STATE OF NEW HAMPSHIRE
INTER-DEPARTMENT COMMUNICATION

DATE: May 3, 2024

FROM: Joshua Brown
Wetlands Program Analyst

AT (OFFICE): Department of Transportation
Bureau of Environment

SUBJECT Dredge & Fill Application
Andover, 40392

TO Karl Benedict, Public Works Permitting Officer
New Hampshire Wetlands Bureau
29 Hazen Drive, P.O. Box 95
Concord, NH 03302-0095

Forwarded herewith is the application package prepared by NH DOT Bureau of Bridge Design for the subject major impact project. The proposed project involves the replacement of the existing bridge (Bridge No. 143/077) that carries US Route 4 over the Blackwater River in the Town of Andover. Proposed work includes the replacement of the existing 70-foot span bridge with a 104-foot span bridge (100.5-foot clear span). The new abutments will be constructed behind the existing abutments. The bridge will be widened 8 feet and approximately 500 feet of roadway widening will occur at each end of the bridge. The roadway will also be raised 4.5 feet near the bridge. In addition, an existing farm access driveway will be relocated further west and a stormwater treatment swale is proposed in the northwest bridge quadrant.

This project was reviewed at the Natural Resource Agency Coordination Meeting on April 17, 2019 & January 17, 2024. A copy of the minutes has been included with this application package. A copy of this application and plans can be accessed on the Departments website via the following link: https://www.dot.nh.gov/projects-plans-and-programs/programs/environmental-management-system/project-management-section-0.

NHDOT anticipates and request that this project be reviewed and permitted by the Army Corp of Engineers through the State Programmatic General Permit process. A copy of the application has been sent to the Army Corp of Engineers.

Mitigation was determined to be required as the proposed permanent impacts are over 200 linear feet and impacts floodplain wetlands, which are a Priority Resource Area (PRA).

The lead people to contact for this project are Jason Tremblay, Bureau of Bridge Design (271-2731or jason.a.tremblay@dot.nh.gov) or Andrew O’Sullivan, Wetlands Program Manager, Bureau of Environment (271-3226 or Andrew.O’Sullivan@dot.nh.gov).

A payment voucher has been processed for this application (Voucher #755351) in the amount of $4,280.00.

If and when this application meets with the approval of the Bureau, please send the permit directly to Andrew O’Sullivan, Wetlands Program Manager, Bureau of Environment.

JRB;
cc:
BOE Original
Town of Andover (4 copies via certified mail)
Mike Dionne & Kevin Newton, NH Fish & Game (via electronic notification)
Maria Tur, US Fish & Wildlife (via electronic notification)
Jeanie Brochi, US Environmental Protection Agency (via electronic notification)
Michael Hicks & Rick Kristoff, US Army Corp of Engineers (via electronic notification)
Kevin Nyhan, BOE (via electronic notification)

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US ROUTE 4 OVER THE BLACKWATER RIVER

BRIDGE REPLACEMENT

ANDOVER 40392

NHDES WETLANDS PERMIT APPLICATION

Submitted for:

NH Department of Transportation
7 Hazen Drive
Concord, NH 03302

Prepared by:

GM2 Associates, Inc.
197 Loudon Road, Suite 310
Concord, NH 03301

April 2024

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NEW HAMPSHIRE DEPARTMENT OF Environmental Services

STANDARD DREDGE AND FILL WETLANDS PERMIT APPLICATION

Water Division / Land Resources Management

Check the Status of your Application

RSA/Rule: RSA 482-A/Env-Wt 100-900

APPLICANT'S NAME: NHDOT **TOWN NAME:** Andover

Administrative Use Only	Administrative Use Only	Administrative Use Only	File No.:
			Check No.:
			Amount:
			Initials:

A person may request a waiver of the requirements in Rules Env-Wt 100-900 to accommodate situations where strict adherence to the requirements would not be in the best interest of the public or the environment but is still in compliance with RSA 482-A. A person may also request a waiver of the standards for existing dwellings over water pursuant to RSA 482-A:26, III(b). For more information, please consult the Waiver Request Form.

SECTION 1 - REQUIRED PLANNING FOR ALL PROJECTS (Env-Wt 306.05; RSA 482-A:3, I(d)(2))

Please use the Wetland Permit Planning Tool (WPPT), the Natural Heritage Bureau (NHB) DataCheck Tool, the Aquatic Restoration Mapper, or other sources to assist in identifying key features such as: Priority Resource Areas (PRAs), protected species or habitats, coastal areas, designated rivers, or designated prime wetlands.

Has the required planning been completed?	● Yes ○ No
Does the property contain a PRA? If yes, provide the following information:	● Yes ○ No
• Does the project qualify for an Impact Classification Adjustment (e.g. NH Fish and Game Department (NHFG) and NHB agreement for a classification downgrade) or a Project-Type Exception (e.g. Maintenance or Statutory Permit-by-Notification (SPN) project)? See Env-Wt 407.02 and Env-Wt 407.04.	○ Yes ● No
• Protected species or habitat? o If yes, species or habitat name(s): o NHB Project ID #: NHB23-3680	○ Yes ● No
• Bog?	○ Yes ● No
• Floodplain wetland contiguous to a tier 3 or higher watercourse?	● Yes ○ No
• Designated prime wetland or duly-established 100-foot buffer?	● Yes ○ No
• Sand dune, tidal wetland, tidal water, or undeveloped tidal buffer zone?	○ Yes ● No
Is the property within a Designated River corridor? If yes, provide the following information: • Name of Local River Management Advisory Committee (LAC): • A copy of the application was sent to the LAC on Month: Day: Year:	○ Yes ● No

For dredging projects, is the subject property contaminated? • If yes, list contaminant:	◯ Yes ◉ No
Is there potential to impact impaired waters, class A waters, or outstanding resource waters?	◉ Yes ◯ No
For stream crossing projects, provide watershed size (see WPPT or Stream Stats): 97.09 sq mi (62,138 acres)	

SECTION 2 - PROJECT DESCRIPTION (Env-Wt 311.04(i))

Provide a description of the project and the purpose of the project, the need for the proposed impacts to jurisdictional areas, an outline of the scope of work to be performed, and whether impacts are temporary or permanent.

The proposed project involves the replacement of the existing bridge (Bridge No. 143/077) that carries US Route 4 over the Blackwater River in the Town of Andover. Proposed work includes the replacement of the existing 70-foot span bridge with a 104-foot span bridge (100.5-foot clear span). The new abutments will be constructed behind the existing abutments. The existing abutments will be cut at ground level and stone will be placed at the edges of the channel for scour protection. The bridge will be widened 8 feet and approximately 500 feet of roadway widening will occur at each end of the bridge. The roadway will also be raised 4.5 feet near the bridge. In addition, an existing farm access driveway will be relocated further west and a stormwater treatment swale is proposed in the northwest bridge quadrant. The bridge will be closed during construction and traffic will be detoured.

The purpose of the project is to improve safety by replacing a deteriorated bridge. Rehabilitation of the existing bridge is not feasible due to the poor condition of the existing substructure. In addition, the existing bridge is undersized and does not convey the 100-year storm. The new bridge will accommodate the 100-year storm event and increase the hydraulic capacity of the crossing.

A total of 10,700 square feet of wetland and watercourse impact is proposed. This includes approximately 7,802 square feet of permanent wetland impact, of which approximately 4,463 square feet is permanent prime wetland impact. The permanent wetland impacts will result from roadway widening, slope work, and relocation of an existing farm access driveway. Approximately 891 square feet (138 linear feet) of permanent perennial stream channel impact and approximately 675 square feet (137 linear feet) of permanent bank impact is proposed from construction of the new bridge abutments and the placement of stone for scour protection. Approximately 1,041 square feet (17 linear feet) of temporary perennial stream channel impact and approximately 291 square feet (60 linear feet) of temporary bank impact is proposed from the removal of the existing abutments, dewatering, and construction access.

SECTION 3 - PROJECT LOCATION

Separate wetland permit applications must be submitted for each municipality within which wetland impacts occur.

ADDRESS: US Route 4 over the Blackwater River (Bridge No. 143/077)

TOWN/CITY: Andover

TAX MAP/BLOCK/LOT/UNIT: N/A

US GEOLOGICAL SURVEY (USGS) TOPO MAP WATERBODY NAME: Blackwater River
☐ N/A

(Optional) LATITUDE/LONGITUDE in decimal degrees (to five decimal places): 43.42184, -71.77686

SECTION 4 - APPLICANT (DESIRED PERMIT HOLDER) INFORMATION (Env-Wt 311.04(a)) If the applicant is a trust or a company, then complete with the trust or company information.		
NAME: NH Department of Transportation (Contact: Jason Tremblay, P.E.)		
MAILING ADDRESS: 7 Hazen Drive, PO Box 483		
TOWN/CITY: Concord	STATE: NH	ZIP CODE: 03302
EMAIL ADDRESS: Jason.A.Tremblay@dot.nh.gov		
FAX:	PHONE: 603-271-2731	
ELECTRONIC COMMUNICATION: By initialing here, I hereby authorize NHDES to communicate all matters relative to this application electronically. JAT		
SECTION 5 - AUTHORIZED AGENT INFORMATION (Env-Wt 311.04(c)) ☐ N/A		
LAST NAME, FIRST NAME, M.I.: Riordan, Jennifer, M.		
COMPANY NAME: GM2 Associates, Inc.		
MAILING ADDRESS: 197 Loudon Road, Suite 310		
TOWN/CITY: Concord	STATE: NH	ZIP CODE: 03301
EMAIL ADDRESS: jriordan@gm2inc.com		
FAX:	PHONE: 603-856-7854	
ELECTRONIC COMMUNICATION: By initialing here, I hereby authorize NHDES to communicate all matters relative to this application electronically. JMR		
SECTION 6 - PROPERTY OWNER INFORMATION (IF DIFFERENT THAN APPLICANT) (Env-Wt 311.04(b)) If the owner is a trust or a company, then complete with the trust or company information. ☒ Same as applicant		
NAME:		
MAILING ADDRESS:		
TOWN/CITY:	STATE:	ZIP CODE:
EMAIL ADDRESS:		
FAX:	PHONE:	
ELECTRONIC COMMUNICATION: By initialing here, I hereby authorize NHDES to communicate all matters relative to this application electronically.		

SECTION 7 - RESOURCE-SPECIFIC CRITERIA ESTABLISHED IN Env-Wt 400, Env-Wt 500, Env-Wt 600, Env-Wt 700, OR Env-Wt 900 HAVE BEEN MET (Env-Wt 313.01(a)(3))

Describe how the resource-specific criteria have been met for each chapter listed above (please attach information about stream crossings, coastal resources, prime wetlands, or non-tidal wetlands and surface waters):

Env-Wt 400: Wetland resources were delineated in accordance with Env-Wt 400. Additional information is provided in the enclosed Wetland Delineation Report.
Env-Wt 500: The project meets the criteria of Env-Wt 527 (Public Highways). Work is proposed within a 100-year floodplain but the project will not increase flooding on upstream or downstream properties. The project has also been designed to minimize impacts to wetlands and watercourses while improving conditions at the stream crossing.
Env-Wt 600: N/A - The project is not within a coastal area.
Env-Wt 700: The project involves impacts to prime wetlands adjacent to the crossing and US Route 4. The impacts have been minimized where possible and are at the wetland edge, along US Route 4. Overall, the project is not anticipated to result in a loss of functions present within the wetlands.
Env-Wt 900: The project involves the replacement of an existing Tier 3 crossing. The additional information required by Env-Wt 900 is attached.

SECTION 8 - AVOIDANCE AND MINIMIZATION

Impacts within wetland jurisdiction must be avoided to the maximum extent practicable (Env-Wt 313.03(a)).* Any project with unavoidable jurisdictional impacts must then be minimized as described in the Wetlands Best Management Practice Techniques For Avoidance and Minimization and the Wetlands Permitting: Avoidance, Minimization and Mitigation fact sheet. For minor or major projects, a functional assessment of all wetlands on the project site is required (Env-Wt 311.03(b)(10)).*

Please refer to the application checklist to ensure you have attached all documents related to avoidance and minimization, as well as functional assessment (where applicable). Use the Avoidance and Minimization Checklist, the Avoidance and Minimization Narrative, or your own avoidance and minimization narrative.

**See Env-Wt 311.03(b)(6) and Env-Wt 311.03(b)(10) for shoreline structure exemptions.*

SECTION 9 - MITIGATION REQUIREMENT (Env-Wt 311.02)

If unavoidable jurisdictional impacts require mitigation, a mitigation pre-application meeting must occur at least 30 days but not more than 90 days prior to submitting this Standard Dredge and Fill Permit Application.

Mitigation Pre-Application Meeting Date: Month: Day: Year: January 17, 2024

(☐ N/A - Mitigation is not required)

SECTION 10 - THE PROJECT MEETS COMPENSATORY MITIGATION REQUIREMENTS (Env-Wt 313.01(a)(1)c)

Confirm that you have submitted a compensatory mitigation proposal that meets the requirements of Env-Wt 800 for all permanent unavoidable impacts that will remain after avoidance and minimization techniques have been exercised to the maximum extent practicable: ■ I confirm submittal.

(☐ N/A – Compensatory mitigation is not required)

SECTION 11 - IMPACT AREA (Env-Wt 311.04(g))

For each jurisdictional area that will be/has been impacted, provide square feet (SF) and, if applicable, linear feet (LF) of impact, and note whether the impact is after-the-fact (ATF; i.e., work was started or completed without a permit).

For intermittent and ephemeral streams, the linear footage of impact is measured along the thread of the channel. *Please note, installation of a stream crossing in an ephemeral stream may be undertaken without a permit per Rule Env-Wt 309.02(d), however other dredge or fill impacts should be included below.*

For perennial streams/rivers, the linear footage of impact is calculated by summing the lengths of disturbances to the channel and banks.

Permanent (PERM.) impacts are impacts that will remain after the project is complete (e.g., changes in grade or surface materials).

Temporary (TEMP.) impacts are impacts not intended to remain (and will be restored to pre-construction conditions) after the project is completed.

JURISDICTIONAL AREA		PERM. SF	PERM. LF	PERM. ATF	TEMP. SF	TEMP. LF	TEMP. ATF
Wetlands	Forested Wetland	3,339		☐	0		☐
	Scrub-shrub Wetland			☐			☐
	Emergent Wetland			☐			☐
	Wet Meadow			☐			☐
	Vernal Pool			☐			☐
	Designated Prime Wetland	4,463		☐	0		☐
	Duly-established 100-foot Prime Wetland Buffer			☐			☐
Surface	Intermittent / Ephemeral Stream			☐			☐
	Perennial Stream or River	891	138	☐	1,041	17	☐
	Lake / Pond			☐			☐
	Docking - Lake / Pond			☐			☐
	Docking - River			☐			☐
Banks	Bank - Intermittent Stream			☐			☐
	Bank - Perennial Stream / River	675	137	☐	291	60	☐
	Bank / Shoreline - Lake / Pond			☐			☐
Tidal	Tidal Waters			☐			☐
	Tidal Marsh			☐			☐
	Sand Dune			☐			☐
	Undeveloped Tidal Buffer Zone (TBZ)			☐			☐
	Previously-developed TBZ			☐			☐
	Docking - Tidal Water			☐			☐
TOTAL		9,368	275		1,332	77	

SECTION 12 - APPLICATION FEE (RSA 482-A:3, I)

☐ **MINIMUM IMPACT FEE**: Flat fee of $400.

☐ **NON-ENFORCEMENT RELATED, PUBLICLY-FUNDED AND SUPERVISED RESTORATION PROJECTS, REGARDLESS OF IMPACT CLASSIFICATION:** Flat fee of $400 (refer to RSA 482-A:3, 1(c) for restrictions).

