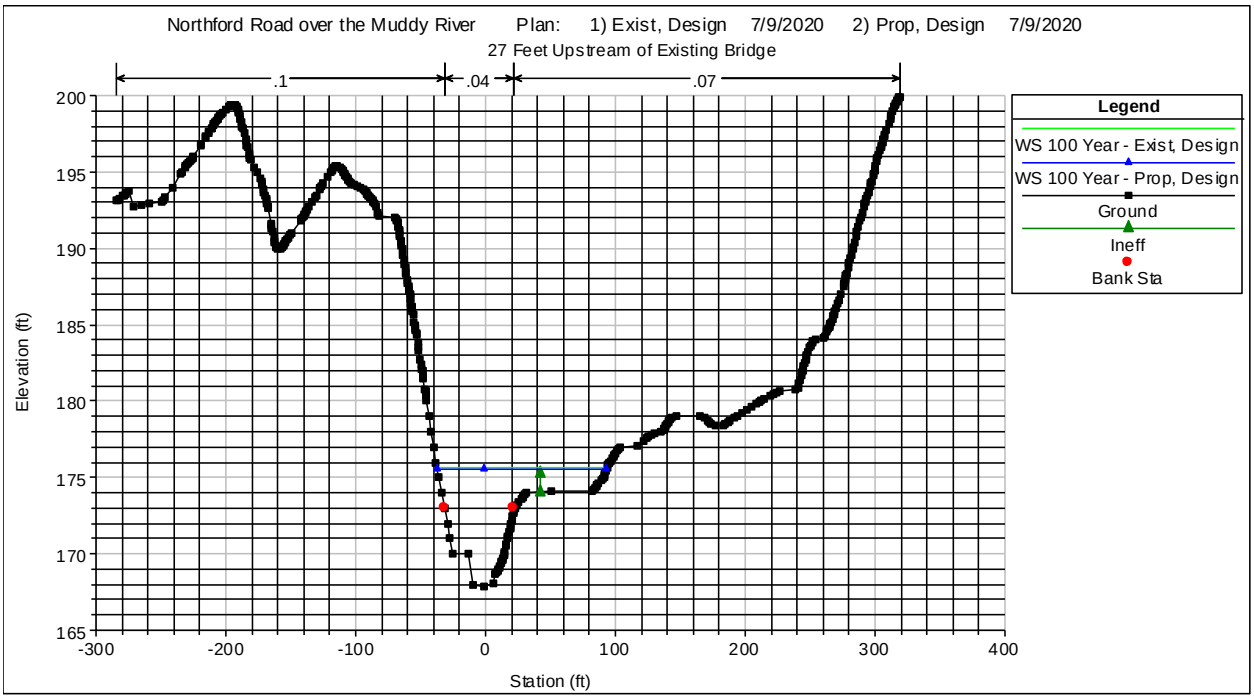
Northford Road over the Muddy River Plan: 1) Exist, Design 7/9/2020 2) Prop, Design 7/9/2020
27 Feet Upstream of Existing Bridge
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Legend
WS 100 Year - Exist, Design
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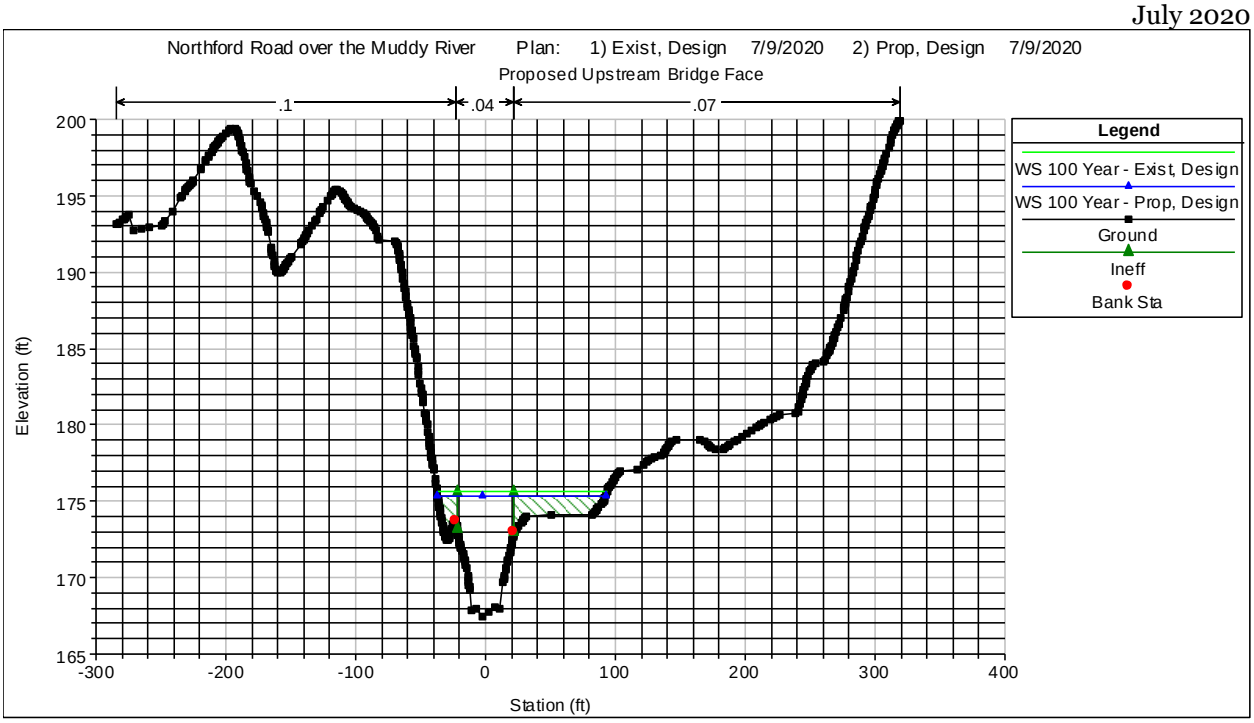
Northford Road over the Muddy River Plan: 1) Exist, Design 7/9/2020 2) Prop, Design 7/9/2020
Proposed Upstream Bridge Face
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Legend
WS 100 Year - Exist, Design
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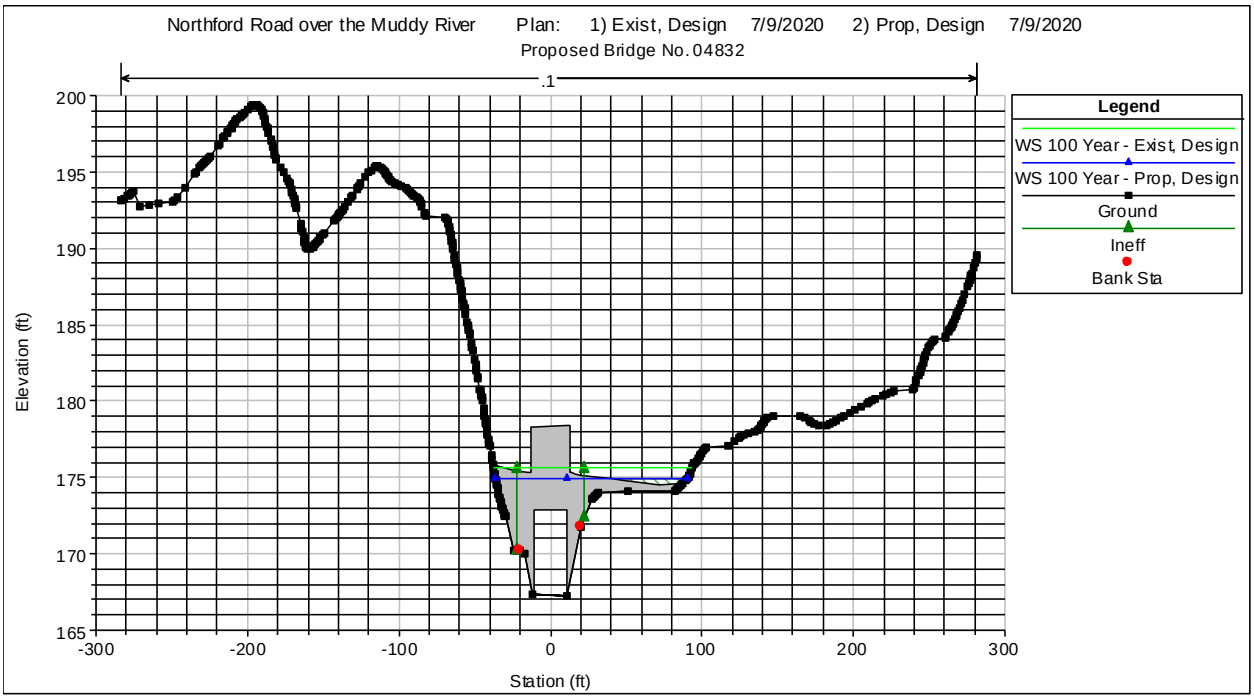
Northford Road over the Muddy River Plan: 1) Exist, Design 7/9/2020 2) Prop, Design 7/9/2020
Proposed Bridge No. 04832
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Legend
WS 100 Year - Exist, Design
WS 100 Year - Prop, Design
Ground
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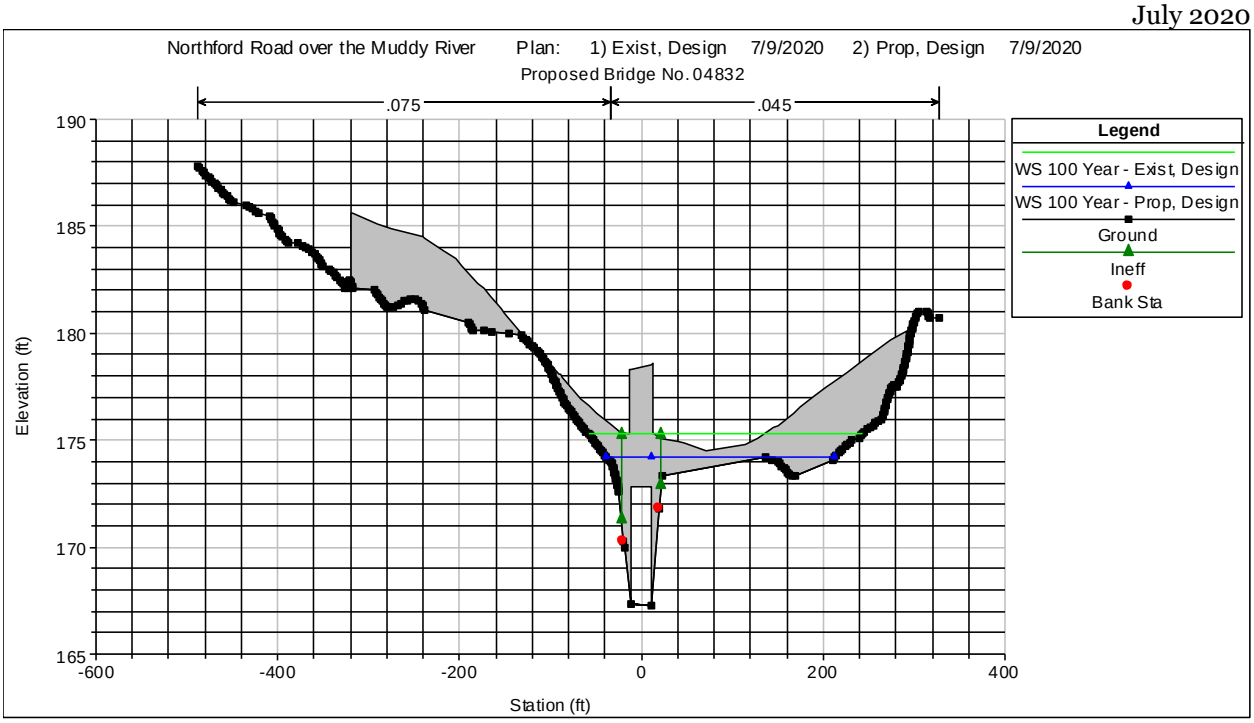
Northford Road over the Muddy River Plan: 1) Exist, Design 7/9/2020 2) Prop, Design 7/9/2020
Proposed Bridge No. 04832
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Legend
WS 100 Year - Exist, Design
WS 100 Year - Prop, Design
Ground
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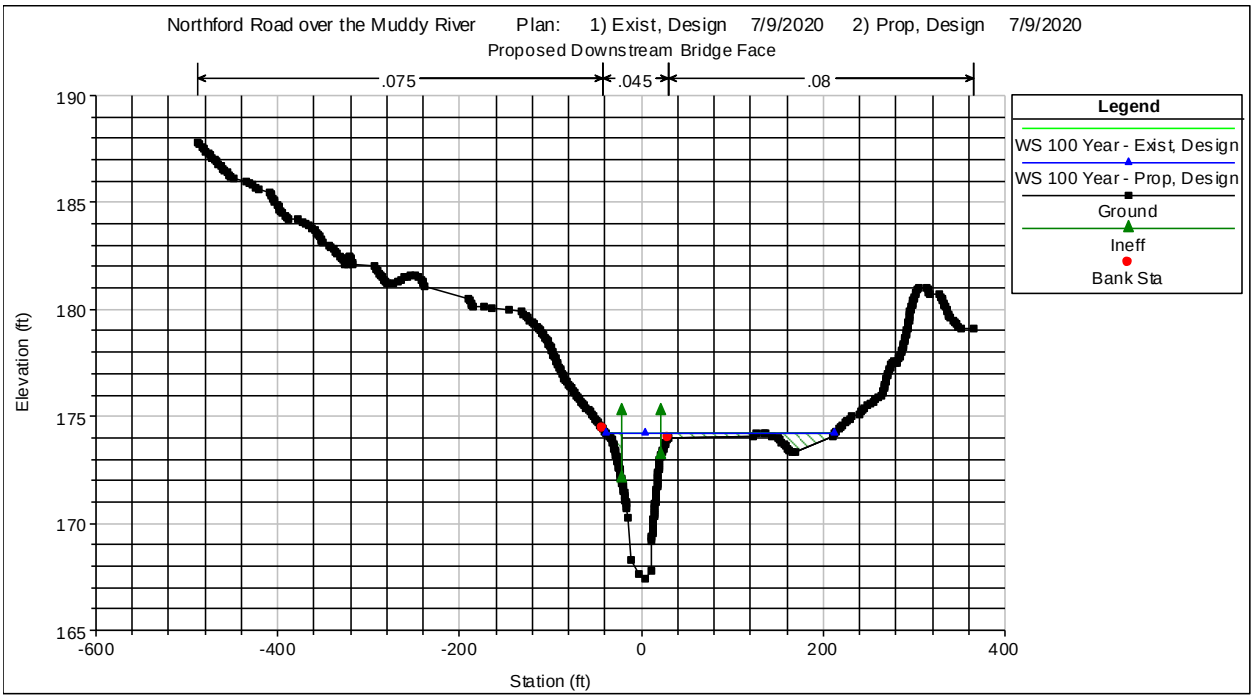
Northford Road over the Muddy River Plan: 1) Exist, Design 7/9/2020 2) Prop, Design 7/9/2020
Proposed Downstream Bridge Face
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Legend
WS 100 Year - Exist, Design
WS 100 Year - Prop, Design
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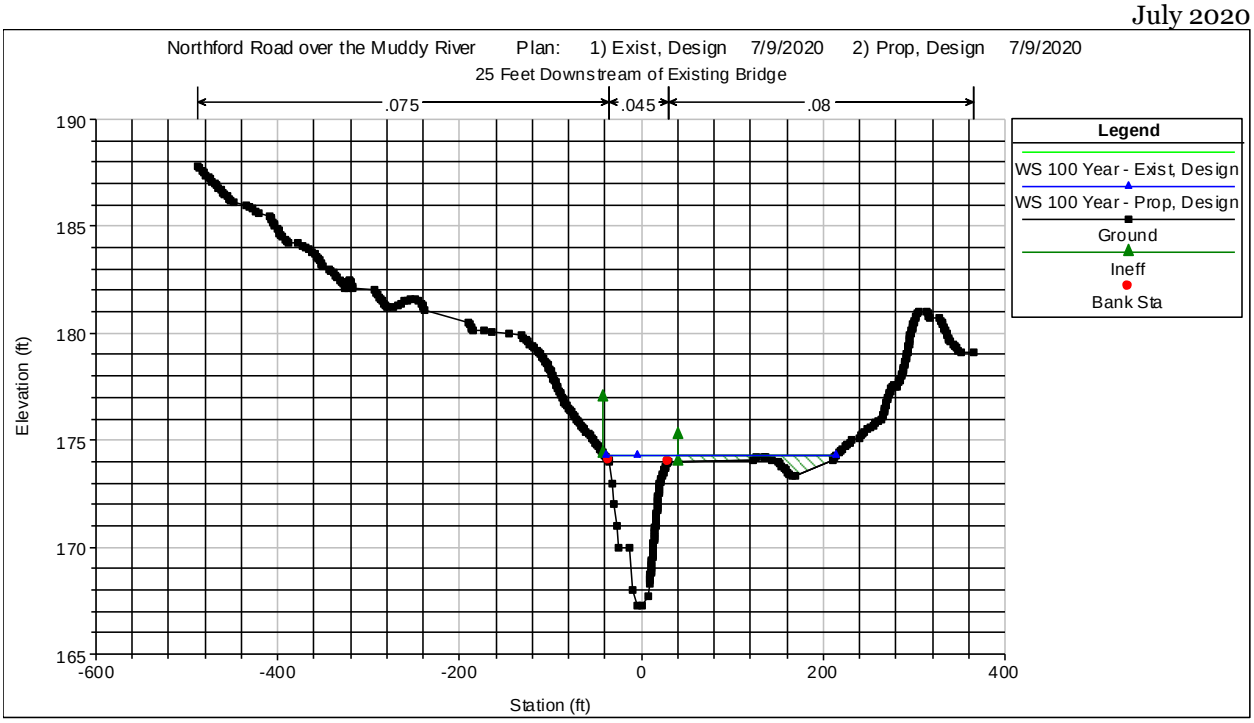
Station (ft)


Northford Road over the Muddy River Plan: 1) Exist, Design 7/9/2020 2) Prop, Design 7/9/2020
25 Feet Downstream of Existing Bridge
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Legend
WS 100 Year - Exist, Design
WS 100 Year - Prop, Design
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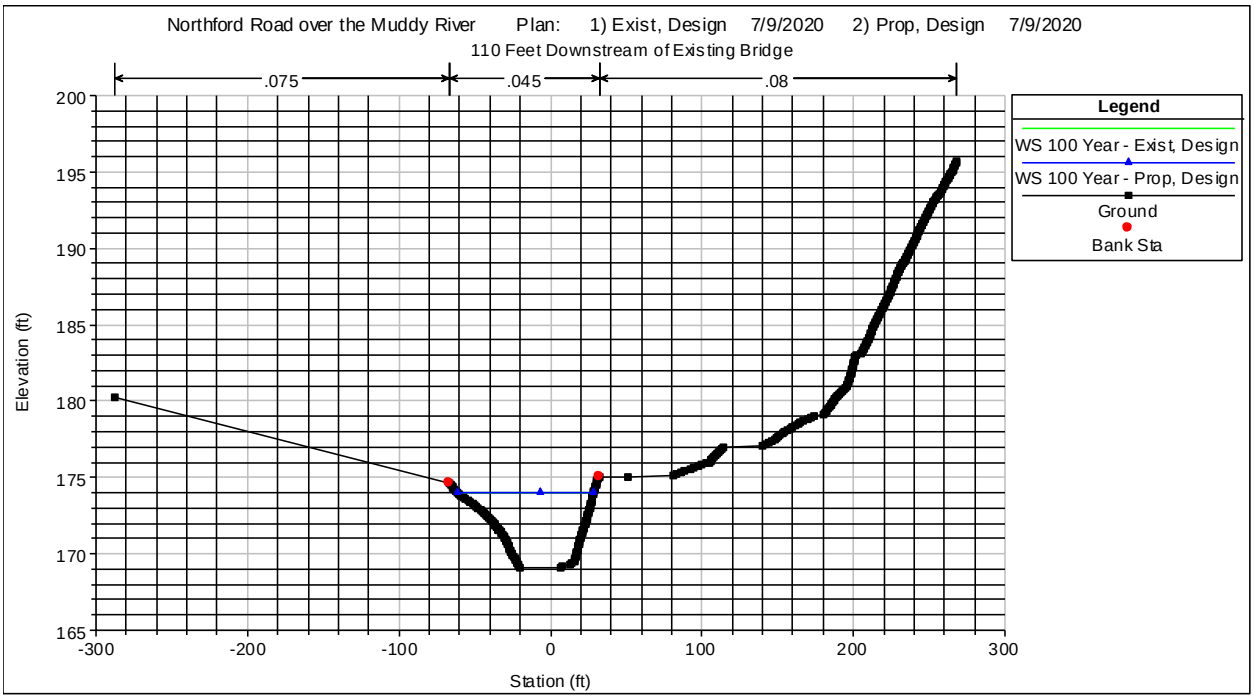
Northford Road over the Muddy River Plan: 1) Exist, Design 7/9/2020 2) Prop, Design 7/9/2020
110 Feet Downstream of Existing Bridge
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Legend
WS 100 Year - Exist, Design
WS 100 Year - Prop, Design
Ground
Bank Sta
Elevation (ft)
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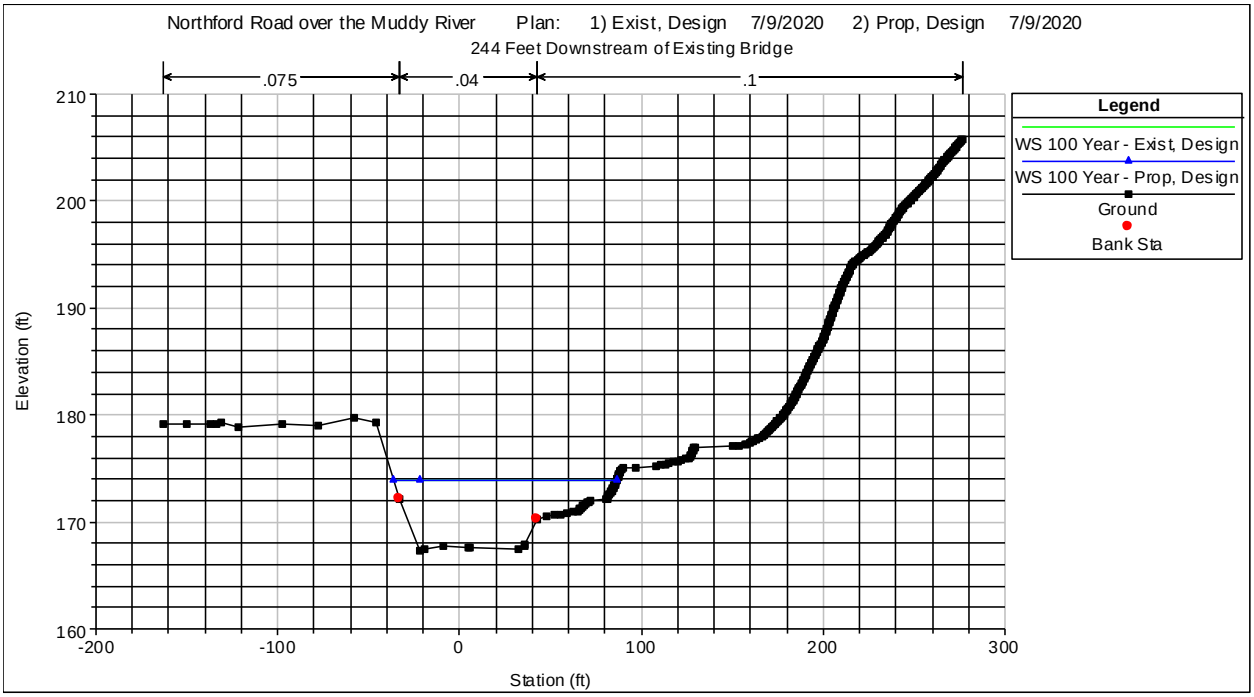
Northford Road over the Muddy River Plan: 1) Exist, Design 7/9/2020 2) Prop, Design 7/9/2020
244 Feet Downstream of Existing Bridge
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Legend
WS 100 Year - Exist, Design
WS 100 Year - Prop, Design
Ground
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Elevation (ft)
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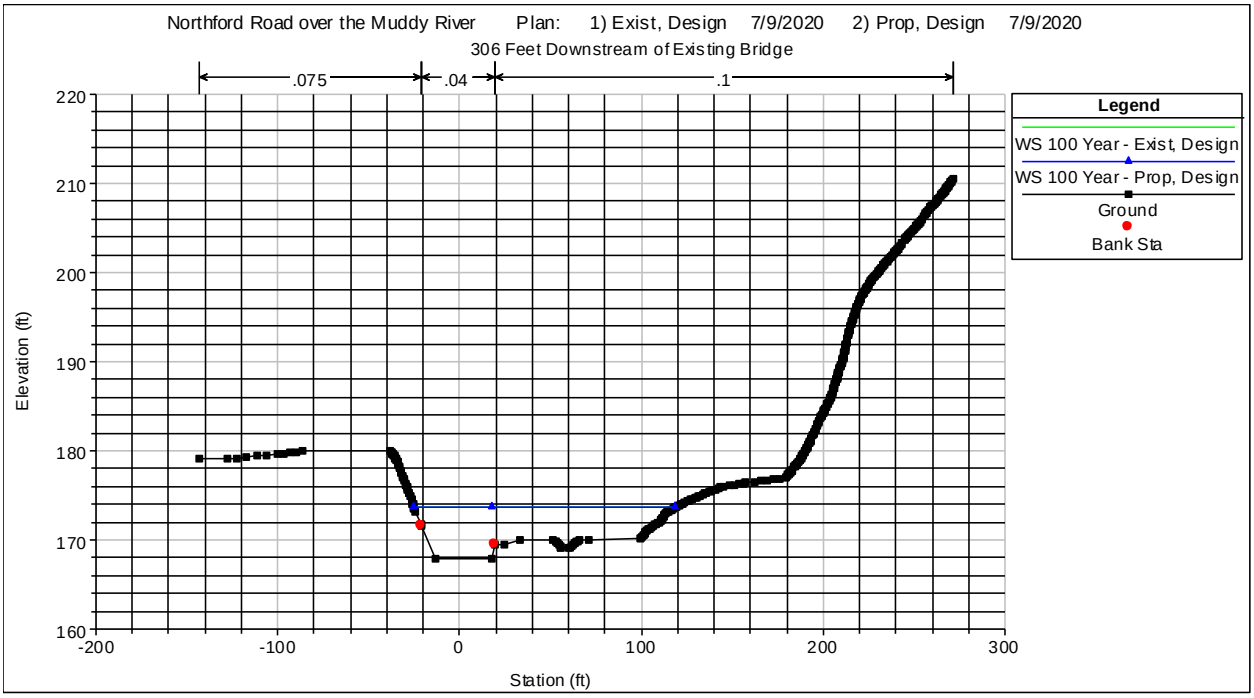
Northford Road over the Muddy River Plan: 1) Exist, Design 7/9/2020 2) Prop, Design 7/9/2020
306 Feet Downstream of Existing Bridge
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Legend
WS 100 Year - Exist, Design
WS 100 Year - Prop, Design
Ground
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Elevation (ft)
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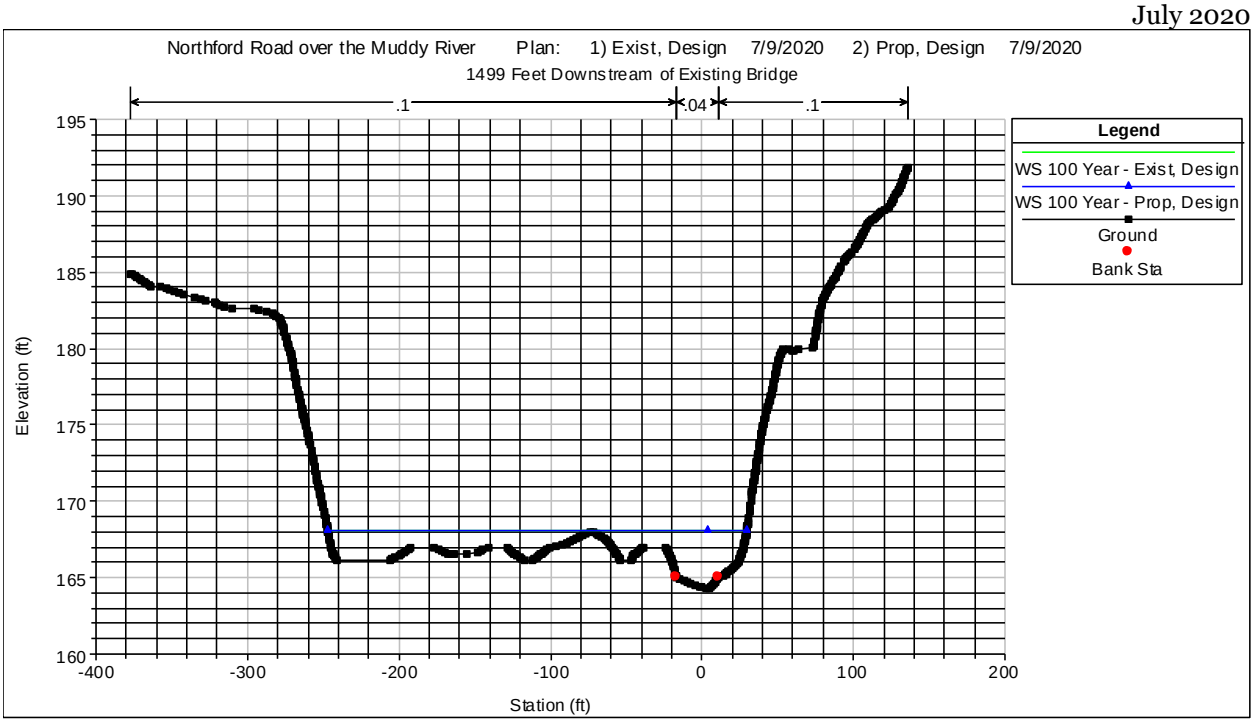