☒ **MINOR OR MAJOR IMPACT FEE:** Calculate using the table below:

Permanent and temporary (non-docking): 10,700	SF	× $0.40 =	$ 4280
Seasonal docking structure:	SF	× $2.00 =	$
Permanent docking structure:	SF	× $4.00 =	$
Projects proposing shoreline structures (including docks) add $400 =			$
		Total =	$ 4280
The application fee for minor or major impact is the above calculated total or $400, whichever is greater =			$ 4280

SECTION 13 - PROJECT CLASSIFICATION (Env-Wt 306.05) Indicate the project classification.		
☐ Minimum Impact Project	☐ Minor Project	☒ Major Project

SECTION 14 - REQUIRED CERTIFICATIONS (Env-Wt 311.11)	
Initial each box below to certify:	
Initials: *JMR*	To the best of the signer's knowledge and belief, all required notifications have been provided.
Initials: *JMR*	The information submitted on or with the application is true, complete, and not misleading to the best of the signer's knowledge and belief.
Initials: *JMR*	The signer understands that: • The submission of false, incomplete, or misleading information constitutes grounds for NHDES to: 1. Deny the application. 2. Revoke any approval that is granted based on the information. 3. If the signer is a certified wetland scientist, licensed surveyor, or professional engineer licensed to practice in New Hampshire, refer the matter to the joint board of licensure and certification established by RSA 310-A:1.
Initials: *N/A*	If the applicant is not the owner of the property, each property owner signature shall constitute certification by the signer that he or she is aware of the application being filed and does not object to the filing.

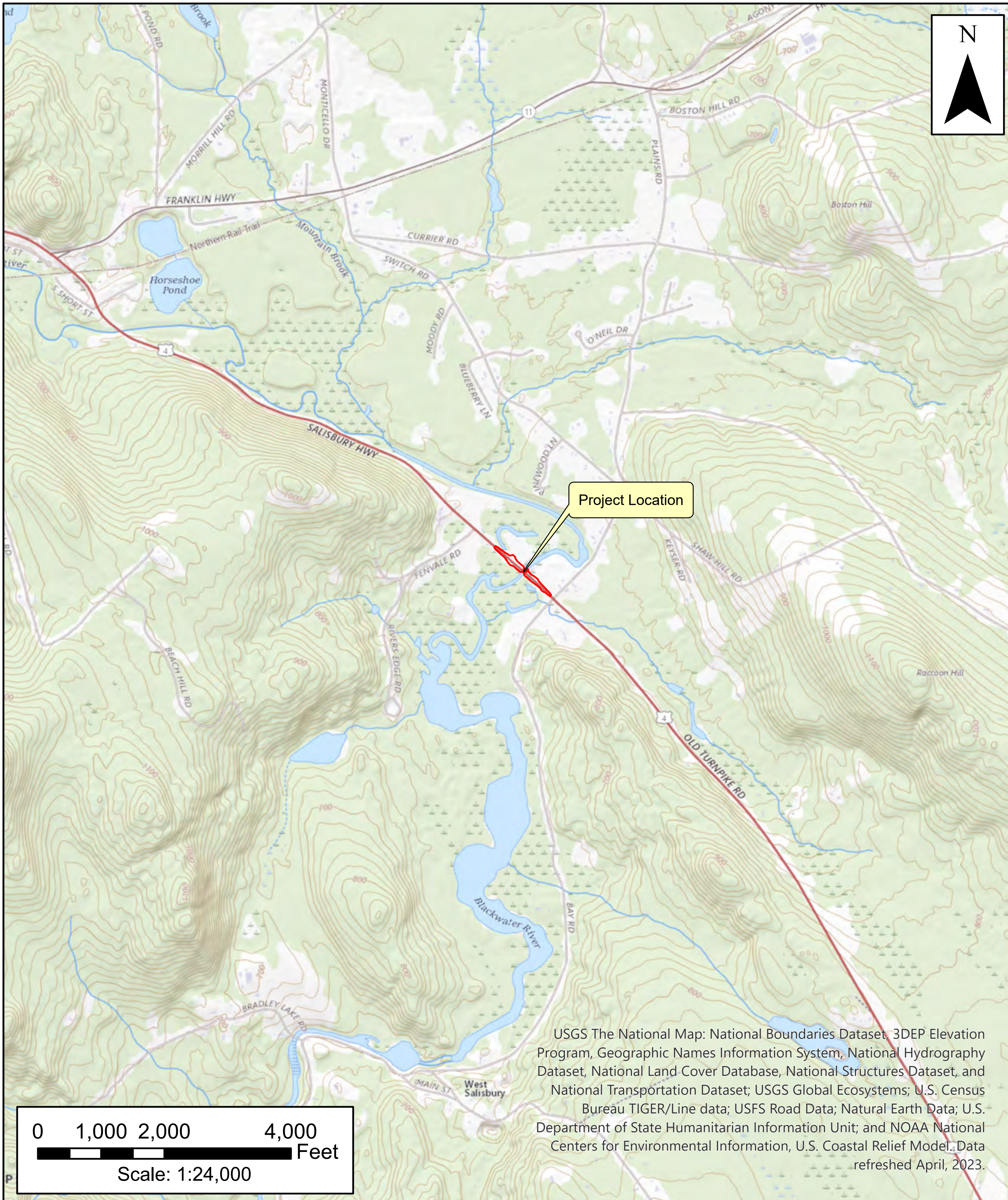
SECTION 15 - REQUIRED SIGNATURES (Env-Wt 311.04(d); Env-Wt 311.11)		
SIGNATURE (OWNER): Jason A. Tremblay	PRINT NAME LEGIBLY: Jason A Tremblay	DATE: 4/26/24
SIGNATURE (APPLICANT, IF DIFFERENT FROM OWNER):	PRINT NAME LEGIBLY:	DATE:
SIGNATURE (AGENT, IF APPLICABLE): Jennifer Riordan	PRINT NAME LEGIBLY: Jennifer Riordan	DATE: 4/25/24

SECTION 16 - TOWN / CITY CLERK SIGNATURE (Env-Wt 311.04(f))	
As required by RSA 482-A:3, I(a)(1), I hereby certify that the applicant has filed four application forms, four detailed plans, and four USGS location maps with the town/city indicated below.	
TOWN/CITY CLERK SIGNATURE: Exempt, State Agency per RSA 482-A:31(a)(1)	PRINT NAME LEGIBLY:
TOWN/CITY: Andover	DATE:

DIRECTIONS FOR TOWN/CITY CLERK:
Per RSA 482-A:3, I(a)(1)

1. IMMEDIATELY sign the original application form and four copies in the signature space provided above.
2. Return the signed original application form and attachments to the applicant so that the applicant may submit the application form and attachments to NHDES by mail or hand delivery.
3. IMMEDIATELY distribute a copy of the application with one complete set of attachments to each of the following bodies: the municipal Conservation Commission, the local governing body (Board of Selectmen or Town/City Council), and the Planning Board.
4. Retain one copy of the application form and one complete set of attachments and make them reasonably accessible for public review.

DIRECTIONS FOR APPLICANT:
Submit the original permit application form bearing the signature of the Town/City Clerk, additional materials, and the application fee to NHDES by mail or hand delivery at the address at the bottom of this page. Make check or money order payable to "Treasurer – State of NH".



USGS Location Map

Andover 40392
US Route 4 over Blackwater River
Andover, NH

New Hampshire DOT
Department of Transportation

Supplemental Narrative

Project Description

The proposed project involves the replacement of the existing bridge (Bridge No. 143/077) that carries US Route 4 over the Blackwater River in the Town of Andover, NH. The existing structure is a through-plate girder, 70-foot single-span bridge (67-foot clear span). The substructure consists of concrete gravity-type abutments and U-back wingwalls. The bridge was built in 1933 and is currently on the State Red List due to its deteriorated condition.

Proposed work includes the replacement of the existing bridge with a 104-foot span bridge (100.5-foot clear span). The new abutments will be constructed behind the existing abutments. The existing abutments will be cut at the ground level and stone will be placed at the edges of the channel for scour protection. The flatter areas of riprap near the abutments will be backfilled with finer material to create wildlife crossing shelves. The bridge will be widened 8 feet and approximately 500 feet of roadway widening will occur at each end of the bridge to match the existing roadway pavement to the wider bridge. The roadway will also be raised 4.5 feet near the bridge.

Since the project is altering the roadway near the agricultural field in the northwest bridge quadrant, an existing farm access driveway is being relocated further west. This relocation was requested by the property owner to accommodate the turning radius of the farm equipment in the southern corner of the field and to allow for safe access to and from US Route 4.

The bridge will be closed during construction and traffic will be detoured. Temporary and permanent easements will be required. Permanent easements are proposed in all four bridge quadrants to allow for long-term access and maintenance with additional area required in the northwest quadrant for the construction and maintenance of the proposed stormwater treatment swale. Temporary construction easements are required along the roadway where the proposed slopes extend beyond the existing NHDOT right-of-way. A utility construction easement is also proposed for utility pole relocation.

The purpose of the project is to improve safety by replacing a deteriorated bridge. Rehabilitation of the existing bridge is not feasible due to the poor condition of the existing substructure. In addition, the existing bridge is undersized and does not convey the 100-year storm. During major storms, water overtops the banks of the Blackwater River and floods the section of US Route 4 near the bridge. The new bridge will convey the 100-year storm with 1-foot of freeboard and will also accommodate the 500-year storm, however the roadway approaches will still experience flooding during major storm events. US Route 4 near the bridge is relatively flat and is below the 100-year floodplain elevation. To prevent overtopping of the roadway, approximately ½-mile of US Route 4 would need to be raised. This was determined to be beyond the scope of the project and would result in additional impacts to adjacent wetland resources.

The widening of the bridge and the roadway approaches will increase the amount of impervious surface (pavement) by approximately 6,325 square feet. Since the project involves greater than 50,000 square feet of disturbance, a stormwater treatment swale is proposed northwest of the bridge in accordance with the NHDES Alteration of Terrain rules. Erosion and sediment controls will be used to avoid water quality impacts during construction.

Existing Conditions / Wetland Resources

The project area includes Bridge No 143/077 and US Route 4, the Blackwater River, adjacent floodplain wetlands, agricultural fields, and upland forested land. Forested wetlands are present in all four bridge quadrants, with an area of emergent wetland further southwest and a ponded area further southeast. A logging yard is located to the northeast.

Wetland resources were delineated on November 28, 2018 and July 19, 2019. Wetland boundaries were field-checked and updated on June 10 and 14, 2022, and April 21, 2023. The wetland resources are summarized in the enclosed Wetland Delineation Report.

The Blackwater River does not have a regulatory floodway, however the entire project is mapped as Zone A floodplain (refer to enclosed FEMA Flood Insurance Rate Map). Floodplain wetlands are located in all four bridge quadrants. These wetlands are considered Priority Resource Areas (PRAs) since they are adjacent to a Tier 3 stream. The US Route 4/Blackwater River crossing is a Tier 3 crossing based on watershed size and the presence of a 100-year floodplain. It is also a Class A water and is subject to the Shoreland Water Quality Protection Act.

Prime wetlands are mapped to the northwest, southwest, and southeast of the bridge. Impacts to prime wetlands are proposed in the northwest and southeast bridge quadrants. Additional information on prime wetlands is provided below.

Conservation land (Fenton Conservation Easement) is located on the southern side of US Route 4, west of the Blackwater River. This easement is held by the Town of Andover. The project will require both temporary and permanent easements on this property, which will be coordinated prior to construction.

Wetland & Watercourse Impacts

The total amount of proposed wetland and watercourse impact is 10,700 square feet and 352 linear feet. This includes approximately 7,802 square feet of total permanent wetland impact, of which approximately 4,463 square feet is prime wetland impact. All of the proposed wetland impact is within PRA wetlands. The permanent wetland impacts will result from roadway widening, slope work, and relocation of a farm field access driveway.

Watercourse impacts will result from the construction of the new bridge abutments and placement of stone for scour protection. Temporary watercourse impacts will result from the removal of the existing bridge abutments, dewatering, and construction access. Approximately 1,566 square feet (275 linear feet) of permanent perennial stream (channel and bank) impact and 1,332 square feet (77 linear feet) of temporary perennial stream (channel and bank) impact is proposed.

Proposed Wetland & Watercourse Impacts

	Permanent		Temporary	
	SF	**LF**	**SF**	**LF**
Forested Wetland	3,339*	--	0	0
Designated Prime Wetland	4,463*	--	0	0
Perennial Stream (Blackwater River)	891	138	1,041	17
Bank – Perennial Stream	675	137	291	60
Total	**9,368**	**275**	**1,332**	**77**

*Priority Resource Area (floodplain wetland contiguous to a Tier 3 watercourse)

Essential Fish Habitat

The Blackwater River is designated as Essential Fish Habitat (EFH) for Atlantic salmon. An EFH Assessment was completed and submitted to the National Marine Fisheries Service (NMFS) in January

2023. NMFS reviewed the project plans and EFH assessment and responded that the project, as proposed, would avoid and minimize adverse impacts to EFH (refer to enclosed correspondence). Specific measures that are proposed to avoid and minimize adverse impacts include: conducting the work in dry conditions (dewatering work areas in the river); maintaining river flow throughout the project; conducting in-water work in the summer; and using erosion and sediment controls during construction.

Prime Wetlands

Prime wetlands are mapped to the northwest, southwest, and southeast of the bridge. These were designed by the Town of Andover in 1989. At this time, wetlands needed to provide various functions and contain very poorly drained soils to be considered for prime wetland designation. The prime wetlands within the study area (identified by the Town of Andover as Site B19, or Blackwater Bay) provided many functions at the time of designation and continue to do so today. Functions provided by this wetland system include:

- Ecological integrity
- Fish habitat
- Flood storage
- Groundwater recharge
- Nutrient trapping
- Production export
- Scenic quality
- Sediment trapping
- Shoreline anchoring
- Uniqueness/heritage
- Wetland-based recreation
- Wetland-dependent wildlife habitat

Based on a review of the NRCS web soil survey, the Blackwater River and prime wetlands are underlain by very poorly drained soil (Medomak mucky silt loam, 0 to 2 percent slopes, frequently flooded). The mapped areas of very poorly drained soils are consistent with field observations during the wetland delineation.

Within the project limits, Wetland 1 (northwest bridge quadrant) is mapped as prime wetland, except for a small area (660 square feet) at the edge of the agricultural field. This area does not contain very poorly drained soil and appears to be inundated less frequently than the rest of the wetland. Wetland 1 continues west and north beyond the project area, eventually connecting to the Blackwater River. The interior of the wetland is very poorly drained and retains flood water from the Blackwater River.

Wetland 2 (southwest bridge quadrant) is mapped as prime wetland beyond the project limits. The portion of Wetland 2 within the project limits is not shown as prime wetland on the NHDES Wetlands Permit Planning Tool. During field reviews, this area of the wetland was observed to have better drained soil compared to the prime wetland areas and it has been disturbed by clearing for the roadway and overhead powerlines. Wetland 2 continues south and west beyond the project area into a forested floodplain wetland that is associated with the Blackwater River.

The entirety of Wetland 7 (southeast bridge quadrant) is identified as prime wetland. Although the mapped prime wetland on the NHDES Wetlands Permit Planning Tool does not extend to US Route 4, the delineated wetland contains very poorly drained soils up to the roadway embankment. Wetland 7 continues south beyond the project area into a large forested floodplain wetland. The mapped prime wetland area extends approximately ½ mile along the Blackwater River to an area known as the Blackwater Bays.

Impacts to prime wetlands are proposed in the northwest and southeast bridge quadrants. The impacts in the northwest quadrant (4,116 square feet) are proposed from roadway widening, slope work, and the relocation of a farm field access driveway. The impacts in the southeast bridge quadrant (347 square feet) are proposed from roadway widening and slope work. Although the project proposes permanent impacts within prime wetlands, no impacts to the functions of the overall prime wetland system are anticipated. The impacts will occur at the edges of the wetlands, along US Route 4. Due to their location near the roadway, these portions of the wetlands provide fewer functions compared to the interior, less disturbed portions of the wetland system. Overall, the proposed impacts represent approximately 1 percent of the total prime wetland area northwest of the bridge and approximately 0.03 percent of the total prime wetland area southeast of the bridge. It is expected that the prime wetland system will continue to provide various functions at a high level and that the fill associated with the roadway improvements will not result in a net loss of these functions. In addition, the bridge replacement will improve conditions at the crossing by replacing an undersized structure with a structure that accommodates the bankfull width and provides for wildlife passage. This is expected to benefit the overall wetland system.