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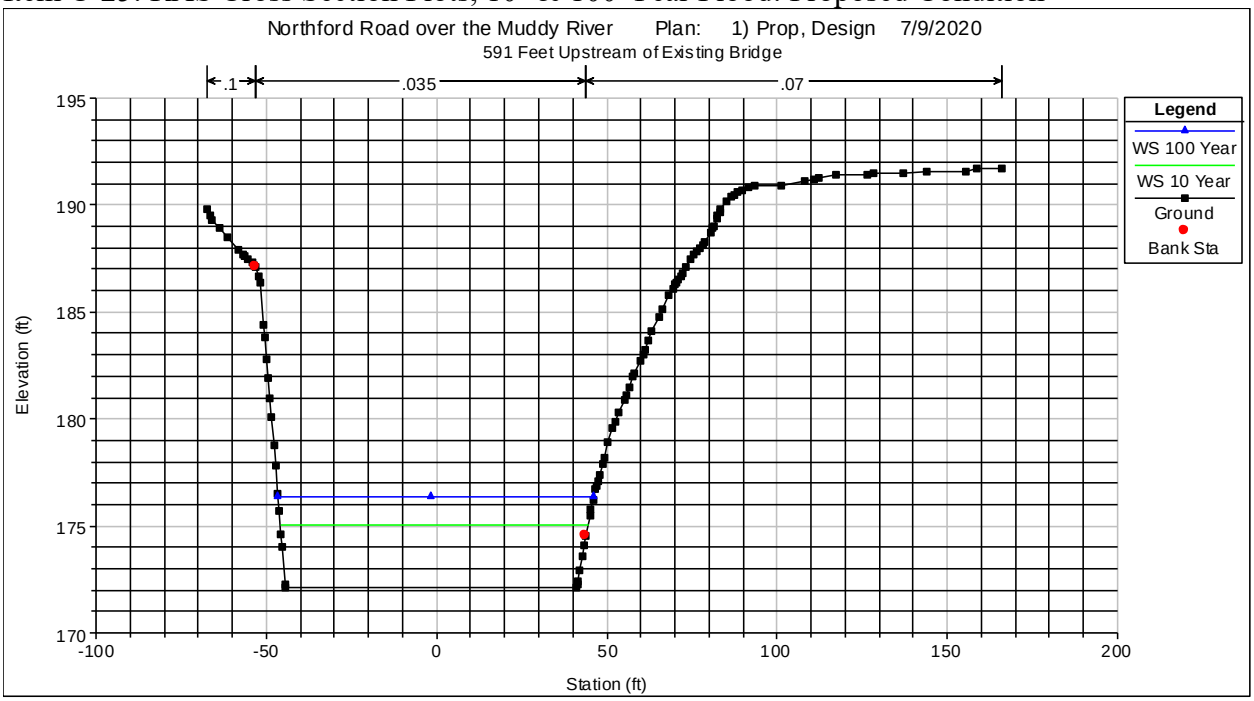
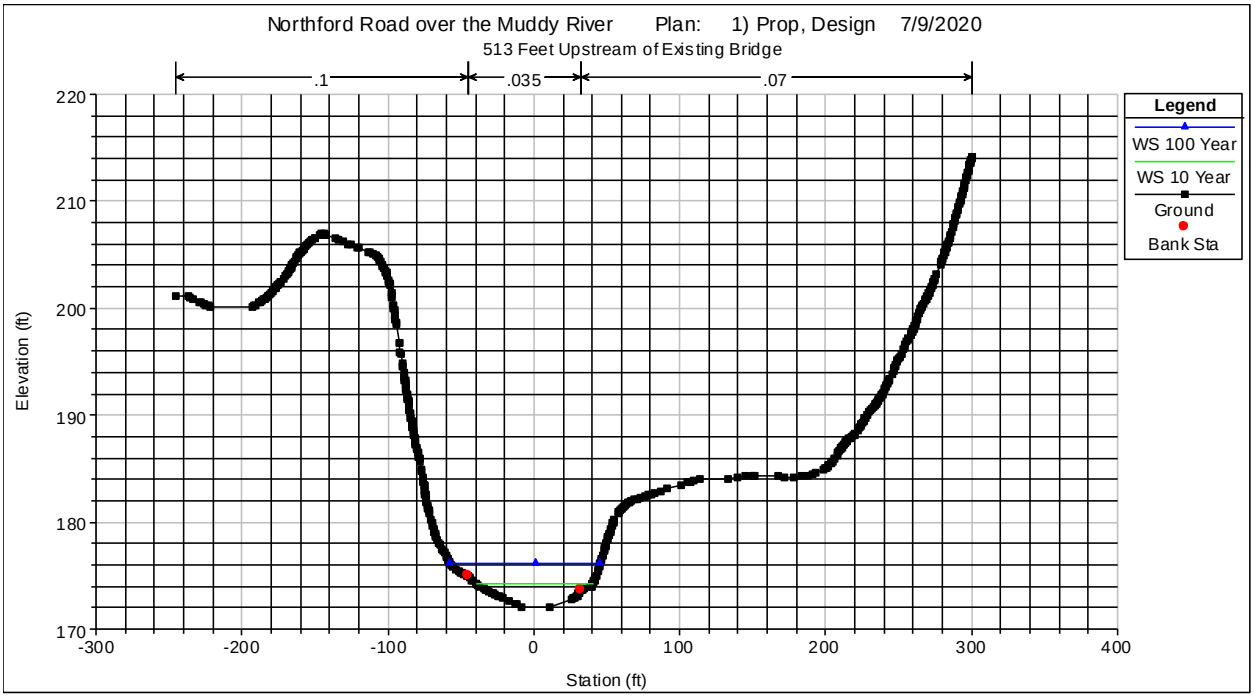
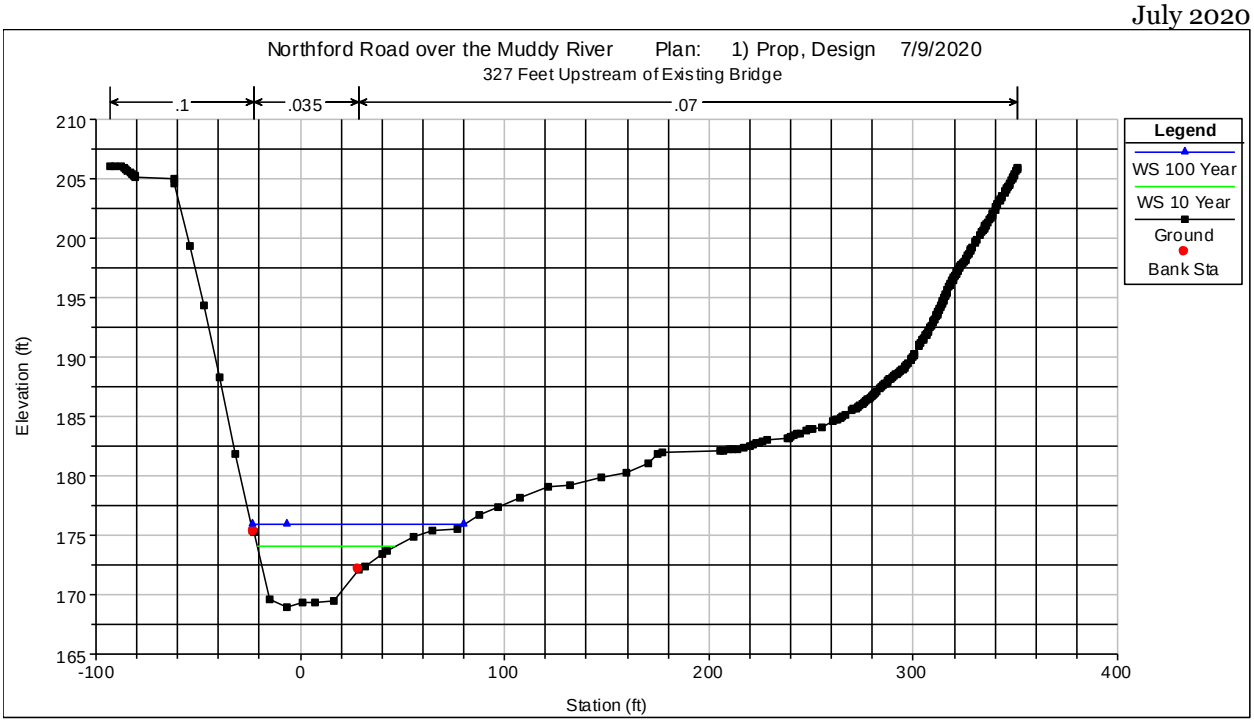
Item C-25: RAS Cross Section Plots, 10- & 100-Year Flood: Proposed Condition






Northford Road over the Muddy River Plan: 1) Prop, Design 7/9/2020
327 Feet Upstream of Existing Bridge
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Legend
WS 100 Year
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Ground
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Elevation (ft)
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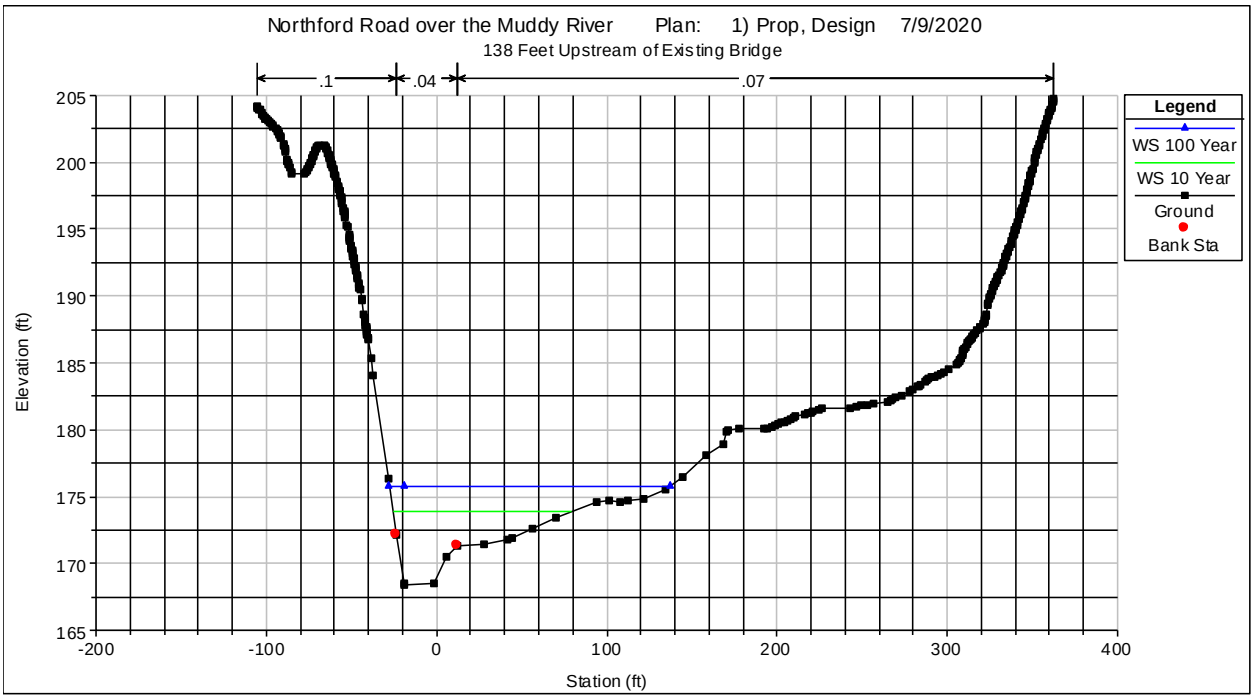
Northford Road over the Muddy River Plan: 1) Prop, Design 7/9/2020
138 Feet Upstream of Existing Bridge
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WS 100 Year
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Elevation (ft)
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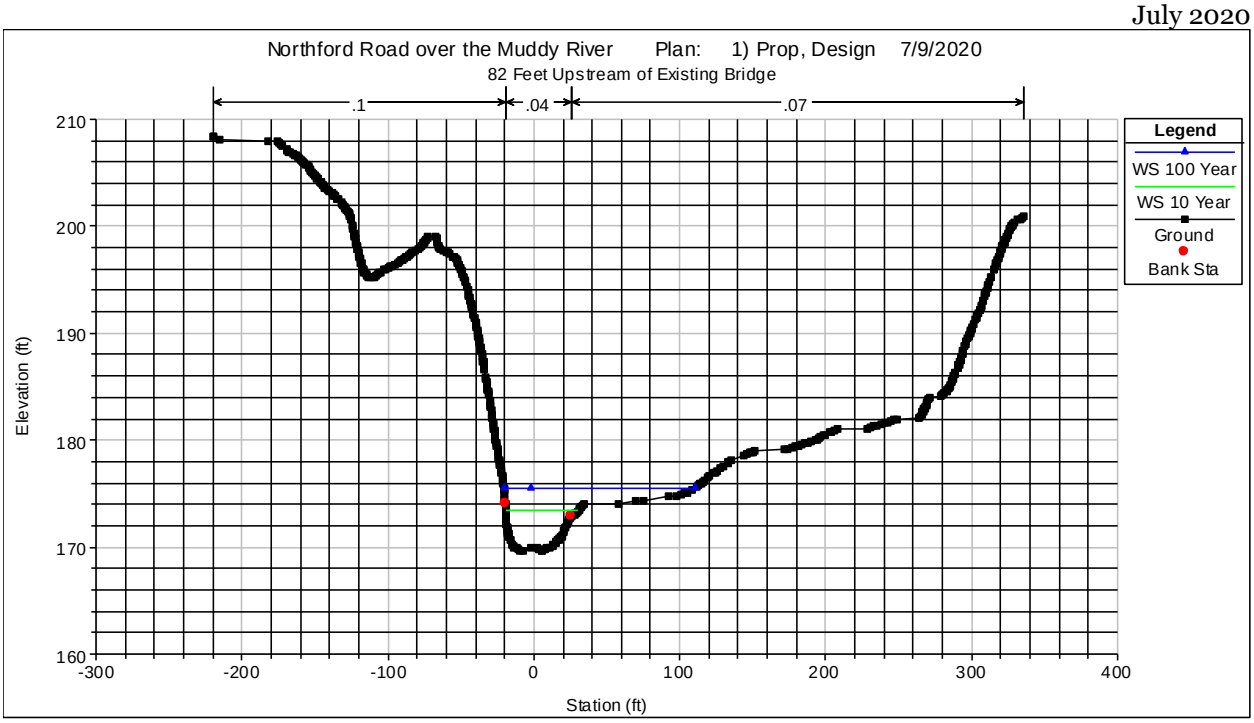
Northford Road over the Muddy River Plan: 1) Prop, Design 7/9/2020
82 Feet Upstream of Existing Bridge
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WS 100 Year
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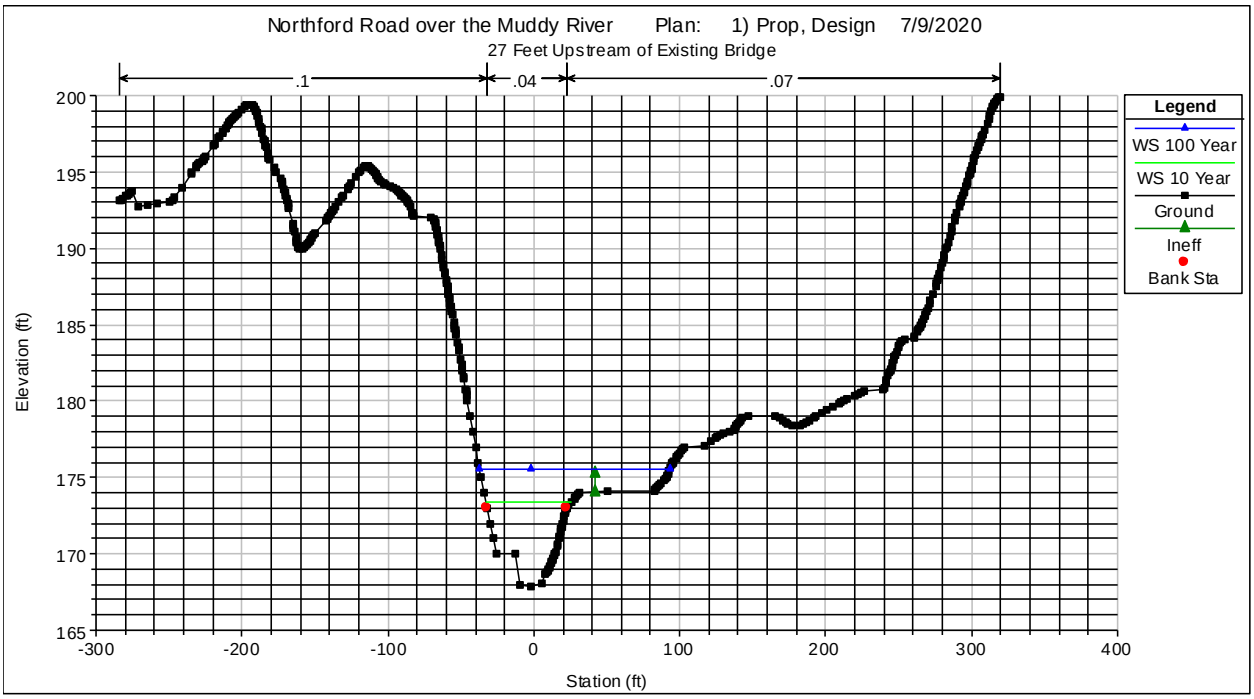
Northford Road over the Muddy River Plan: 1) Prop, Design 7/9/2020
27 Feet Upstream of Existing Bridge
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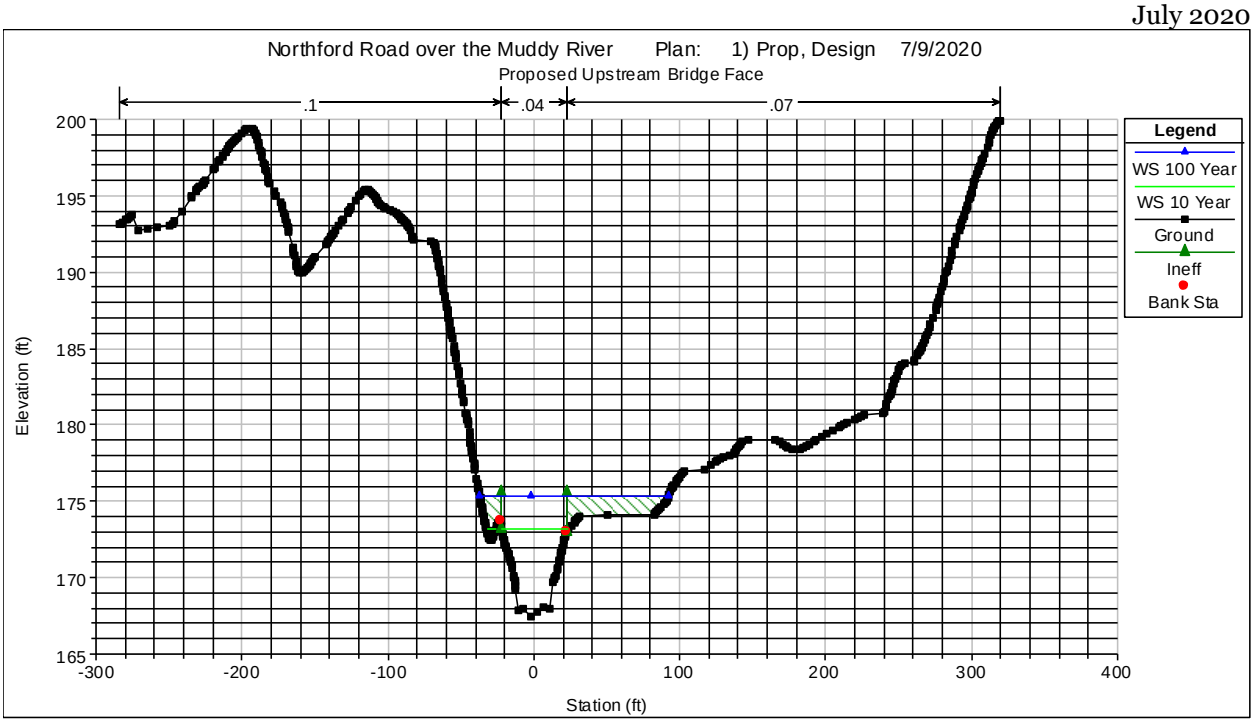
Northford Road over the Muddy River Plan: 1) Prop, Design 7/9/2020
Proposed Upstream Bridge Face
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Legend
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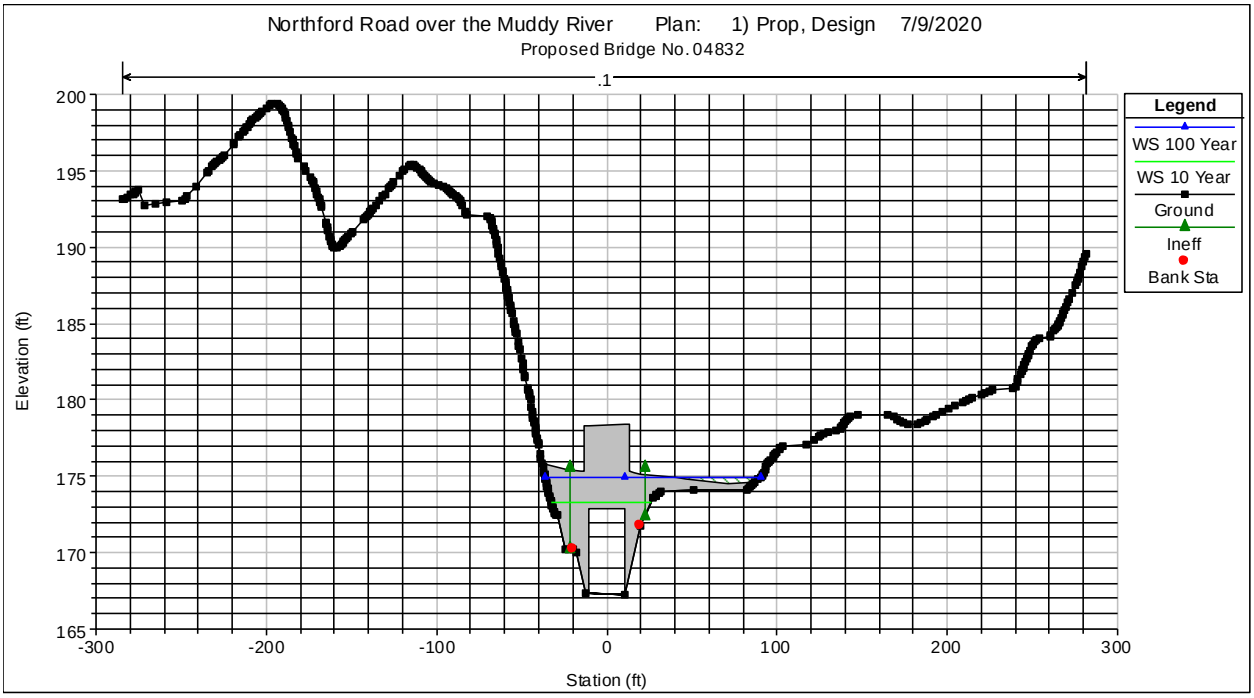
Northford Road over the Muddy River Plan: 1) Prop, Design 7/9/2020
Proposed Bridge No. 04832
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Legend
WS 100 Year
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Elevation (ft)
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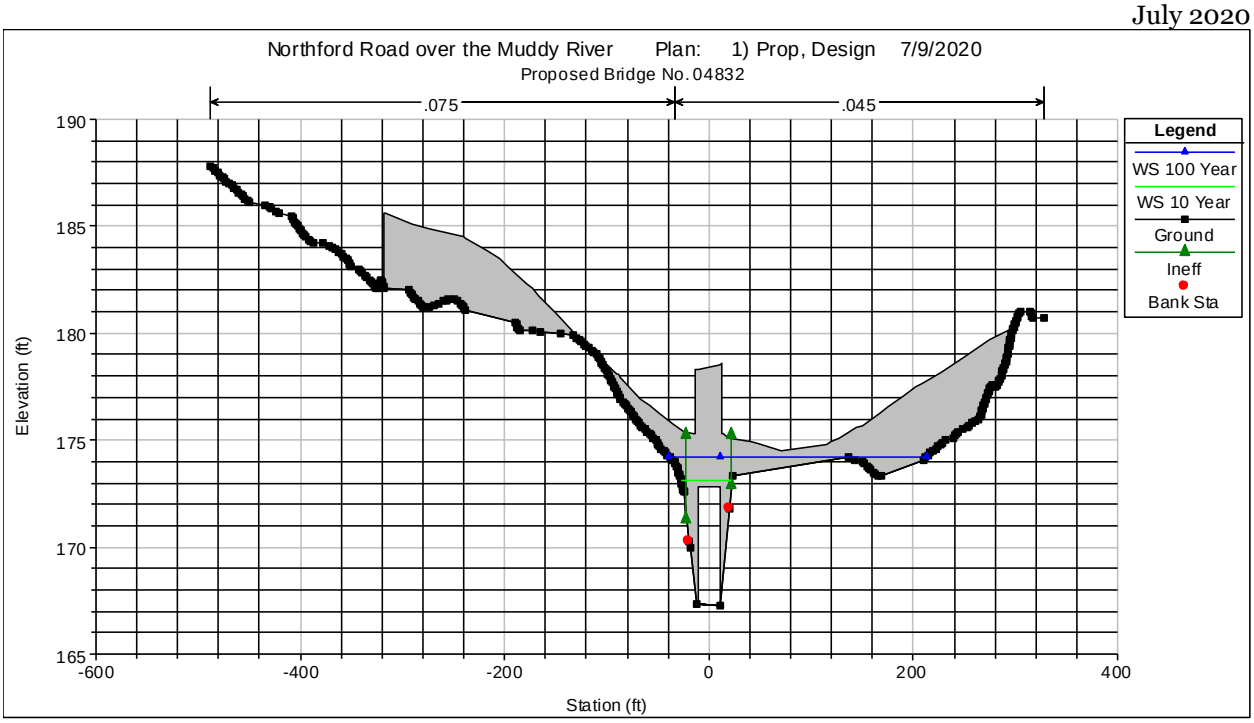
Northford Road over the Muddy River Plan: 1) Prop, Design 7/9/2020
Proposed Bridge No. 04832
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WS 10 Year
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Northford Road over the Muddy River Plan: 1) Prop, Design 7/9/2020
Proposed Downstream Bridge Face
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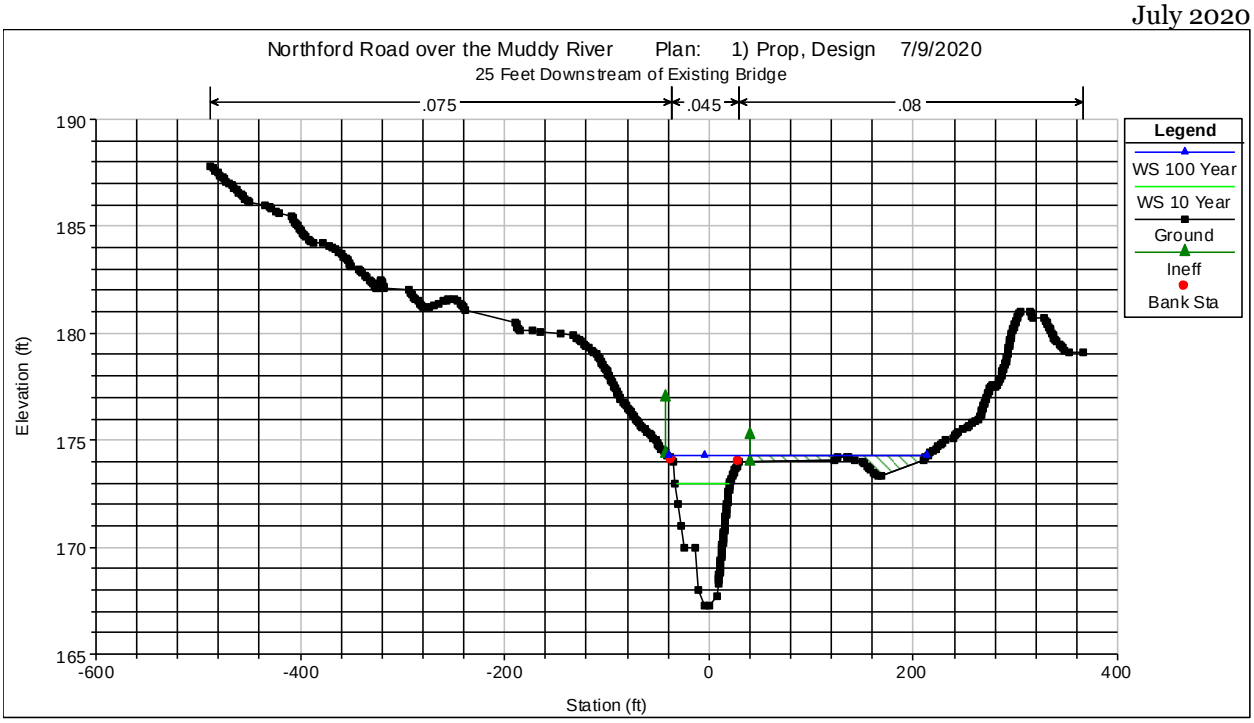
Northford Road over the Muddy River Plan: 1) Prop, Design 7/9/2020
25 Feet Downstream of Existing Bridge
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WS 100 Year
WS 10 Year
Ground
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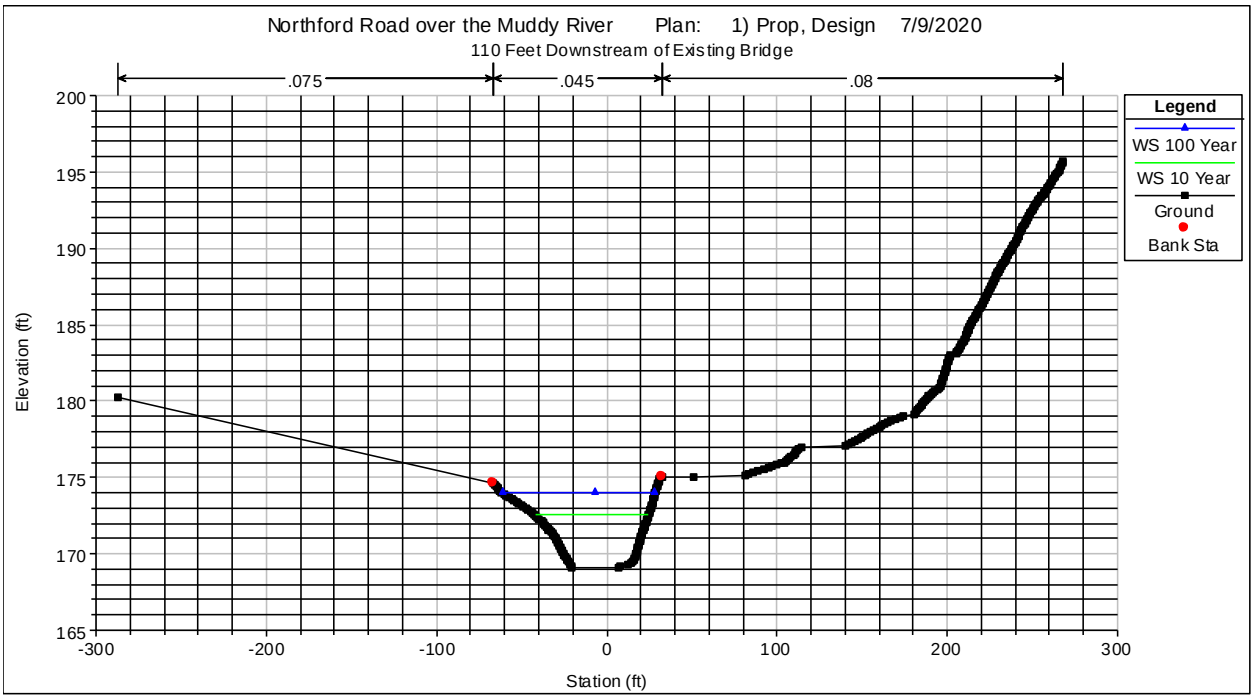
Northford Road over the Muddy River Plan: 1) Prop, Design 7/9/2020
110 Feet Downstream of Existing Bridge
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Legend
WS 100 Year
WS 10 Year
Ground
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Elevation (ft)
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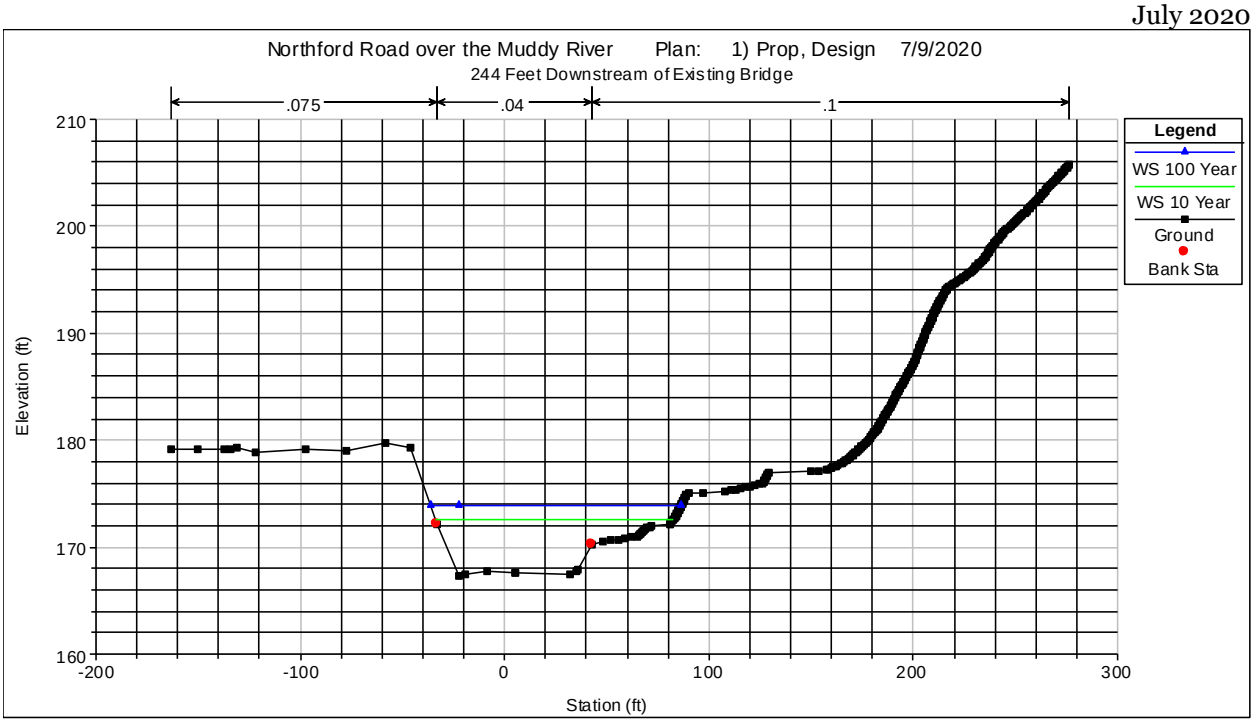
Northford Road over the Muddy River Plan: 1) Prop, Design 7/9/2020
244 Feet Downstream of Existing Bridge
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Legend
WS 100 Year
WS 10 Year
Ground
Bank Sta
Elevation (ft)
Station (ft)
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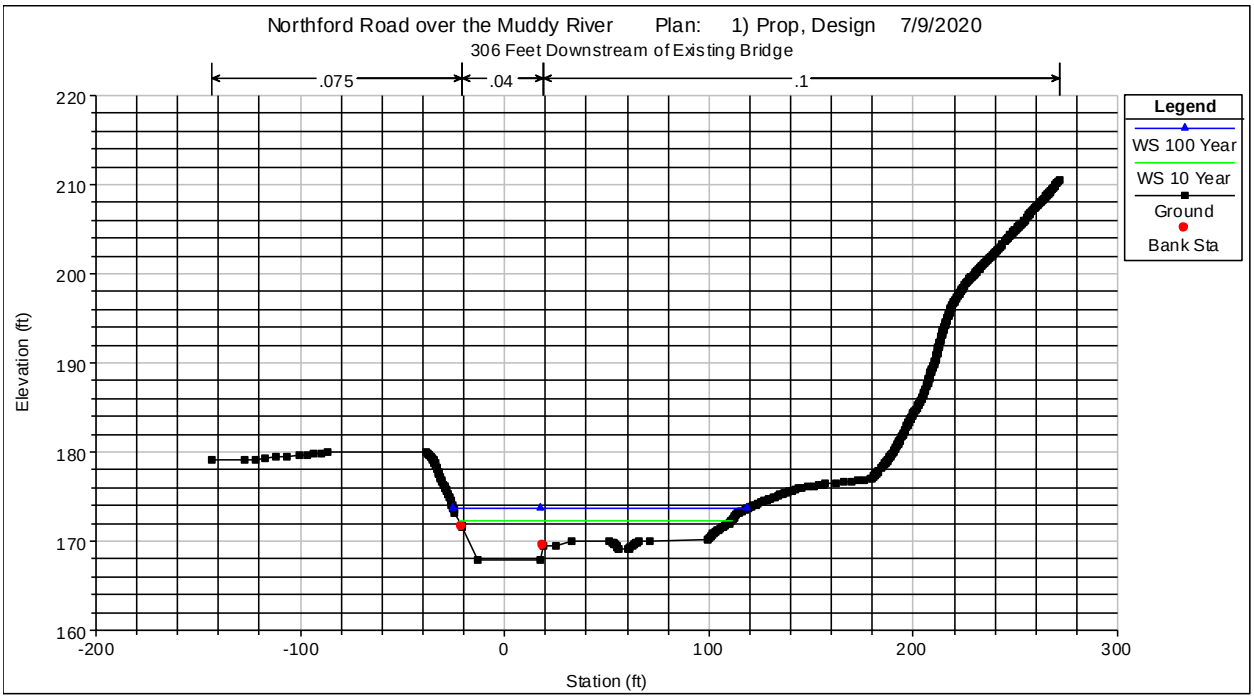
Northford Road over the Muddy River Plan: 1) Prop, Design 7/9/2020
306 Feet Downstream of Existing Bridge
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Legend
WS 100 Year
WS 10 Year
Ground
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Elevation (ft)
Station (ft)
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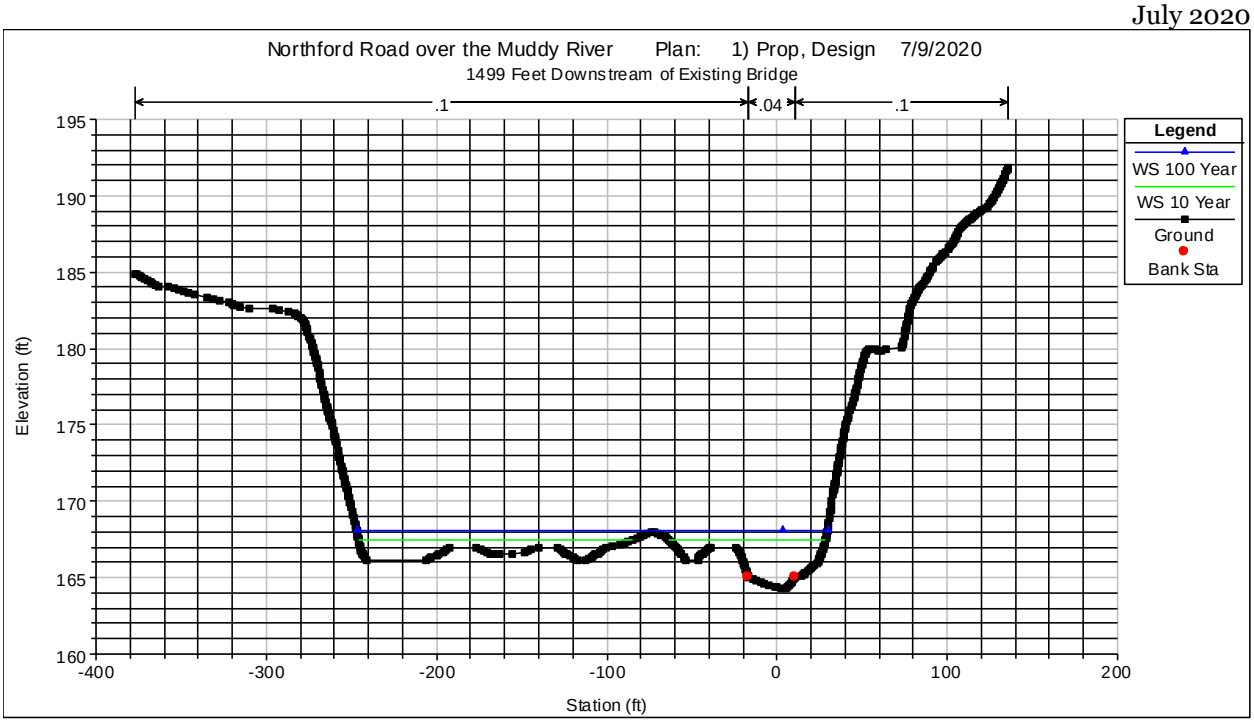