Prime Wetlands
Background map downloaded from NHDES Wetlands Permit Planning Tool on 2/7/2024.

Coordination with Andover Conservation Commission

The Andover Conservation Commission was contacted early in the design process to obtain input on the project and local environmental resources. The Commission sent a response letter in 2018 that summarized known environmental resources near the project, including prime wetlands, invasive species, and flooding issues. A second letter was sent to the Commission in January 2024 to provide an update on the project, including the anticipated prime wetland impacts. A response has not been received to date.

Mitigation

The permanent impacts to PRA wetlands (7,802 square feet) are proposed to be mitigated through an in-lieu fee payment to the NHDES Aquatic Resource Mitigation (ARM) Fund. Using the NHDES ARM Fund Wetland Payment calculator, the required fee for 7,802 square feet of forested wetland impact is $37,075.56 (refer to enclosed ARM Fund wetland calculator spreadsheet).

Although the project will improve hydraulic capacity, geomorphic compatibility, and aquatic organism passage at the crossing and includes wildlife crossing shelves, it will involve over 200 linear feet of permanent bank and channel impact from the placement of stone for scour protection. It is assumed that the stream impacts are not considered self-mitigating under Env-Wt 902.27 due to the placement of riprap. Stone riprap is necessary to protect the bridge abutment. Vegetation or other soft armoring techniques would not withstand flows during large storm events. The placement of natural streambed material over the riprap is not proposed since the slopes near the abutments are too steep for the material to remain in place. The flatter areas of riprap next to the abutments will be backfilled with finer material to create wildlife crossing shelves.

The permanent stream impacts are proposed to be mitigated through an in-lieu fee payment to the ARM fund. Using the NHDES ARM Fund Stream Payment calculator, the required fee for 275 linear feet of perennial stream impact is $88,644.60 (refer to enclosed ARM Fund stream calculator spreadsheet).

STANDARD DREDGE AND FILL WETLANDS PERMIT APPLICATION ATTACHMENT A: MINOR AND MAJOR PROJECTS

Water Division/Land Resources Management
Wetlands Bureau
Check the Status of your Application

RSA/ Rule: RSA 482-A/ Env-Wt 311.10; Env-Wt 313.01(a)(1); Env-Wt 313.03

APPLICANT'S NAME: **NHDOT** **TOWN NAME:** Andover

Attachment A is required for *all minor and major projects*, and must be completed *in addition* to the Avoidance and Minimization Narrative or Checklist that is required by Env-Wt 307.11.

For projects involving construction or modification of non-tidal shoreline structures over areas of surface waters having an absence of wetland vegetation, only Sections I.X through I.XV are required to be completed.

PART I: AVOIDANCE AND MINIMIZATION

In accordance with Env-Wt 313.03(a), the Department shall not approve any alteration of any jurisdictional area unless the applicant demonstrates that the potential impacts to jurisdictional areas have been avoided to the maximum extent practicable and that any unavoidable impacts have been minimized, as described in the Wetlands Best Management Practice Techniques For Avoidance and Minimization.

SECTION I.I - ALTERNATIVES (Env-Wt 313.03(b)(1))
Describe how there is no practicable alternative that would have a less adverse impact on the area and environments under the Department's jurisdiction.

1. NO BUILD - THIS WOULD RESULT IN LESS IMPACT THAN THE PROPOSED ACTION, BUT THE EXISTING BRIDGE IS IN POOR CONDITION AND WOULD POSE A SAFETY CONCERN AS IT CONTINUED TO DETERIORATE. THE EXISTING CROSSING IS UNDERSIZED AND DOES NOT CONVEY THE 100-YEAR STORM EVENT. THE NO-BUILD ALTERNATIVE WOULD NOT ADDRESS THESE ISSUES.

2. REPLACEMENT WITH A LONGER SPAN BRIDGE - A PROPOSED SPAN OF APPROXIMATELY 172 FEET WOULD BE REQUIRED TO FULLY COMPLY WITH THE STREAM CROSSING GUIDELINES (2.2 X BANKFULL WIDTH FOR TYPE E STREAMS). THE BANKFULL WIDTH OF THE BLACKWATER RIVER NEAR THE CROSSING IS APPROXIMATELY 78 FEET. ALTHOUGH THIS ALTERNATIVE WOULD RESULT IN A LONGER SPAN THAT WOULD BETTER ACCOMMODATE THE FLOOD PRONE WIDTH COMPARED TO THE PROPOSED ACTION, IT WOULD REQUIRE RAISING THE ROAD AND ULTIMATELY INCREASE PERMANENT WETLAND IMPACTS. PHYSICAL CONSTRAINTS AT THE CROSSING LIMIT THE SIZE OF THE PROPOSED STRUCTURE. IN ADDITION, COST WOULD BE INCREASED DUE TO RIGHT-OF-WAY IMPACTS.

3. PROPOSED ACTION - REPLACEMENT WITH A 100.5-FOOT CLEAR SPAN BRIDGE - ALTHOUGH THE PROPOSED ACTION DOES NOT MEET THE SPAN REQUIREMENTS OF THE STREAM CROSSING RULES, IT WILL IMPROVE HYDRAULIC CAPACITY, AQUATIC ORGANISM PASSAGE, AND GEOMORPHIC COMPATABILITY AT THE CROSSING BY PROVIDING A LONGER SPAN THAN THE EXISITING BRIDGE (100.5 FEET VS 70 FEET). THE PROPOSED BRIDGE WILL ALSO ACCOMMODATE THE 100-YEAR AND 500-YEAR STORMS.

SECTION I.II - MARSHES (Env-Wt 313.03(b)(2)) Describe how the project avoids and minimizes impacts to tidal marshes and non-tidal marshes where documented to provide sources of nutrients for finfish, crustacean, shellfish, and wildlife of significant value.
N/A - The project does not involve impacts to marshes.

SECTION I.III - HYDROLOGIC CONNECTION (Env-Wt 313.03(b)(3)) Describe how the project maintains hydrologic connections between adjacent wetland or stream systems.
The project will maintain hydrologic connections along the Blackwater River and adjacent wetland systems by replacing an existing crossing. The hydraulic capacity of the structure will be improved and the clear span will be lengthened from 67 feet to 100.5 feet. This will result in improvement to the overall stream/wetland system.

SECTION I.IV - JURISDICTIONAL IMPACTS (Env-Wt 313.03(b)(4))

Describe how the project avoids and minimizes impacts to wetlands and other areas of jurisdiction under RSA 482-A, especially those in which there are exemplary natural communities, vernal pools, protected species and habitat, documented fisheries, and habitat and reproduction areas for species of concern, or any combination thereof.

There are no exemplary natural communities or vernal pools within or adjacent to the project area.

The NH Natural Heritage Bureau (NHB) Report did not include any records of protected species.

The USFWS IPaC report identified northern long-eared bat (NLEB) and monarch butterfly as potentially occuring within the project area. It was determined that the project is within the scope and adheres to the criteria of the FHWA, FRA, FTA Programmatic Biological Opinion for Transportation Projects within the Range of the Indiana Bat and Northern Long-Eared Bat (PBO) and may affect, but is not likely to adversely affect NLEB. A concurrence letter was received from the US Fish and Wildlife Service in February 2024 (enclosed). Tree clearing is proposed to occur during the bat inactive season.

Any impacts to potential monarch butterfly habitat would be temporary during construction. The project includes the use of slope seed mixes that contain native wildflowers post-construction.

The Blackwater River is designated as Essential Fish Habitat (EFH) for Atlantic salmon. An EFH assessment was completed and submitted to the National Marine Fisheries Service (NMFS) in January 2023. NMFS reviewed the project plans and EFH assessment and responded that the project would avoid and minimize adverse effects to EFH (refer to enclosed correspondence).

SECTION I.V - PUBLIC COMMERCE, NAVIGATION, OR RECREATION (Env-Wt 313.03(b)(5))

Describe how the project avoids and minimizes impacts that eliminate, depreciate or obstruct public commerce, navigation, or recreation.

The project is not anticipated to impact public commerce or navigation. The Blackwater River is not considered a navigable waterway, although the segment of the river near the bridge is used for non-motorized boating. Temporary disruptions to recreational boating may occur during construction but no long-term impacts are anticipated. The project will lengthen the span and raise the low-chord elevation of the bridge, which will allow for easier access under the bridge.

During construction, the US Route 4 bridge will be closed and traffic will be detoured. These impacts will be temporary. No permanent impacts to traffic are anticipated.

SECTION I.VI - FLOODPLAIN WETLANDS (Env-Wt 313.03(b)(6))

Describe how the project avoids and minimizes impacts to floodplain wetlands that provide flood storage.

The project area is mapped as a Zone A (100-year) floodplain and the wetlands adjacent to the Blackwater River provide flood storage. The project will result in approximately 7,802 square feet of permanent impact to floodplain wetlands from roadway widening, slope work, and relocation of a farm field access driveway. These impacts are necessary to raise the road profile and to match the existing roadway pavement to the wider bridge. Impacts were minimized by steepening the slopes where possible. The proposed impacts are located near edge of the wetland system, adjacent to US Route 4. No substantial loss of flood storage is anticipated since the impacts are small and represent less than 0.5 percent of the overall wetland system

The new bridge will improve the hydraulic capacity of the crossing and convey the 100-year and 500-year storm events. The hydraulic analysis completed for the project showed that the flood capacity of the Blackwater River near the project will be increased by the proposed bridge replacement. In addition, the water surface elevations immediately upstream of the bridge will be slightly decreased during the 50- and 100-year storm events and there will be no appreciable change in the downstream water survey elevations.

SECTION I.VII - RIVERINE FORESTED WETLAND SYSTEMS AND SCRUB-SHRUB – MARSH COMPLEXES (Env-Wt 313.03(b)(7))

Describe how the project avoids and minimizes impacts to natural riverine forested wetland systems and scrub-shrub – marsh complexes of high ecological integrity.

The wetlands within the project area are part of a large riverine forested wetland system that is associated with the Blackwater River. They include designated prime wetlands and all are Priority Resource Areas (floodplain wetlands adjacent to a Tier 3 stream) with high ecological integrity. Proposed impacts are located along the edges of wetlands, near US Route 4, and in a portion of the wetland complex that has lower ecological integrity compared to the interior, undisturbed portion.

Although the project will result in permanent impacts to forested wetlands (approximately 7,640 square feet), it will improve hydraulic capacity and aquatic organism passage at the US Route 4/Blackwater River crossing, which is expected to have a positive effect on the overall wetland complex.

SECTION I.VIII - DRINKING WATER SUPPLY AND GROUNDWATER AQUIFER LEVELS (Env-Wt 313.03(b)(8))

Describe how the project avoids and minimizes impacts to wetlands that would be detrimental to adjacent drinking water supply and groundwater aquifer levels.

The Blackwater River is designated as a Class A water but is not considered an Outstanding Resource Water.

Overall, the project will not result in a large amount of fill within wetlands and surface waters. Since the project involves the replacement of an existing stream crossing, impacts are unavoidable. A stormwater treatment swale is proposed in the northwest bridge quadrant to provide treatment for the pavement within the project area. Stormwater runoff from US Route 4 is currently untreated, so this will result in an improvement to water quality.

The groundwater recharge functions provided by the wetland complex are not expected to be adversely affected by the project since the proposed impact area is small relative to the overall wetland complex. In addition, the high quality, interior portions of the wetlands will remain undisturbed.

Potential temporary impacts to water quality that could result during construction will be avoided through the use of erosion and sedimentation controls and other Best Management Practices (BMPs).

SECTION I.IX - STREAM CHANNELS (Env-Wt 313.03(b)(9))

Describe how the project avoids and minimizes adverse impacts to stream channels and the ability of such channels to handle runoff of waters.

Although the project involves permanent and temporary impacts to the Blackwater River, it will improve the condition of the stream channel at the US Route 4 crossing once construction is complete. The existing bridge does not convey the 100-year storm event. The proposed bridge will improve the hydraulic capacity of the crossing and will accommodate the 100-year and 500-year storm events.

Impacts to the surounding floodplain wetlands will be located at the edges of the wetlands and are minor relative to the overall size of the wetlands. Since there are extensive wetlands near the crossing that will remain undisturbed, no impacts to the wetland system's overall ability to handle runoff are expected.

SECTION I.X - SHORELINE STRUCTURES - CONSTRUCTION SURFACE AREA (Env-Wt 313.03(c)(1)) Describe how the project has been designed to use the minimum construction surface area over surface waters necessary to meet the stated purpose of the structures.
N/A - The project does not involve the construction of shoreline structures.

SECTION I.XI - SHORELINE STRUCTURES - LEAST INTRUSIVE UPON PUBLIC TRUST (Env-Wt 313.03(c)(2)) Describe how the type of construction proposed is the least intrusive upon the public trust that will ensure safe docking on the frontage.
N/A - The project does not involve the construction of shoreline structures.

SECTION I.XII - SHORELINE STRUCTURES – ABUTTING PROPERTIES (Env-Wt 313.03(c)(3)) Describe how the structures have been designed to avoid and minimize impacts on ability of abutting owners to use and enjoy their properties.
N/A - The project does not involve the construction of shoreline structures.

SECTION I.XIII - SHORELINE STRUCTURES – COMMERCE AND RECREATION (Env-Wt 313.03(c)(4)) Describe how the structures have been designed to avoid and minimize impacts to the public's right to navigation, passage, and use of the resource for commerce and recreation.
N/A - The project does not involve the construction of shoreline structures.

SECTION I.XIV - SHORELINE STRUCTURES – WATER QUALITY, AQUATIC VEGETATION, WILDLIFE AND FINFISH HABITAT (Env-Wt 313.03(c)(5)) Describe how the structures have been designed, located, and configured to avoid impacts to water quality, aquatic vegetation, and wildlife and finfish habitat.
N/A - The project does not involve the construction of shoreline structures.

SECTION I.XV - SHORELINE STRUCTURES – VEGETATION REMOVAL, ACCESS POINTS, AND SHORELINE STABILITY (Env-Wt 313.03(c)(6)) Describe how the structures have been designed to avoid and minimize the removal of vegetation, the number of access points through wetlands or over the bank, and activities that may have an adverse effect on shoreline stability.
N/A - The project does not involve the construction of shoreline structures.

PART II: FUNCTIONAL ASSESSMENT
REQUIREMENTS Ensure that project meets the requirements of Env-Wt 311.10 regarding functional assessment (Env-Wt 311.04(j); Env-Wt 311.10).
FUNCTIONAL ASSESSMENT METHOD USED: US Army Corps of Engineers Highway Methodology Workbook Supplement
NAME OF CERTIFIED WETLAND SCIENTIST (FOR NON-TIDAL PROJECTS) OR QUALIFIED COASTAL PROFESSIONAL (FOR TIDAL PROJECTS) WHO COMPLETED THE ASSESSMENT: JENNIFER RIORDAN (CWS #269)
DATE OF ASSESSMENT: 1/24/2024
Check this box to confirm that the application includes a NARRATIVE ON FUNCTIONAL ASSESSMENT: ☒
For minor or major projects requiring a standard permit without mitigation, the applicant shall submit a wetland evaluation report that includes completed checklists and information demonstrating the RELATIVE FUNCTIONS AND VALUES OF EACH WETLAND EVALUATED. Check this box to confirm that the application includes this information, if applicable: ☒ Note: The Wetlands Functional Assessment worksheet can be used to compile the information needed to meet functional assessment requirements.

AVOIDANCE AND MINIMIZATION WRITTEN NARRATIVE

Water Division/Land Resources Management Wetlands Bureau

Check the Status of your Application

RSA/ Rule: RSA 482-A/ Env-Wt 311.04(j); Env-Wt 311.07; Env-Wt 313.01(a)(1)b; Env-Wt 313.01(c)

APPLICANT'S NAME: NHDOT **TOWN NAME:** Andover

An applicant for a standard permit shall submit with the permit application a written narrative that explains how all impacts to functions and values of all jurisdictional areas have been avoided and minimized to the maximum extent practicable. This attachment can be used to guide the narrative (attach additional pages if needed). Alternatively, the applicant may attach a completed Avoidance and Minimization Checklist (NHDES-W-06-050) to the permit application.

SECTION 1 - WATER ACCESS STRUCTURES (Env-Wt 311.07(b)(1))
Is the primary purpose of the proposed project to construct a water access structure?

No. The project is a bridge replacement project and does not involve the construction of a water access structure.

SECTION 2 - BUILDABLE LOT (Env-Wt 311.07(b)(1))
Does the proposed project require access through wetlands to reach a buildable lot or portion thereof?

No

SECTION 3 - AVAILABLE PROPERTY (Env-Wt 311.07(b)(2))*
For any project that proposes permanent impacts of more than one acre, or that proposes permanent impacts to a PRA, or both, are any other properties reasonably available to the applicant, whether already owned or controlled by the applicant or not, that could be used to achieve the project's purpose without altering the functions and values of any jurisdictional area, in particular wetlands, streams, and PRAs?

**Except as provided in any project-specific criteria and except for NH Department of Transportation projects that qualify for a categorical exclusion under the National Environmental Policy Act.*

The project does not propose more than one acre of permanent impact but includes 7,802 SF of permanent impact to PRA wetlands.

Since the project involves the replacement of an exisiting stream crossing, there are no other properties available that would be feasible. Relocating US Route 4 would result in a greater amount of wetland impact since there are large PRA wetlands on both sides of the existing crossing. The project is located at an existing crossing and the wetland impacts are at the edge of the roadway.

Although the project will result in permanent impacts to PRAs, it will improve the conditions at the US Route 4/Blackwater River crossing by lengthening the bridge span and improving hydraulic capacity, aquatic organism passage, and geomorphic compatability. These improvements will benefit the overall wetland system near the Blackwater River.

SECTION 4 - ALTERNATIVES (Env-Wt 311.07(b)(3))

Could alternative designs or techniques, such as different layouts, different construction sequencing, or alternative technologies be used to avoid impacts to jurisdictional areas or their functions and values as described in the Wetlands Best Management Practice Techniques For Avoidance and Minimization?

The majority of the proposed permanent impact to the Blackwater River is associated with the construction of new bridge abutments and the placement of stone for scour protection. These impacts will occur at the edges of the channel and the center of the river will remain undisturbed. Since the new bridge will improve hydraulic capacity, aquatic organism passage, and geomorphic compatability at the crossing, no loss of functions is anticipated. Stone is necessary to protect the bridge abutments from scour during storm events. Natural stabilization or soft armoring would not be adequate for protecting the bridge substructure.

Permanent wetland impacts beyond the bridge location will occur from the relocation of the agricultural field driveway, roadway widening, and slope work. Complete avoidance of wetland impacts from roadway slope work was not possible since the roadway widening is required to match the existing roadway to the wider bridge. The roadway profile also needs to be raised to allow for the required 1-foot of freeboard during the 100-year flood event.

During construction, the bridge will be closed and traffic will be detoured. Other traffic control options would result in a greater amount of impact to jurisdictional areas. Construction of an offline temporary bridge would allow the roadway to remain fully open during construction, but this would also result in additional wetland and stream impacts.

SECTION 5 - CONFORMANCE WITH Env-Wt 311.10(c) (Env-Wt 311.07(b)(4))**

How does the project conform to Env-Wt 311.10(c)?

***Except for projects solely limited to construction or modification of non-tidal shoreline structures only need to complete relevant sections of Attachment A*.

A functional assessment was completed for the wetlands within the project area (refer to functional assessment form in Appendix B of the Wetland Delineation Report).

The project will not impact the functions provided by the Blackwater River and associated wetland system located within and adjacent to the project area. All impacts are located adjacent to the bridge and US Route 4, within lower functioning portions of the wetland. The project will ultimately improve the conditions at the crossing by providing a longer span that accommodates more of the flood prone width. In addition, the proposed wetland impacts are small relative to the overall wetland system (less than 0.5% of the total wetland area near the US Route 4 bridge).

Functions provided by the Blackwater River and associated wetlands include ecological integrity, fish and aquatic life habitat, flood storage, groundwater recharge, nutrient trapping, production export, scenic quality, sediment trapping, shoreline anchoring, uniqueness/heritage, wetland-based recreation, and wetland-dependent wildlife habitat. Of these, all are provided at the principal level except groundwater recharge and production export.

BUREAU OF ENVIRONMENT
CONFERENCE REPORT

SUBJECT: NHDOT Monthly Natural Resource Agency Coordination Meeting
DATE OF CONFERENCE: April 17, 2019
LOCATION OF CONFERENCE: John O. Morton Building
ATTENDED BY:

NHDOT
Sarah Large
Andrew O'Sullivan
Ron Crickard
Doug Locker
Tim Boodey
Mike Licciardi
Kevin Russell

ACOE
Mike Hicks

NHDES
Gino Infascelli
Lori Sommer
Dale Keirstead
Eben Lewis

NHF&G
Carol Henderson

NHB
Amy Lamb

Consultants/Public Participants
Devon Smith
Billy Kitchens
Tom Levins

PRESENTATIONS/ PROJECTS REVIEWED THIS MONTH: *(minutes on subsequent pages)*

(When viewing these minutes online, click on a project to zoom to the minutes for that project)

This project was previously discussed at the 8/17/2016 Monthly Natural Resource Agency Coordination Meeting.

Andover, #40392

Tom Levins from GM2 Associates provided an overview of the project which involves the replacement of the bridge that carries US Route 4 over the Blackwater River in the Town of Andover. The project is currently in the preliminary design phase. The structural steel has deteriorated to a point that repair or rehabilitation is not a feasible option.

The existing bridge was constructed in 1933 and is on the state's Red List. Severe deterioration to structural steel was discovered during an in-depth inspection in September 2018. The purpose of the project is to replace a structurally deficient deteriorated bridge that has substandard width (24 feet between rails) for current vehicle and bicycle use. The existing bridge span is 70 feet. The proposed bridge typical section is 11-foot lanes and 5-foot shoulders for all alternatives. A clear span of 96 feet is proposed to meet the stream crossing rules (bankfull width is approximately 78 feet).

Three alternatives are currently under consideration and will be discussed with the Town of Andover:

• Bridge replacement using Accelerated Bridge Construction (28-day bridge closure) and detour on state routes (16 miles);
• Bridge replacement using conventional construction (3 to 4 month bridge closure) and detour on state routes (16 miles); and
• Bridge replacement using conventional construction and a temporary on-site diversion upstream (north side) of US Route 4 with a temporary bridge to maintain alternating two-way traffic with signals (construction duration of 4 to 5 months).

The same replacement bridge would be constructed for all three alternatives, with the only difference being the traffic control and construction methods.

Jenn Riordan from GM2 Associates provided an overview of the natural resources. The Blackwater River is a Tier 3 stream crossing. It appears that the project will be able to meet the bankfull width/bridge span requirements of the NHDES stream crossing rules. There are floodplain wetlands next to the river. The Blackwater River and adjacent wetlands on the south side of US Route 4 are designated as Prime Wetlands with no 100-foot buffer. There are also prime wetlands located northwest of the bridge beyond the project limits.

Impacts will likely be outside of the river and banks since the new abutments would be constructed behind the existing abutments. Wetland impacts have not been determined at this point. If the temporary traffic diversion alternative is selected, there would be temporary wetland impacts on the north side of US Route 4.

A Shoreland Permit will be required for the project. In addition, the entire project area is mapped as a Zone A floodplain. There is no regulatory floodway mapped. There are no listed water quality impairments. The Blackwater River is designated as a Class A water within the project vicinity.

The NH Natural Heritage Bureau report indicated no impacts. Northern long-eared bat (NLEB) is the only federally-listed species. A bat survey of the bridge will be completed. The list of known NLEB hibernacula showed Salisbury, Warner, and Danbury as having hibernacula, but none in Andover. Jenn said this will be investigated further to determine the locations.

Conservation land (a town-owned easement) is located south of US Route 4 and west of the Blackwater River.

Mike Hicks asked if Section 106 review had been/will be completed. Jenn replied that an inventory of the existing bridge had been done and it was determined to be Not Eligible. A Phase IA archaeological survey will be completed on the north side of the bridge if the temporary traffic diversion alternative is selected.

Carol Henderson asked if there will be impacts within the channel of the Blackwater River. Tom Levins replied that none are anticipated, although some riprap may be necessary at the edges. A hydraulic analysis has not yet been completed to determine if riprap is necessary. Carol mentioned the potential need for a brook floater survey if there will be channel impacts. There are known brook floater populations upstream and downstream of the project and there is suitable habitat near the bridge.

Lori Sommer asked if there will be any impacts to the conservation parcel located adjacent to the project. Tom Levins replied that impacts are not currently proposed and the project will try to avoid any impacts.

Ron Crickard asked about the length of the approach roadway work. Tom Levins said that it would be approximately 100 feet on each end of the bridge, although the exact length hasn't been determined yet.

Gino Infascelli recommended cutting the vegetation and maintaining the soil and roots within the temporary wetland impacts areas if the temporary traffic diversion is used.

Mike Hicks asked about the proposed construction schedule. Tom Levins replied that construction in 2023 is currently anticipated, although the proposed construction date may be moved up.

Sarah Large stated that the project should be presented at another Natural Resource Meeting once wetland impacts have been identified and before the wetland permit application is submitted.

After the meeting, Sarah Large emailed Tom Levins and Jenn Riordan to mention that the US Coast Guard had reviewed the agenda and provided the following comment on the Andover project: *This bridge is a navigable body of water but may be exempt from a USCG bridge permit as previous projects on this waterway have fallen under FHWA-Surface Transportation Act (STA). Recommend further discussion with this office.*

This project has not been previously discussed at a Monthly Natural Resource Agency Coordination Meeting.

BUREAU OF ENVIRONMENT
CONFERENCE REPORT

SUBJECT: NHDOT Monthly Natural Resource Agency Coordination Meeting
DATE OF CONFERENCE: January 17, 2024
LOCATION OF CONFERENCE: Virtual meeting held via Zoom

ATTENDED BY:

NHDOT
Andrew O'Sullivan
Joshua Brown
Jon Evans
Mark Hemmerlein
Rebecca Martin
Levi Byers
Kerry Ryan
Chris Carucci
David Smith
Rhona Thomson
Curtis Morrill
Arin Mills
Ron Grandmaison
Carol Niewola
Jason Tremblay
Meli Dube
Corey Spetelunas
Hans Weber
Rick Dyment
Lilah Flynn

ACOE
Absent

USCG
Absent

EPA
Jean Brochi

NHDES
Karl Benedict
Seta Detzel
Emily Nichols
Mary Ann Tilton
Eben Lewis

NHB
Absent

NH Fish & Game
Mike Dionne
Kevin Newton
Jared Lamy
Melissa Winters

Federal Highway
Jamie Sikora

US Fish & Wildlife
Absent

The Nature Conservancy
Absent

NH Transportation & Wildlife Workgroup
Absent

Consultants/ Public Participants
Leslie Merrithew
Gregg Cohen
Carl Gross
Jennifer Riordan
Tom Levins

PRESENTATIONS/ PROJECTS REVIEWED THIS MONTH: *(minutes on subsequent pages)*

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Seta Detzel (NHDES, Wetland Mitigation Specialist) – Would like to understand where in the application it says that these wetlands are ditches and where Stantec shows. This might help clarify the Airport's request and NHDES could take another look at whether the removal of these wetlands would require mitigation.

Stantec advised that they would be found in the Wetland Scientist's report included in the permit application and will send the page details to the group for their review.

Seta noted that it would be helpful if Stantec could also provide a description on how we are preserving usefulness in another way on this project. Stantec agreed.

Stantec noted that time is of the essence, as we are required to have permits in hand as soon as possible to be eligible for this year's federally funded AIP program. This is a multimillion-dollar safety improvement project that is important for the region and we have already experienced a one year delay due to the lengthy permitting process. Anything the agencies can do to assist with the project obtaining the permits would be very much appreciated.

Emily Nichols (NHDES, ARM Fund Program Manager) – Supports comments that Mary Ann provided.
Kevin Newton (NHFG, Wildlife Biologist) – No comments.

Stantec requested if there were any updates on the status of the NHFG 1004 Fis consultation application, which was submitted on November 21, 2023. Kevin will check with his colleagues and get back to Stantec.

Jared Lamy (NHFG) – No comments.

Jamie Sikora (FHWA) – No comments.

Jean Brochi (USEPA) – Confirms that the USACE AJD was sent to Stantec on January 3, 2024 via email by Taylor Bell. Notes that Stantec also requested an AJD on another wetland, Wetland M, which the Corps disagreed with and was not included in the current AJD.

Stantec agreed that they are not asking NHDES to evaluate Wetland M at this time. We would like to focus the agency's review on Wetlands F, G, H, and I.

Andy asked if there were any further comments or discussion. Nothing further from the group.

Andover, 40392 (X-A004(384)):

Jenn Riordan (GM2) explained that the project was last presented in 2019 and that the preliminary design has been completed and final design is ongoing. The wetlands permit application is expected to be submitted in April 2024. The project involves the replacement of the bridge that carries US Route 4 over the Blackwater River in Andover. The existing structure is a through-plate girder bridge with a 70-foot span. It was constructed in 1933. The bridge is currently on the State's Red List and has previous occurrences of roadway flooding. During large storms, water overtops the banks of the Blackwater River and floods the section of Route 4 near the bridge. The existing bridge does not accommodate the 100-year storm event. Rehabilitation of the existing bridge is not feasible due to the condition of the existing structure.

The project proposes the replacement of the existing bridge with a 104-foot span bridge (101-foot clear span) that will convey the 100-year storm with 1-foot of freeboard. New abutments will be constructed behind the existing abutments. The existing abutments will be cut at the ground level and stone will be placed at the edge of the channel for scour protection. A farm access driveway in the northwest bridge quadrant will be relocated further west. The bridge will be closed during construction and traffic will be detoured. The bridge will be widened 8 feet and approximately 500 feet of roadway widening will occur at each end of the bridge. The roadway will also be raised 4.5 feet near the bridge and there will be an increase in new impervious surface of approximately 6,325 SF. The project is subject to Alteration of Terrain requirements, so a stormwater treatment swale is proposed in the northwest quadrant of the bridge. Temporary and permanent easements will be required.

The following project alternatives were evaluated:

- Bridge Rehabilitation – Not feasible due to poor condition of existing bridge.
- Bridge Replacement with a 101-foot clear span – This is the proposed action.
- Stream Crossing Rules Compliant Structure with 172-foot span – Not practicable at existing location due to cost and impacts to adjacent properties.
- Traffic Control Alternatives
  - Accelerated Bridge Construction with bridge closure and detoured traffic – This is the proposed action.
  - Offline temporary bridge – This would result in a larger amount of wetland & watercourse impact.

Environmental resources include prime wetlands in the northwest and southeast bridge quadrants. All wetlands within and adjacent to the project area are Priority Resource Areas (floodplain wetlands adjacent to a Tier 3 stream). The crossing of the Blackwater River is a Tier 3 crossing. The river is subject to the Shoreland Water Quality Protection Act and is listed as a Class A water. The river was determined to be non-navigable by the US Coast Guard and is mapped as Essential Fish Habitat (EFH) for Atlantic salmon. An EFH assessment was completed in 2023 and NOAA responded that the project as proposed would avoid and minimize impacts to EFH. The project is also located within a Drinking Water Source Protection Area and a Zone A floodplain.