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Project Name: Northford Road over Muddy River
WMC Project Number: 16022
Bridge No.: 04832
ConnDOT Project No.: N/A
Calculation Date: June 30, 2020 **By:** MEF

Summary - Scour Depths

Semi-Final

Event Return (Years)	Flow Condition	Long-Term Aggradation and Degradation		Contraction Scour		Abutment (Local) Scour		Pier Scour	
		Aggrading, degrading, or stable condition?				#2 East	#1 West		
		Condition	Long-term Scour (Feet)	Pressure Flow (Y/N)	Scour Depth (Feet)	Left Abutment (Feet)	Right Abutment (Feet)	Pier 1 (Feet)	Pier 2 (Feet)
10	Live-Bed	Degrading	0.15	N	0.00	0.00	0.47	0.00	0.00
50	Live-Bed	Degrading	0.15	N	0.00	0.02	1.77	0.00	0.00
100	Live-Bed	Degrading	0.15	y	0.00	0.16	3.86	0.00	0.00
200	Live-Bed	Degrading	0.15	y	0.00	0.19	4.37	0.00	0.00

Summary - Scour Elevations

Channel Thalweg Elevation	HEC-18 Method							
167.25	Total Scour Depths				Scour Elevations			NAVD88
Event Return (Years)	Left (Feet)	Pier 1 (Feet)	Pier 2 (Feet)	Right (Feet)	Left (Feet)	Pier 1 (Feet)	Pier 2 (Feet)	Right (Feet)
10	0.15	0.00	0.00	0.62	167.10	N/A	N/A	166.63
50	0.17	0.00	0.00	1.92	167.08	N/A	N/A	165.33
100	0.31	0.00	0.00	4.01	166.94	N/A	N/A	163.24
200	0.34	0.00	0.00	4.52	166.91	N/A	N/A	162.73

Project Name:	**Northford Road over Muddy River**
WMC Project Number:	16022
Bridge No.:	04832
ConnDOT Project No.:	N/A
Calculation Date:	June 30, 2020
By:	MEF

SCOUR COMPUTATIONS

Per FHWA Hydraulic Engineering Circular #18, (HEC-18) *Evaluating Scour at Bridges* , 5th Ed., 2012

Determine the Flow Condition: Clear-Water or Live-Bed

$$V_c = K_u y^{1/6} D^{1/3}$$ **Equation 6.1**

V_c = Critical velocity above which bed material of size D and smaller will be transported, ft/s
K_u = Coefficient
= 11.17, English units
y = Average depth of flow upstream of the bridge, ft
D = Particle size for V_c, ft
D_{50} = Particle size in a mixture of which 50% are smaller, ft

Define Variables:

K_u =	11.17			
D_{50} =	0.0009	ft	**0.28**	**mm**

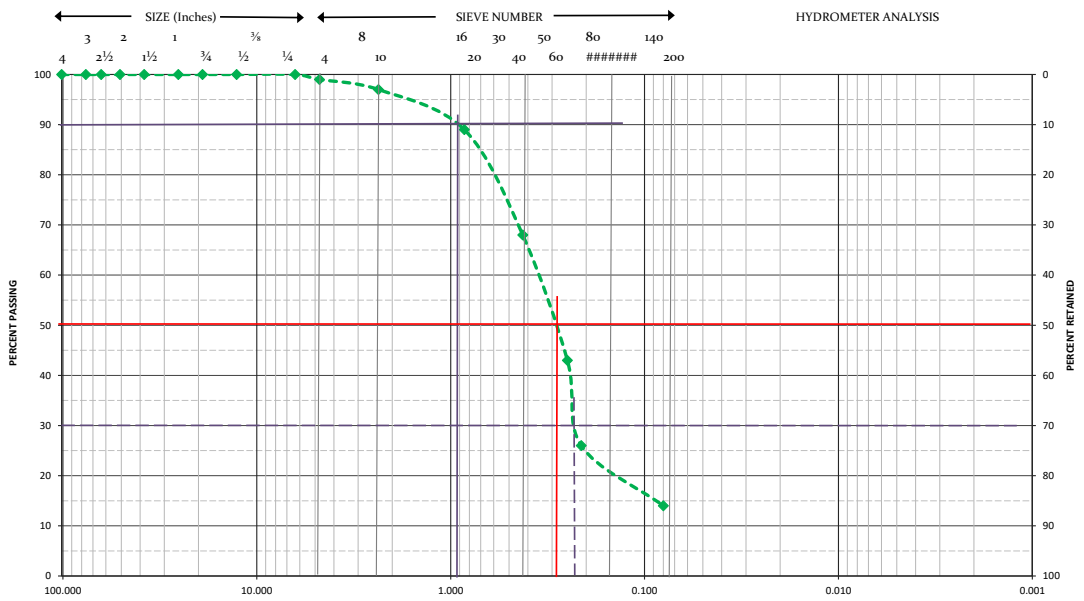
Determine Flow Condition:

	Event-Specific Variables	Events				Notes
		10-YR	50-YR	100-YR	200-YR	
y =	Channel Average Depth at Approach Section, feet	2.98	3.94	5.08	5.23	At Approach Section - 2614
V_c =	Critical Velocity, fps	1.30	1.36	1.42	1.43	Equation 6.1
V =	Channel Velocity in the Approach Section, fps	5.53	5.91	4.81	5.20	At Approach Section - 2614
	Flow Condition	**Live-Bed**	**Live-Bed**	**Live-Bed**	**Live-Bed**	
		Energy	Energy	Pressure	Pressure	

GRAIN SIZE DISTRIBUTION GRAPH - AGGREGATE GRADATION CHART

1. PROJECT	2. DATE

SIEVE ANALYSIS - US STANDARD SIEVE SIZES



D_{90} = #### D_{60} = #### D_{30} = ####
D_{85} = #### D_{50} = ####
D_{84} = #### D_{30} = #####

EXCAVATION ID	SAMPLE ID	LL	PL	PI	Cu = (D_{60}/D_{10})	Cc = (D_{30})²/(D_{60} x D_{10})	SOILS DESCRIPTION/REMARKS	CLASSIFICATION (USCS)
					6.36	2.99		

3. TECHNICIAN (*Signature*)	4. Plotted by (*Signature*)	5. CHECKED BY (*Signature*)

Project Name:	**Northford Road over Muddy River**		
WMC Project Number:	16022		
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Calculation Date:	June 30, 2020	**By:**	MEF

Long-term Aggradation/Degradation Estimate

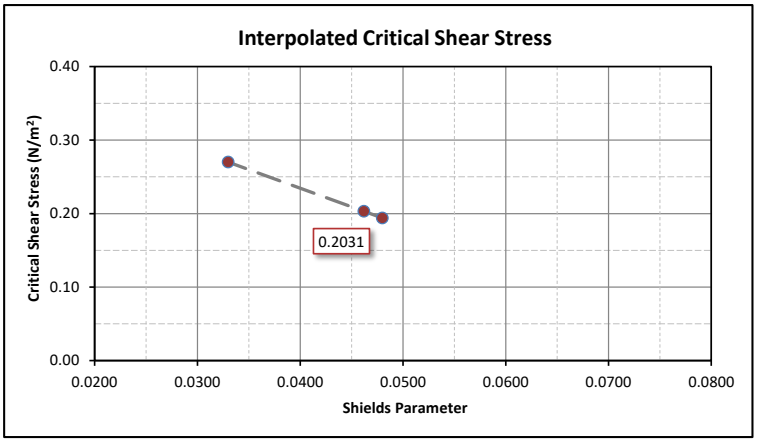
U.S. GEOLOGICAL SURVEY **Scientific Investigations Report 2008–5093**

Table 7. Critical shear stress by particle-size classification for determining approximate condition for sediment mobility at 20 degrees Celsius.

[Modified from Julien, 1998, table 7.1. Sediment mobility for a given particle size occurs when the bed shear stress exceeds the critical shear stress. This only determines whether or not a given particle size is mobile. Critical bed shear stress (τ_c) calculated from equation 4 using particle diameters from this table. Abbreviations: ϕ, phi scale where ϕ = -log2(diameter in mm); mm, millimeter; N/m², Newtons per square meter]

Particle classification name	Ranges of particle diameters		Shields parameter (dimensionless)	Critical bed shear stress (τ_c) (N/m²)	Bed Material
	ϕ	mm			
Coarse cobble	-7 – -8	128 – 256	0.054 – 0.054	112 – 223	Coarse
Fine cobble	-6 – -7	64 – 128	0.052 – 0.054	53.8 – 112	
Very coarse gravel	-5 – -6	32 – 64	0.050 – 0.052	25.9 – 53.8	
Coarse gravel	-4 – -5	16 – 32	0.047 – 0.050	12.2 – 25.9	
Medium gravel	-3 – -4	8 – 16	0.044 – 0.047	5.7 – 12.2	
Fine gravel	-2 – -3	4 – 8	0.042 – 0.044	2.7 – 5.7	Fine
Very fine gravel	-1 – -2	2 – 4	0.039 – 0.042	1.3 – 2.7	
Very coarse sand	0 – -1	1 – 2	0.029 – 0.039	0.47 – 1.3	
Coarse sand	1 – 0	0.5 – 1	0.033 – 0.029	0.27 – 0.47	
Medium sand	2 – 1	0.25 – 0.5	0.048 – 0.033	0.194 – 0.27	
Fine sand	3 – 2	0.125 – 0.25	0.072 – 0.048	0.145 – 0.194	
Very fine sand	4 – 3	0.0625 – 0.125	0.109 – 0.072	0.110 – 0.145	
Coarse silt	5 – 4	0.0310 – 0.0625	0.165 – 0.109	0.0826 – 0.110	
Medium silt	6 – 5	0.0156 – 0.0310	0.250 – 0.165	0.0630 – 0.0826	
Fine silt	7 – 6	0.0078 – 0.0156	0.300 – 0.250	0.0378 – 0.0630	

Soil Sample D_{50} (mm)		Shields Parameter (Dimensionless)		Critical bed shear stress (N/m²)	
0.25	Min.	Minimum	0.0480	0.1940	Minimum
0.28	Actual	Interpolated	0.0462	0.2031	Interpolated
0.50	Max.	Maximum	0.0330	0.2700	Maximum



D_{90} =	0.92	mm, or	0.0030	Feet
D_{50} =	0.28	mm, or	0.0009	Feet
D_{30} =	0.24	mm, or	0.0008	Feet
Calculated D_C =		Feet	0.0000	mm
		Interpolated T_C =	0.2031	N/m²
			0.0042	lb/ft²

Hydraulic Analysis Report

Project Data

Project Title:	Northford Road
Designer:	MEF
Project Date:	6/30/2020
Project Units:	U.S. Customary Units
Notes:	Calculate Long-term Scour

Bridge Scour Analysis: Long Term Scour Analysis

Notes: Use FHWA Hydraulic Toolbox v 4.2
Reference: FHWA-HIF-12-004, Hydraulic Engineering Circular No. 20
Stream Stability at Highway Structures, 4th Edition, 2012

Long-Term Scour
Computation Type: Controlled by Equillibrium Slope

Input Parameters (2-yr flood, approach cross section)		
D_{90}	########	ft
Shield's Parameter	0.0462	
Manning's n value	0.045	ft
Discharge per unit width	10.05	cfs/ft
Current slope	0.002	ft/ft
Distance upstream of base level control	100	ft
Results		
Equilibrium slope	0.0005	ft/ft
Ultimate degradation amount	0.15	ft

Project Name:	**Northford Road over Muddy River**
WMC Project Number:	16022
Bridge No.:	04832
ConnDOT Project No.:	N/A
Calculation Date:	June 30, 2020

By: MEF

SCOUR COMPUTATIONS

Per FHWA Hydraulic Engineering Circular #18, (HEC-18) *Evaluating Scour at Bridges* , 5th Ed., 2012

Determine Live-Bed Contraction Scour - Without Pressure - for the Proposed Condition

Compute y_2 for flow through bridge

$$Y_2 = Y_1\left(\frac{Q_2}{Q_1}\right)^{6/7}\left(\frac{W_1}{W_2}\right)^{k_1} \qquad \textbf{Equation 6.2}$$

$$y_s = y_2 - y_o \qquad \textbf{Equation 6.3}$$

- y_1 = Average Depth in the upstream main channel, ft
- y_2 = Average depth in the contracted section, ft
- y_o = Existing depth in the contracted section before scour, ft
- y_s = Average contraction scour depth, ft
- Q_1 = Flow in the upstream channel transporting sediment, ft^3/s
- Q_2 = Flow in the contracted channel, ft^3/s
- W_1 = Bottom width of the upstream channel that is supporting bed material, ft
- W_2 = Bottom width of the main channel in the contracted section less pier width(s), ft
- k_1 = Exponent determined below

V_*/w	k_1	Mode of Bed Material Transport
<0.50	0.59	Mostly contact bed material discharge
0.50 to 2.0	0.64	Some suspended bed material discharge
>2.0	0.69	Mostlly suspended bed materal discharge

- V_* = Shear velocity in the upstream section, ft/s
- = $(gy_1s_1)^{0.5}$
- w = Fall velocity of bed material based on the D_{50}, m/s **See Figure 6.8**
  For fall velocity in English units (ft/s) multiply by 3.28
- g = Acceleration due to gravity ($32.2\ ft/s^2$)
- S_1 = Slope of energy grade line of main channel, ft/ft
- T_o = Shear stress on the bed, lb/ft^2
- r = Density of water, 1.94 $slugs/ft^3$

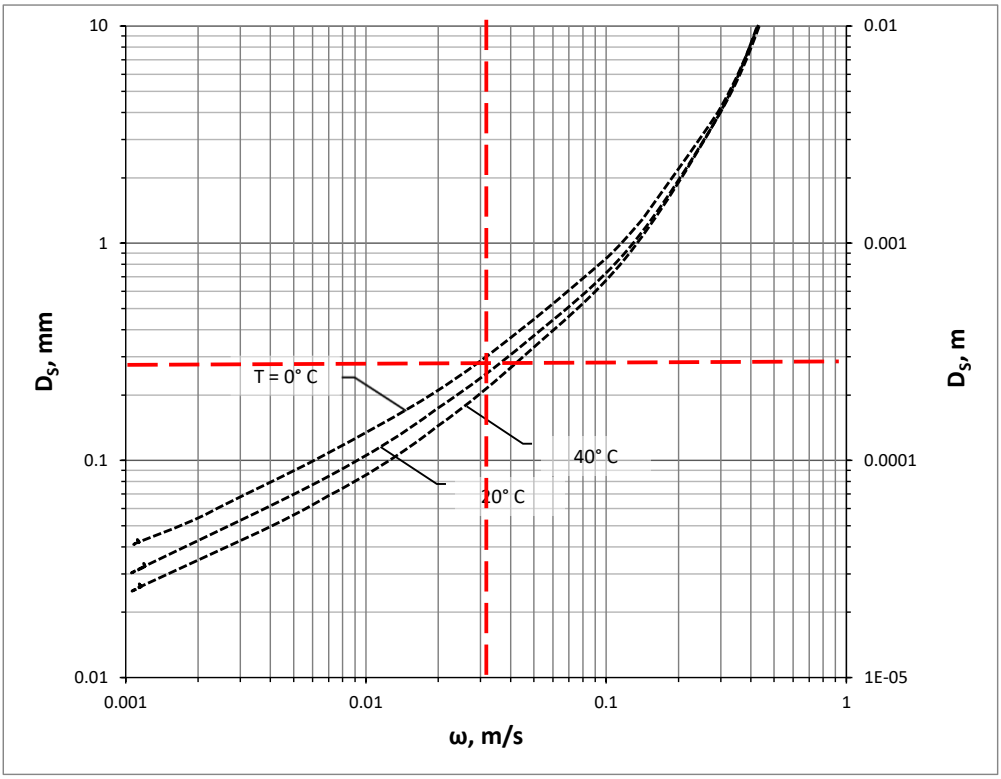


Figure 6.8

D_{50} = **0.28** **mm** or 0.0009 ft From analyzed sample

w = 0.03 m/s or 0.1017 ft/s

Assume T = 10° C

Event-Specific Variables		Flood Events 10-Yr	50-Yr	100-Yr	200-Yr	Notes
S_1 =		0.005423	0.004323			At U/S section, from HEC-RAS
y_1 =		2.98	3.94			At U/S section, from HEC-RAS
V_* =		**0.72**	**0.74**	**0.00**	**0.00**	Approaach = 2614
	V_*/w =	7.09	7.28	0.00	0.00	
Therefore:	k_1 =	0.69	0.69	0	0	

Event-Specific Variables	Flood Events 10-Yr	50-Yr	100-Yr	200-Yr	Notes
y_1 =	2.98	3.94	0.00	0.00	At U/S section, from HEC-RAS
y_0 =	5.12	6.07			At bridge, from HEC-RAS
Q_1 =	740.92	1053.28			At U/S section, from HEC-RAS
Q_2 =	741.40	1065.80			In contracted section, fron HEC-RAS
W_1 =	44.95	45.28			Width of U/S channel
W_2 =	39.42	39.42			Width in contracted section
k_1 =	0.69	0.69	0.00	0.00	
y_2 =	3.26	4.38	N/A	N/A	
y_s =	**0.00**	**0.00**	**N/A**	**N/A**	**Scour Depths**

Project Name:	**Northford Road over Muddy River**
WMC Project Number:	16022
Bridge No.:	04832
ConnDOT Project No.:	N/A
Calculation Date:	June 30, 2020 **By:** MEF

SCOUR COMPUTATIONS

Per FHWA Hydraulic Engineering Circular #18, (HEC-18) *Evaluating Scour at Bridges* , 5th Ed., 2012

Determine Live-Bed Contraction Scour - With Overtopping - for the Proposed Condition
Calculate by pressure-flow methodology

Part 1. Calculate effective upstream channel flow depth (h_{ue}) and discharge (Q_{ue})

Equation: $h_{ue} = h_b + T$

h_b = Bridge opening height (ft) - from design plans and hydraulic models
T = Deck thickness (ft) - from design plans, low chord to parapet top height

Define Variables:

Bridge Opening Area (A) =	267.06	SF
Hydraulic Opening (W) =	39.42	feet
Top of Parapet =	177.69	feet
Low Chord =	174.75	feet
h_b (A/W) =	6.77	feet
T =	2.94	feet
h_{ue} =	9.71	feet

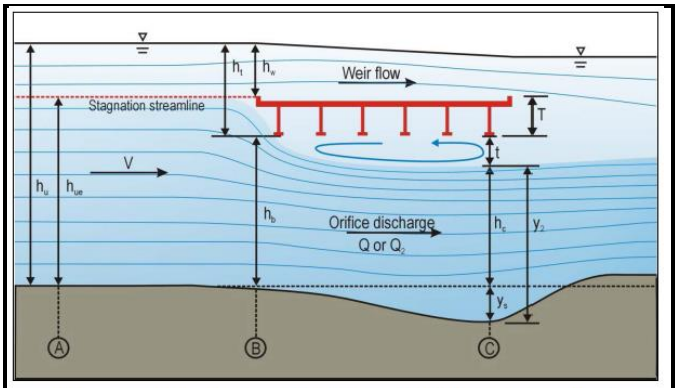


Figure 6.18. Vertical contraction and definition for geometric parameters.

Equation 6.15: $Q_{ue} = Q_1 \left(\frac{h_{ue}}{h_u} \right)^{8/7}$

Q_{ue} = Effective channel flow for live-bed condition and bridge overtopping, CFS
Q_1 = Upstream channel discharge, CFS
h_u = Upstream channel flow depth, feet

Event-Specific Variables	Events 10-YR	50-Yr	100-Yr	200-Yr	Notes
Q_1 =			1105.73	1230.55	At approach section, from HEC-RAS
Water Surface Elevation =			175.52	175.67	At approach section, from HEC-RAS
h_u =			5.08	5.23	Approach Section - 2614
Q_{ue} Check=	N/A	N/A	N/A	N/A	If $h_u < H_{ue}$, no change in Q_1
Q_{ue} =	**0.00**	**0.00**	**1105.73**	**1230.55**	Use Q_{ue} where computed, else Q_1

Part 2. Compute y_2 for flow through bridge

Equation:

$$Y_2 = Y_1\left(\frac{Q_2}{Q_1}\right)^{6/7}\left(\frac{W_1}{W_2}\right)^{k_1}$$

Equation 6.2

y_1 = Average depth in the upstream main channel, ft = h_{ue} in overtopping condition = h_b + T
y_2 = Average depth in the contracted section, ft
y_o = Existing depth in the contracted section before scour, ft
y_s = Average contraction scour depth, ft
Q_2 = Flow in the contracted channel, ft^3/s
W_1 = Width of the upstream channel that is supporting bed material, ft
W_2 = Width of the main channel in the contracted section less pier width(s), ft
k_1 = Exponent determined below

	k_1	Mode of Bed Material Transport
<0.50	0.59	Mostly contact bed material discharge
0.50 to 2.0	0.64	Some suspended bed material discharge
>2.0	0.69	Mostlly suspended bed materal discharge

V_* = Shear velocity in the upstream section, ft/s

$= (\vartheta_O \Delta)^{1/2}$

$= (gy_1s_1)^{1/2}$

w = Fall velocity of bed material based on the D_{50}, m/s **See Figure 6.8**
For fall velocity in English units (ft/s) multiply by 3.28
g = Acceleration due to gravity (32.2 ft/s^2)
S_1 = Slope of energy grade line of main channel, ft/ft
ϑ_O = Shear stress on the bed, lb/ft^2
Δ = Density of water, 1.94 $slugs/ft^3$

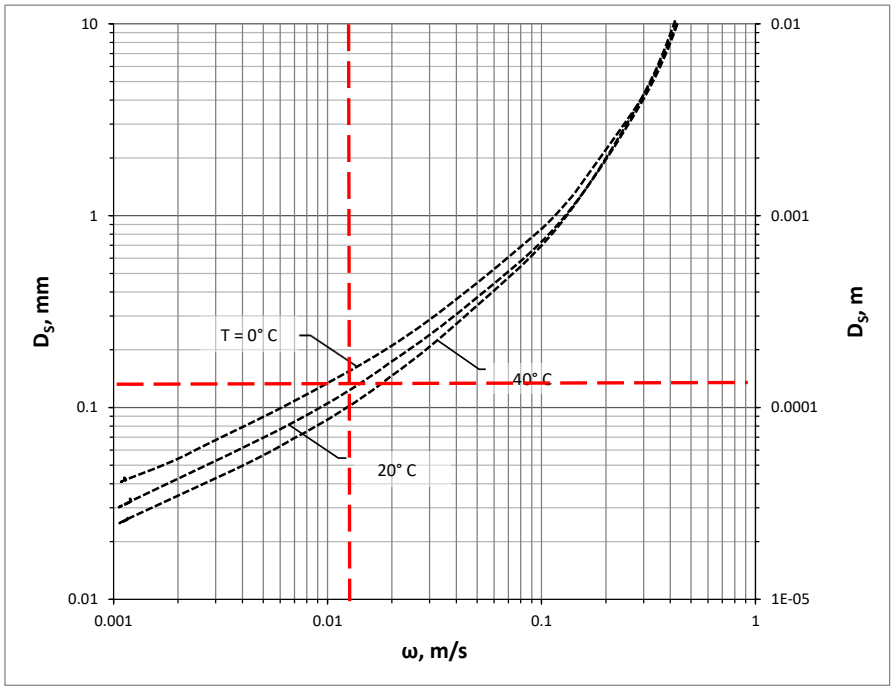


Figure 6.8

D_{50} = **0.280** **mm** or 0.0009 ft From analyzed sample

w = 0.014 m/s or 0.046 ft/s
Assume T = 10° C

Event-Specific Variables	Events				Notes
	10-YR	50-Yr	100-Yr	200-Yr	
S_1 =			0.002035	0.002290	Section 2614
y_1 =	0.00	0.00	5.08	5.23	Section 2614 or h_{ue}, as applicable
V_* =	**0.00**	**0.00**	**0.58**	**0.62**	
V_*/w =	0.00	0.00	12.56	13.52	
Therefore: k_1 =	0.59	0.59	0.69	0.69	

And: W_1 = 45.28 feet - from hydraulic model — Channel width at U/S section

W_2 = 39.42 feet - at bridge

Event-Specific Variables	Events				Notes
	Max Q 10-YR	50-Yr	100-Yr	200-Yr	
Q_2 =			1214.48	1369.29	In bridge opening, from HEC-RAS
Q_1 =	0.00	0.00	1105.73	1230.55	Q_1 or Q_{ue} From Part 1
y_2 =	**NA**	**NA**	**6.06**	**6.31**	

Part 3. Compute the separation zone thickness for the overtopping case

Equation:

$$t = 0.5\left(\frac{h_b \times h_t}{h_u^{\,2}}\right)^{0.2}\left(1-\frac{h_w}{h_t}\right)^{-0.1} h_b$$ **Equation 6.16**

h_t = Distance from the water surface to the lower face (low chord) of the bridge girders, equals $h_u - h_b$, feet

h_w = Weir flow height = $h_t - T$ for $h_t > T$, $h_w = 0$ for $h_t \le T$

t = Separation zone thickness, feet

Event-Specific Variables	Events				Notes
	Max Q 10-YR	50-Yr	100-Yr	200-Yr	
h_t =	0.00	0.00	0.00	0.00	
h_w =	0.00	0.00	0.00	0.00	
t =	**0.00**	**0.00**	**0.00**	**0.00**	

Part 4. Compute scour using Equation 6.14

Equation:

$$y_s = y_2 + t - h_b$$ **Equation 6.14**

h_b = 6.77 feet — From Part 1

Event-Specific Variables	Events				Notes
	Max Q 10-YR	50-Yr	100-Yr	200-Yr	
y_2 =	NA	NA	6.06	6.31	From Part 2
t =	0.00	0.00	0.00	0.00	From Part 3
y_s =	**NA**	**NA**	**0.00**	**0.00**	**Feet**

Worksheet - Calculate Froelich Equation values for local scour

Approach Section = 2614

Embankment Angle (θ) = 90 Degrees **Right** 1.57 Radians

Reciprocal Embankment Angle = 90 Degrees **Left** 1.57 Radians

WSEL = 173.22 **Upstream Face of Bridge** **10-year**

	Left	1			Right	2		Abutment ID
LOB =	#REF!	to	#REF!	**ROB =**	56.72	to	25.68	Overbank start/end
Total Length =		0.00	Ft	**Total Length =**		31.04	Ft	Overbank true length
Adj. Projected Length =		0.00	Ft	**Adj. Projected Length =**		31.04	Ft	Adjusted width - from embankment angle
Tube Mid Pt. Station =		#REF!	Ft	**Tube Mid Pt. Station =**		41.20	Ft	First overbank flow tube
Tube Mid Pt. Elevation =		0.00	Ft	**Tube Mid Pt. Elevation =**		177.62	Ft	Ground elevation for tube
V_{tube} =		#REF!	Ft/Sec	**V_{tube} =**		0.73	Ft/Sec	Velocity for tube
Y_{tube} =		#REF!	Ft	**Y_{tube} =**		0.32	Ft	Adjusted
q_{tube} =		#REF!	$Ft^3/S/Ft$	**q_{tube} =**		0.23	$Ft^3/S/Ft$	= V_{tube} x Y_{tube}
	L' =	0.00	Ft		**L' =**	4.62	Ft	= Q_e/q_{tube}
Froelich	**A_e =**	0.00	Ft^2	Froelich	**A_e =**	1.48	Ft^2	
Eq. Values	**Q_e =**	0.00	Ft^3/Sec	Eq. Values	**Q_e =**	1.08	Ft^3/Sec	= A_e x V_e
(Left)	**Y_a =**	0.00	Ft	(Right)	**Y_a =**	0.05	Ft	= A_e/Adj. L

Flow Tubes	Position	Left Station (ft)	Right Station (ft)	Flow (Q) (cfs)	Area (sq ft)	Percent Conv	Hydraulic Depth (ft)	Velocity (ft/s)	Adjusted for overtopping: Hydraulic Depth	Flow (Q')	Area (A')	Width (FT)	
										#REF!	#REF!	#REF!	Sums
1	Chan	-19.6	-15.07	31.17	8.82	4.2	2.1	3.53					
2	Chan	-15.07	-10.54	89.94	15.48	12.12	3.42	5.81					
3	Chan	-10.54	-6.02	102.57	16.68	13.82	3.68	6.15					
4	Chan	-6.02	-1.49	97	16.13	13.07	3.56	6.01					
5	Chan	-1.49	3.04	94.34	15.86	12.71	3.5	5.95					
6	Chan	3.04	7.57	100.57	16.49	13.55	3.64	6.1					
7	Chan	7.57	12.1	92.21	15.66	12.43	3.46	5.89					
8	Chan	12.1	16.62	75.21	13.9	10.14	3.07	5.41					
9	Chan	16.62	21.15	46.62	10.52	6.28	2.32	4.43					
10	Chan	21.15	25.68	11.29	4.5	1.52	0.99	2.51					
11	ROB	**25.68**	**56.72**	1.08	1.48	0.14	0.32	0.73	0.32	1.08	1.48	31.04	Tube Values
										1.08	1.48	31.04	Sums

WSEL =	174.16	Upstream Face of Bridge	50-year

Left	1		Right	2		Abutment ID
LOB = -19.60	to	-39.61	ROB = 56.72	to	25.68	Overbank start/end
Total Length =	20.01	Ft	Total Length =	31.04	Ft	Overbank true length
Adj. Projected Length =	20.01	Ft	Adj. Projected Length =	31.04	Ft	Adjusted width - from embankment angle
Tube Mid Pt. Station =	-29.61	Ft	Tube Mid Pt. Station =	41.20	Ft	First overbank flow tube
Tube Mid Pt. Elevation =	177.15	Ft	Tube Mid Pt. Elevation =	177.62	Ft	Ground elevation for tube
V_{tube} =	0.21	Ft/Sec	V_{tube} =	0.80	Ft/Sec	Velocity for tube
Y_{tube} =	0.18	Ft	Y_{tube} =	0.52	Ft	Adjusted
q_{tube} =	0.04	$Ft^2/S/Ft$	q_{tube} =	0.42	$Ft^2/S/Ft$	= V_{tube} x Y_{tube}
L' =	0.26	Ft	L' =	32.96	Ft	= Q_e/q_{tube}
Froelich A_e =	0.04	Ft^2	Froelich A_e =	18.57	Ft^2	
Eq. Values Q_e =	0.01	Ft^3/Sec	Eq. Values Q_e =	13.71	Ft^3/Sec	= A_e x V_e
(Left) Y_a =	0.00	Ft	(Right) Y_a =	0.30	Ft	= A_e/Adj. L

Flow Tubes	Position	Left Station (ft)	Right Station (ft)	Flow (Q) (cfs)	Area (sq ft)	Percent Conv	Hydraulic Depth (ft)	Velocity (ft/s)	Adjusted for overtopping: Hydraulic Depth	Flow (Q')	Area (A')	Width (FT)	
1	LOB	**-39.61**	**-19.60**	0.01	0.04	0.00	0.18	0.21	0.18	0.01	0.04	20.01	Tube Values
										0.01	0.04	20.01	Sums
2	Chan	-19.6	-15.07	50.89	13.15	4.77	2.9	3.87					
3	Chan	-15.07	-10.54	124.25	19.91	11.64	4.4	6.24					
4	Chan	-10.54	-6.02	137.92	21.11	12.93	4.66	6.53					
5	Chan	-6.02	-1.49	131.99	20.56	12.37	4.54	6.42					
6	Chan	-1.49	3.04	129.15	20.29	12.1	4.48	6.36					
7	Chan	3.04	7.57	135.78	20.92	12.73	4.62	6.49					
8	Chan	7.57	12.1	126.84	20.09	11.89	4.44	6.31					
9	Chan	12.1	16.62	108.31	18.33	10.15	4.05	5.91					
10	Chan	16.62	21.15	76.04	14.95	7.13	3.3	5.08					
11	Chan	21.15	25.68	32.12	8.93	3.01	1.97	3.6					
12	ROB	**25.68**	**56.72**	12.81	16.01	1.20	0.52	0.80	0.52	12.81	16.01	31.04	Tube Values
13	ROB	56.72	87.76	0.90	2.56	0.08	0.15	0.35	0.15	0.90	2.56	31.04	
										13.71	18.57	62.08	Sums

WSEL =	175.30	Upstream Face of Bridge	100-year

Left	1		Right	2		Abutment ID
LOB = -19.60	to	-39.61	ROB = 56.72	to	25.68	Overbank start/end
Total Length =	20.01	Ft	Total Length =	31.04	Ft	Overbank true length
Adj. Projected Length =	20.01	Ft	Adj. Projected Length =	31.04	Ft	Adjusted width - from embankment angle
Tube Mid Pt. Station =	-29.61	Ft	Tube Mid Pt. Station =	41.20	Ft	First overbank flow tube
Tube Mid Pt. Elevation =	177.15	Ft	Tube Mid Pt. Elevation =	177.62	Ft	Ground elevation for tube
V_{tube} =	0.38	Ft/Sec	V_{tube} =	1.26	Ft/Sec	Velocity for tube
Y_{tube} =	0.73	Ft	Y_{tube} =	1.66	Ft	Adjusted
q_{tube} =	0.28	$Ft^2/S/Ft$	q_{tube} =	2.09	$Ft^2/S/Ft$	= V_{tube} x Y_{tube}
	L' = 1.08	Ft		L' = 52.58	Ft	= Q_e/q_{tube}
Froelich	A_e = 0.80	Ft^2	Froelich	A_e = 101.59	Ft^2	
Eq. Values	Q_e = 0.30	Ft^3/Sec	Eq. Values	Q_e = 109.98	Ft^3/Sec	= A_e x V_e
(Left)	Y_a = 0.04	Ft	(Right)	Y_a = 1.09	Ft	= A_e/Adj. L

Flow Tubes	Position	Left Station (ft)	Right Station (ft)	Flow (Q) (cfs)	Area (sq ft)	Percent Conv	Hydraulic Depth (ft)	Velocity (ft/s)	Adjusted for overtopping: Hydraulic Depth	Flow (Q')	Area (A')	Width (FT)	
1	LOB	**-39.61**	**-19.60**	0.30	0.80	0.02	0.73	0.38	0.73	0.30	0.80	20.01	Tube Values
										0.30	0.80	20.01	Sums
2	Chan	-19.60	-15.07	61.54	18.33	5.06	4.05	3.36					
3	Chan	-15.07	-10.54	127.00	25.09	10.44	5.54	5.06					
4	Chan	-10.54	-6.02	138.21	26.30	11.37	5.81	5.26					
5	Chan	-6.02	-1.49	133.44	25.74	10.97	5.69	5.18					
6	Chan	-1.49	3.04	131.14	25.48	10.78	5.63	5.15					
7	Chan	3.04	7.57	136.48	26.10	11.22	5.76	5.23					
8	Chan	7.57	12.10	129.25	25.27	10.63	5.58	5.12					
9	Chan	12.10	16.62	114.01	23.51	9.38	5.19	4.85					
10	Chan	16.62	21.15	86.78	20.14	7.14	4.45	4.31					
11	Chan	21.15	25.68	47.88	14.11	3.94	3.12	3.39					
12	ROB	**25.68**	**56.72**	64.80	51.53	5.33	1.66	1.26	1.66	64.80	51.53	31.04	Tube Values
13	ROB	56.72	87.76	36.32	36.38	2.99	1.17	1.00	1.17	36.32	36.38	31.04	
14	ROB	87.76	118.80	8.86	13.68	0.73	0.61	0.65	0.61	8.86	13.68	31.04	
										109.98	101.59	93.12	Sums

WSEL =	175.38	Upstream Face of Bridge	200-year

Left	1		Right	2		Abutment ID
LOB = -19.60	to	-39.61	ROB = 56.72	to	25.68	Overbank start/end
Total Length =	20.01	Ft	Total Length =	31.04	Ft	Overbank true length
Adj. Projected Length =	20.01	Ft	Adj. Projected Length =	31.04	Ft	Adjusted width - from embankment angle
Tube Mid Pt. Station =	-29.61	Ft	Tube Mid Pt. Station =	41.20	Ft	First overbank flow tube
Tube Mid Pt. Elevation =	177.15	Ft	Tube Mid Pt. Elevation =	177.62	Ft	Ground elevation for tube
V_{tube} =	0.43	Ft/Sec	V_{tube} =	1.42	Ft/Sec	Velocity for tube
Y_{tube} =	0.81	Ft	Y_{tube} =	1.81	Ft	Adjusted
q_{tube} =	0.35	$Ft^2/S/Ft$	q_{tube} =	2.57	$Ft^2/S/Ft$	= V_{tube} x Y_{tube}
L' =	1.21	Ft	L' =	54.49	Ft	= Q_e/q_{tube}
Froelich A_e =	0.97	Ft^2	Froelich A_e =	114.21	Ft^2	
Eq. Values Q_e =	0.42	Ft^3/Sec	Eq. Values Q_e =	140.04	Ft^3/Sec	= A_e x V_e
(Left) Y_a =	0.05	Ft	(Right) Y_a =	1.23	Ft	= A_e/Adj. L

Flow Tubes	Position	Left Station (ft)	Right Station (ft)	Flow (Q) (cfs)	Area (sq ft)	Percent Conv	Hydraulic Depth (ft)	Velocity (ft/s)	Adjusted for overtopping: Hydraulic Depth	Flow (Q')	Area (A')	Width (FT)	
1	LOB	**-39.61**	**-19.60**	0.42	0.97	0.03	0.81	0.43	0.81	0.42	0.97	20.01	Tube Values
										0.42	0.97	20.01	Sums
2	Chan	-19.60	-15.07	69.39	19.00	5.06	4.20	3.65					
3	Chan	-15.07	-10.54	140.94	25.76	10.28	5.69	5.47					
4	Chan	-10.54	-6.02	153.07	26.97	11.17	5.96	5.68					
5	Chan	-6.02	-1.49	147.92	26.42	10.79	5.83	5.60					
6	Chan	-1.49	3.04	145.44	26.15	10.61	5.77	5.56					
7	Chan	3.04	7.57	151.21	26.77	11.03	5.91	5.65					
8	Chan	7.57	12.10	143.39	25.94	10.46	5.73	5.53					
9	Chan	12.10	16.62	126.90	24.18	9.26	5.34	5.25					
10	Chan	16.62	21.15	97.34	20.81	7.10	4.60	4.68					
11	Chan	21.15	25.68	54.94	14.78	4.01	3.26	3.72					
12	ROB	**25.68**	**56.72**	79.70	56.13	5.81	1.81	1.42	1.81	79.70	56.13	31.04	Tube Values
13	ROB	56.72	87.76	47.25	40.98	3.45	1.32	1.15	1.32	47.25	40.98	31.04	
14	ROB	87.76	118.80	13.09	17.10	0.95	0.71	0.77	0.71	13.09	17.10	31.04	
										140.04	114.21	93.12	Sums

Project Name:	**Northford Road over Muddy River**
WMC Project Number:	16022
Bridge No.:	04832
ConnDOT Project No.:	N/A
Calculation Date:	June 30, 2020

By: MEF

SCOUR COMPUTATIONS

Per FHWA Hydraulic Engineering Circular #18, (HEC-18) *Evaluating Scour at Bridges* , 5th Ed., 2012

Determine Local Abutment Scour for the Proposed Condition

Equation: $$Y_s/Y_a = 2.27K_1K_2\left(\frac{L'}{Y_a}\right)^{0.43} Fr^{0.61} + 0.05$$

Equation 8.1 (HEC-18) & Appendix 9.B of the ConnDOT Drainage Manual

Froelich's Live-Bed Abutment Scour Equation, As Amended, ConnDOT Drainage Manual, 2000

K_1 = Coefficient for abutment shape (Table 8.1 & Figure 8.6)

K_2 = Coefficient for angle of abutment to flow

K_2 = $(\theta/90)^{0.13}$ (see Figure 8.5 for a defintion)

θ<90° if embankment points downstream

θ>90° if embankment points upstream

L' = Length of active flow obstructed by the embankment, ft

A_e = Flow area of the approach cross section obstructed by the embankment, ft^2

Fr = Froude number of approach flow upstream of the abutment

= $V_e/(gy_a)^{1/2}$

V_e = Q_e/A_e ft/s

Q_e = Flow obstructed by the abutment and approach embankment, ft^3/s

Y_a = Average depth of flow on the floodplain (A_e/L), ft

Y_s = Scour Depth, ft

Table 8.1 Abutment Shape Coefficients.	
Description	K_1
Vertical-wall abutment	1.00
Vertical-wall abutment with wing walls	0.82
Spill-through abutment	0.55

K_1 = **0.82**

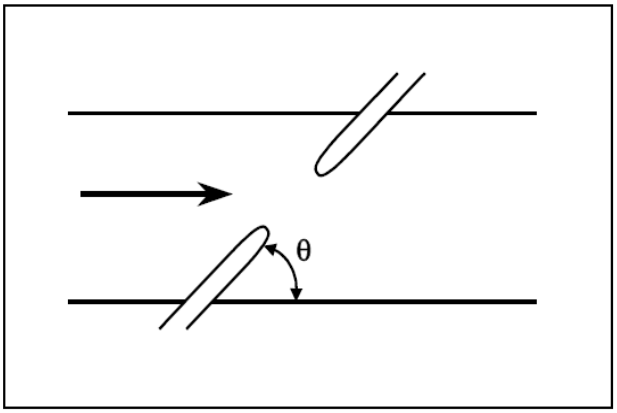


Figure 8.5. Orientation of embankment angle, 2, to the flow.

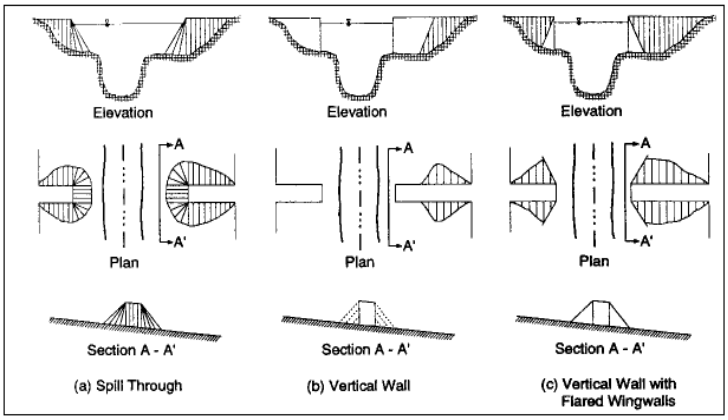


Figure 8.6. Abutment shape.

		Left		Right
q =		90	degrees	90
Therefore:	K_2 =	**1.00**		**1.00**

Compute Right Local Abutment Scour **Right is** **West** **abutment**

Event-Specific Variables	Flood Events 10-Yr	50-Yr	100-Yr	200-Yr	Notes
K_1 =	0.82	0.82	0.82	0.82	
K_2 =	1.00	1.00	1.00	1.00	
L' =	4.62	32.96	52.58	54.49	See abutment worksheets
A_e =	1.48	18.57	101.59	114.21	
Q_e =	1.08	13.71	109.98	140.04	
Y_a =	0.05	0.30	1.09	1.23	
V_e =	0.73	0.74	1.08	1.23	$V_e = Q_e/A_e$
g =	32.2	32.2	32.2	32.2	
Fr =	0.58	0.24	0.18	0.19	$V_e/(gY_a)^{0.5}$
Y_s =	0.47	1.77	3.86	4.37	Feet

Compute Left Local Abutment Scour **Left is** **East** **abutment**

Event-Specific Variables	Flood Events 0 10-Yr	50-Yr	100-Yr	200-Yr	Notes
K_1 =	0.82	0.82	0.82	0.82	
K_2 =	1.00	1.00	1.00	1.00	
L' =	0.00	0.26	1.08	1.21	
A_e =	0.00	0.04	0.80	0.97	
Q_e =	0.00	0.01	0.30	0.42	
Y_a =	0.00	0.00	0.04	0.05	
V_e =	0.00	0.25	0.38	0.43	$V_e = Q_e/A_e$
g =	32.2	32.2	32.2	32.2	
Fr =	0.00	1.39	0.33	0.34	$V_e/(gY_a)^{0.5}$
Y_s =	0.00	0.02	0.16	0.19	Feet

Riprap Revetment Design

HEC-23 "*Bridge Scour and Stream Instability Countermeasures: Experience, Selection, and Design Guidance*"
3rd Edition, September 2009

Design Guideline 4 - Riprap Revetment
After ACOE EM 1110-2-1601

$$d_{30} = y\left(S_f C_S C_V C_T\right)\left[\frac{V_{des}}{\sqrt{K_1\left(S_g - 1\right)gy}}\right]^{2.5} \qquad \text{Eq. 4.1}$$

d_{30} = Particle size for which 30% is finer by weight, ft
y = Local depth of flow, ft
S_f = Safety Factor (must be > 1.0)
C_S = Stability coefficient (for blanket thickness = d_{100} or $1.5d_{50}$, whichever is greater, and uniformity ratio d_{85}/d_{15} = 1.7 to 5.2)
C_V = Velocity distribution coefficient
= 1.0 for straight channels or the inside of bends
= 1.283 - 0.2log(R_c/W) for the outside of bends (1.0 for R_c/W> 26)
= 1.25 downstream from concrete channels
= 1.25 at the end of dikes
C_T = Blanket thickness coefficient given as a function of the uniformity ratio d_{85}/d_{15}
C_T = 1.0 is recommended because it is based on very limited data
V_{des} = Characteristic velocity for design, defined as the depth-averaged velocity at a point 20% upslope from the toe of the revetment, ft/s
For natural channels, $V_{des} = V_{avg}(1.74\text{-}0.52\log(R_c/W))$
$V_{des} = V_{avg}$ for $R_c/W > 8$
For trapezoidal channels, $V_{des} = V_{avg}(1.71\text{-}0.78\log(R_c/W))$
$V_{des} = V_{avg}$ for $R_c/W > 8$
V_{avg} = Channel cross-sectional average velocity, ft/s
K_1 = Side slope correction factor

$$K_1 = \sqrt{1 - \left(\frac{\sin(\theta - 14°)}{\sin(32°)}\right)^{1.6}}$$

where: θ is the bank angle in degrees

R_c = Centerline radius of curvature of channel bend, ft
W = Width of water surface at upstream end of channel bend, ft
S_g = Specific gravity of riprap (2.65 unless otherwise noted)
g = Acceleration due to gravity, 32.2 ft/s²
d_{50} = 1.2 x d_{30}

FHWA Nominal Riprap Class by Median Particle Diameter	
Size (Ft)	Class
0.000	I
0.667	II
0.917	III
1.167	IV
1.417	V
1.667	VI
1.917	VII
2.333	VIII
2.917	IX
3.417	X
4.000	> X

ConnDOT Riprap Type	
Size (Ft)	Class
0.000	Modified
0.500	Intermediate
0.833	Standard
1.875	Heavy

Table 4.1. Minimum and Maximum Allowable Particle Size in Inches.

Nominal Riprap Class by Median Particle Diameter		d_{15}		d_{50}		d_{85}		d_{100}
Class	Size	Min	Max	Min	Max	Min	Max	Max
I	6 in	3.7	5.2	5.7	6.9	7.8	9.2	12.0
II	9 in	5.5	7.8	8.5	10.5	11.5	14.0	18.0
III	12 in	7.3	10.5	11.5	14.0	15.5	18.5	24.0
IV	15 in	9.2	13.0	14.5	17.5	19.5	23.0	30.0
V	18 in	11.0	15.5	17.0	20.5	23.5	27.5	36.0
VI	21 in	13.0	18.5	20.0	24.0	27.5	32.5	42.0
VII	24 in	14.5	21.0	23.0	27.5	31.0	37.0	48.0
VIII	30 in	18.5	26.0	28.5	34.5	39.0	46.0	60.0
IX	36 in	22.0	31.5	34.0	41.5	47.0	55.5	72.0
X	42 in	25.5	36.5	40.0	48.5	54.5	64.5	84.0

Note: Particle size d corresponds to the intermediate ("B") axis of the particle.