A determination of No Historic Properties Affected was received. No evidence of archaeological resources is present and the existing bridge is not eligible for the National Register of Historic Places. Conservation land (town-owned easement) is located southwest of the crossing and temporary and permanent easements will be required.

Federally-listed species include northern long-eared bat and monarch butterfly. A Not Likely to Adversely Affect determination was received under the FHWA Programmatic Biological Opinion. Tree removal during the bat inactive season is proposed. The most recent NHB report did not contain any state-listed species. Brook floater was listed on a previous report and a survey in August 2022 was completed. No brook floater mussels were found and NHFG consultation was completed in 2022. NHFG recommendations regarding the project have been included as environmental commitments.

A stream crossing assessment was completed using a combination of bathymetric survey, LiDAR elevation data, and field observations. Field measurements were not able to be taken due to the width and depth of the river. The Blackwater River is a Type E stream at the crossing and downstream of the bridge and a Type F stream upstream of the bridge. The average bankfull width is 78 feet, meaning a stream crossing rules compliant crossing would be 172 feet (2.2 x BFW). A 172-foot span is not practicable due to property impacts and cost. A longer span bridge would also have additional wetland impacts. The proposed 101- foot span meets all items in Env-Wt 904.07 and 904.09 except the span requirement. All requirements under Env-Wt 904.01 will be met.

Permanent wetland impacts are proposed from roadway widening and slope work. The largest portion of prime wetland impact will result from relocating the farm field access. Watercourse impacts will result from the placement of stone for scour protection, water diversion, and construction access. A total of 9,335 SF (256 LF) of permanent impact and 1,332 SF (213 LF) of temporary impact is proposed. This includes 4,430 SF of permanent prime wetland impact and 3,339 SF of permanent non-prime wetland impact. No loss of wetland functions is anticipated as the impact areas are small relative to the overall wetland system.

Mitigation will be required for the proposed impacts to the PRA wetlands and Blackwater River. Approximately 7,769 SF of permanent impact is proposed to PRA wetlands, which will involve a proposed payment of approximately $36,919 to the ARM fund. In addition, an ARM fund payment of approximately $82,520 is proposed to mitigate the watercourse impact. The design will improve hydraulic capacity, aquatic organism passage, and geomorphic compatibility by lengthening the span, however the project involves >200 LF of watercourse impact from the placement of stone riprap.

The meeting was then opened for comments and discussion.

Karl Benedict (NHDES)

- Asked about coordination with the local conservation commission regarding prime wetlands. Correspondence with the conservation commission will be necessary to determine that there will be no loss of functions and it would be best to have the correspondence done before application submittal.
  - Meli Dube (NHDOT) added that an initial contact letter was sent to the Andover Conservation Commission, and they were invited to the public information meeting and public hearing. A copy of the permit package will be sent to the conservation commission.
- Suggested checking on time-of-year restrictions for EFH in the USACE NH General Permit, regardless of the prior NOAA coordination and approval of project.
- Anti-degradation standards (0 NTU, no mixing zone) need to be met for Class A waters. Coordination with NHDOT's Water Quality Program is recommended during permitting process.
- The project appears to meet the criteria for Env-Wt 904.09 and Alternative Design is not needed if engineer can certify the anticipated improvements at the crossing. It may be

considered self-mitigating if natural streambed simulation can be used instead of the stone riprap and if a wildlife shelf can be incorporated.

- Andrew O'Sullivan (NHDOT) asked if a wildlife shelf is possible and if streambed simulation could be used.
  - Tom Levins (GM2) mentioned that a flatter area is proposed near one of the abutments. This could potentially be utilized as a wildlife shelf. Riprap at the edge of the channel is necessary for scour protection near the abutments. The center of the channel will be natural material.

Mary Ann Tilton (NHDES)

- Reinforced the prime wetland discussion regarding correspondence with the conservation commission. Recommended looking at the October 2023 rule change regarding mitigation (Env-Wt 803.01).

Seta Detzel (NHDES)

- Questioned if the project is self-mitigating if riprap extends beyond the existing abutments. Cross-sections would be helpful. Permanent impacts to prime wetlands and PRAs from roadway widening and farm drive relocation require mitigation.

Kevin Newton (NHFG)

- Asked if brook floater was the only record on the NHB report.
  - Jenn Riordan – The most current NHB report had no records. A previous report had brook floater.

Jared Lamy (NHFG)

- No comments.

Jamie Sikora (FHWA)

- No comments.

Jean Brochi

- Asked if EFH consultation with NOAA is complete.
  - Jenn Riordan confirmed that it was completed. NOAA responded that the project as proposed is not anticipated to adversely affect EFH.

Nottingham, 40612 (Non-fed):

Jenn Riordan (GM2) introduced the project which involves the replacement of the NH Route 152 bridge over the North River in Nottingham. The existing bridge is a reinforced concrete jack-arch structure with a 17-foot span. It is on the State's Red List and does not convey the 100-year storm. The project proposes to replace the existing bridge with a 30-foot span bridge. The new bridge will convey the 100-year storm. The bridge will be widened 2 feet and the project will also involve 200 feet of roadway widening at each end of the bridge. Approximately 2,600 square feet of new impervious surface (pavement) is proposed. The project is not subject to AoT requirements (under 50,000 square feet of disturbance). Temporary and permanent easements will be required.

NHDES AQUATIC RESOURCE MITIGATION FUND
WETLAND PAYMENT CALCULATION
INSERT AMOUNTS IN YELLOW CELLS

1	**Convert square feet of impact to acres:**	
INSERT SQ FT OF IMPACT	Square feet of impact =	7802.00
		43560.00
	Acres of impact =	0.1791
	Total Wetland Credits =	0.1791
2	**Determine acreage of wetland construction:**	
	Forested wetlands:	0.2687
	Tidal wetlands:	0.5373
	All other areas:	0.2687
3	**Wetland construction cost:**	
	Forested wetlands:	$29,122.31
	Tidal Wetlands:	$58,244.62
	All other areas:	$29,122.31
4	**Land acquisition cost (See land value table):**	
INSERT LAND VALUE FROM TABLE WHICH APPEARS TO THE LEFT. (Insert the amount do not copy and paste.)	Town land value:	6603
	Forested wetlands:	$1,773.99
	Tidal wetlands:	$3,547.98
	All other areas:	$1,773.99
5	**Construction + land costs:**	
	Forested wetland:	$30,896.30
	Tidal wetlands:	$61,792.59
	All other areas:	$30,896.30
6	**NHDES Administrative cost:**	
	Forested wetlands:	$6,179.26
	Tidal wetlands:	$12,358.52
	All other areas:	$6,179.26
************	**TOTAL ARM PAYMENT*************	
	Forested wetlands:	$37,075.56
	Tidal wetlands:	$74,151.11
	All other areas:	$37,075.56

NHDES AQUATIC RESOURCE MITIGATION FUND
STREAM PAYMENT CALCULATION
INSERT AMOUNTS IN YELLOW CELLS

PERENNIAL STREAMS: INSERT LINEAR FEET OF IMPACT ON BOTH BANKS AND CHANNEL	**Right Bank**	93.00
	Left Bank	44.00
	Channel	138.00
INTERMITTENT STREAMS: INSERT LINEAR FEET OF IMPACT ALONG THREAD OF CHANNEL	**Channel**	
	TOTAL IMPACT	275.00
	TOTAL STREAM CREDITS	91.67
	Stream Impact Cost:	$73,870.50
	NHDES Administrative cost:	$14,774.10
*********	**TOTAL ARM FUND STREAM PAYMENT**********	
		$88,644.60

US Route 4 over the Blackwater River
Bridge Replacement
Andover 40392

WETLAND DELINEATION REPORT

Prepared for:

New Hampshire DOT Department of Transportation

NH Department of Transportation
7 Hazen Drive
Concord, NH 03302

Prepared by:

GM2

GM2 Associates, Inc.

February 2024

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APPENDICES

A. Wetland Determination Data Forms
B. NHDES Functional Assessment Worksheet
C. Prime Wetland Map

1.0 INTRODUCTION

This report provides a summary of the wetland resources and stream crossing assessment for the US Route 4 over the Blackwater River bridge replacement project in Andover, New Hampshire (NHDOT Project Number 40392).

2.0 METHODOLOGY

The study area for the wetland delineation included approximately 170 feet north (upstream) and 170 feet south (downstream) of the crossing and approximately 800 feet west and 600 feet east of the crossing along US Route 4.

The delineation was completed on November 28, 2018 and July 19, 2019 by Jennifer Riordan (NH Certified Wetland Scientist #269). Wetland boundaries were field checked and updated on June 10 and 14, 2022, and April 21, 2023 by Jennifer Riordan and Ethan Maskiell of GM2 Associates, Inc. (GM2). The wetland delineation was conducted in accordance with the US Army Corps of Engineers (USACE) 1987 Methodology and the USACE Northcentral and Northeast Regional Supplement (2012). Individually-labeled flags were placed in the field to designate the wetland resource boundaries, Ordinary High Water (OHW), and Top of Bank (TOB), and the flags were survey located. Individually-labeled flags placed in the field during the June 10, 2022 site visit were located with a Trimble Geo7x GPS unit. USACE wetland determination data forms were completed in 2019 and 2022 and are included in Appendix A.

Federal wetland classifications were assigned in accordance with “Classification of Wetlands and Deepwater Habitats of the United States” (Federal Geographic Data Committee, 2013). Wetland functions were assessed in accordance with the USACE New England District Highway Methodology Workbook Supplement (1999). A NH Department of Environmental Services Functional Assessment worksheet was completed and is included in Appendix B.

The wetland delineation was conducted during normal conditions, based on a review of the U.S. Drought Monitor map.

3.0 SITE DESCRIPTION

The study area includes the Blackwater River, adjacent floodplain wetlands, forested upland, and agricultural fields. The area adjacent to the bridge includes wetlands, forested upland, and an agricultural field. Tree species within the forested areas include silver maple (*Acer saccharinum*), red maple (*Acer rubrum*), northern red oak (*Quercus rubra*), slippery elm (*Ulmus rubra*), and white pine (*Pinus strobus*).

There are Prime Wetlands located to the northwest, southwest, and southeast of the bridge, which were all designated by the Town of Andover in 1989 (see Prime Wetland Map in Appendix C). At this time, wetlands needed to provide multiple functions and contain very poorly drained soils to be considered for prime wetland designation.

All wetlands within the project area are Priority Resource Areas (floodplain wetlands adjacent to a Tier 3 stream).

The surrounding area consists of undeveloped forested land, fields, wetlands, and scattered rural residential areas. A logging yard is located in the northeast bridge quadrant.

Conservation land (Fenton Conservation Easement) is located on the south side of US Route 4, west of the Blackwater River. The easement is held by the Town of Andover.

The portion of the Blackwater River within the project area has a Zone A floodplain but there is no regulatory floodway, based on a review of the current FEMA Flood Insurance Rate Map.

4.0 SUMMARY OF WETLAND RESOURCES

4.1. Blackwater River (TOB & OHW)

Classification:

riverine, lower perennial, unconsolidated bottom, permanently flooded (R2UBH)

Top of bank (TOB) and ordinary high water (OHW) of the Blackwater River was delineated as it flows from north to south at the crossing. The segment of the Blackwater River channel under and adjacent to the bridge varies from approximately 70 feet to 90 feet wide with banks approximately 5 to 7 feet high. During the site visit in July 2019, the water was approximately 3 to 5 feet deep. The substrate is muddy and mostly consists of sand.

Vegetation on the banks includes silver maple, red maple, American hazelnut (*Corylus americana*), slippery elm, Virginia creeper (*Parthenocissus quinquefolia*), and poison ivy (*Toxicodendron radicans*).

Blackwater River
View northeast (upstream)
from bridge
Photo taken 7/19/19

Blackwater River
View southwest
(downstream) of bridge
Photo taken 7/19/19

Blackwater River, view
downstream toward bridge
Photo taken 7/19/19

4.2. Wetland 1 and Wetland 2 (Flag Series H & I and Flag Series B & J)

Classification:

palustrine, forested, broad-leaved deciduous, seasonally flooded/saturated (PFO1E)
palustrine, emergent, persistent, seasonally flooded/saturated (PEM1E)

Wetland 1 (Flag Series H-1 to H-22 and I-1 to I-5) is a large forested wetland located northwest of Bridge No. 143/077, northwest of the agricultural field. Most of the wetland contains very poorly drained soils and is designated as Prime Wetland. A very small area at the southeastern edge of the wetland, adjacent to US Route 4 and the agricultural field, does not contain very poorly drained soils and appears to be inundated less frequently than the rest of the wetland. This area is not included as Prime Wetland.

There were areas of standing water within Wetland 1 during the June 2022 site visit. The wetland is connected to the Blackwater River further upstream from the project site. Vegetation within Wetland 1 includes red maple, speckled alder (*Alnus incana*), buttonbush (*Cephalanthus occidentalis*), sensitive fern (*Onoclea sensibilis*), and Japanese knotweed (*Reynoutria japonica*).

Wetland 2 (Flag Series B-1 to B-24 and J-1 to J-28) is located southwest of Bridge No. 143/077. The wetland is mostly forested except for a small emergent area at the edge of a field. The western portion of the wetland is designated as Prime Wetland. The emergent area and the portion of the wetland located near the US Route 4 bridge are not mapped as Prime Wetland. Wetland 2 is predominantly vegetated with red maple, slippery elm, sensitive fern, and royal fern.

Functions provided by Wetland 1 and Wetland 2 include ecological integrity, fish habitat, flood storage, groundwater recharge, nutrient trapping, production export, scenic quality, sediment trapping, shoreline anchoring, uniqueness/heritage, and wetland-based recreation, wetland-dependent wildlife habitat. All of these are provided at the principal level except groundwater recharge, production export, and wetland-based recreation.

Wetland 1 (Flag Series H)
View northeast
Photo taken 6/10/22

Wetland 1 (Flag Series H)
View northeast
Photo taken 6/10/22

Wetland 1 (Flag Series I)
View southeast
Photo taken 6/10/22

Wetland 2 forested portion
(Flag Series B)
View southwest
Photo taken 7/19/19

Wetland 2 emergent portion
(Flag Series J)
View northwest
Photo taken 6/10/22

4.3. Wetland 6 and Wetland 7 (Flag Series D, E, & F and Flag Series G)

Classification:

palustrine, forested, broad-leaved deciduous, seasonally flooded/saturated (PFO1E)
palustrine, unconsolidated bottom, semipermanently flooded (PUBF)

Wetland 6 is a forested wetland located northeast of Bridge No. 143/077, between the Blackwater River to the west and a logging yard to the east. The wetland continues north/northeast beyond the study area where it connects to the river. Wetland 6 is sparsely vegetated with red maple, slippery elm, and sensitive fern. Wetland 6 is not mapped as Prime Wetland.

Wetland 7 (Flag Series G-1 to G-12) is a large forested wetland located southeast of Bridge No. 143/077. It includes a small, ponded area (PUBH) located approximately 300 feet southeast of the bridge. The ponded portion had approximately 6 to 8 inches of standing water at the time of the June 2022 site visit. The entirety of Wetland 7 is identified as Prime Wetland. Although the mapped prime wetland on the NHDES Wetlands Permit Planning Tool does not extend to US Route 4, the delineated wetland contains very poorly drained soils up to the roadway embankment. The wetland continues southwest beyond the study area, where it connects to the Blackwater River. Wetland 7 vegetation includes red maple, slippery elm, silky dogwood (*Cornus amomum*), buttonbush, winterberry holly (*Ilex verticillata*), royal fern, and sensitive fern.

Wetland 6 and Wetland 7 provide ecological integrity, fish habitat, flood storage, groundwater recharge, nutrient trapping, production export, scenic quality, sediment trapping, shoreline anchoring, uniqueness/heritage, wetland-based recreation, and wetland-dependent wildlife habitat. Of these, all are provided at the principal level except groundwater recharge, production export, and wetland-based recreation.