Project Name: Northford Road over Muddy River
WMC Project Number: 16022
Bridge No.: 148-0028
ConnDOT Project No.: N/A
Calculation Date: July 1, 2020 **By:** MEF

Section = **2558** Section near U/S wall

Variable	Flood Event 10-yr	50-yr	100-yr	200-yr	Notes
y =	3.77	4.77	5.92	6.07	From HEC-RAS
V_{avg} =	3.65	4.12	3.55	3.87	From HEC-RAS
W =					From HEC-RAS
R_C =					Centerline radius
R_C/W =	99999	99999	99999	99999	If Rc is 0, then 99999
S_f =	1.1	1.1	1.1	1.1	Safety Factor (1.1 for bank revetments)
C_s =	0.375	0.375	0.375	0.375	Stability coefficient 0.300 for angular rock (default) 0.375 for rounded rock
Location	Straight	Straight	Straight	Straight	See C_v for options (below)
C_v =	1.00	1.00	1.00	1.00	1.0 for straight channels or inside of bends 1.283-0.2log(Rc/W) for outside of bends 1.0 for Rc/W > 26 1.25 downstream of concrete channels 1.25 at the end of dikes
C_T =	1.00	1.00	1.00	1.00	HEC-23 recommended value
Channel Type	Natural	Natural	Natural	Natural	Natural or Trapezoidal
V_{des} =	3.65	4.12	3.55	3.87	Natural channels: $V_{des} = V_{avg}(1.74 - 0.52(\log(R_C/W))$ $V_{des} = V_{avg}$ for $R_C/W > 26$ Trapezoidal channels: $V_{des} = V_{avg}(1.71 - 0.78(\log(R_C/W))$ $V_{des} = V_{avg}$ for $R_C/W > 8$
θ =	26.57	26.57	26.57	26.57	2 H:1V slope (Average)
K_1 =	0.87	0.87	0.87	0.87	
S_g =	2.65	2.65	2.65	2.65	Default Value = 2.65
D_{30} =	0.06	0.08	0.05	0.06	Feet
D_{50} =	0.07	0.10	0.06	0.08	Feet
D_{50} =	0.90	1.15	0.75	0.92	Inches
ConnDOT Riprap Size	Modified	Modified	Modified	Modified	
FHWA Riprap Class	I	I	I	I	

Use **Modified** **Riprap**

Riprap Type	D_{50} Inch	D_{50} Feet	Φ	Riprap Layer Thickness	Granular Filter Base Thickness
Modified	5	0.42	40.9°	12"	6"
Intermediate	8	0.67	41.0°	18"	6"
Standard	15	1.25	41.2°	36"	12"
Heavy	See ConnDOT or FHWA references				

Φ = Angle of Repose

WMC Consulting Engineers, Inc.
87 Holmes Road
Newington, CT 06111
(860) 667-9624

Project Name: Northford Road over Muddy River
WMC Project Number: 16022
Bridge No.: 148-0028
ConnDOT Project No.: N/A
Calculation Date: July 1, 2020 **By:** MEF

Section = **2531** Section near U/S face of proposed bridge

Variable	Flood Event 10-yr	50-yr	100-yr	200-yr	Notes
y =	3.84	4.78	5.92	6.00	From HEC-RAS
V_{avg} =	4.37	5.05	4.64	5.16	From HEC-RAS
W =					From HEC-RAS
R_C =					Centerline radius
R_C/W =	99999	99999	99999	99999	If Rc is 0, then 99999
S_f =	1.1	1.1	1.1	1.1	Safety Factor (1.1 for bank revetments)
C_s =	0.375	0.375	0.375	0.375	Stability coefficient 0.30 for angular rock (default) 0.375 for rounded rock
Location	Straight	Straight	Straight	Straight	See C_v for options (below)
C_v =	1.00	1.00	1.00	1.00	1.0 for straight channels or inside of bends 1.283-0.2log(Rc/W) for outside of bends 1.0 for Rc/W > 26 1.25 downstream of concrete channels 1.25 at the end of dikes
C_T =	1.00	1.00	1.00	1.00	HEC-23 recommended value
Channel Type	Natural	Natural	Natural	Natural	Natural or Trapezoidal
V_{des} =	4.37	5.05	4.64	5.16	Natural channels: $V_{des} = V_{avg}(1.74 - 0.52(\log(R_C/W))$ $V_{des} = V_{avg}$ for $R_C/W > 26$ Trapezoidal channels: $V_{des} = V_{avg}(1.71 - 0.78(\log(R_C/W))$ $V_{des} = V_{avg}$ for $R_C/W > 8$
θ =	26.57	26.57	26.57	26.57	2 H:1V slope (Average)
K_1 =	0.87	0.87	0.87	0.87	
S_g =	2.65	2.65	2.65	2.65	Default Value = 2.65
D_{30} =	0.10	0.13	0.10	0.13	Feet
D_{50} =	0.12	0.16	0.12	0.16	Feet
D_{50} =	1.40	1.91	1.46	1.90	Inches
ConnDOT Riprap Size	Modified	Modified	Modified	Modified	
FHWA Riprap Class	I	I	I	I	

Use **Modified** **Riprap**

Riprap Type	D_{50} Inch	D_{50} Feet	Φ	Riprap Layer Thickness	Granular Filter Base Thickness
Modified	5	0.42	40.9°	12"	6"
Intermediate	8	0.67	41.0°	18"	6"
Standard	15	1.25	41.2°	36"	12"
Heavy	See ConnDOT or FHWA references				

Φ = Angle of Repose

WMC Consulting Engineers, Inc.
87 Holmes Road
Newington, CT 06111
(860) 667-9624

Project Name: Northford Road over Muddy River
WMC Project Number: 16022
Bridge No.: 148-0028
ConnDOT Project No.: N/A
Calculation Date: July 1, 2020 **By:** MEF

Section = 2499 Section D/S of bridge

Variable	Flood Event 10-yr	50-yr	100-yr	200-yr	Notes
y =	3.81	4.56	4.92	5.22	From HEC-RAS
V_{avg} =	4.61	5.31	5.62	5.97	From HEC-RAS
W =					From HEC-RAS
R_C =					Centerline radius
R_C/W =	99999	99999	99999	99999	If Rc is 0, then 99999
S_f =	1.1	1.1	1.1	1.1	Safety Factor (1.1 for bank revetments)
C_s =	0.375	0.375	0.375	0.375	Stability coefficient 0.30 for angular rock (default) 0.375 for rounded rock
Location	Straight	Straight	Straight	Straight	See C_v for options (below)
C_v =	1.00	1.00	1.00	1.00	1.0 for straight channels or inside of bends 1.283-0.2log(Rc/W) for outside of bends 1.0 for Rc/W > 26 1.25 downstream of concrete channels 1.25 at the end of dikes
C_T =	1.00	1.00	1.00	1.00	HEC-23 recommended value
Channel Type	Natural	Natural	Natural	Natural	Natural or Trapezoidal
V_{des} =	4.61	5.31	5.62	5.97	Natural channels: $V_{des} = V_{avg}(1.74 - 0.52(\log(R_C/W))$ $V_{des} = V_{avg}$ for $R_C/W > 26$ Trapezoidal channels: $V_{des} = V_{avg}(1.71 - 0.78(\log(R_C/W))$ $V_{des} = V_{avg}$ for $R_C/W > 8$
θ =	26.57	26.57	26.57	26.57	2 H:1V slope (Average)
K_1 =	0.87	0.87	0.87	0.87	
S_g =	2.65	2.65	2.65	2.65	Default Value = 2.65
D_{30} =	0.11	0.15	0.17	0.20	Feet
D_{50} =	0.13	0.18	0.21	0.24	Feet
D_{50} =	1.61	2.19	2.47	2.83	Inches
ConnDOT Riprap Size	Modified	Modified	Modified	Modified	
FHWA Riprap Class	I	I	I	I	

Use **Modified** **Riprap**

Riprap Type	D_{50} Inch	D_{50} Feet	Φ	Riprap Layer Thickness	Granular Filter Base Thickness
Modified	5	0.42	40.9°	12"	6"
Intermediate	8	0.67	41.0°	18"	6"
Standard	15	1.25	41.2°	36"	12"
Heavy	See ConnDOT or FHWA references				

Φ = Angle of Repose

WMC Consulting Engineers, Inc.
87 Holmes Road
Newington, CT 06111
(860) 667-9624

Project Name: Northford Road over Muddy River
WMC Project Number: 16022
Bridge No.: 148-0028
ConnDOT Project No.: N/A
Calculation Date: July 1, 2020 **By:** MEF

Section = 2475 Section D/S of bridge - upstream of tributary

Variable	Flood Event 10-yr	50-yr	100-yr	200-yr	Notes
y =	3.58	3.85	4.04	4.37	From HEC-RAS
V_{avg} =	3.93	4.41	4.56	4.75	From HEC-RAS
W =					From HEC-RAS
R_C =					Centerline radius
R_C/W =	99999	99999	99999	99999	If Rc is 0, then 99999
S_f =	1.1	1.1	1.1	1.1	Safety Factor (1.1 for bank revetments)
C_s =	0.375	0.375	0.375	0.375	Stability coefficient 0.30 for angular rock (default) 0.375 for rounded rock
Location	Straight	Straight	Straight	Straight	See C_v for options (below)
C_v =	1.00	1.00	1.00	1.00	1.0 for straight channels or inside of bends 1.283-0.2log(Rc/W) for outside of bends 1.0 for Rc/W > 26 1.25 downstream of concrete channels 1.25 at the end of dikes
C_T =	1.00	1.00	1.00	1.00	HEC-23 recommended value
Channel Type	Natural	Natural	Natural	Natural	Natural or Trapezoidal
V_{des} =	3.93	4.41	4.56	4.75	Natural channels: $V_{des} = V_{avg}(1.74 - 0.52(\log(R_C/W))$ $V_{des} = V_{avg}$ for $R_C/W > 26$ Trapezoidal channels: $V_{des} = V_{avg}(1.71 - 0.78(\log(R_C/W))$ $V_{des} = V_{avg}$ for $R_C/W > 8$
θ =	26.57	26.57	26.57	26.57	2 H:1V slope (Average)
K_1 =	0.87	0.87	0.87	0.87	
S_g =	2.65	2.65	2.65	2.65	Default Value = 2.65
D_{30} =	0.08	0.10	0.11	0.12	Feet
D_{50} =	0.09	0.12	0.13	0.14	Feet
D_{50} =	1.09	1.43	1.54	1.67	Inches
ConnDOT Riprap Size	Modified	Modified	Modified	Modified	
FHWA Riprap Class	I	I	I	I	

Use **Modified** **Riprap**

Riprap Type	D_{50} Inch	D_{50} Feet	Φ	Riprap Layer Thickness	Granular Filter Base Thickness
Modified	5	0.42	40.9°	12"	6"
Intermediate	8	0.67	41.0°	18"	6"
Standard	15	1.25	41.2°	36"	12"
Heavy	See ConnDOT or FHWA references				

Φ = Angle of Repose

WMC Consulting Engineers, Inc.
87 Holmes Road
Newington, CT 06111
(860) 667-9624

Appendix D - Field Information

WMC Consulting Engineers
Newington, CT
(860) 667-9624

Appendix D Contents

Photo 1: Upstream Face

Photo 2: Looking upstream

Photo 3: Downstream face

Photo 4: Looking downstream

Photo 5: Looking Northwesterly

Photo 6: Looking Southeasterly

Structure No. 0 4832

Northford Road

over

Muddy River

{Spring Lake, Spring Brook & MacKenzie Reservoir-Upstream}
{Farm River - Downstream}

Wallingford

Northford Road - Mile Point 1.48

Routine Inspection

on

18-Feb-15

Inspected By Team No. 8 - CTDOT - Bridge Safety

For Area No. 7

TEAM: Forwarded to T.E. 3: D PAWLIKOWSKI Date: 2 20 15

T.E. 3: Reviewed By T.E. 3: D PAWLIKOWSKI Date: 2 24 15

BMM Required NO
Town Structure YES
Rating <= 5 {Item Nos. 58, 59, 60, 61 or 62} YES

Forwarded to Supervisor: T LAPIERRE Date: 4 30 15

Forwarded to "To Be Copied Drawer" _____ Date: _____

Date BRI-19 Entered 2 24 15

SUPERVISOR: Reviewed By Supervisor TPL Date: 5/14/15

Support: Date Copies Made: _____ BMM No. _____

Scanned By: _____ Date: _____ PDF Box No.: _____

NBIS: Yes

Last Inspection: April 29, 2013 Sufficiency Rating: 68.28

State of Connecticut - Department of Transportation
Bureau of Engineering & Construction - Bridge Safety & Evaluation

Bridge No.: 0 4832 **Town:** Wallingford

Location: Northford Road over Muddy River
{Spring Lake, Spring Brook & MacKenzie Reservoir - Upstream}
{Farm River - Downstream}

Inspection Date: February 18, 2015

TABLE OF CONTENTS

Bridge Number **04832**

Inspected By: Ferrara & Venoutsos

Sufficiency Rating 68.33
Previous Inspection Date 4/29/2013

NTM2 SR 68.28

BS&E Received ☐ Data Entry By: DP
Copies Made ☐ Data Entry Date: 2 24 15

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION
BRIDGE SAFETY & EVALUATION
STRUCTURE EVALUATION

SHEET____ OF____ (INSP. REPORT)

90) Inspection Date	Inspection Team	91) Frequency	Class:
02/18/15	808	24	01

Indepth Insp	Deck Survey	Access	Flagman
4/29/2013	1/1/1900 12:	0	0

CRITICAL FEATURE INSPECTIONS

	Type	Frequency	Team	Date
Fracture:				
Uwater:				
Special:				

RED FLAG ☐

IDENTIFICATION

Bridge Name
Town Name WALLINGFORD Town Code 78740
5) Inventory Route:
A) Record Type 1
B) Signing Prefix 5 City Street
C) Level of Service 0 None of the bel
D) Route Number 00000
E) Directional Suffix 0 NA
6) Feature Intersected MUDDY RIVER
7) Facility Carried: NORTHFORD ROAD
9) Location 0.5 MI S OF I-91
11) Milepoint 1.48 Miles
16) Latitude 41deg 26 min 42.00 sec
17) Longitude 72deg 46 min 48.00 sec
98) Border Bridge:
A) State Code
B) Percent Responsibility %
C) Border Town Name
99) Border Bridge Structure No

STRUCTURE TYPE AND MATERIAL

43) Structure Type, Main:
A) Material 3 Steel
B) Design Type 2 Stringer/Multi-beam or Girder
44) Structure Type, Approach:
A) Material 0 Other
B) Design Type 0 Other
45) Number of Spans, Main Unit 1
46) Number of Approach Spans 0
107) Deck Structure Type 1 Concrete Cast-in-Place
108) Wearing Surface/Protective System:
A) Type of Wearing Surface 6 Bituminous
B) Type of Membrane 0 None
C) Type of Deck Protection 0 None

AGE AND SERVICE

27) Year Built 1938
106) Year Reconstructed
42) Type of Service:
A) On 1 Highway
B) Under 5 WATERWAY
28) Number of Lanes:
A) On 2
B) Under
29) Average Daily Traffic 2200
2310 Half ADT?: No
109) Percent Truck 2%
30) Year of ADT 2010
2015
19) Bypass, Detour Length 4miles

GEOMETRIC DATA

48) Length of Max Span 22ft
49) Structure Length 27ft
50) Curb or Sidewalk Widths:
A) Left 0.0ft
B) Right 0.0ft
51) Brg Rdwy width,curb-curb 26.3ft
52) Deck Width, Out-Out 28.8ft
32) Approach Roadway Width 21ft
33) Bridge Median 0 No Median
Deck Area 778 sqft

34) Skew Angle 0deg
35) Structure Flared 0
10)Inv. Rte. Min. Vert Clearance 99ft 99in
47) Log Inv. Rte. Total Horiz Clr.: 26.3ft
47) RLog Inv. Rte. Total Horiz. Clr.: ft
53) Min Vert Clearance Over Bridge 99ft 99in
54) Min Vert Under Clearance N Ref 0ft 0in Ref
55) Min Lat Under Clearance on Right N Ref 99.9ft Ref
56) Min Lat Under Clearance on Left 0.0ft

BRIDGE COMMENTS

Northford Road - Inventory Route Log Direction - North..

STRUCTURE EVALUATION

SHEET 2 OF 2 FORM BRI-19 REV 10/00

SHEET_____ OF_____

Bridge Number	04832	NBIS Length	
Town Name	WALLINGFORD	Yes 27	
Facility Carried	NORTHFORD ROAD		
Feature Crossed	MUDDY RIVER		

Inspected By: Ferrara & Vavarsos

CLASSIFICATION

112) NBIS Bridge Length	Yes	
104) Highway System	0	Off System
26) Functional Class	7	Rural Major Collector
100) Defense Highway	0	Route is not a STRAHNET Route
101) Parallel Structure	N	No parallel structure exists
102) Direction of Traffic	2	2-way traffic
103) Temporary Structure		
110) Designated National Network	0	Not on national network
20) Toll	3	On Free Road
21) Maintain	3	Town or Township Highway Agency
22) Owner	3	Town or Township Highway Agency
Report Class	L	LOCAL
37) Historical Significance	5	Bridge is not eligible for National Register

WATERWAY

DrainageBasinCode	5299	
38) Navigation Control	0	No navigation control on waterway
39) Navigation Vert Clr.	0	
40) Navigation Horiz Clr.	0	
116) Vert-Lift Brg Nav Min		
111) Pier Abutment Protection		

PROPOSED IMPROVEMENTS

75A) Type of Work Proposed		
75B) Work Done By		
76) Length of Struct. Improvement		ft
94) Bridge Improvement Cost	$	
95) Roadway Improvement Cost	$	
96) Total Project Cost	$	
97) Year of Improvement Cost Est.		
114) Future ADT		115) Year Future ADT
List No.	Project No.	Advertised

POSTED SIGNS & UTILITIES

Other Posted Signs 1	0	Blank			
Other Posted Signs 2	0	Blank			
Actual P.L. Single Unit Truck		tons	Actual P.L. 4Axle Truck		tons
Rec. P.L. Single Unit Truck		tons	Rec. P.L. 4Axle Truck		tons
Actual P.L. Semi-TrailerTruck		tons	Actual P.L. 3S2 Truck		tons
Rec. P.L. Semi-TrailerTruck		tons	Rec. P.L. 3S2 Truck		tons
Rec. P.L. All Vehicles		tons	Actual P.L. All Vehicles		tons
Posted Vert Clearance On Bridge		ft in			ft In
Posted Vert UnderClearance		ft in			ft In
Posted Speed Limit	25	mph			mph
Utility					
Utility	0	Other			

LOAD RATING AND POSTING

31) Design Load	0	Evaluation Code	L	
63) Operating Rating Type	1	Year of Evaluation	1997	
64) Operating Rating	99.0 / 01.3	70) Bridge Posting	5	
65) Inventory Rating Type	1	41) Structure Status	A	A
66) Inventory Rating	60.0 / 06.8	Open, no restriction		

CONDITION

	Rating	By
58) Deck	5	5 AF
59) Superstructure	5	5 AF
60) Substructure	6	6 AF
61) Channel & Chan. Protection	7	7 AF
62) Culverts	N	

APPRAISALS

	Rating	By
67) Structure Evaluation	5	5
68) Deck Geometry	3	3 ✓
69) Under Clear Vert & Horiz	N	N
71) Waterway Adequacy	6	6 ✓
72) Approach Rdwy Alignment	5	5 ✓
113) Scour Critical	5	

Items 58 Thru 72 Checked By:

36) Traffic Safety Features:

A) Bridge Railings	0
B) Transitions	0
C) Approach Guardrail	0
D) Approach Guardrail End	0

OTHER FEATURES

Fence Required	No			Barrel Ladder	No
Fence Present	No			Stand Pipes	No
Fence Height	ft		ft	Cat Walks	No
Fence Type				Movable Inspection System	No
Fence Material				Loose Concrete Checked?	Yes
Fence Top Type					

INSPECTION COMMENTS

Proposed Next Indepth Insp Year 2023

Senior Parviz Mirzaee

Supervisor Theodore Lapierr

REVIEWED BY: [signature] Date 2/24/15

CT Prime 2015

DAVID PANCHOUTE

Abutment Stem Work Sheet

Bridge No.: 0 4832
Town: Wallingford
Facility Carried\Feature Intersected: Northford Road over Muddy River
{Spring Lake, Spring Brook & MacKenzie Reservoir - Upstream}
{Farm River - Downstream}

Abutment Stem No. or Nos.: Abutment Nos. 1 {South} & 2 {North}

Abutment Stem Design Type: Full Height\Closed Abutments - Gravity

Abutment Stem Material Type: Concrete

Abutment Stem Foundation Type: Unknown

Item No. 113 Scour Critical: - 5 - Scour Susceptible

Tidal: No **Rip Rap:** No

Exposed Footing: No

Footing Undermining: No

Sheet Piles - Timber or Steel: No

Bed Rock: Unknown **Concrete Apron:** No

Abutment Stem - In Water - At Normal Stage:

Normal Stage - The water stage prevailing during the greater part of the year.

Comments: Bridge Plans - No Bridge Plans Available - Year 1938

Prepared By: David Pawlikowski, P.E.
CTDOT - Bridge Safety

Date: February 24 2015

Connecticut Department of Transportation

Bridge Inspection Report BRI-18

Bridge #: 04832 **Inspection Date: 2/18/2015**

Inspection Type:	Routine	**Previous Inspection Date:**	4/29/2013	**Snooper Required:**	No
Inspection Performed By:	Team 8	**Feature Carried:**	NORTHFORD ROAD	**Snooper Used:**	No
Town:	WALLINGFORD	**Feature Intersected:**	MUDDY RIVER	**Year Built:**	1938
Location:	0.5 MI S OF I-91	**Main Design:**	Stringer/Multi-beam or Girder	**Year Rebuilt:**	-
Main Material:	Steel				

Visits

Visit Date:	Temp:	Start Time:	End Time:
2/18/2014	2	9:30:00 AM	10:45:00 AM

Inspectors:

Inspector:	Task:
A. Ferrara	Lead Inspector
P. Venoutsos	Lead Inspector

DECK: Inspected south to north.

East is the inlet.

Overall Rating: 5

	Rating	
OVERLAY:	7	Bituminous overlay exhibits: New overlay since the last inspection. (1) 3' long longitudinal crack at the south deck end. 40% light raveling.
DECK-STR. CONDITION:	5	The stay in place forms show extensive light rust and holes along the base. Some of the concrete deck is exposed and exhibits honeycomb and some deterioration. Isolated sections of the beam webs are also exposed.
CURBS:	N	West & East Parapet Height Approximately 42 inches.. Snow covered.
MEDIAN:	N	-
SIDEWALKS:	N	-
PARAPET:	3	West Parapet exhibits: West elevation: The upper portion exhibits horizontal cracking with and without efflorescence. The lower portion exhibits 58 sf of hollow concrete with horizontal cracking and efflorescence.

		+/- 8 sf of severe scale up to 2.5" deep. East elevation: 900 sf of severe scale, hollow concrete, punky concrete and map cracking with efflorescence. The cap exhibits 100% severe scale up to 3" deep. East Parapet exhibits: East elevation: A wood inclusion with an adjacent 4" diameter area of moderate scale. 5 sf of severe scale x 2.5" deep. West elevation: A 7" long vertical crack open 1/32". 8 sf total of light to moderate scale. The cap with a total of 3 sf of light to moderate scale. An 8" x 4" x 1" deep spall on the upper north end. The inside elevations are snow covered.
RAILING:	N	-
PAINT:	N	-
FENCE:	N	-
DRAINS:	4	Clay pipes through parapets for roadway drains: Broken ends of pipes. Drainage is causing severe deterioration on outside faces of parapets.
LIGHTING STANDARD:	N	-
UTILITIES TYPE/SIZE:	N	-
CONSTR JOINTS:	N	-
EXPANSION JOINTS:	N	-

59. SUPERSTRUCTURE: **Overall Rating:** 5

	Rating	
BEARING DEVICES:	6	Steel plates encased in substructure: Only front face of the plates is visible: shows light to heavy rust.
STRINGERS:	N	-
GIRDERS:	5	Encased Rolled Beams ("S" type) with exposed lower flanges exhibit: Bottom flanges are visible only, except where the stays in place forms have deteriorated. The exposed steel generally shows light to medium rust throughout. Heavy laminar rust on the lower flanges where the steel has been subjected to leakage located along the fascia beams and the beam ends. Fascia Beams: The inside legs of the lower flanges show varying degrees of laminar rust and section loss. Beam # 1: Bottom flange starting 7'-06" out from A-1 for a length of 5'-03", the inside leg "toe" measurement is down to knife edge and the "heel" measurement (taken adjacent to the concrete) is down to .354". The bottom flange width is down to 5-3/8" from the original 6". Beams # 1, 10 and 11: Section loss on the east side of the bottom flange for beams 1 and 10 and west side of beam 11 adjacent to A-1 x 8" long. "Toe measurement is .130" and the "heel" measurement is down to .393" (taken adjacent to the concrete). The bottom flange width is down to 5-1/2" from the original 6". Beam # 11: Section loss at mid span x 18" long. "Toe" measurement is knife edge and the "heel" measurement is down to .335" (taken adjacent to the concrete). The bottom flange width is down to 5-3/8" from the original 6". Note: Very little change in section loss measurements.
FLOOR BEAMS:	N	-
TRUSSES-GENERAL:	N	-
TRUSSES-PORTALS:	N	-
TRUSSES-BRACING:	N	-
PAINT:	3	The beams show no paint remaining.
RUST:	5	See above items.
MACHINERY MOV SPAN:	N	-
RIVETS & BOLTS:	N	-
WELDS - CRACKS:	8	The fascia beams show clip angle attachments welded to the to the bottom flanges.
TIMBER DECAY:	N	-

CONCRETE CRACKING:	N	-
COLLISION DAMAGE:	8	-
MEMBER ALIGNMENT:	8	-
DEFLECT. UNDER LOAD:	N	-
VIBRATION UNDER LOAD:	N	-
STAND PIPES:	N	-
BARREL LADDERS:	N	-

ARE BARREL LADDERS OSHA COMPLIANT? NA

---

60. SUBSTRUCTURE: **Overall Rating:** 6

	Rating	
ABUTMENTS-STEM:	6	Abutments exhibit: Light to medium scale at and below the waterline. See settlement and wings. Wings are monolithic with abutments.
ABUTMENTS-BACKWALL:	6	Backwalls (where visible) exhibit: Minor efflorescence. Areas of honeycomb. Light scale throughout.
ABUTMENTS-FOOTINGS:	N	Not visible.
ABUTMENTS-SETTLEMENT:	6	Southwest wingwall: Full height diagonal crack open 1/4" +/-, starting at the slab. Wingwalls Integral with stem wall.
ABUTMENTS-WINGWALLS:	5	Wingwalls exhibit: Southwest: Full height diagonal crack, open 1/4" +/-. Vertical hairline crack with efflorescence. Scale areas totaling 5 sf x 1.5" deep. A couple of small hollow areas totaling 1 sf. Southeast: 5 square feet of heavy scale along the top. Hollow concrete areas. 4 square feet of heavy scale on the front face. Northwest: Heavy scale at the bottom approximately 10 sf with adjacent hollow area. Diagonal hairline crack.

		Northeast: A few small spalls and hairline cracks.
PIERS/BENTS-CAPS:	N	-
PIERS/BENTS-PILE BENT:	N	-
PIERS/BENTS-COLUMNS:	N	-
PIERS/BENTS-FOOTING:	N	-
PIERS/BENTS-SETTLMT:	N	-
EROSION-SCOUR:	8	See channel scour.
CONCRETE CRACK-SPALL:	5	See above.
STEEL CORROSION:	N	-
PAINT:	N	-
TIMBER DECAY:	N	-
COLLISION DAMAGE:	8	-
DEBRIS:	N	-

---

61. CHANNEL & CHANNEL PROTECTION: **Overall Rating:** 7

	Rating	
CHANNEL SCOUR:	7	Freeboard: 50", measurement taken 1' out from A-1. Water depths upstream range from 4" to 7" deep. Water depths under the structure range from 6" to 17" deep. Water depths downstream range from 13" to 18" deep.
EMBANKMENT EROSION:	7	Minor undrcutting at the southwest.
DEBRIS:	7	A steel fence post with a concrete base is in the channel at the inlet. Moderate accumulation of limbs, brush and debris lying along the embankments. Brush overhanging the downstream embankments.
VEGETATION:	6	Embankments are well vegetated.
CHANNEL CHANGE:	7	Reservoir control spillway located +/- 300' upstream.
FENDER SYSTEM:	N	-
SPUR, DIKES &	N	-

JETTIES:		
RIP RAP:	N	-

62. CULVERTS & RETAINING WALL: -

Overall Rating: N

65. APPROACH CONDITION

Overall Rating: 6

	Rating	
APPROACH SLAB:	N	-
RELIEF JOINTS:	N	-
APPROACH GUIDE RAIL:	7	MBR exhibits: Random minor scrapes and dents. Snow covered.
APPROACH PAVEMENT:	8	Bituminous exhibits: New overlay.
APPROACH EMBANKMENT:	8	Snow covered.

TRAFFIC SAFETY FEATURES

	Rating	
BRIDGE RAILINGS:	Last Inspection: 0 Current: 0	-
TRANSITIONS:	Last Inspection: 0 Current: 0	-
APPROACH GUARDRAILS:	Last Inspection: 0 Current: 0	-
APPR. GUARDRAIL ENDS:	Last Inspection: 0 Current: 0	-

66. LOAD

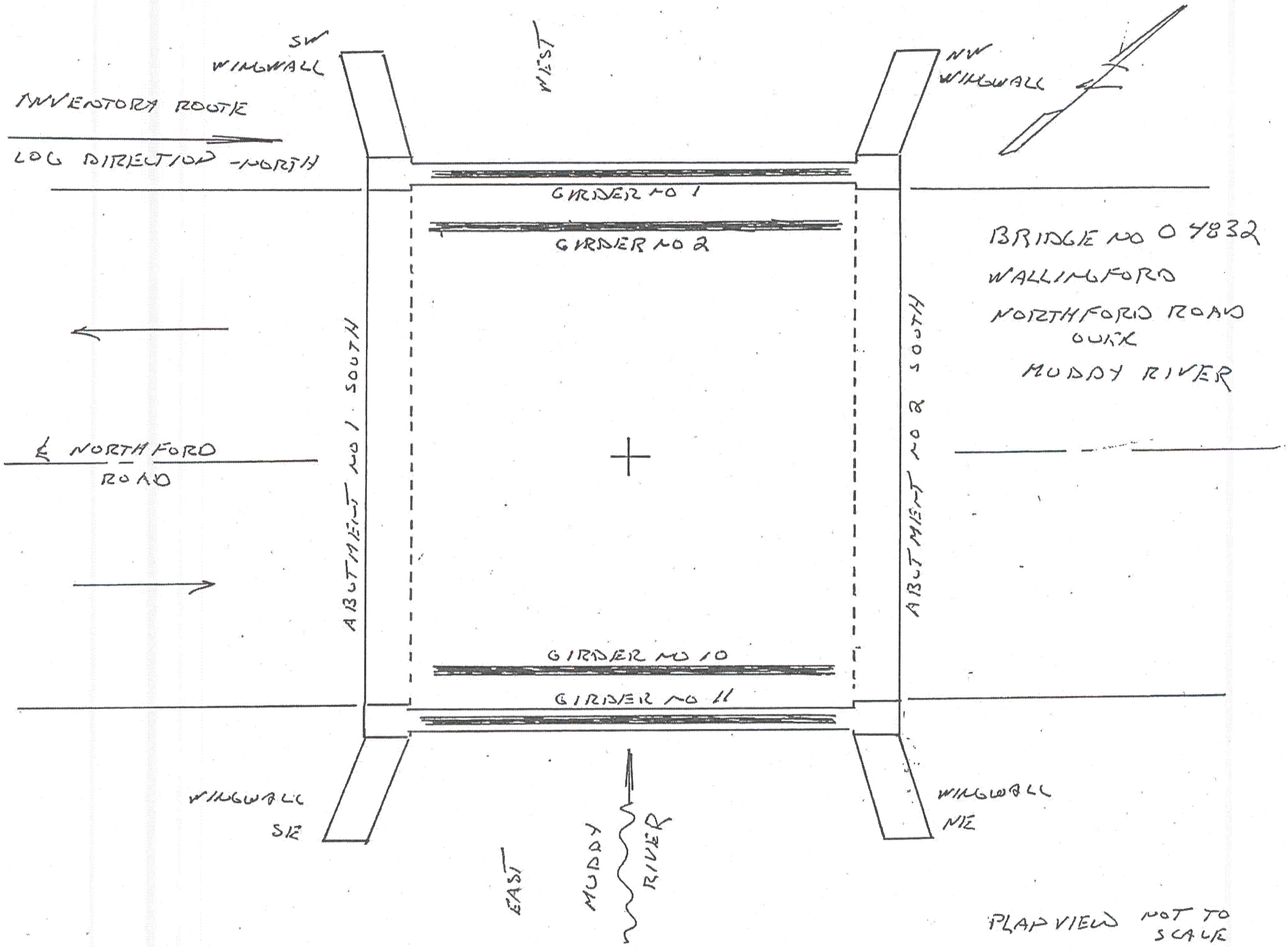
POSTING

	- Posted Loading -	
SINGLE UNIT (TONS):	Last Inspection: - Current: -	-
SEMI TRAILER (TONS):	Last Inspection: - Current: -	-
4 AXLE (TONS):	Last Inspection: - Current: -	-
3S2 (TONS):	Last Inspection: - Current: -	-
ADVANCE WARNING (Y/N):	N	-
LEGIBILITY:	N	-
VISIBILITY/LOCATION:	N	-

67. MISCELLANEOUS

	Rating	
MIN. VERT. UNDERCLEARANCE:	Last Inspection: 0' 0" Current: -' -"	-
POSTED CLR. UNDER BRIDGE:	Last Inspection: -' -" Current: -' -"	-
POSTED CLR. ON BRIDGE:	Last Inspection: -' -" Current: -' -"	-
ADVANCED WARNING (YES/NO):	No	-
SPEED LIMIT (IF ANY):	Last Inspection: - Current: 55	-
CHARACTER OF TRAFIC:		Light volume with mixed weights.
ADDITIONAL NOTES:		The inventory direction is south to north.
ADDITIONAL COMMENTS:		-

Inspectors' Signatures:	1)	**Date:** 2/20/15
	2)	**Date:** 02/23/15
	3)	**Date:** ----/----/-----
	4)	**Date:** ----/----/-----
P.E. Signature:		**Date:** ----/----/-----
P.E. #:	20879	**Date:** 2/24/15
Reviewed by:	conndot DAVID D'ALLESSANDRO	**Date:** 2/24/15

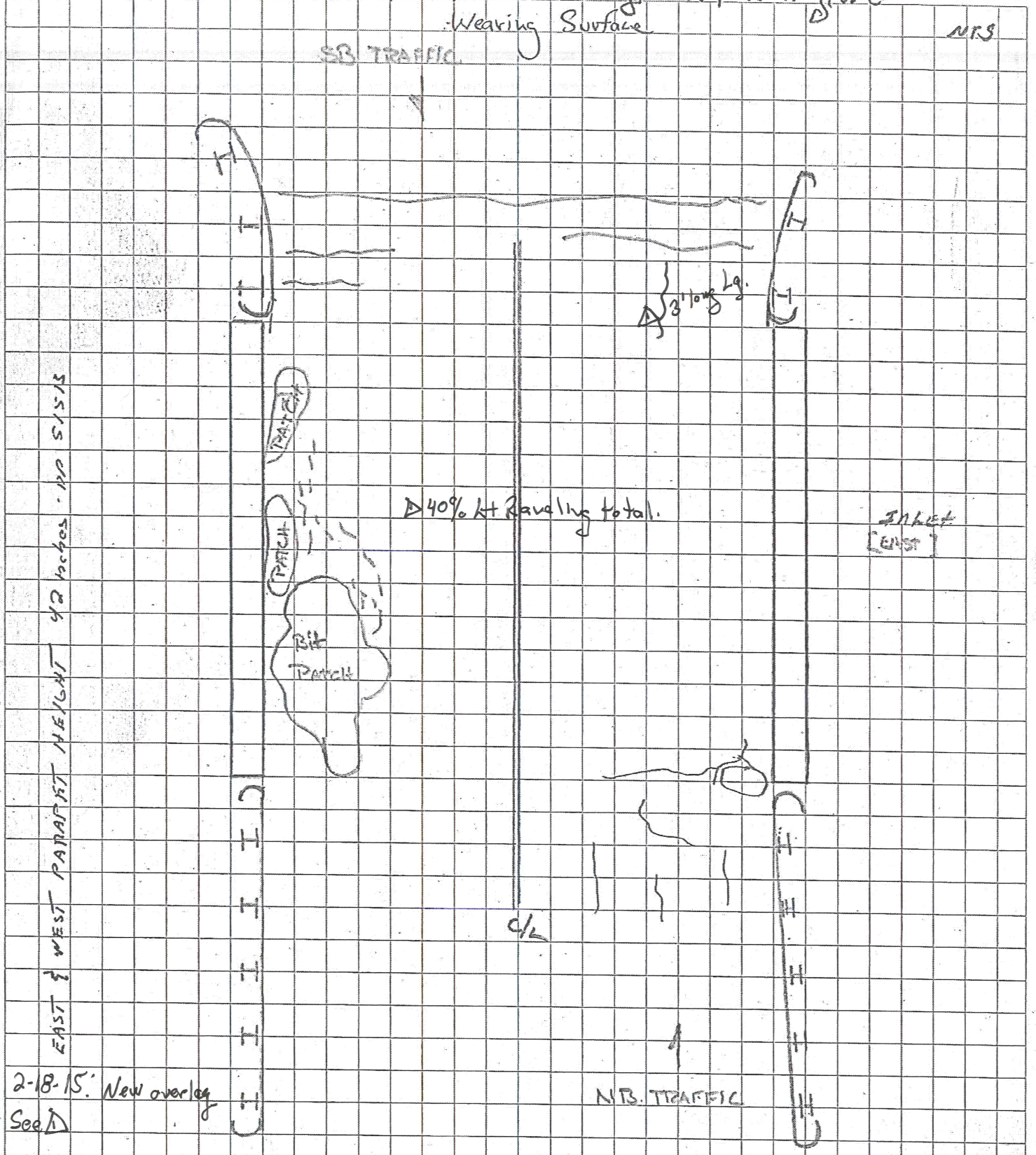

SW WINGWALL
WEST
NW WINGWALL
INVENTORY ROUTE
LOG DIRECTION - NORTH
GIRDER NO 1
GIRDER NO 2
BRIDGE NO 0 4832
WALLINGFORD
NORTHFORD ROAD
OVER
MUDDY RIVER
℄ NORTHFORD ROAD
ABUTMENT NO 1 SOUTH
ABUTMENT NO 2 SOUTH
GIRDER NO 10
GIRDER NO 11
WINGWALL SE
WINGWALL NE
EAST
MUDDY RIVER
PLAN VIEW NOT TO SCALE

DATE PREPARED	PREPARED BY	State of Connecticut Department of Transportation Bureau of Engineering & Highway Operations DES-003 REV 1-93 (302-06-0225) COMPUTATION SHEET	ORGANIZATION UNIT NO.	WORK ORDER NO.
1-29-13	P.V.			
DATE CHECKED	CHECKED BY			SHEET NO.

SUBJECT:

Bridge 7832 Northford Rd -o- Muddy River, Wallingford

Wearing Surface



2-18-15. New overlay

See Δ

DATE PREPARED	PREPARED BY	State of Connecticut Department of Transportation Bureau of Engineering & Highway Operations DES-003 REV 1-93 (302-06-0225) COMPUTATION SHEET	ORGANIZATION UNIT NO.	WORK ORDER NO.
4-29-13	AE			
DATE CHECKED	CHECKED BY			SHEET NO.

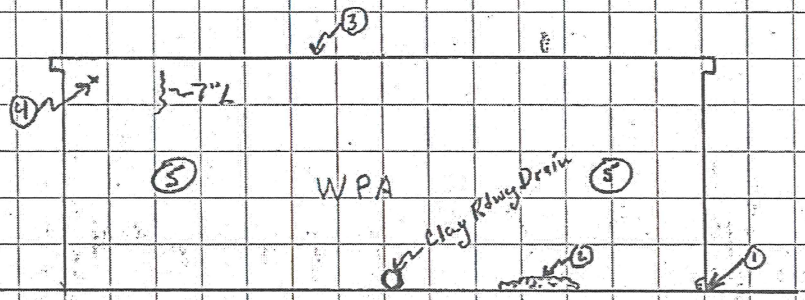
SUBJECT:

Br # 04832 Northford Road -o- Muddy River, Wallingford

NTS

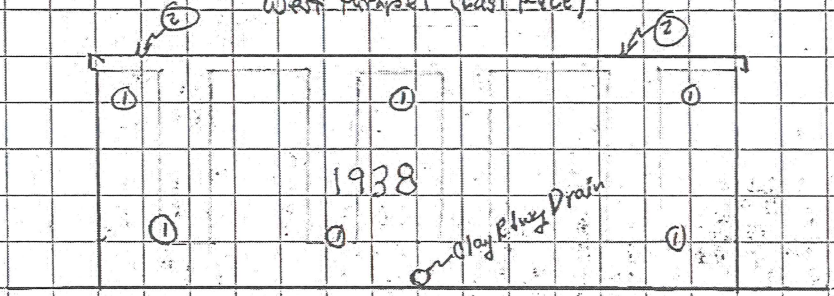
2-18-15: NC

East Parapet (West Face)



Remarks: ①: 13'L x 3"H x 1"D Heavy scale.
②: 24"L x 4"H x 2"D Heavy scale
③: Cap with a total of +/- 3SF milled to heavy scale.
④: 8"L x 4"H x 1"D spall.
⑤: Vertical face with +/- 8SF total of LSC to MSC.

West Parapet (East Face)



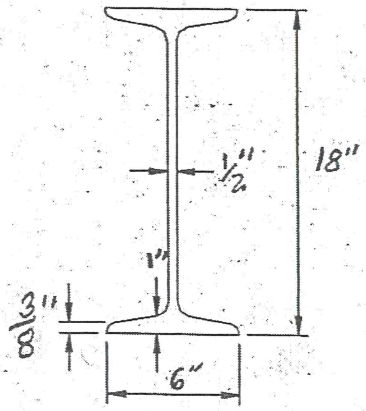
①: 910SF Total vertical face, 10SF is good. 900SF exhibit Severe, Heavy, Moderate and light scale. Hollow areas, punky concrete and map cracking with efflorescence.
② 100% of cap is severly deteriorated.

FIELD NOTES	BRIDGE NO. 04832	DATE: 4-29-13
	CREW: Team 8	SHEET

2-18-15: NC

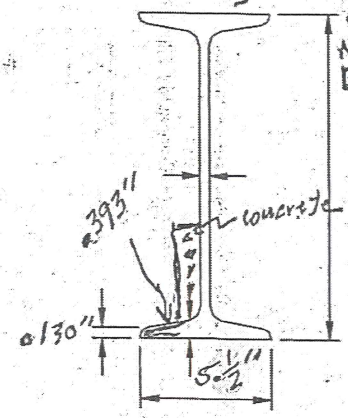
S-SHAPE BEAM
Concrete Encased Beams

S18X46



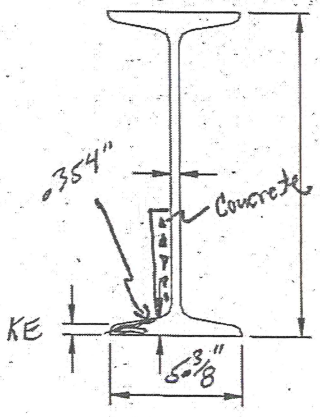
Beam No. Original

Looking South thru 1 & 10 and looking North for Beam 11.



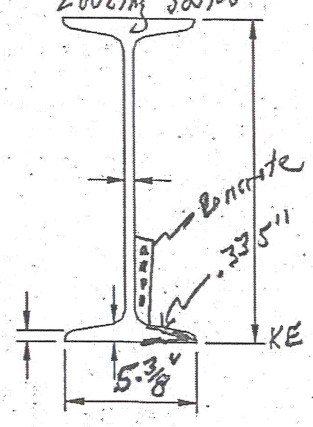
Beam No. 1
Typical of Beams 1, 10 and 11 adjacent to A-1 x 8" out.

Looking South



Beam No. 1
Typical condition starting 7'-06" out from A-1 x 5'-03" long.

Looking South

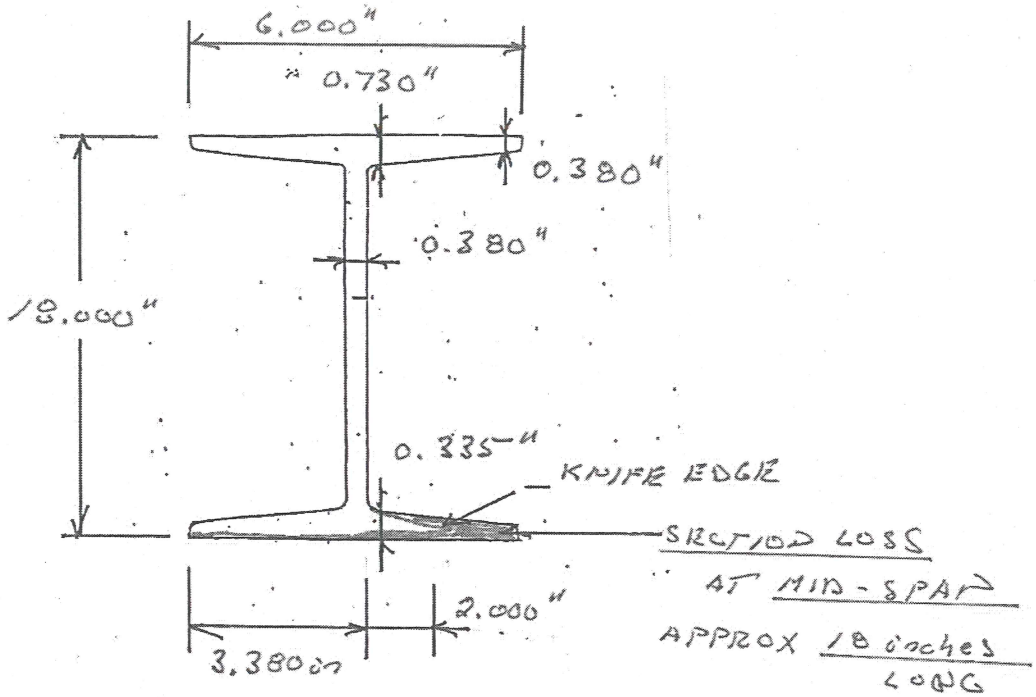


Beam No. 11
Typical at midspan x 18" long.

BRIDGE NO 4832 - WALLINGFORD - NORTHFORD ROAD
OVER MUDDY RIVER

APRIL 29, 2013

2-18-15: NC



BEAM NO. 11

ELEVATION VIEW

NOT TO SCALE

LOOKING SOUTH

BOTTOM FLANGE SECTION LOSS - REMAINING AREA -

$\frac{1}{2}$ [0.380in + 0.730in] × 2.810in = 1.560 in² ✓

0.730in × 0.380in = 0.277 in²

$\frac{1}{2}$ [0.000in + 0.335in] × 2.000in = 0.335 in²

total 2.172 in² REMAINING AREA

ORIGINAL BOTTOM FLANGE AREA WITHOUT SECTION LOSS

$\frac{1}{2}$ [0.380in² + 0.73in] × 5.620in = 3.119 in²

0.730in × 0.380in = 0.277 in²

total 3.396 in² ORIGINAL AREA

BOTTOM FLANGE SECTION LOSS REMAINING AREA

64% REMAINING

BOTTOM FLANGE LOSS OF SECTION

36% LOSS

PREPARED BY: DAVID PAWLIKOWSKI III - CTDOT - BRIDGE SAFETY

MAY 8, 2013

NORTHFORD ROAD

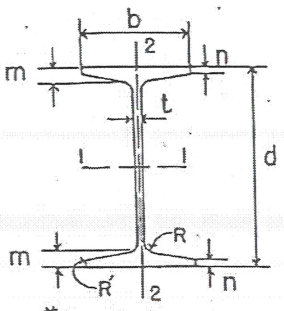
BRIDGE NO 04832 - WALLINGFORD - OVER MUDDY RIVER

16

18" AMERICAN STANDARD BEAMS

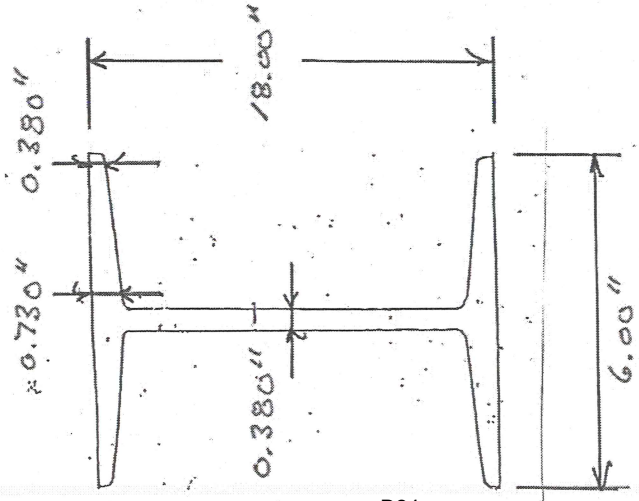
REFERENCES; SEE COLUMN (1) AND PAGE 4

6	4	10	22	1,2,3,■5,8,
1921	C1921	SI3-1922	PH1906	9,11,12,13,14,
C1923	C1923	SI9-1926	PH1908	15,16,17,18,20
IL1925	7	S30-1929	PH1912	21,23,26,27
C1926	IL1914	S43-1933	PH1915	See Page 15
C1930	IL1925	S47-1934	24	
C1931	IL1932	S51-1938	PH1923	
IL1932	19	S53-1943	PH1929	
C1934	PA1900	28	PH1938	
IL1934	PA1901	JN 1946	25	
CIL1940	PA1903		PH1931	



COL. (1)	WEIGHT PER FOOT	AREA	DEPTH	FLANGE WIDTH	WEB THICK	DIMENSIONS				SLOPE INSIDE FLANGE	AXIS 1—1			AXIS 2—2		
			d	b	t	m	n	R	R'		I	S	r	I	S	r
	Lb.	Sq.In.	In.	In.	In.	In.	In.	In.	In.	%	In.⁴	In.³	In.	In.⁴	In.³	In.
1,9,12,14,15,18	65.0	19.12	18.0	6.177	.637	.922	.460	.56	.276	16⅔	881.5	97.9	6.79	23.47	7.6*	1.11
21	65.0	19.12	18.0	6.17	.63	.92	.46	.56	.27	16⅔*	889.73	98.9	6.82	23.30	7.55*	1.10
23	65.0	19.12	18.0	6.163	.623	.922	.460	.56	.276	16⅔	881.5	97.9	6.79	23.47	7.62	1.11
19	65.0	19.1	18.0	6.17	.64	.94	.47	.56	—	17.0*	886.1	98.5	6.81	23.9	7.7*	1.12
6,10,17,26,13	65.0	18.98	18.0	6.169	.629	.922	.460	.56	.28	16⅔	877.7	97.5	6.80	23.4	7.6	1.11
16	65.0	18.92*	18.0	6.166	.626	.922	.460	.56	.276	16⅔*	876.2*	97.4*	6.81*	23.32*	7.6*	1.11*
1,9,12,14,15,18	60.0	17.65	18.0	6.095	.555	.922	.460	56	.276	16⅔*	841.8	93.5	6.91	22.38	7.3*	1.13
23	60.0	17.65	18.0	6.082	.542	.922	.460	.56	.276	16⅔*	841.8	93.5	6.91	22.38	7.36*	1.13
21	60.0	17.64	18.0	6.08	.54	.92	.46	.56	.27	16⅔*	849.88	94.4	6.94	22.22	7.31*	1.12
19	60.0	17.6	18.0	6.08	.55	.94	.47	.56	—	17.0*	846.5	94.1	6.94	22.7	7.5*	1.13
6,10,17,26,13	60.0	17.50	18.0	6.087	.547	.922	.460	.56	.28	16⅔*	837.8	93.1	6.92	22.3	7.3	1.13
16	60.0	17.43*	18.0	6.083	.543	.922	.460	.56	.276	16⅔*	835.9*	92.9*	6.93*	22.19*	7.3*	1.13*
)	55.0	16.2	18.0	6.00	.47	.94	.47	.56	—	17.0*	806.8	89.6	7.08	21.6	7.2*	1.16
20	55.0	16.2	18.0	6.00	.46	.92	.46	.56	.27	16⅔*	809.0	89.9	7.07	20.82	6.94*	1.13
22	55.0	16.18	18.0	6.000	.460	.922	.460	.56	.276	16⅔*	795.6	88.4	7.07	21.19	7.06*	1.15
21	55.0	16.13	18.0	6.00	.46	.92	.46	.56	.27	16⅔*	809.05	89.9	7.08	21.17	7.06*	1.14
1,9,12,15,16,18	55.0	15.93	18.0	6.000	.460	.922	.460	.56	.276	16⅔*	795.6	88.4	7.07	21.19	7.1*	1.15
25	54.7	16.09	18.0	6.000	.460	.922	.460	.56	.28	16⅔*	799.8	88.9	7.05	21.42	7.14	1.15
8,11,13,14,17,24,27,28	54.7	15.94	18.0	6.000	.460	.922	.460	.56	.28	16⅔	795.5	88.4	7.07	21.2	7.1	1.15
4	48.2	14.09	18.0	7.500	.380	.664	.340	.34	—	9.1*	737.1	81.9	7.23	30.0	8.0	1.46
3	48.0	14.08	18.0	7.500	.380	.664	.340	.34	—	9.1*	737.1	81.9	7.23	30.0	8.0	1.46
2	46.0	13.53	18.0	6.000	.322	.900	.427	.50	—	16⅔*	733.2	81.5	7.36	19.9	6.6	1.21
7	46.0	13.34	18.0	6.000	.380	.730	.380	.38	—	12.5*	675.7	75.1	7.12	17.14	5.71	1.13

5/18 × 5/16 ORIGINAL SIZE



5/18 × 5/16 ORIGINAL SIZE

2-18-15: JVC

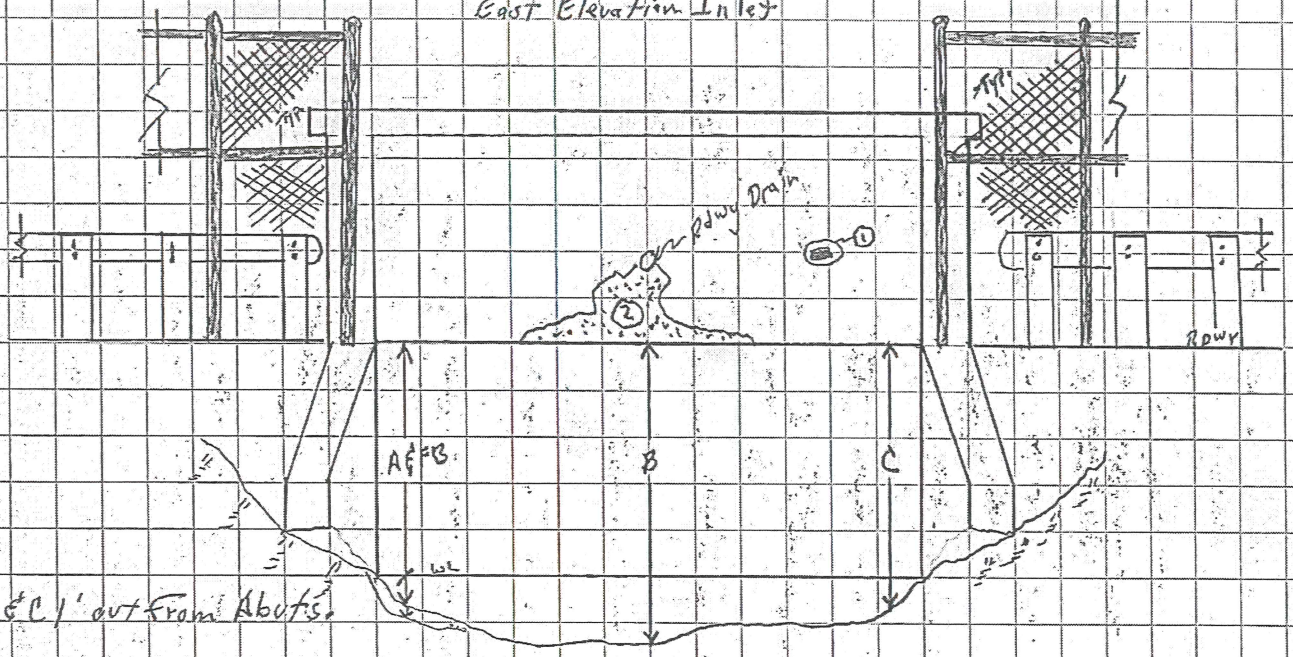
DATE PREPARED	PREPARED BY	State of Connecticut Department of Transportation Bureau of Engineering & Highway Operations DES-003 REV 1-93 (302-06-0225) COMPUTATION SHEET	ORGANIZATION UNIT NO.	WORK ORDER NO.
4-29-13	AF			
DATE CHECKED	CHECKED BY			SHEET NO.

SUBJECT:

Br #04832 Northford Road -o- Muddy River, Wallingford

NTS

East Elevation Inlet



A & C 1' out from Abut's.

	4-29-13	2-18-15
A	64"	59"
B	64"	65"
C	58"	57"
FB	50"	50"

Remarks:

(1) = wood inclusion w/ adj. 4" Ø area of mud scale.

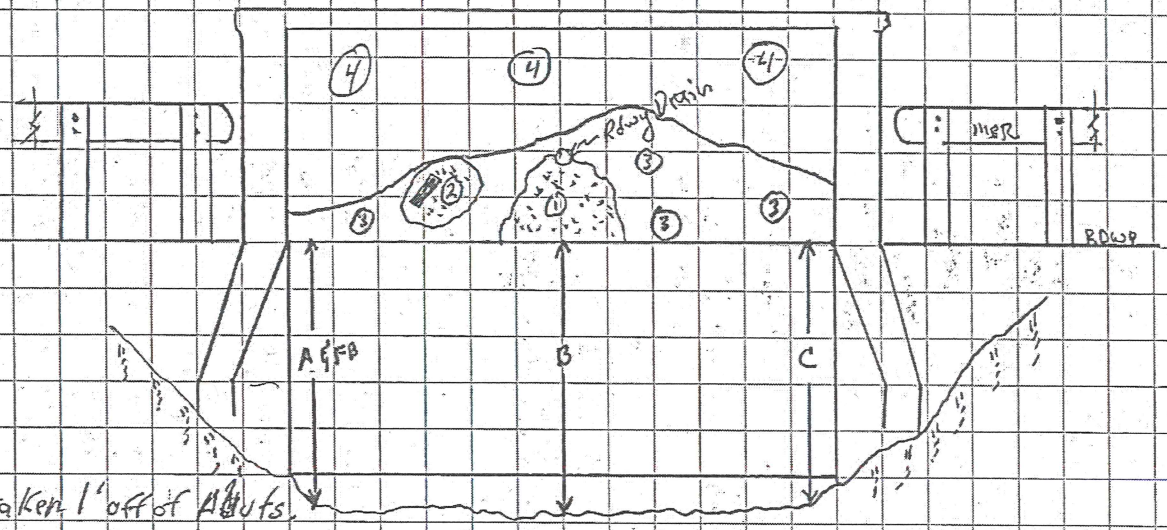
(2) = 5 S F severe scaling x 2.5' Deep.

DATE PREPARED	PREPARED BY	State of Connecticut Department of Transportation Bureau of Engineering & Highway Operations DES-003 REV 1-93 (302-06-0225) COMPUTATION SHEET	ORGANIZATION UNIT NO.	WORK ORDER NO.
4-29-13	AF			
DATE CHECKED	CHECKED BY			SHEET NO.

SUBJECT:

Br #04832 Northford Road -o- Muddy River, Wallingford

West Elevation Outlet



A & C taken 1' off of Abuts.

	4-29-13	2-18-15				
A	63"	63"				
B	65"	64"				
C	53"	52"				
FB	52"	52"				

Remarks:

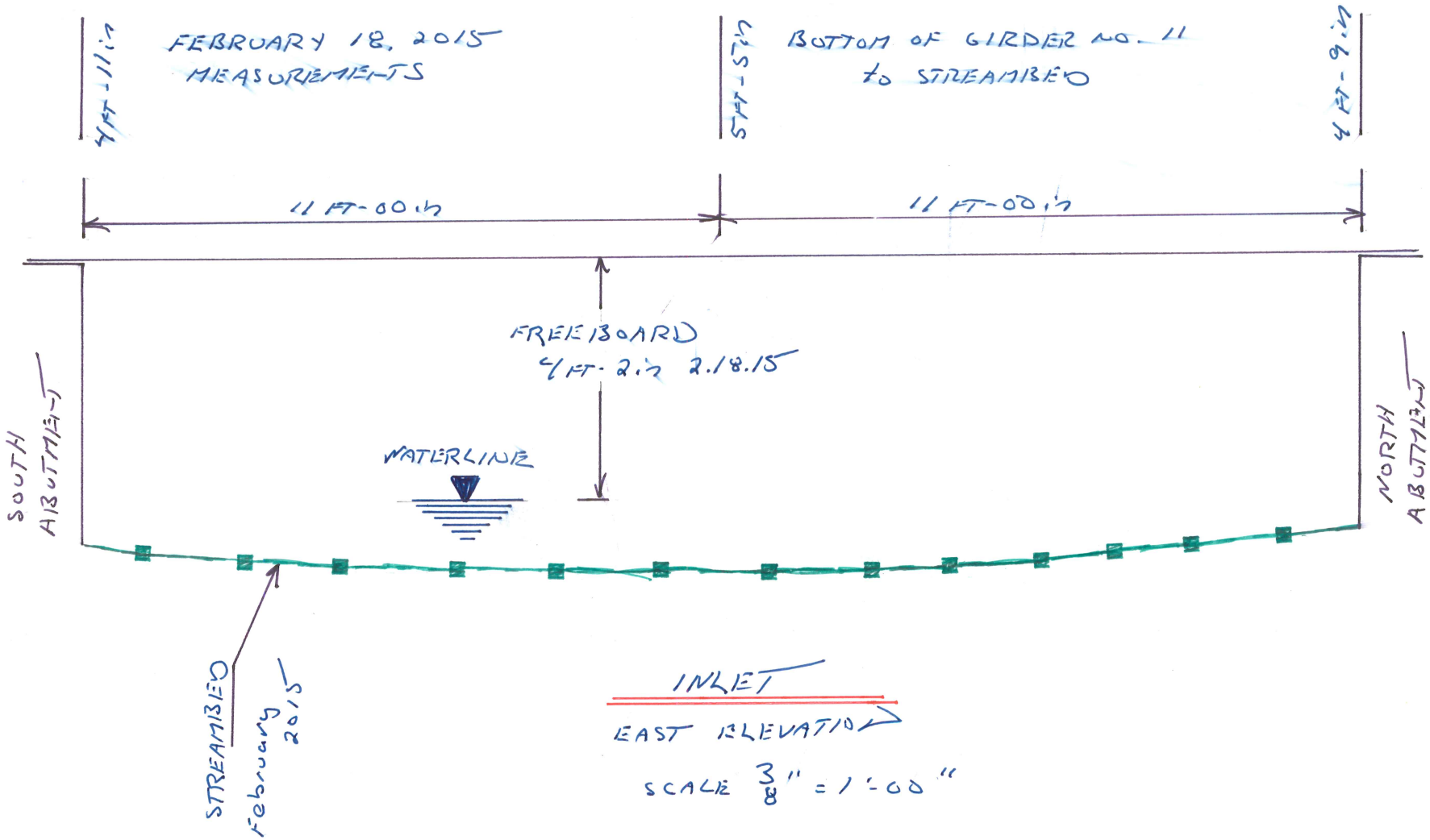
①: 65 = severe scale

②: Wood inclusion severe scale 20"x16"Hx2.5"D.