Wetland 6 (Flag Series F)
View northeast
Photo taken 7/19/19

Wetland 7 forested portion
(Flag Series G)
View southwest
Photo taken 7/19/19

Wetland 7 along US Route 4
(Flag Series G)
View southeast
Photo taken 7/19/19

5.0 STREAM CROSSING ASSESSMENT

The bridge to be replaced (Bridge No. 143/077) carries US Route 4 over the Blackwater River. The watershed size at the crossing is approximately 62,138 acres (97.1 mi^2), making it a Tier 3 crossing. The crossing is also located within a 100-year floodplain. In accordance with Env-Wt 900, a stream crossing assessment was conducted utilizing a combination of field observations and desktop analysis using aerial imagery and LiDAR data available from NH GRANIT, as well as bathymetric survey data. Field measurements of bankfull width, maximum bankfull depth, and flood prone width were not able to be taken during the site visits due to the depth and width of the river.

There are large floodplain wetlands, agricultural fields, a logging yard, and forested upland within the vicinity of the US Route 4/Blackwater River crossing. Conservation land is located southwest of the crossing. Vegetation adjacent to the river includes silver maple, red maple, American hazelnut, elm, Virginia creeper, and poison ivy.

Stream crossing assessment measurements of bankfull width and flood prone width were completed using bathymetric survey data and GRANIT LiDAR data for three cross sections in the Blackwater River within the vicinity of the bridge: just downstream of the US Route 4 crossing, approximately 1,900 feet downstream of the bridge, and approximately 3,000 feet upstream of the bridge (refer to Table 5-1). These cross-section locations were chosen since the river channel changes further downstream and upstream. A reference reach that matches the characteristics of the river near the US Route 4 bridge is not located nearby. Downstream of Cross Section 2, the river widens into an area referred to as “The Bay”. Upstream of Cross-Section 3, the river channel becomes less sinuous and has a narrower flood prone width.

The widths that were measured using desktop data and maps were consistent with field observations. The flood prone width downstream of the bridge is very wide, which made field measurements impractical. Bathymetric survey data was used to determine approximate mean and maximum bankfull depths. These depths were consistent with field observations. Water depth at the time of the site visits ranged from approximately 3 to 8+ feet.

Substrate at the crossing location consists of approximately 70% sand and 30% silt, based on field observations.

Table 5-1
Blackwater River – US Route 4 Crossing

	Cross Section 1 (DS of bridge – crossing location)	Cross Section 2 (1,900’ DS of bridge)	Cross Section 3 (3,000’ US of bridge)	Range	Average
Bankfull Width*	75 feet	73 feet	93 feet	73-93 feet	81.3 feet
Mean Bankfull Depth**	5 feet	5 feet	3 feet	3-5 feet	4.3 feet
Width to Depth Ratio	15	15	31	15-31	20.3
Max Bankfull Depth**	8 feet	9 feet	4 feet	4-9 feet	7 feet
Flood Prone Width*	2,600 feet	1,470 feet	102 feet	102-2,600 feet	1,390.7 feet
Entrenchment Ratio	35	20	1.1	1.1-35	18.7

*Bankfull width and flood prone width were estimated using bathymetric survey data and LiDAR elevation data in GRANIT, combined with aerial photographs, FEMA floodplain maps, and site observations,
**Mean and maximum bankfull depths were estimated based on bathymetric survey data and site observations.

Sinuosity was measured using bathymetric survey data and LiDAR elevation data within the vicinity of the crossing. Based on these measurements, the sinuosity was estimated to be 1.97 downstream of the crossing and 1.06 at the crossing.

Due to the high entrenchment ratio and flood prone width, the Rosgen classification for the segment of the Blackwater River downstream of the crossing is Type E. Upstream of the bridge, the lower entrenchment ratio and greater width to depth ratio are characteristic of a Type F stream.

6.0 REFERENCES

Environmental Laboratory. 1987. *Corps of Engineers Wetlands Delineation Manual*, Technical Report Y-87-1, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Federal Geographic Data Committee. 2013. *Classification of wetlands and deepwater habitats of the United States*. FGDC-STD-004-2013. Second Edition. Wetlands Subcommittee, Federal Geographic Data Committee and U.S. Fish and Wildlife Service, Washington, DC.

U.S. Army Corps of Engineers. 2012. *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Northcentral and Northeast Region (Version 2.0)*, ed. J. S. Wakeley, R. W. Lichvar, C. V. Noble, and J. F. Berkowitz. ERDC/EL TR-12-1. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

U.S. Army Corps of Engineers New England District. 1999. *The Highway Methodology Workbook Supplement: Wetland Functions and Values.* NEDEP-360-1-30a.

APPENDIX A

Wetland Determination Field Data Forms

WETLAND DETERMINATION DATA FORM – Northcentral and Northeast Region

Project/Site: Andover 40392 City/County: Andover / Merrimack Sampling Date: 7/19/2019

Applicant/Owner: NHDOT State: NH Sampling Point: DP-1

Investigator(s): Jenn Riordan Section, Township, Range: ____

Landform (hillside, terrace, etc.): floodplain wetland Local relief (concave, convex, none): concave Slope (%): <2

Subregion (LRR or MLRA): LRR R Lat: 43.422 N Long: 71.777 W Datum: ____

Soil Map Unit Name: 406A - Medomak mucky silt loam, 0-2% slopes, frequently flooded NWI classification: PFO1E

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes X No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No ___	**Is the Sampled Area**
Hydric Soil Present?	Yes X No ___	**within a Wetland?** **Yes** X **No** ___
Wetland Hydrology Present?	Yes X No ___	If yes, optional Wetland Site ID: Series B

Remarks: (Explain alternative procedures here or in a separate report.)
Data point is located near flag B-20

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

___ Surface Water (A1)	___ Water-Stained Leaves (B9)
___ High Water Table (A2)	___ Aquatic Fauna (B13)
___ Saturation (A3)	___ Marl Deposits (B15)
___ Water Marks (B1)	___ Hydrogen Sulfide Odor (C1)
___ Sediment Deposits (B2)	___ Oxidized Rhizospheres on Living Roots (C3)
___ Drift Deposits (B3)	___ Presence of Reduced Iron (C4)
___ Algal Mat or Crust (B4)	___ Recent Iron Reduction in Tilled Soils (C6)
___ Iron Deposits (B5)	___ Thin Muck Surface (C7)
___ Inundation Visible on Aerial Imagery (B7)	___ Other (Explain in Remarks)
___ Sparsely Vegetated Concave Surface (B8)	

Secondary Indicators (minimum of two required)

___ Surface Soil Cracks (B6)
___ Drainage Patterns (B10)
___ Moss Trim Lines (B16)
___ Dry-Season Water Table (C2)
___ Crayfish Burrows (C8)
___ Saturation Visible on Aerial Imagery (C9)
___ Stunted or Stressed Plants (D1)
X Geomorphic Position (D2)
___ Shallow Aquitard (D3)
___ Microtopographic Relief (D4)
X FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes ___	No X	Depth (inches): ___
Water Table Present?	Yes ___	No X	Depth (inches): ___
Saturation Present? (includes capillary fringe)	Yes ___	No X	Depth (inches): ___

Wetland Hydrology Present? **Yes** X **No** ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION – Use scientific names of plants.

Sampling Point: DP-1

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. *Acer rubrum*	63	Yes	FAC
2.			
3.			
4.			
5.			
6.			
7.			
	63	=Total Cover	
Sapling/Shrub Stratum (Plot size: 15')			
1. *Ulmus rubra*	20	Yes	FAC
2. *Cornus amomum*	5	No	FACW
3. *Spiraea latifolia*	5	No	FACW
4.			
5.			
6.			
7.			
	30	=Total Cover	
Herb Stratum (Plot size: 5')			
1. *Onoclea sensibilis*	63	Yes	FACW
2. *Osmunda spectabilis*	38	Yes	OBL
3. Unknown grass (Calamagrostis canadensis?)	3	No	
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	104	=Total Cover	
Woody Vine Stratum (Plot size: 30')			
1. *None*			
2.			
3.			
4.			
		=Total Cover	

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 4 (A)

Total Number of Dominant Species Across All Strata: 4 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100.0% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:	(A)		(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

X 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Vegetation Strata:

Tree – Woody plants 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/shrub – Woody plants less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vines – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: DP-1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-4	10YR 4/2	98	10YR 4/6	2	C	M	Sandy	loamy fine sand
4-12	2.5Y 5/4	50	2.5Y 5/6	2	C	M	Sandy	Distinct redox concentrations
	2.5Y 6/3	48						

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- X Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) (**LRR R, MLRA 149B**)
- ___ Thin Dark Surface (S9) (**LRR R, MLRA 149B**)
- ___ High Chroma Sands (S11) (**LRR K, L)**
- ___ Loamy Mucky Mineral (F1) (**LRR K, L**)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Marl (F10) (**LRR K, L**)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) (**LRR K, L, MLRA 149B**)
- ___ Coast Prairie Redox (A16) (**LRR K, L, R**)
- ___ 5 cm Mucky Peat or Peat (S3) (**LRR K, L, R**)
- ___ Polyvalue Below Surface (S8) (**LRR K, L**)
- ___ Thin Dark Surface (S9) (**LRR K, L**)
- ___ Iron-Manganese Masses (F12) (**LRR K, L, R**)
- ___ Piedmont Floodplain Soils (F19) (**MLRA 149B**)
- ___ Mesic Spodic (TA6) (**MLRA 144A, 145, 149B**)
- ___ Red Parent Material (F21)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______

Depth (inches): ______

Hydric Soil Present? **Yes** X **No** ___

Remarks:
This data form is revised from Northcentral and Northeast Regional Supplement Version 2.0 to reflect the NRCS Field Indicators of Hydric Soils version 7.0 March 2013 Errata. (http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051293.docx)

WETLAND DETERMINATION DATA FORM – Northcentral and Northeast Region

Project/Site: Andover 40392 City/County: Andover / Merrimack Sampling Date: 7/19/2019

Applicant/Owner: NHDOT State: NH Sampling Point: DP-2

Investigator(s): Jenn Riordan Section, Township, Range: ______

Landform (hillside, terrace, etc.): terrace next to bank Local relief (concave, convex, none): convex Slope (%): <2

Subregion (LRR or MLRA): LRR R Lat: 43.422 N Long: 71.777 W Datum: ______

Soil Map Unit Name: 406A - Medomak mucky silt loam, 0-2% slopes, frequently flooded NWI classification: PFO1E

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes X No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No ___
Hydric Soil Present?	Yes ___	No X
Wetland Hydrology Present?	Yes ___	No X

Is the Sampled Area within a Wetland? **Yes** ___ **No** X

If yes, optional Wetland Site ID: ______

Remarks: (Explain alternative procedures here or in a separate report.)
Upland data point located between flag series B and TOB line

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9)
___ Aquatic Fauna (B13)
___ Marl Deposits (B15)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres on Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Thin Muck Surface (C7)
___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

___ Surface Soil Cracks (B6)
___ Drainage Patterns (B10)
___ Moss Trim Lines (B16)
___ Dry-Season Water Table (C2)
___ Crayfish Burrows (C8)
___ Saturation Visible on Aerial Imagery (C9)
___ Stunted or Stressed Plants (D1)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
___ Microtopographic Relief (D4)
___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes ___	No X	Depth (inches): ___
Water Table Present?	Yes ___	No X	Depth (inches): ___
Saturation Present? (includes capillary fringe)	Yes ___	No X	Depth (inches): ___

Wetland Hydrology Present? **Yes** ___ **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION – Use scientific names of plants.

Sampling Point: DP-2

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. *Acer rubrum*	25	Yes	FAC
2.			
3.			
4.			
5.			
6.			
7.			
	25	=Total Cover	

Sapling/Shrub Stratum (Plot size: 15')	Absolute % Cover	Dominant Species?	Indicator Status
1. *Prunus virginiana*	20	Yes	FACU
2. *Acer rubrum*	10	Yes	FAC
3. *Corylus americana*	10	Yes	FACU
4.			
5.			
6.			
7.			
	40	=Total Cover	

Herb Stratum (Plot size: 5')	Absolute % Cover	Dominant Species?	Indicator Status
1. *Toxicodendron radicans*	20	Yes	FAC
2. *Onoclea sensibilis*	10	Yes	FACW
3. *Thalictrum sp.*	5	No	
4. *Aster sp.*	5	No	
5. *Carex sp,*	3	No	
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	43	=Total Cover	

Woody Vine Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. *Parthenocissus quinquefolia*	10	Yes	FACU
2.			
3.			
4.			
	10	=Total Cover	

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 4 (A)

Total Number of Dominant Species Across All Strata: 7 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 57.1% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:		(A)	(B)

Prevalence Index = B/A = ____

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

X 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Vegetation Strata:

Tree – Woody plants 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/shrub – Woody plants less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vines – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: DP-2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features				Texture	Remarks
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]		
0-12	2.5Y 5/2	50					Sandy	loamy fine sand
	2.5Y 5/4	50						

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) (**LRR R, MLRA 149B**)
- ___ Thin Dark Surface (S9) (**LRR R, MLRA 149B**)
- ___ High Chroma Sands (S11) (**LRR K, L)**
- ___ Loamy Mucky Mineral (F1) (**LRR K, L**)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Marl (F10) (**LRR K, L**)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) (**LRR K, L, MLRA 149B**)
- ___ Coast Prairie Redox (A16) (**LRR K, L, R**)
- ___ 5 cm Mucky Peat or Peat (S3) (**LRR K, L, R**)
- ___ Polyvalue Below Surface (S8) (**LRR K, L**)
- ___ Thin Dark Surface (S9) (**LRR K, L**)
- ___ Iron-Manganese Masses (F12) (**LRR K, L, R**)
- ___ Piedmont Floodplain Soils (F19) (**MLRA 149B**)
- ___ Mesic Spodic (TA6) (**MLRA 144A, 145, 149B**)
- ___ Red Parent Material (F21)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______

Depth (inches): ______

Hydric Soil Present? **Yes** ___ **No** X

Remarks:
This data form is revised from Northcentral and Northeast Regional Supplement Version 2.0 to reflect the NRCS Field Indicators of Hydric Soils version 7.0 March 2013 Errata. (http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051293.docx)

WETLAND DETERMINATION DATA FORM – Northcentral and Northeast Region

Project/Site: Andover 40392 City/County: Andover / Merrimack Sampling Date: 7/19/2019

Applicant/Owner: NHDOT State: NH Sampling Point: DP-3

Investigator(s): Jenn Riordan Section, Township, Range: ____

Landform (hillside, terrace, etc.): floodplain wetland Local relief (concave, convex, none): concave Slope (%): <2

Subregion (LRR or MLRA): LRR R Lat: 43.422 N Long: 71.776 W Datum: ____

Soil Map Unit Name: 406A - Medomak mucky silt loam, 0-2% slopes, frequently flooded NWI classification: PFO1E

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ____ (If no, explain in Remarks.)

Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes X No ____

Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No ____	**Is the Sampled Area**	
Hydric Soil Present?	Yes X No ____	**within a Wetland?**	**Yes** X **No** ____
Wetland Hydrology Present?	Yes X No ____	If yes, optional Wetland Site ID:	Series D

Remarks: (Explain alternative procedures here or in a separate report.)
Data point is located near flag D-3

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

___ Surface Water (A1)	X Water-Stained Leaves (B9)	
___ High Water Table (A2)	___ Aquatic Fauna (B13)	
___ Saturation (A3)	___ Marl Deposits (B15)	
___ Water Marks (B1)	___ Hydrogen Sulfide Odor (C1)	
___ Sediment Deposits (B2)	___ Oxidized Rhizospheres on Living Roots (C3)	
___ Drift Deposits (B3)	___ Presence of Reduced Iron (C4)	
___ Algal Mat or Crust (B4)	___ Recent Iron Reduction in Tilled Soils (C6)	
___ Iron Deposits (B5)	___ Thin Muck Surface (C7)	
___ Inundation Visible on Aerial Imagery (B7)	___ Other (Explain in Remarks)	
X Sparsely Vegetated Concave Surface (B8)		

Secondary Indicators (minimum of two required)

___ Surface Soil Cracks (B6)
___ Drainage Patterns (B10)
X Moss Trim Lines (B16)
___ Dry-Season Water Table (C2)
___ Crayfish Burrows (C8)
___ Saturation Visible on Aerial Imagery (C9)
___ Stunted or Stressed Plants (D1)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
___ Microtopographic Relief (D4)
___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes ____	No X	Depth (inches): ____
Water Table Present?	Yes ____	No X	Depth (inches): ____
Saturation Present? (includes capillary fringe)	Yes ____	No X	Depth (inches): ____

Wetland Hydrology Present? **Yes** X **No** ____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION – Use scientific names of plants.