③: 5@5 = HR w/efflo and cracking

④: Hairline Hex cracking with and without efflo.

BRIDGE NO 04832 - WALLINGFORD - NORTHFORD ROAD OVER MUDDY RIVER



INLET

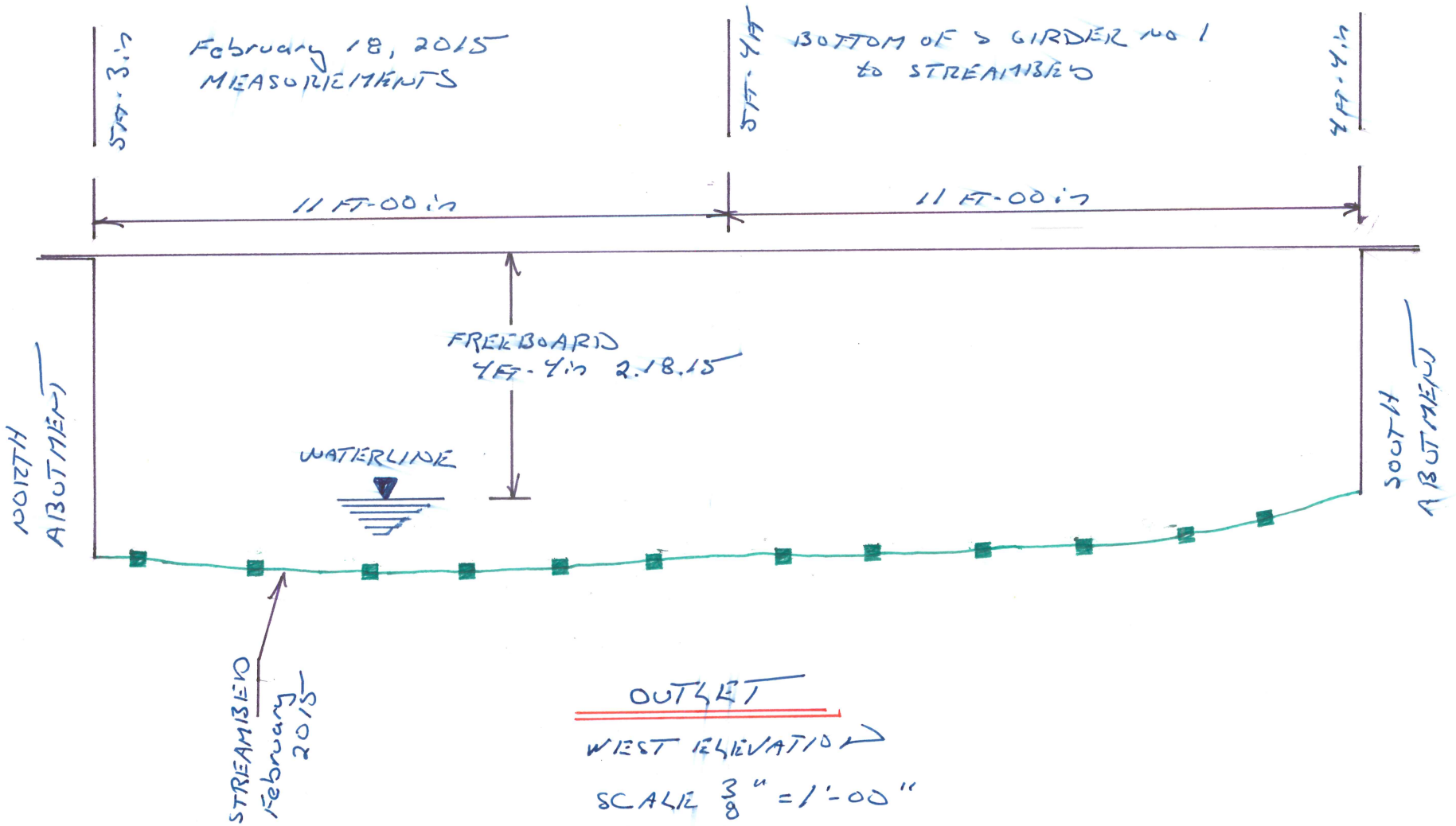
EAST ELEVATION

SCALE $\frac{3}{32}$" = 1'-00"

PREPARED BY: DAVID PADALIKOWSKI PE - CTDOT - BRIDGE SAFETY - Feb 24, 2015

D27

BRIDGE NO 04832 - WALLINGFORD - NORTHFORD ROAD OVER MUDDY RIVER



PREPARED BY: DAVID PAWLIKOWSKI JR. - CTDOT - BRIDGE SAFETY - Feb 24, 2015

D28

DATE PREPARED	PREPARED BY	State of Connecticut Department of Transportation Bureau of Engineering & Highway Operations . DES-003 REV 1-93 (302-06-0225) COMPUTATION SHEET	ORGANIZATION UNIT NO.	WORK ORDER NO.
4-29-13	P.V.			
DATE CHECKED	CHECKED BY			SHEET NO.

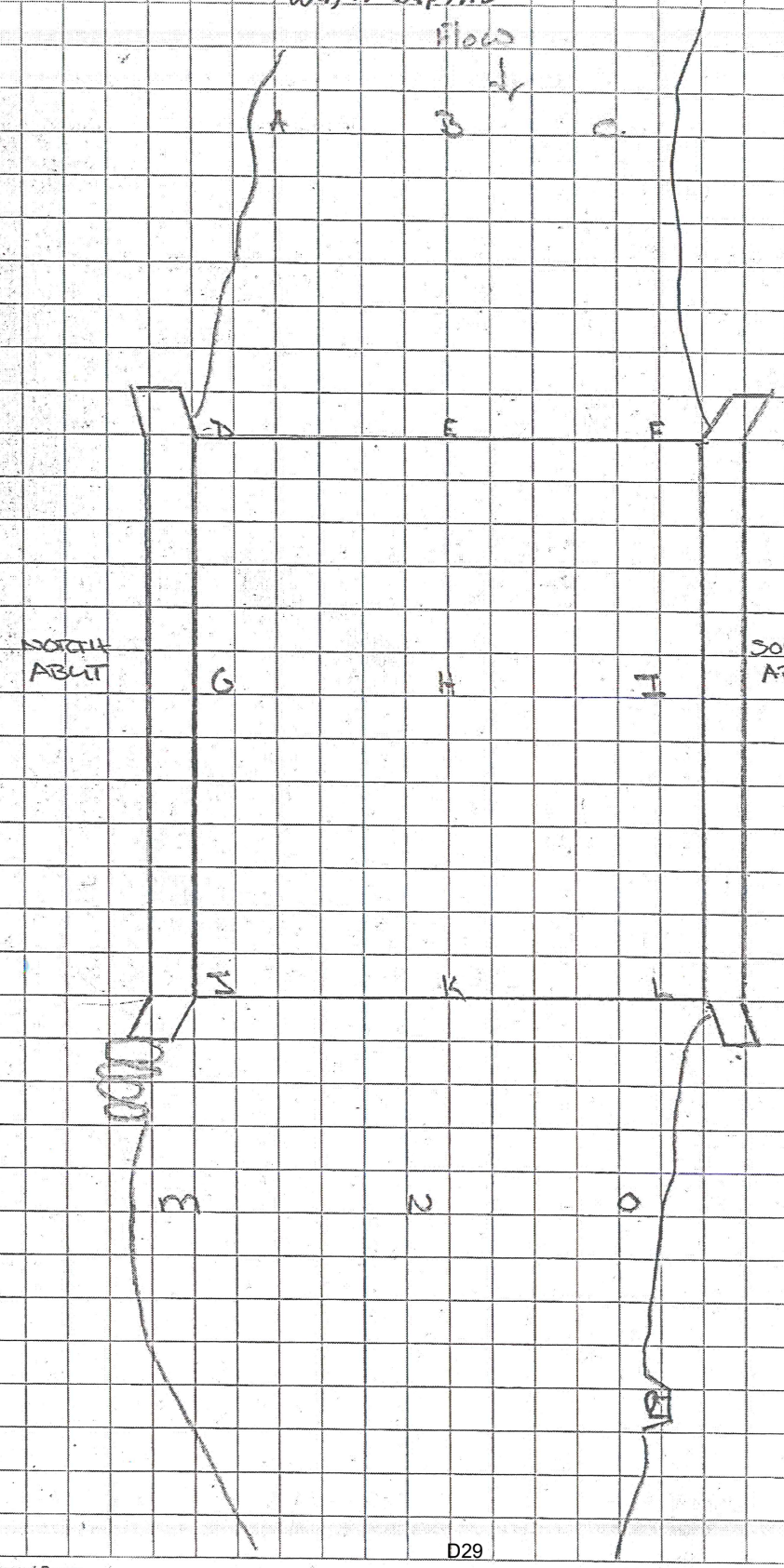
SUBJECT:

Bridge 4837 Northford Rd - o - Muddy River, Wallingford

Water Depths

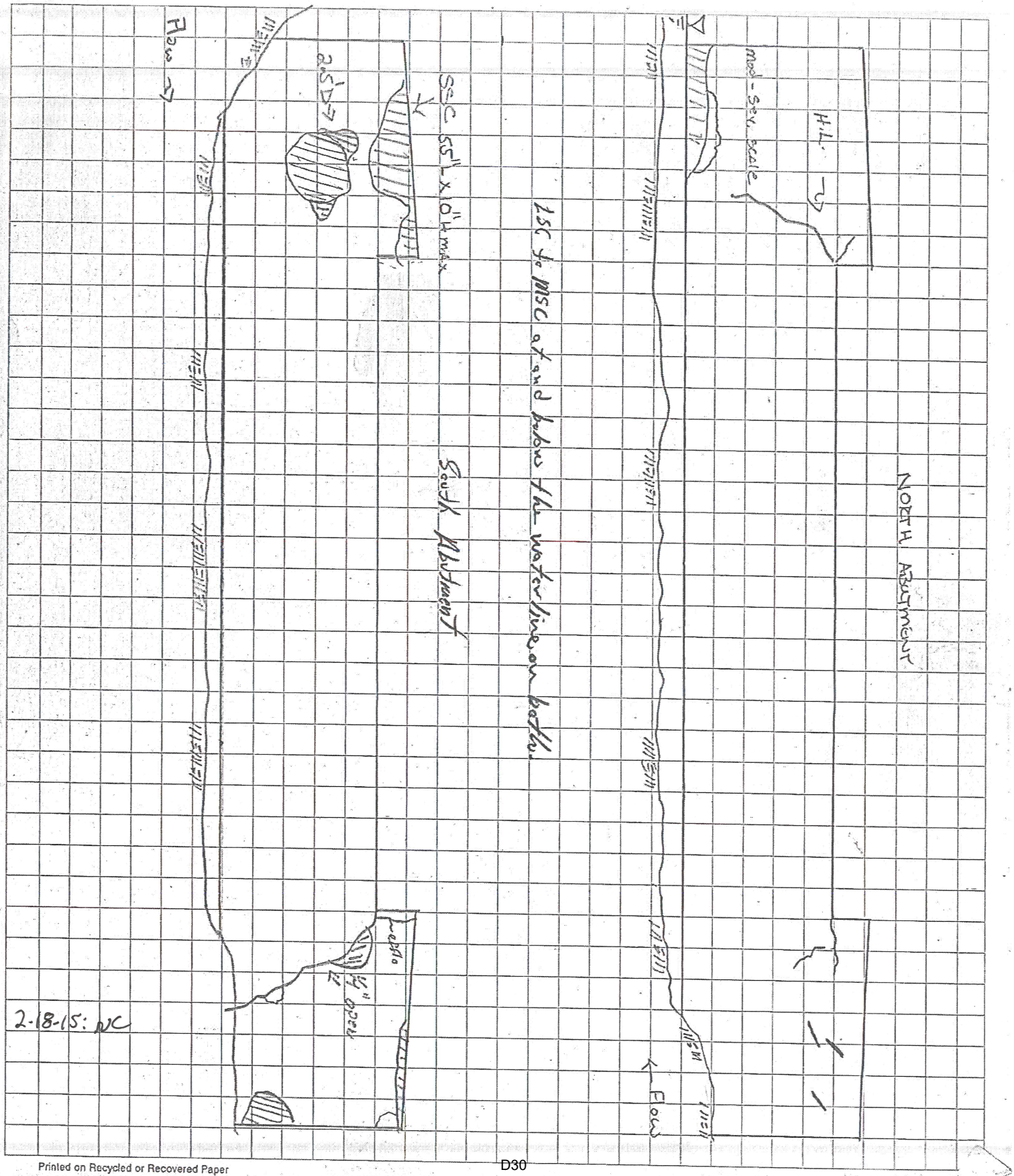
NTS

	4-29-13	2-18-15
A	6'	7'
B	9'	10"
C	5	4"
D	8	6"
E	14	13"
F	14	13"
G	11	8"
H	17	16"
I	7	8"
J	11	10"
K	13"	15"
L	1"	11"
M	12"	13"
N	19"	18"
O	17"	15"



PREPARED	PREPARED BY	State of Connecticut Department of Transportation Bureau of Engineering & Highway Operations DES-003 REV 1-93 (302-06-0225) COMPUTATION SHEET	ORGANIZATION UNIT NO.	WORK ORDER NO.
ATE CHECKED	P.U. CHECKED BY			SHEET NO.

SUBJECT:



Your Agency Name

Your Office Name
Your Department Name

Structure Inventory and Appraisal Sheet (English Units)

Bridge Key: 04832 Agency ID: 04832 SR: 67.7 SD/FO: FO

IDENTIFICATION

State 1:	09 Connecticut	Struc Num 8:	04832
Facility Carried 7:	NORTHFORD ROAD	Location 9:	0.5 MI S OF I-91
Rte.(On/Under) 5A:	Route On Structure	Rte. Signing Prefix 5B:	5 City Street
Level of Service 5C:	0 None of the below	Route Number 5D:	00000
Directional Suffix 5E:	0 N/A (NBI)	% Responsibility:	0.00
SHD District 2:	03	County Code 3:	New Haven
Place Code 4:	WALLINGFORD	Mile Post 11:	1.480 mi
Feature Intersected 6:	MUDDY RIVER		
Latitude 16:	41° 26' 42"	Longitude 17	072° 46' 48"
Border Bridge Code 98	Unknown (P)		
Border Bridge Number 99	NA		

STRUCTURE TYPE AND MATERIALS

Number of Approach Spans 46	0	Number of Spans Main Unit 45:	1
3 Steel		02 Stringer/Girder	
Deck Type 107:	1 Concrete-Cast-in-Place		
Wearing Surface 108A:	6 Bituminous		
Membrane 108B:	0 None		
Deck protection 108C	None		

AGE AND SERVICE

Year Built 27:	1938	Year Reconstructed 106:	-1		
Type of Service on 42A	1 Highway				
Type of Service under 42B	5 Waterway				
Lanes on 28A:	2	Lanes under 28B:	0	Detour Length 19:	4.0 mi
ADT 29:	2,310	Truck ADT 109:	2%	Year of ADT 30:	2015

GEOMETRIC DATA

Length Max Span 48:	22.00 ft	Structure Length 49:	27.00 ft
Curb/Sdwlk Width L 50A	0.00 ft	Curb/Sidewalk Width R 50B	0.00 ft
Width Curb to Curb 51:	26.30 ft	Width Out to Out 52:	28.80 ft
Approach Roadway width 32: (w/ shoulders)	21.00 ft	Median 33:	0 No median
Deck Area:	778.00 sq. ft		
Skew 34:	0.00°	Structure Flared 35	0 No flare
Vertical Clearance 10	99.90 ft	Horizontal Clearance 47:	26.30 ft
Minimum Vertical Clearance Over Bridge 53:		328.05 ft	
Minimum Vertical Underclearance Reference 54A		N Feature not hwy or RR	
Minimum Vertical Underclearance 54B:		0.00 ft	
Minimum Lateral Underclearance Reference R 55A:		N Feature not hwy or RR	
Minimum Lateral Underclearance R 55:		327.76 ft	
Minimum Lateral Underclearance L 56:		0.00 ft	

INSPECTION

Frequency 91:	24 months	Inspection Date 90:	2/18/2015	Next Inspection:	2/23/2017
FC Frequency 92A:	NA	FC Inspection Date 93A:	NA	Next FC Inspection:	NA
UW Frequency 92B:	NA	UW Inspection Date 93B:	NA	Next UW Inspection	NA
SI Frequency 92C:	NA	SI Date 93C:	NA	Next SI:	NA
Element Frequency:	24 months	Element Insp. Date:	2/18/2015	Next Elem. Insp.:	2/23/2017

CLASSIFICATION

Defense Highway 100:	0 Not a STRAHNET hwy	Parallel Structure 101:	No || bridge exists
Direction of Traffic 102:	2 2-way traffic	Temporary Structure 103:	Not Applicable (P)
Highway System 104:	0 Not on NHS	NBIS Length 112:	Long Enough
Toll Facility 20:	3 On free road	Functional Class 26:	07 Rural Mjr Collector
Defense Hwy 110:	0 Not a STRAHNET hwy	Historical Significance 37	5 Not eligible for NRHP
Owner 22:	03 Town/Township Hwy Agency		
Custodian 21:	03 Town/Township Hwy Agency		

CONDITION

Deck 58:	5 Fair	Super 59:	5 Fair	Sub 60:	6 Satisfactory
Culvert 62:	N N/A (NBI)	Channel/Channel Protection 61:		7 Minor Damage	

LOAD RATING AND POSTING

Inventory Rating Method 65:	1 LF Load Factor	Operating Rating Method 63:	1 LF Load Factor
Inventory Rating 66:	HS33.7	Operating Rating 64:	HS56.2
Design Load 31:	0 Other or Unknown	Posting 70:	5 At/Above Legal Loads
Posting Status 41:	A Open, no restriction		

APPRAISAL

Bridge Rail 36A:	0 Substandard	Approach Rail 36C:	0 Substandard
Transition 36B:	0 Substandard	Approach Rail Ends 36D:	0 Substandard
Str Evaluation 67:	5 Above Min Tolerable	Deck Geometry 68:	3 Intolerable - Correct
Underclearance, Vertical and Horizontal 69:		N Not applicable (NBI)	
Waterway Adequacy 71:	6 Equal Minimum	Approach Alignment 72:	5 Above Tolerable
Scour Critical 113:	5 Stable w/in footing		

PROPOSED IMPROVEMENTS

Bridge Cost 94:	$1,000	Type of Work 75:	38 Other Structural
Roadway Cost 95:	$1,000	Length of Improvement 76	0.3 ft
Total Cost 96:	$2,000	Future ADT 114:	582
Year of Cost Estimate 97	2000	Year of Future ADT 115:	2029

NAVIGATION DATA

Navigation Control 38	Permit Not Required		
Vertical Clearance 39	0.0 ft	Horizontal Clearance 40:	0.0 ft
Pier Protection 111:	Not Applicable (P)	Lift Bridge Vertical Clearance 116	0.0 ft

Structure Inventory and Appraisal Sheet (English Units)

ELEMENT CONDITION STATE DATA

Str Unit	Elm/Env	Description	Units	Total Qty	% in 1	Qty. St. 1	% in 2	Qty. St. 2	% in 3	Qty. St. 3	% in 4	Qty. St. 4
UNIT0	13/3	Pre Concrete Deck	sq.ft	778	90%	704	8%	60	2%	14	0%	0
UNIT0	215/3	Re Conc Abutment	ft	58	64%	37	28%	16	9%	5	0%	0
UNIT0	301/3	Pourable Joint Seal	ft	0	0%	0	0%	0	0%	0	0%	0
UNIT0	311/3	Moveable Bearing	each	11	0%	0	100%	11	0%	0	0%	0
UNIT0	313/3	Fixed Bearing	each	11	0%	0	100%	11	0%	0	0%	0
UNIT0	331/3	Re Conc Bridge Railing	ft	54	0%	0	0%	0	0%	0	100%	54

Bridge No.	04832	**Inspected by:**	ANDREW FERRARA
Town:	WALLINGFORD	**Inspected by:**	PETER VENOUTSOS
Feature Carried:	NORTHFORD ROAD	**Date Inspected:**	FEBRUARY 18, 2015
Feature Crossed:	MUDDY BROOK	**Project No.:**	

Photo #: LOOKING SOUTH OVER BRIDGE.

Photo #: TYPICAL PARAPET SNOW COVERED. WEST END SHOWN

D33

Bridge No.	04832	**Inspected by:**	ANDREW FERRARA
Town:	WALLINGFORD	**Inspected by:**	PETER VENOUTSOS
Feature Carried:	NORTHFORD ROAD	**Date Inspected:**	FEBRUARY 18, 2015
Feature Crossed:	MUDDY BROOK	**Project No.:**	

Photo #: VIEW OF OVERLAY.

Photo #: WEST ELEVATION. (OUTLET)

D34

Bridge No.	04832	**Inspected by:**	ANDREW FERRARA
Town:	WALLINGFORD	**Inspected by:**	PETER VENOUTSOS
Feature Carried:	NORTHFORD ROAD	**Date Inspected:**	FEBRUARY 18, 2015
Feature Crossed:	MUDDY BROOK	**Project No.:**	

Photo #: LOOKING DOWNSTREAM.

Photo #: EAST ELEVATION. (INLET)

D35

Bridge No.	04832	**Inspected by:**	ANDREW FERRARA
Town:	WALLINGFORD	**Inspected by:**	PETER VENOUTSOS
Feature Carried:	NORTHFORD ROAD	**Date Inspected:**	FEBRUARY 18, 2015
Feature Crossed:	MUDDY BROOK	**Project No.:**	

Bridge No.	04832	**Inspected by:**	ANDREW FERRARA
Town:	WALLINGFORD	**Inspected by:**	PETER VENOUTSOS
Feature Carried:	NORTHFORD ROAD	**Date Inspected:**	FEBRUARY 18, 2015
Feature Crossed:	MUDDY BROOK	**Project No.:**	

Photo #: VIEW OF SUPERSTRUCTURE.

Photo #: SOUTH ABUTMENT.

D37

Bridge No.	04832	**Inspected by:**	ANDREW FERRARA
Town:	WALLINGFORD	**Inspected by:**	PETER VENOUTSOS
Feature Carried:	NORTHFORD ROAD	**Date Inspected:**	FEBRUARY 18, 2015
Feature Crossed:	MUDDY BROOK	**Project No.:**	

	**Double-click here to insert picture**
Photo #: NORTH ABUTMENT.	**Photo # :**

D38

BRIDGE ASSESSMENT
DATA COLLECTION AND FIELD REVIEW

Field Visit Date: 10/14/2016 Attendees: MEF

I. GENERAL PROJECT DATA

Bridge No. 04832

Town: Wallingford County: New Haven

Feature Carried: Northford Road Feature Crossed: Muddy River

Quadrangle: Wallingford DEEP Basin ID: 5208-00

Functional Class:

- ☐ Urban Principal Arterial - Interstate
- ☐ Urban Principal Arterial - Other Expressway
- ☐ Urban Principal Arterial - Other
- ☐ Urban Minor Arterial
- ☐ Urban Collector
- ☐ Urban Local
- ☐ Rural Principal Arterial - Interstate
- ☐ Rural Principal Arterial – Other Expressway
- ☐ Principal Arterial - Other
- ☐ Rural Minor Arterial
- ☒ Rural Major Collector
- ☐ Rural Minor Collector
- ☐ Rural Local

Year Built: 1938 Year of Reconstruction: N/A

Overall NBIS Structure Rating: 5 NBIS Item 113 Rating: 5

USGS Total Scour Index: 39 Sufficiency Rating: 68.28

Plans Available? ☐ Yes ☑ No

II. SUPERSTRUCTURE INFORMATION

Bridge Width: 28.8 FT Bridge Length: 22 FT

Number of Spans: 1 Bridge Skew: 0 Degrees

Bearing Connection Type: ☐ Positive Connection ☑ No Positive Connection

III. HYDROLOGIC AND HYDRAULIC INFORMATION

Watershed Area: 8.88 Square Miles

Is It Tidally Influenced? ☐ Yes ☑ No

What Information is Available?

- ☐ Hydraulic Analysis
- ☑ Scour Report
- ☐ Floodway Analysis Report
- ☐ SCEL Analysis
- ☑ Comparative Report
- ☑ FEMA FIS
- ☑ Other: ConnDOT Inspection (2-18-15)

	Source	2-YR Event	10-YR Event	50-YR Event	100-YR Event	500-YR Event
Flow Rates (CFS)	FIS	----------	1,560	2,490	2,980	4,030
	StreamStats	413	869	1,340	1,560	2,010
	Other	N/A				
Precipitation (In.)	StreamStats	3.77	5.44	7.88	9.24	---------
Tidal Elevation (Ft.)	N/A					

Elevations, Feet (Datum = NAVD88)							
At Structure			**Water Surface at Approach Cross Section (**				
Streambed	Low Chord	Roadway	2-YR Event	10-YR Event	50-YR Event	100-YR Event	500-YR Event
167.3	174.85	177.6	172.25	173.77	175.39	175.69	176.31

Pressure Flow at Design Flood? ☑ Yes ☐ Underclearance: ____ Feet

Comments:

FIS shows bridge overtopping for<10-yr flood event. Low area with confluence of stream and overflow spillway just downstream of bridge.

IV. SITE DATA

A. Existing Structure(s) – Provide sketch of culvert/structure with dimensions and brief description.

Sketch from inspection is attached.

Utilities - apparent water pipe crossing over pipe. Overhead utilities at downstream side of bridge.

No scour noted. Stream slope is very shallow, and bridge apparently overtops at ±10-year flood event, so opportunity for scour is reduced. Stream channel is primarily cobble0sized material. Banks are riprapped.

Comments: Include structure or culvert type and condition. Note particularly any scour adjacent to abutments or at culvert outlet and the presence of debris or sediment. Also, note the location of any utilities in the area of the crossing.

B. High Water Marks – Describe the nature and location of any apparent high water marks and relate to a date of occurrence, if possible.

No high water marks noted. Region is in a prolonged drought, and it is unlikely that there has been a high flow event within the last year.

C. Maximum Allowable Headwater – Describe the nature of the apparent controlling feature and note its location.

The roadway (other than the parapets) is the controlling feature. There is a ridge close too the bridge left, and another ridge several hundred feet to the right. In between, the roadway is flat and is the controlling feature.

D. Fish Passage Requirements – Comment on the apparent need for fish passage or impediments to same; such as dams or restrictive crossings in the area.

There is no impediment to fish passage at the bridge. However, the MacKenzie Reservoir dam is approximately 500 feet upstream and prevents all fish passage upstream. The dam has a low level outlet that is used. In this condition, it is possible for fish to move downstream from the reservoir into the river.

V. PERIPHERAL SITE DATA

A. Hydraulic Control – Note location and description.

Dam located ±500 feet upstream

B. Upstream and Downstream Structures – Provide sketches and brief descriptions of existing bridges/culverts. Include dimensions.

No other road crossing of river in the vicinity of this crossing.

Comments:

C. Watershed Area – Check watershed boundaries for accuracy. Note current land uses within watershed.

Water shed boundary found by StreamStats is very close to drainage area listed in the FIS. Boundary appears to be accurate.

D. Flow Control Structures within Watershed – Note the location and type of all significant flow control structures (dams, etc.) within the watershed. Provide sketches with dimensions as required.

The MacKenzie Reservoir dam is just upstream. Main section of dam is 30 feet high, with the dam being earth and the spillway concrete. The dam is ±400 feet long and the reservoir holds ±1100 acre-feet.

Pistapaug Pond dam is upstream of MacKenzie Reservoir. The dam is 10 feet high and 300 feet long. Storage is ±4500 acre-feet.

E. Site Photographs – Attach to report. Include an index and sketch of photograph locations.

Photos included.