Sampling Point: DP-3

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. *Acer rubrum*	63	Yes	FAC
2. *Ulmus rubra*	38	Yes	FAC
3.			
4.			
5.			
6.			
7.			
	101	=Total Cover	
Sapling/Shrub Stratum (Plot size: 15')			
1. *Ulmus rubra*	10	Yes	FAC
2.			
3.			
4.			
5.			
6.			
7.			
	10	=Total Cover	
Herb Stratum (Plot size: 10')			
1. *Acer rubrum*	20	Yes	FAC
2. *Carex utriculata*	10	Yes	OBL
3. *Onoclea sensibilis*	5	No	FACW
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	35	=Total Cover	
Woody Vine Stratum (Plot size: 30')			
1. *None*	10	Yes	
2.			
3.			
4.			
	10	=Total Cover	

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 5 (A)

Total Number of Dominant Species Across All Strata: 6 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 83.3% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:		(A)	(B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

X 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Vegetation Strata:

Tree – Woody plants 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/shrub – Woody plants less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vines – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (Include photo numbers here or on a separate sheet.)
10 foot radius used on herbaceous stratum due to sparse vegetation.

SOIL

Sampling Point: DP-3

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-3	10YR 5/2	95	10YR 4/4	5	C	M	Loamy/Clayey	fine sandy loam
3-12	10YR 3/1	90	10YR 3/6	10	C	M	Loamy/Clayey	Prominent redox concentrations

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) (**LRR R, MLRA 149B**)
- ___ Thin Dark Surface (S9) (**LRR R, MLRA 149B**)
- ___ High Chroma Sands (S11) (**LRR K, L)**
- ___ Loamy Mucky Mineral (F1) (**LRR K, L**)
- ___ Loamy Gleyed Matrix (F2)
- X Depleted Matrix (F3)
- X Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Marl (F10) (**LRR K, L**)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) (**LRR K, L, MLRA 149B**)
- ___ Coast Prairie Redox (A16) (**LRR K, L, R**)
- ___ 5 cm Mucky Peat or Peat (S3) (**LRR K, L, R**)
- ___ Polyvalue Below Surface (S8) (**LRR K, L**)
- ___ Thin Dark Surface (S9) (**LRR K, L**)
- ___ Iron-Manganese Masses (F12) (**LRR K, L, R**)
- ___ Piedmont Floodplain Soils (F19) (**MLRA 149B**)
- ___ Mesic Spodic (TA6) (**MLRA 144A, 145, 149B**)
- ___ Red Parent Material (F21)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______

Depth (inches): ______

Hydric Soil Present? **Yes** X **No** ___

Remarks:
This data form is revised from Northcentral and Northeast Regional Supplement Version 2.0 to reflect the NRCS Field Indicators of Hydric Soils version 7.0 March 2013 Errata. (http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051293.docx)

WETLAND DETERMINATION DATA FORM – Northcentral and Northeast Region

Project/Site: Andover 40392 City/County: Andover / Merrimack Sampling Date: 7/19/2019

Applicant/Owner: NHDOT State: NH Sampling Point: DP-4

Investigator(s): Jenn Riordan Section, Township, Range: ____

Landform (hillside, terrace, etc.): terrace Local relief (concave, convex, none): none Slope (%): 2

Subregion (LRR or MLRA): LRR R Lat: 43.422 N Long: 71.776 W Datum: ____

Soil Map Unit Name: 406A - Medomak mucky silt loam, 0-2% slopes, frequently flooded NWI classification: PFO1E

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes X No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ___	No X	**Is the Sampled Area within a Wetland?** **Yes** ___ **No** X
Hydric Soil Present?	Yes ___	No X	
Wetland Hydrology Present?	Yes ___	No X	If yes, optional Wetland Site ID: ____

Remarks: (Explain alternative procedures here or in a separate report.)
Upland data point located between Wetland D and Route 4

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ Marl Deposits (B15)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes ___	No X	Depth (inches): ___
Water Table Present?	Yes ___	No X	Depth (inches): ___
Saturation Present? (includes capillary fringe)	Yes ___	No X	Depth (inches): ___

Wetland Hydrology Present? **Yes** ___ **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION – Use scientific names of plants.

Sampling Point: DP-4

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. *Acer rubrum*	63	Yes	FAC
2. *Tilia americana*	38	Yes	FACU
3.			
4.			
5.			
6.			
7.			
	101	=Total Cover	

Sapling/Shrub Stratum (Plot size: 15')	Absolute % Cover	Dominant Species?	Indicator Status
1. *Ulmus rubra*	10	Yes	FAC
2. *Carpinus caroliniana*	10	Yes	FAC
3.			
4.			
5.			
6.			
7.			
	20	=Total Cover	

Herb Stratum (Plot size: 5')	Absolute % Cover	Dominant Species?	Indicator Status
1. *Toxicodendron radicans*	10	No	FAC
2. *Grasses/sedges*	10	No	
3. *Parthenocissus quinquefolia*	20	Yes	FACU
4. *Aster sp.*	10	No	
5. *Solidago sp.*	20	Yes	
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	70	=Total Cover	

Woody Vine Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. *Vitis sp.*	5	Yes	
2.			
3.			
4.			
	5	=Total Cover	

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)

Total Number of Dominant Species Across All Strata: 7 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 42.9% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:		(A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
___ 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Vegetation Strata:

Tree – Woody plants 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/shrub – Woody plants less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vines – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** ___ **No** X

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: DP-4

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-10	10YR 5/3	100					Loamy/Clayey	fine sandy loam
10-12	10YR 6/3	100					Loamy/Clayey	rocks at 12"

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Stratified Layers (A5)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Dark Surface (S7)
___ Polyvalue Below Surface (S8) (**LRR R, MLRA 149B**)
___ Thin Dark Surface (S9) (**LRR R, MLRA 149B**)
___ High Chroma Sands (S11) (**LRR K, L)**
___ Loamy Mucky Mineral (F1) (**LRR K, L**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)
___ Marl (F10) (**LRR K, L**)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10) (**LRR K, L, MLRA 149B**)
___ Coast Prairie Redox (A16) (**LRR K, L, R**)
___ 5 cm Mucky Peat or Peat (S3) (**LRR K, L, R**)
___ Polyvalue Below Surface (S8) (**LRR K, L**)
___ Thin Dark Surface (S9) (**LRR K, L**)
___ Iron-Manganese Masses (F12) (**LRR K, L, R**)
___ Piedmont Floodplain Soils (F19) (**MLRA 149B**)
___ Mesic Spodic (TA6) (**MLRA 144A, 145, 149B**)
___ Red Parent Material (F21)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______

Depth (inches): ______

Hydric Soil Present? **Yes** ___ **No** X

Remarks:
This data form is revised from Northcentral and Northeast Regional Supplement Version 2.0 to reflect the NRCS Field Indicators of Hydric Soils version 7.0 March 2013 Errata. (http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051293.docx)

WETLAND DETERMINATION DATA FORM – Northcentral and Northeast Region

Project/Site: Andover 40392 City/County: Andover/Merrimack Sampling Date: 6/14/22

Applicant/Owner: NHDOT State: NH Sampling Point: DP-G-1

Investigator(s): J.Riordan, E.Maskiell Section, Township, Range: ____

Landform (hillside, terrace, etc.): floodplain Local relief (concave, convex, none): concave Slope (%): <2

Subregion (LRR or MLRA): LRR R Lat: 43.421 N Long: 71.776 W Datum: ____

Soil Map Unit Name: 406A Medomak mucky silt loam, 0 to 2% slopes, frequently flooded NWI classification: PFO1E

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes X No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes X No ___	**Is the Sampled Area**	
Hydric Soil Present? Yes X No ___	**within a Wetland?**	**Yes** X **No** ___
Wetland Hydrology Present? Yes X No ___	If yes, optional Wetland Site ID:	Wetland G

Remarks: (Explain alternative procedures here or in a separate report.)

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- X Surface Water (A1)
- X High Water Table (A2)
- X Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ Marl Deposits (B15)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- X FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes X	No ___	Depth (inches):	6
Water Table Present?	Yes X	No ___	Depth (inches):	2
Saturation Present? (includes capillary fringe)	Yes X	No ___	Depth (inches):	surface

Wetland Hydrology Present? Yes X **No** ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:
6-8" of standing water nearby

VEGETATION – Use scientific names of plants. Sampling Point: DP-G-1

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. *Acer rubrum*	50	Yes	FAC
2. *Quercus rubra*	10	No	FACU
3.			
4.			
5.			
6.			
7.			
	60	=Total Cover	
Sapling/Shrub Stratum (Plot size: 15')			
1. *Ulmus americana*	20	Yes	FACW
2. *Cornus amomum*	10	No	FACW
3. *Cephalanthus occidentalis*	10	No	OBL
4. *Ilex verticillata*	20	Yes	FACW
5.			
6.			
7.			
	60	=Total Cover	
Herb Stratum (Plot size: 5')			
1. *Osmunda regalis*	90	Yes	OBL
2. *Onoclea sensibilis*	10	No	FACW
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	100	=Total Cover	
Woody Vine Stratum (Plot size: 30')			
1.			
2.			
3.			
4.			
		=Total Cover	

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 4 (A)

Total Number of Dominant Species Across All Strata: 4 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100.0% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:	(A)		(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
X 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Vegetation Strata:

Tree – Woody plants 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/shrub – Woody plants less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vines – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: DP-G-1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-14	7.5YR 2.5/1	100					Mucky Sand	mucky loamy sand

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- X Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) (**LRR R, MLRA 149B**)
- ___ Thin Dark Surface (S9) (**LRR R, MLRA 149B**)
- ___ High Chroma Sands (S11) (**LRR K, L)**
- ___ Loamy Mucky Mineral (F1) (**LRR K, L**)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Marl (F10) (**LRR K, L**)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) (**LRR K, L, MLRA 149B**)
- ___ Coast Prairie Redox (A16) (**LRR K, L, R**)
- ___ 5 cm Mucky Peat or Peat (S3) (**LRR K, L, R**)
- ___ Polyvalue Below Surface (S8) (**LRR K, L**)
- ___ Thin Dark Surface (S9) (**LRR K, L**)
- ___ Iron-Manganese Masses (F12) (**LRR K, L, R**)
- ___ Piedmont Floodplain Soils (F19) (**MLRA 149B**)
- ___ Mesic Spodic (TA6) (**MLRA 144A, 145, 149B**)
- ___ Red Parent Material (F21)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______

Depth (inches): ______

Hydric Soil Present? **Yes** X **No** ___

Remarks:
This data form is revised from Northcentral and Northeast Regional Supplement Version 2.0 to reflect the NRCS Field Indicators of Hydric Soils version 7.0 March 2013 Errata. (http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051293.docx)

WETLAND DETERMINATION DATA FORM – Northcentral and Northeast Region

Project/Site: Andover 40392 City/County: Andover/Merrimack Sampling Date: 6/14/22

Applicant/Owner: NHDOT State: NH Sampling Point: DP-G-2

Investigator(s): J. Riordan, E.Maskiell Section, Township, Range: ____

Landform (hillside, terrace, etc.): terrace/road fill Local relief (concave, convex, none): none Slope (%): 2-5

Subregion (LRR or MLRA): LRR R Lat: 43.421 N Long: 71.776 W Datum: ____

Soil Map Unit Name: 406A Medomak mucky silt loam, 0 to 2% slopes, frequently flooded NWI classification: PFO1E

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)

Are Vegetation ___ , Soil ___ , or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes X No ___

Are Vegetation ___ , Soil ___ , or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No ___	**Is the Sampled Area within a Wetland?** **Yes** ___ **No** X
Hydric Soil Present?	Yes X	No ___	
Wetland Hydrology Present?	Yes ___	No X	If yes, optional Wetland Site ID: ____

Remarks: (Explain alternative procedures here or in a separate report.)
upland point between wetland G and US Route 4

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ Marl Deposits (B15)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- X FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes ___	No X	Depth (inches): ___
Water Table Present?	Yes ___	No X	Depth (inches): ___
Saturation Present? (includes capillary fringe)	Yes ___	No X	Depth (inches): ___

Wetland Hydrology Present? **Yes** ___ **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION – Use scientific names of plants.

Sampling Point: DP-G-2

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. *Quercus rubra*	5	Yes	FACU
2.			
3.			
4.			
5.			
6.			
7.			
	5	=Total Cover	

Sapling/Shrub Stratum (Plot size: 15')	Absolute % Cover	Dominant Species?	Indicator Status
1. *Quercus rubra*	3	No	FACU
2. *Viburnum cassinoides*	3	No	FACW
3. *Ilex verticillata*	3	No	FACW
4. *Frangula alnus*	3	No	FAC
5. *Ulmus americana*	10	Yes	FACW
6. *Alnus incana*	10	Yes	FACW
7.			
	32	=Total Cover	

Herb Stratum (Plot size: 5')	Absolute % Cover	Dominant Species?	Indicator Status
1. *Osmunda claytoniana*	30	Yes	FAC
2. *Dichanthelium clandestinum*	10	No	FACW
3. *Thalictrum sp.*	3	No	
4. *Athyrium angustum*	30	Yes	FAC
5. Unknown grass	20	Yes	
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	93	=Total Cover	

Woody Vine Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
		=Total Cover	

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 4 (A)

Total Number of Dominant Species Across All Strata: 6 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 66.7% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:		(A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

X 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Vegetation Strata:

Tree – Woody plants 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/shrub – Woody plants less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vines – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: DP-G-2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-6	10YR 2/1	95	7.5YR 4/6	5	C	M	Sandy	Prominent redox concentrations
6-12	10YR 3/3	100					Sandy	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Stratified Layers (A5)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
X Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Dark Surface (S7)
___ Polyvalue Below Surface (S8) (**LRR R, MLRA 149B**)
___ Thin Dark Surface (S9) (**LRR R, MLRA 149B**)
___ High Chroma Sands (S11) (**LRR K, L)**
___ Loamy Mucky Mineral (F1) (**LRR K, L**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)
___ Marl (F10) (**LRR K, L**)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10) (**LRR K, L, MLRA 149B**)
___ Coast Prairie Redox (A16) (**LRR K, L, R**)
___ 5 cm Mucky Peat or Peat (S3) (**LRR K, L, R**)
___ Polyvalue Below Surface (S8) (**LRR K, L**)
___ Thin Dark Surface (S9) (**LRR K, L**)
___ Iron-Manganese Masses (F12) (**LRR K, L, R**)
___ Piedmont Floodplain Soils (F19) (**MLRA 149B**)
___ Mesic Spodic (TA6) (**MLRA 144A, 145, 149B**)
___ Red Parent Material (F21)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______

Depth (inches): ______

Hydric Soil Present? **Yes** X **No** ___

Remarks:
This data form is revised from Northcentral and Northeast Regional Supplement Version 2.0 to reflect the NRCS Field Indicators of Hydric Soils version 7.0 March 2013 Errata. (http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051293.docx)

WETLAND DETERMINATION DATA FORM – Northcentral and Northeast Region

Project/Site: Andover 40392 City/County: Andover/Merrimack Sampling Date: 6/14/22

Applicant/Owner: NHDOT State: NH Sampling Point: DP-H-1

Investigator(s): J. Riordan, E. Maskiell Section, Township, Range: ____

Landform (hillside, terrace, etc.): floodplain Local relief (concave, convex, none): concave Slope (%): <2

Subregion (LRR or MLRA): LRR R Lat: 43.422 N Long: 71.777 W Datum: ____

Soil Map Unit Name: 406A Medomak mucky silt loam, 0 to 2% slopes, frequently flooded NWI classification: PFO1E

Are climatic / hydrologic conditions on the site typical for this time of year? Yes x No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes X No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No ___
Hydric Soil Present?	Yes X	No ___
Wetland Hydrology Present?	Yes X	No ___

Is the Sampled Area within a Wetland? **Yes** X **No** ___

If yes, optional Wetland Site ID: Wetland H

Remarks: (Explain alternative procedures here or in a separate report.)