VI. STREAM CHANNEL AND RELATED ASPECTS

A. Stream Characterization

Twenty Groupings of Stream Characteristics (Check Box)

	Identifier	Drainage Area	Streambed Slope	Streambed Soils	Land Use
☐	A	Large	Low	SD	S/F
☐	B	Large	Low	SD	Urban
☐	C	Large	Moderate	SD	Forested
☐	D	Medium	Moderate	SD	Urban
☐	E	Medium	Moderate	SD	S/F
☐	F	Medium	Moderate	Clay	S/F
☐	G	Medium	Moderate	Till	S/F
☐	H	Medium	Moderate	SD	Forested
☐	I	Medium	Moderate	Till	Forested
☐	J	Small	Low	SD	Urban
☐	K	Small	Moderate	Till	Urban
☒	L	Small	Low	SD	S/F
☐	M	Small	Moderate	SD	S/F
☐	N	Small	Moderate	SD	Forested
☐	O	Small	Low	Clay	S/F
☐	P	Small	Steep	Till	S/F
☐	Q	Small	Moderate	Till	S/F
☐	R	Small	Low	Till	S/F
☐	S	Small	Moderate	Till	Forested
☐	T	Small	Steep	Till	Forested

Drainage Area	Small	≤ 25 square miles
	Medium	> 25 square miles and ≤ 100 square miles
	Large	> 100 square miles
Streambed Slope	Low	≤ 25 feet/mile
	Moderate	> 25 feet/mile and ≤ 100 feet/mile
	Steep	> 100 feet/mile
Streambed Soils	SD = Stratified Drift	
Land Use	S/F = Suburban or Farming	

B. Channel Stability

Previous NBIS Item 61 Rating: 7

Lateral Stability: ☑ Stable ☐ Unstable

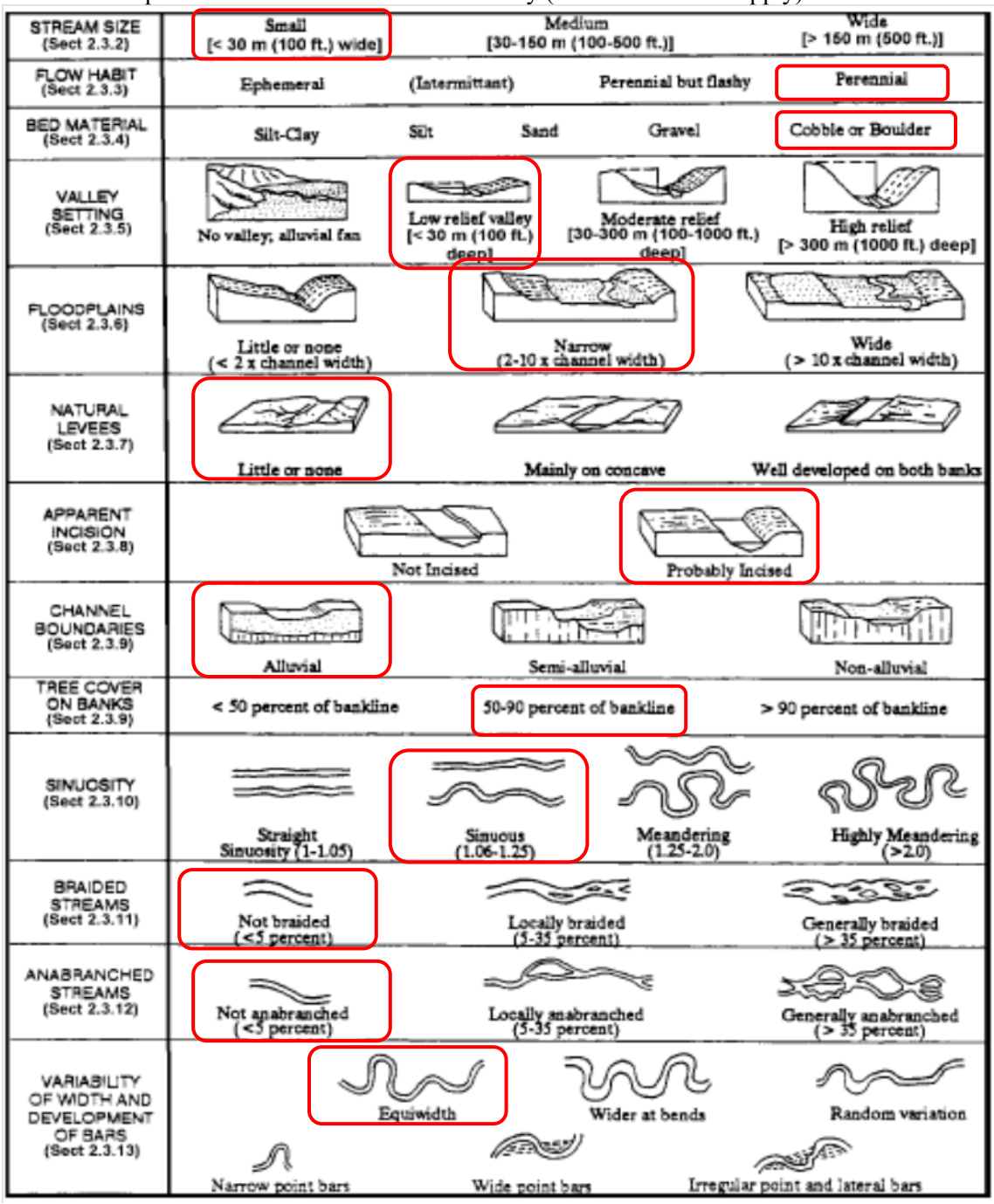
Bank Erosion:

☐ None ☑ Light Fluvial Erosion ☐ Heavy Fluvial Erosion ☐ Mass Wasting

Streambed: ☐ Stable ☐ Aggrading ☐ Degrading

Armoring Potential: ☐ None ☐ Low ☐ Moderate ☐ High

Geomorphic factors that affect stream stability (circle factors that apply)



Source: Adapted from Brice and Blodgett, 1978

(See also FHWA HEC-20, "Stream Stability at Highway Structures" for discussion of the above factors)

Secondary Bed Material: ☐ Sand ☑ Gravel ☐ Boulders ☐ Manmade
☐ Silt/Clay ☐ Cobble ☐ Bedrock

Bank Protection
Type: ☐ None ☐ Modified ☑ Intermediate ☐ Standard
☐ Concrete ☐ Slope Paving ☐ Absent ☐ Other:

Condition: ☐ N/A ☑ Good ☐ Weathered ☐ Slumped
☐ Poor ☐ Missing ☐ Fair

Comment on the need (if any) for training walls, cutoff walls or special slope or channel protection.

None needed

C. Channel and Overbank Roughness Coefficients

Basic Channel Description: ☐ Channel in Earth ☐ Channel Cut into Rock
☑ Channel in Fine Gravel ☐ Channel in Coarse Gravel

Surface Irregularity of Channel:
☐ Smooth - Best obtainable section for materials involved
☑ Minor - Slightly eroded or scoured side slopes
☐ Moderate - Moderately sloughed or eroded side slopes
☐ Severe - Badly sloughed banks of natural channels or badly eroded sides of man-made channels - jagged and irregular sides or bottom sections of channels in rock

Variations in shape and size of cross sections:

Channel Obstructions – (Judge the relative effect of obstructions – consider the degree to which the obs tructions r educe t he av erage cr oss s ectional ar ea, character o f obs tructions, and location and spacing of obstructions).

NOTE: Smooth or rounded objects create less turbulence than sharp, angular objects.

The effect of obstructions is:
☑ Negligible
☐ Minor
☐ Appreciable
☐ Severe

Degree of Vegetation – (Note amount and character of foliage).

Minimal vegetation. Some near banks.

The effect of vegetative growth upon flow condition is:

- [x] LOW – Dense growths of flexible turf grasses where average depth of flow is 2 to 3 times the height of vegetation. Supple seedling tree switches where the average depth of flow is 3 to 4 times the height of the vegetation.
- [ ] MEDIUM – Turf grasses where the average depth of flow is 1 to 2 times the height of vegetation. Stemmy grasses, weeds or tree seedlings, (moderate cover), average depth of flow 2 to 3 times the height of vegetation. Bushy growths, (moderately dense), along channel side slopes with no significant vegetation along channel bottom.
- [ ] HIGH – Turf grasses where average height is about equal to the average depth of flow. Willow of Cottonwood trees 8 to 10 years old with some weeds or brush. Bushy growths about 1 year old with some weeks. No significant vegetation along channel bottom.
- [ ] VERY HIGH – Turf grasses where the average depth of flow is less than one half the height of vegetation. Bushy growths about 1 year old intergrown with weeds. Dense growth of cattails along channel bottom. Trees intergrown with weeds and brush (thick growth).

Additional Comments:

Vegetation on banks between the normal water surface elevation and the bankfull depth is very dense.

VII. HYDRAULIC VULNERABILITY

Previous Item 71 Rating: 6

Is there confluence present? [x] Yes [ ] No

Angle of Attack (flood flow): [ ] Yes [x] No

Bends in Channel: [ ] Upstream of Bridge [ ] Downstream of Bridge [x] Straight Channel Reach [ ] At Bridge

Velocity order of magnitude: 3 (ft/s)

Trapping potential: [x] Low [ ] Medium [ ] High

Debris potential: [x] Low [ ] Medium [ ] High

Overtopping relief: [ ] None [ ] Left Approach [x] Right Approach [x] On Bridge [x] Relief Bridge [ ] Cannot be Determined

Primary B ed Material: ☐ Sand ☐ Gravel ☐ Boulders ☐ Manmade
☐ Silt/Clay ☑ Cobble ☐ Bedrock

Comments:

Combination of armoring and bank, outfall, and tributary protection.

VIII. VISUAL SCOUR EVIDENCE

USGS observed scour index: 19

History of scour problem: ☐ Yes ☑ No

Comments:

Possibility of significant scour is remote in current configuration. Recommend flow through parapet, which further reduce scouring potential.

Note: Comment should address any evidence of scour at ALL substructure units.

CONTRACTION SCOUR SUSCEPTIBILITY

Channel width upstream: 18 feet
Channel width under bridge: 22 feet
Channel width ratio (channel width upstream/channel width under the bridge): 0.82

Overbank flow: ☐ Yes ☑ No

Percent of flow in main channel of the approach section:
☑ > 90% ☐ 75% - 90% ☐ 50% - 75% ☐ 25% - 50% ☐ < 25%

Average bed material size (D_{50}):
@ Approach section 2 inch ☐ Sample taken for sieve analysis
@ Bridge 4 inch ☐ Sample taken for sieve analysis

Contraction scour susceptibility rating: ☑ Low ☐ Medium ☐ High

Comments:

Flow on overbank will cross over roadway rather than contract and pass through bridge opening.

ABUTMENT SUSCEPTIBILITY

Which abutment is worst? ☑ Left ☐ Right

Observed scour depth: 0 feet Remaining embedment in river bed: ? feet

Abutment shape: ☐ Vertical ☑ Vertical with wing walls ☐ Spill through

Abutment location: ☐ In channel ☑ At bank ☐ Set Back

Abutment foundation: ☐ Set in rock ☐ Friction piles ☑ Spread footing ☐ EB piles ☐ Pile Bent ☐ Set in rock

Pile type: ☐ Metal ☐ Concrete ☐ Timber ☑ N/A

Pile length: N/A feet

Abutment material: ☐ Timber ☑ Concrete ☐ Metal ☐ Stone

Angle of inclination: vertical degrees

Primary bed material: ☐ Sand ☐ Silt/Clay ☐ Gravel ☑ Cobble ☐ Boulders ☐ Bedrock ☐ Manmade

Are borings available? ☑ Yes ☐ No

Abutment protection

Type: ☐ Modified ☐ Concrete ☑ Intermediate ☐ Absent ☐ Standard ☐ None ☐ Slope Paving ☐ None

Permanent or temporary: ☐ N/A ☑ Permanent ☐ Temporary

Condition: ☑ Good ☐ Fair ☐ Slumped ☐ Poor ☐ Weathered ☐ N/A ☐ Missing

Abutment exposure due to scour:

☑ None ☐ No Exposure ☐ Footing Exposed ☐ Piles Exposed
☐ Undermining ☐ Settlement ☐ Failed

Abutment susceptibility rating: ☑ Low ☐ Medium ☐ High

Comments:

PIER SUSCEPTIBILITY

Worst pier number: _____
Observed scour depth: _____ feet Remaining embedment in river bed _____feet

Angle of attack flood flow: _____ degrees

Pier foundation:
☐ Unknown ☐ Spread footings ☐ Pile bent
☐ EB piles ☐ Set in rock ☐ Friction piles ☐ N/A

Pile Type: ☐ Metal ☐ Concrete ☐ Timber ☐ N/A

Pile length: _____feet

Pier material:
☐ Concrete ☐ Stone ☐ Wood ☐ Metal ☐ N/A

Pier shape:
☐ Solid pier with square nose ☐ Solid pier with round nose
☐ Solid pier with sharp nose ☐ Column with square nose ☐ Column with round nose
☐ Column with sharp nose ☐ Cylinders/Group of cylinders

Pier width: _____feet Pier dimensions: _____

Cap/Footing dimensions: _____

Pier exposure due to scour:
☐ None ☐ No exposure ☐ Footing exposed
☐ Piles Exposed ☐ Undermining ☐ Settlement
☐ Failed

Pier protection

Type:
☐ Modified ☐ Intermediate ☐ Standard ☐ Slope paving
☐ Concrete ☐ Other ☐ Absent ☐ None

Permanent or temporary:
☐ N/A ☐ Permanent ☐ Temporary

Condition:
☐ Good ☐ Weathered ☐ Slumped ☐ Missing
☐ Fair ☐ Poor ☐ N/A

Primary bed material:
☐ Sand ☐ Gravel ☐ Boulders ☐ Manmade
☐ Silt/Clay ☐ Cobble ☐ Bedrock

Are borings available?
☐ Yes ☐ No

Pier susceptibility rating
☐ Low ☐ Medium ☐ High

Comments:

Appendix E – FEMA Information

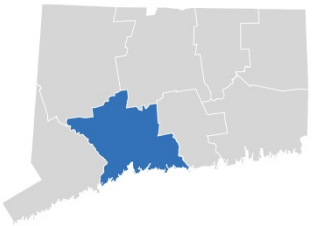
WMC Consulting Engineers
Newington, CT
(860) 667-9624

Appendix E Contents

FLOOD INSURANCE STUDY

FEDERAL EMERGENCY MANAGEMENT AGENCY

VOLUME 1 OF 10



NEW HAVEN COUNTY, CONNECTICUT

(ALL JURISDICTIONS)

COMMUNITY NAME	NUMBER
CITY OF ANSONIA	090071
TOWN OF BEACON FALLS	090072
TOWN OF BETHANY	090144
TOWN OF BRANFORD	090073
TOWN OF CHESHIRE	090074
CITY OF DERBY	090075
TOWN OF EAST HAVEN	090076
TOWN OF GUILFORD	090077
TOWN OF HAMDEN	090078
TOWN OF MADISON	090079
CITY OF MERIDEN	090081
TOWN OF MIDDLEBURY	090080
CITY OF MILFORD	090082
BOROUGH OF NAUGATUCK	090137
CITY OF NEW HAVEN	090084
TOWN OF NORTH BRANFORD	090085
TOWN OF NORTH HAVEN	090086
TOWN OF ORANGE	090087
TOWN OF OXFORD	090150
TOWN OF PROSPECT	090151
TOWN OF SEYMOUR	090088
TOWN OF SOUTHBURY	090089
TOWN OF WALLINGFORD	090090
CITY OF WATERBURY	090091
CITY OF WEST HAVEN	090092
TOWN OF WOLCOTT	090093
TOWN OF WOODBRIDGE	090153
BOROUGH OF WOODMONT	090168

REVISED:

MAY 16, 2017

FLOOD INSURANCE STUDY NUMBER
09009CV001D

Version Number 2.3.3.2

FEMA

Table 10: Summary of Discharges

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)				
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Muddy River (Upper Reach)	At McKenzie Reservoir	8.92	1,560	*	2,490	2,980	4,030
Muddy River (Upper Reach)	At Railroad Bridge	6.06	850	*	1,320	1,780	2,150
Muddy River (Upper Reach)	At cross section AB	6.06	1,150	*	1,840	2,220	3,010
Muddy River (Upper Reach)	At confluence of Spring Brook	5.89	1,130	*	1,800	2,180	2,950
Muddy River (Upper Reach)	At Williams Road	1.95	440	*	710	860	1,180
Muddy River (Upper Reach)	At Hampton Trail	1.27	360	*	560	660	870
Muddy River Tributary C	At North Branford/North Haven corporate limits	0.78	165	*	265	330	460
Muddy River Tributary C	At Cross Section D	0.65	145	*	230	285	400
Muddy River Tributary C	At Woodvale Drive	0.32	85	*	135	170	235
Muddy River Tributary C	At Woodhouse Avenue	0.11	40	*	60	75	105
Munger Brook	At confluence with Branford River	4.09	430	*	720	870	1,250
Munger Brook	At Ciro Road	3.5	390	*	650	790	1,130
Munger Brook	At Beech Street	2.83	330	*	550	670	960
Munger Brook	At Manor Drive	1.29	185	*	310	370	530
Naugatuck River	At Ansonia/Derby corporate limits	309	11,400	*	25,900	36,000	81,900

*Not calculated for this Flood Risk Project

Table 2: Flooding Sources Included in this FIS Report

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Mountain Brook	Town of Cheshire, Town of Prospect			01100004	1.8		N	A	
Mountain Brook	Town Of Prospect	50 ft downstream of Juggernaut Rd	about 4,600 ft upstream of Juggernaut Rd	01100004	0.9		Y	AE	12/1/1993
Muddy River (Lower Reach)	Town Of North Haven	confluence with Quinnipiac River	475 ft upstream of Old Clintonville Rd	01100004	5.3		Y	AE	7/1/1978
Muddy River (Upper Reach)	Town Of Wallingford	corporate limits	50 ft upstream of Hampton Trail	01100004	7.2		Y	AE	4/1/1977
Muddy River	Town of Wallingford	Old Clintonville Road	Riverside Drive	01100004	3.2		Y	AE	9/1/2014
Muddy River Tributary C	Town Of North Branford	at corp limits	Woodhouse Ave	01100004	1.3		Y	AE	2/1/1977
Munger Brook	Town Of North Branford	at conf with Branford River	Corp limits	01100004	2.6		Y	AE	2/1/1977
Munger Brook	Town of Guilford, Town of North Branford			01100004	1.5		N	A	
Naugatuck River	City of Derby, City of Ansonia, Town of Seymour, Town of Beacon Falls, Borough of Naugatuck, City of Waterbury	confluence with Housatonic River	corporate limits	01100005	24.6		Y	AE	12/1/1976
Neck River	Town Of Madison	Goulds Pond dam	about 1,500 ft upstream of Bradley Corners Rd	01100004	7.3		Y	AE	6/1/1991

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
AW	37,432	48	405	8.3	100.5	100.5	101.5	1.0
AX	37,597	62	869	3.9	104.3	104.3	105.3	1.0
AY	37,835	112	910	3.7	104.7	104.7	105.7	1.0
AZ	37,887	49	280	12.0	110.9	110.9	111.4	0.5
BA	37,925	170	2,062	1.6	112.8	112.8	113.8	1.0
BB	41,017	211	1,228	2.7	115.7	115.7	116.7	1.0
BC	41,257	147	798	4.1	117.0	117.0	118.0	1.0
BD	46,962	129	661	4.7	143.3	143.3	144.3	1.0
BE	47,124	66	589	5.3	146.3	146.3	147.3	1.0
BF	47,326	72	595	5.3	150.8	150.8	151.8	1.0
BG	50,482	90	634	4.8	164.7	164.7	165.7	1.0
BH	53,222	154	824	3.7	171.5	171.5	172.5	1.0
BI	54,418	50	412	7.3	176.1	176.1	177.1	1.0
BJ	54,562	85	549	5.3	177.1	177.1	178.1	1.0
BK	54,684	87	630	4.6	178.7	178.7	179.7	1.0
BL	55,140	73	774	3.7	179.3	179.3	180.3	1.0
BM	55,242	89	329	8.7	197.4	197.4	197.9	0.5
BN	55,292	330	4,861	0.6	199.0	199.0	199.5	0.5
BO	57,563	403	5,482	0.5	199.0	199.0	199.5	0.5
BP	57,759	329	4,410	0.6	201.7	201.7	202.2	0.5
BQ	59,352	194	1,346	1.5	202.0	202.0	203.0	1.0
BR	59,548	52	457	4.3	202.6	202.6	203.6	1.0
BS	62,047	97	353	5.2	217.0	217.0	218.0	1.0
BT	64,674	166	517	3.5	225.5	225.5	226.5	1.0

[1]Feet above confluence with Quinnipiac River

Northford Road

TABLE 24

FEDERAL EMERGENCY MANAGEMENT AGENCY

NEW HAVEN COUNTY, CONNECTICUT

(ALL JURISDICTIONS)

FLOODWAY DATA

FLOODING SOURCE: MUDDY RIVER

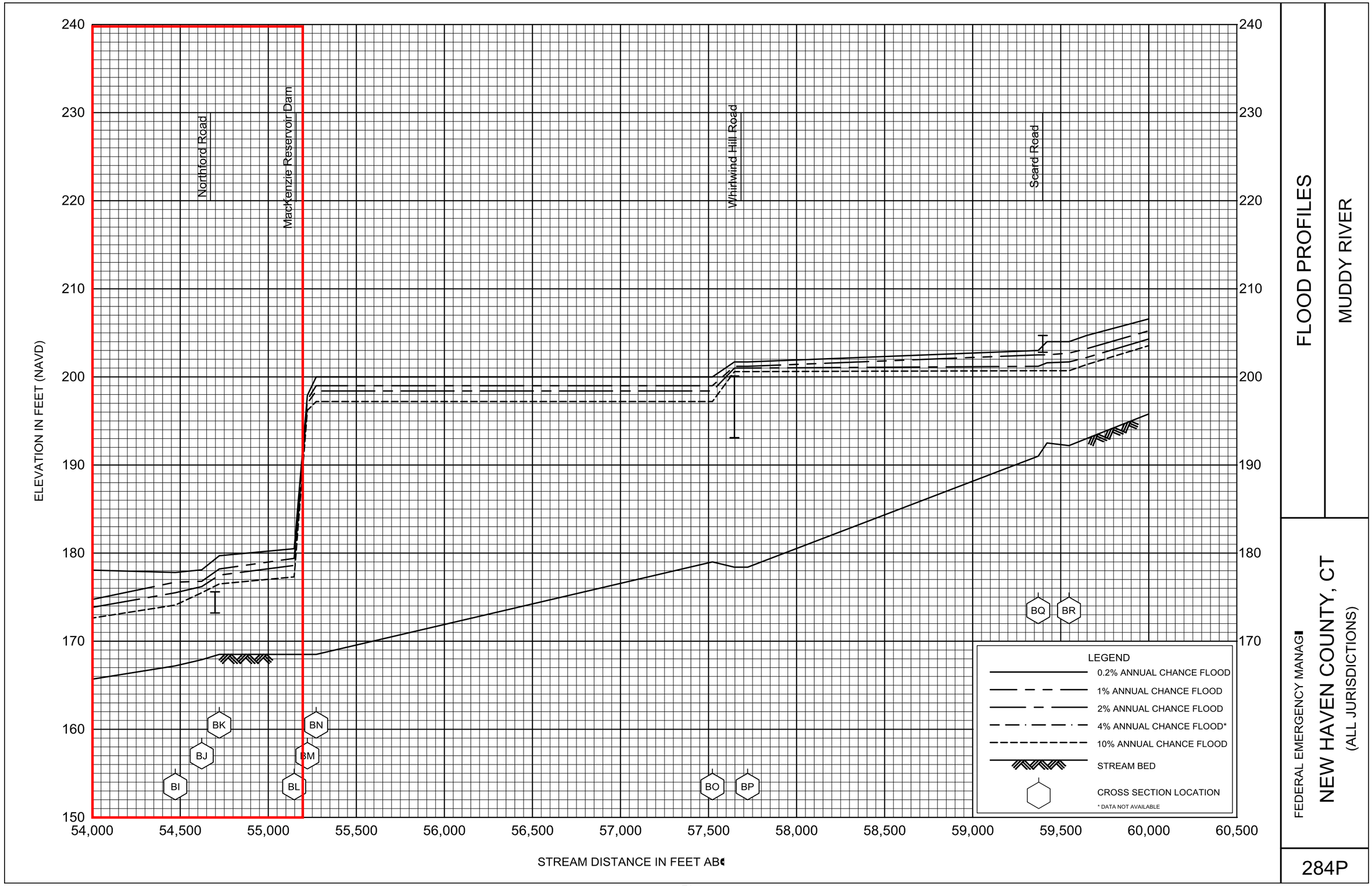
Table 28: Community Map History

Community Name	Initial Identification Date (First NFIP Map Published)	Initial FHBM Effective Date	FHBM Revision Date(s)	Initial FIRM Effective Date	FIRM Revision Date(s)
Town of North Branford	06/21/1974	None	None	07/03/1978	12/17/2010 07/08/2013
Town of North Haven	05/24/1974	None	None	09/17/1980	05/01/1985 12/17/2010 07/08/2013
Town of Orange	09/14/1973	12/10/1976	None	03/18/1980	08/02/1995 12/17/2010 07/08/2013
Town of Oxford	06/28/1974	12/17/1976	None	12/04/1979	03/18/1991 12/17/2010
Town of Prospect	06/21/1974	None	None	02/04/1977	05/16/1995 12/17/2010
Town of Seymour	07/26/1974 01/07/1977	None	None	07/03/1978	04/16/1991 12/17/2010 10/16/2013
Town of Southbury	02/08/1974	10/17/1975	None	03/28/1980	12/11/1981 12/17/2010
Town of Wallingford	08/02/1974	None	None	09/15/1978	06/04/1990 04/16/1991 09/07/2000 12/17/2010
City of Waterbury	03/22/1974	06/07/1977	None	11/01/1979	12/17/2010
City of West Haven	05/31/1974	None	None	01/17/1979	04/18/1983 06/16/1992 12/17/2010 07/08/2013
Town of Wolcott	05/03/1974	11/26/1976	None	07/05/1982	12/17/2010
Town of Woodbridge	06/28/1974	11/19/1976	None	03/16/1981	03/18/1991 12/17/2010
Borough of Woodmont	10/18/1974	08/02/1977	None	09/29/1978	08/15/1983 10/01/1983 07/02/1987 06/16/1992 11/06/1996 09/07/1999 12/17/2010 07/08/2013

SECTION 7.0 – CONTRACTED STUDIES AND COMMUNITY COORDINATION

7.1 Contracted Studies

Table 29 provides a summary of the contracted studies, by flooding source, that are included in this FIS Report.



FLOOD PROFILES

MUDDY RIVER

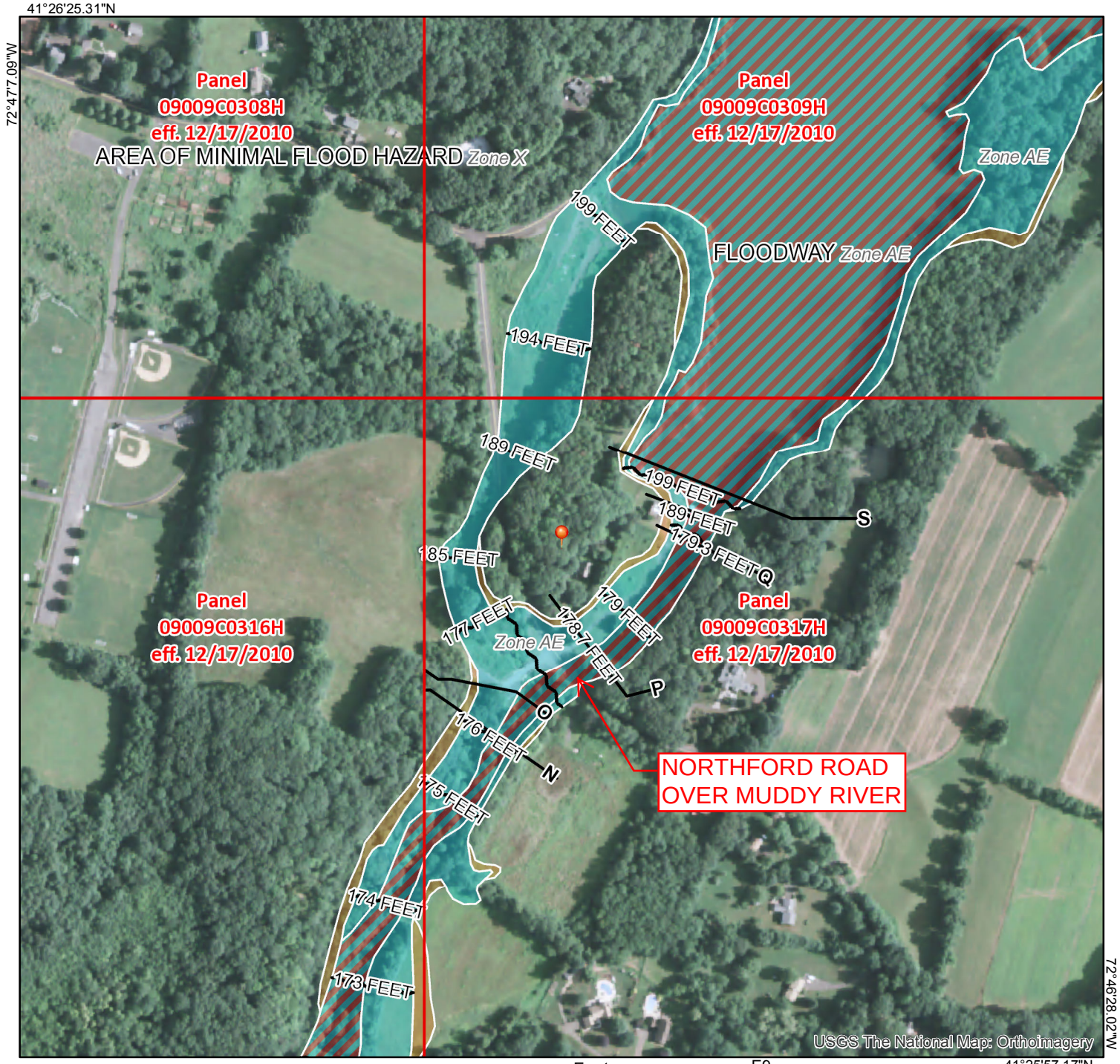
FEDERAL EMERGENCY MANAGEMENT AGENCY

NEW HAVEN COUNTY, CT

(ALL JURISDICTIONS)

284P

National Flood Hazard Layer FIRMette



Legend

- Cross-Sections
- Base Flood Elevations

N

Flood Hazard Zones

- 1% Annual Chance Flood
- Regulatory Floodway
- Special Floodway
- Area of Undetermined Flood Hazard
- 0.2% Annual Chance Flood
- Future Conditions 1% Annual Chance Flood Hazard
- Area with Reduced Risk Due to Levee

LOMRs

- Effective

Map Panels

- Digital Data
- Unmodernized Maps
- Unmapped

This map complies with FEMA's standards for the use of digital flood maps. The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. The base map shown complies with FEMA's base map accuracy standards.

The NFHL is a living database, updated daily, and this map represents a snapshot of information at a specific time.

Flood risks are dynamic and can change frequently due to a variety of factors, including weather patterns, erosion, and new development. FEMA flood maps are continually updated through a variety of processes. Users should always verify through the Map Service Center (http://msc.fema.gov) or the Community Map Repository that they have the current effective information.

NFHL maps should not be created for unmapped or unmodernized areas.

FEMA

Date: 9/27/2016 Time: 10:40:46 AM