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- x Surface Water (A1)
- x High Water Table (A2)
- x Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ Marl Deposits (B15)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- X FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes x	No ___	Depth (inches): ___
Water Table Present?	Yes x	No ___	Depth (inches): surface+
Saturation Present? (includes capillary fringe)	Yes x	No ___	Depth (inches): surface

Wetland Hydrology Present? **Yes** X **No** ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:
6-8" of standing water nearby

VEGETATION – Use scientific names of plants.

Sampling Point: DP-H-1

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
		=Total Cover	
Sapling/Shrub Stratum (Plot size: 15')			
1. *Cephalanthus occidentalis*	30	Yes	OBL
2.			
3.			
4.			
5.			
6.			
7.			
	30	=Total Cover	
Herb Stratum (Plot size:)			
1. *Onoclea sensibilis*	10	Yes	FACW
2. *Fallopia japonica*	3	Yes	FACU
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	13	=Total Cover	
Woody Vine Stratum (Plot size: 30')			
1.			
2.			
3.			
4.			
		=Total Cover	

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 66.7% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:		(A)	(B)

Prevalence Index = B/A = ____

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

X 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Vegetation Strata:

Tree – Woody plants 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/shrub – Woody plants less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vines – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: DP-H-1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-14	7.5YR 2.5/1	95	10YR 3/4	5	C	M	Sandy	Prominent redox concentrations
								mucky loamy sand

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- X Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) (**LRR R, MLRA 149B**)
- ___ Thin Dark Surface (S9) (**LRR R, MLRA 149B**)
- ___ High Chroma Sands (S11) (**LRR K, L)**
- ___ Loamy Mucky Mineral (F1) (**LRR K, L**)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Marl (F10) (**LRR K, L**)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) (**LRR K, L, MLRA 149B**)
- ___ Coast Prairie Redox (A16) (**LRR K, L, R**)
- ___ 5 cm Mucky Peat or Peat (S3) (**LRR K, L, R**)
- ___ Polyvalue Below Surface (S8) (**LRR K, L**)
- ___ Thin Dark Surface (S9) (**LRR K, L**)
- ___ Iron-Manganese Masses (F12) (**LRR K, L, R**)
- ___ Piedmont Floodplain Soils (F19) (**MLRA 149B**)
- ___ Mesic Spodic (TA6) (**MLRA 144A, 145, 149B**)
- ___ Red Parent Material (F21)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______

Depth (inches): ______

Hydric Soil Present? **Yes** X **No** ___

Remarks:
This data form is revised from Northcentral and Northeast Regional Supplement Version 2.0 to reflect the NRCS Field Indicators of Hydric Soils version 7.0 March 2013 Errata. (http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051293.docx)

WETLAND DETERMINATION DATA FORM – Northcentral and Northeast Region

Project/Site: Andover 40392 City/County: Andover/Merrimack Sampling Date: 6/14/22

Applicant/Owner: NHDOT State: NH Sampling Point: DP-H-2

Investigator(s): J. Riordan, E. Maskiell Section, Township, Range: ____

Landform (hillside, terrace, etc.): terrace Local relief (concave, convex, none): convex Slope (%): <2

Subregion (LRR or MLRA): LRR R Lat: 43.422 N Long: 71.778 W Datum: ____

Soil Map Unit Name: 406A Medomak mucky silt loam, 0 to 2% slopes, frequently flooded NWI classification: PFO1E

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ____ (If no, explain in Remarks.)

Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes X No ____

Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No ____	**Is the Sampled Area within a Wetland?** **Yes** ____ **No** X
Hydric Soil Present?	Yes ____	No X	If yes, optional Wetland Site ID: ____
Wetland Hydrology Present?	Yes ____	No X	

Remarks: (Explain alternative procedures here or in a separate report.)
Upland data point near wetland flag H-17

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ____ Surface Water (A1)
- ____ High Water Table (A2)
- ____ Saturation (A3)
- ____ Water Marks (B1)
- ____ Sediment Deposits (B2)
- ____ Drift Deposits (B3)
- ____ Algal Mat or Crust (B4)
- ____ Iron Deposits (B5)
- ____ Inundation Visible on Aerial Imagery (B7)
- ____ Sparsely Vegetated Concave Surface (B8)
- ____ Water-Stained Leaves (B9)
- ____ Aquatic Fauna (B13)
- ____ Marl Deposits (B15)
- ____ Hydrogen Sulfide Odor (C1)
- ____ Oxidized Rhizospheres on Living Roots (C3)
- ____ Presence of Reduced Iron (C4)
- ____ Recent Iron Reduction in Tilled Soils (C6)
- ____ Thin Muck Surface (C7)
- ____ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ____ Surface Soil Cracks (B6)
- ____ Drainage Patterns (B10)
- ____ Moss Trim Lines (B16)
- ____ Dry-Season Water Table (C2)
- ____ Crayfish Burrows (C8)
- ____ Saturation Visible on Aerial Imagery (C9)
- ____ Stunted or Stressed Plants (D1)
- ____ Geomorphic Position (D2)
- ____ Shallow Aquitard (D3)
- ____ Microtopographic Relief (D4)
- ____ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes ____	No X	Depth (inches): ____
Water Table Present?	Yes ____	No X	Depth (inches): ____
Saturation Present? (includes capillary fringe)	Yes ____	No X	Depth (inches): ____

Wetland Hydrology Present? **Yes** ____ **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION – Use scientific names of plants.

Sampling Point: DP-H-2

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. *Betula papyrifera*	10	No	FACU
2. *Populus deltoides*	20	Yes	FAC
3. *Acer rubrum*	40	Yes	FAC
4. *Quercus rubra*	20	Yes	FACU
5.			
6.			
7.			
	90	=Total Cover	

Sapling/Shrub Stratum (Plot size: 15')	Absolute % Cover	Dominant Species?	Indicator Status
1. *Hamamelis virginiana*	60	Yes	FACU
2. *Viburnum cassinoides*	5	No	FACW
3. *Alnus incana*	10	No	FACW
4. *Populus deltoides*	3	No	FAC
5. *Fagus grandifolia*	10	No	FACU
6.			
7.			
	88	=Total Cover	

Herb Stratum (Plot size: 5')	Absolute % Cover	Dominant Species?	Indicator Status
1. *Thelypteris noveboracensis*	40	Yes	FAC
2. *Athyrium angustum*	40	Yes	FAC
3. *Maianthemum canadense*	10	No	FACU
4. *Gaultheria procumbens*	20	No	FACU
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	110	=Total Cover	

Woody Vine Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status
1. *Toxicodendron radicans*	5	Yes	FAC
2.			
3.			
4.			
	5	=Total Cover	

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 5 (A)

Total Number of Dominant Species Across All Strata: 7 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 71.4% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:	(A)		(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
X 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Vegetation Strata:

Tree – Woody plants 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/shrub – Woody plants less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vines – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: DP-H-2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-6	10YR 2/2	100					Sandy	
6-12	10YR 4/4	50					Sandy	
	10YR 3/4	50						Loamy sand

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Stratified Layers (A5)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Dark Surface (S7)
___ Polyvalue Below Surface (S8) (**LRR R, MLRA 149B**)
___ Thin Dark Surface (S9) (**LRR R, MLRA 149B**)
___ High Chroma Sands (S11) (**LRR K, L)**
___ Loamy Mucky Mineral (F1) (**LRR K, L**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)
___ Marl (F10) (**LRR K, L**)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10) (**LRR K, L, MLRA 149B**)
___ Coast Prairie Redox (A16) (**LRR K, L, R**)
___ 5 cm Mucky Peat or Peat (S3) (**LRR K, L, R**)
___ Polyvalue Below Surface (S8) (**LRR K, L**)
___ Thin Dark Surface (S9) (**LRR K, L**)
___ Iron-Manganese Masses (F12) (**LRR K, L, R**)
___ Piedmont Floodplain Soils (F19) (**MLRA 149B**)
___ Mesic Spodic (TA6) (**MLRA 144A, 145, 149B**)
___ Red Parent Material (F21)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ____________

Depth (inches): ____________

Hydric Soil Present? **Yes** ___ **No** X

Remarks:
This data form is revised from Northcentral and Northeast Regional Supplement Version 2.0 to reflect the NRCS Field Indicators of Hydric Soils version 7.0 March 2013 Errata. (http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051293.docx)

APPENDIX B

NHDES Functional Assessment Worksheet

WETLANDS FUNCTIONAL ASSESSMENT WORKSHEET

Water Division/Land Resource Management
Wetlands Bureau

Check the Status of your Application

RSA/Rule: RSA 482-A / Env-Wt 311.03(b)(10); Env-Wt 311.10

APPLICANT LAST NAME, FIRST NAME, M.I.: NHDOT

As required by Env-Wt 311.03(b)(10), an application for a standard permit for minor and major projects must include a functional assessment of all wetlands on the project site as specified in Env-Wt 311.10. This worksheet will help you compile data for the functional assessment needed to meet federal (US Army Corps of Engineers (USACE); if applicable) and NHDES requirements. Additional requirements are needed for projects in tidal area; please refer to the Coastal Area Worksheet (NHDES-W-06-079) for more information.

Both a desktop review and a field examination are needed to accurately determine surrounding land use, hydrology, hydroperiod, hydric soils, vegetation, structural complexity of wetland classes, hydrologic connections between wetlands or stream systems or wetland complex, position in the landscape, and physical characteristics of wetlands and associated surface waters. The results of the evaluation are to be used to select the location of the proposed project having the least impact to wetland functions and values (Env-Wt 311.10). This worksheet can be used in conjunction with the Avoidance and Minimization Written Narrative (NHDES-W-06-089) and the Avoidance and Minimization Checklist (NHDES-W-06-050) to address Env-Wt 313.03 (Avoidance and Minimization). If more than one wetland/ stream resource is identified, multiple worksheets can be attached to the application. All wetland, vernal pools, and stream identification (ID) numbers are to be displayed and located on the wetlands delineation of the subject property.

SECTION 1 - LOCATION (USACE HIGHWAY METHODOLOGY)	
ADJACENT LAND USE: undeveloped forest, agricultural, rural residential, transportation	
CONTIGUOUS UNDEVELOPED BUFFER ZONE PRESENT? ☐ Yes ☒ No	
DISTANCE TO NEAREST ROADWAY OR OTHER DEVELOPMENT (in feet): 0 (river crossing)	
SECTION 2 - DELINEATION (USACE HIGHWAY METHODOLOGY; Env-Wt 311.10)	
CERTIFIED WETLAND SCIENTIST (if in a non-tidal area) or QUALIFIED COASTAL PROFESSIONAL (if in a tidal area) who prepared this assessment: Jennifer Riordan (CWS #269)	
DATE(S) OF SITE VISIT(S): 11/28/2018, 7/19/2019, 6/10/2022, 4/21/2023	DELINEATION PER ENV-WT 406 COMPLETED? ☒ Yes ☐ No
CONFIRM THAT THE EVALUATION IS BASED ON: ☒ Office and ☒ Field examination.	
METHOD USED FOR FUNCTIONAL ASSESSMENT (check one and fill in blank if "other"): ☒ USACE Highway Methodology. ☐ Other scientifically supported method (enter name/ title):	

SECTION 3 - WETLAND RESOURCE SUMMARY (USACE HIGHWAY METHODOLOGY; Env-Wt 311.10)	
WETLAND ID: Blackwater River & adjacent wetlands	LOCATION: (LAT/ LONG) 43.422/71.78
WETLAND AREA: large (50+ acres)	DOMINANT WETLAND SYSTEMS PRESENT: riverine, palustrine
HOW MANY TRIBUTARIES CONTRIBUTE TO THE WETLAND? unknown	COWARDIN CLASS: R2UBH, PFO1E, PEM1E, PUBF
IS THE WETLAND A SEPARATE HYDRAULIC SYSTEM? ☐ Yes ☒ No if not, where does the wetland lie in the drainage basin? Middle	IS THE WETLAND PART OF: ☒ A wildlife corridor or ☐ A habitat island? IS THE WETLAND HUMAN-MADE? ☐ Yes ☒ No
IS THE WETLAND IN A 100-YEAR FLOODPLAIN? ☒ Yes ☐ No	ARE VERNAL POOLS PRESENT? ☐ Yes ☒ No (If yes, complete the Vernal Pool Table)
ARE ANY WETLANDS PART OF A STREAM OR OPEN-WATER SYSTEM? ☒ Yes ☐ No	ARE ANY PUBLIC OR PRIVATE WELLS DOWNSTREAM/ DOWNGRADIENT? ☒ Yes ☐ No
PROPOSED WETLAND IMPACT TYPE:	PROPOSED WETLAND IMPACT AREA:

SECTION 4 - WETLANDS FUNCTIONS AND VALUES (USACE HIGHWAY METHODOLOGY; Env-Wt 311.10)

The following table can be used to compile data on wetlands functions and values. The reference numbers indicated in the "Functions/ Values" column refer to the following functions and values:

1. Ecological Integrity (from RSA 482-A:2, XI)
2. Educational Potential (from USACE Highway Methodology: Educational/Scientific Value)
3. Fish & Aquatic Life Habitat (from USACE Highway Methodology: Fish & Shellfish Habitat)
4. Flood Storage (from USACE Highway Methodology: Floodflow Alteration)
5. Groundwater Recharge (from USACE Highway Methodology: Groundwater Recharge/Discharge)
6. Noteworthiness (from USACE Highway Methodology: Threatened or Endangered Species Habitat)
7. Nutrient Trapping/Retention & Transformation (from USACE Highway Methodology: Nutrient Removal)
8. Production Export (Nutrient) (from USACE Highway Methodology)
9. Scenic Quality (from USACE Highway Methodology: Visual Quality/Aesthetics)
10. Sediment Trapping (from USACE Highway Methodology: Sediment /Toxicant Retention)
11. Shoreline Anchoring (from USACE Highway Methodology: Sediment/Shoreline Stabilization)
12. Uniqueness/Heritage (from USACE Highway Methodology)
13. Wetland-based Recreation (from USACE Highway Methodology: Recreation)
14. Wetland-dependent Wildlife Habitat (from USACE Highway Methodology: Wildlife Habitat)

First, determine if a wetland is suitable for a particular function and value ("Suitability" column) and indicate the rationale behind your determination ("Rationale" column). Please use the rationale reference numbers listed in Appendix A of USACE *The Highway Methodology Workbook Supplement*. Second, indicate which functions and values are principal ("Principal Function/value?" column). As described in *The Highway Methodology Workbook Supplement*, "functions and values can be principal if they are an important physical component of a wetland ecosystem (function only) and/or are considered of special value to society, from a local, regional, and/or national perspective". "Important Notes" are to include characteristics the evaluator used to determine the principal function and value of the wetland.

FUNCTIONS/ VALUES	SUITABILITY (Y/N)	RATIONALE (Reference #)	PRINCIPAL FUNCTION/VALUE? (Y/N)	IMPORTANT NOTES
1	☒ Yes ☐ No		☒ Yes ☐ No	The Blackwater River and adjacent wetlands/Prime Wetlands are ecologically important to area
2	☐ Yes ☒ No	5, 11	☐ Yes ☐ No	River and wetlands are not easily accessible, no safe parking nearby
3	☒ Yes ☐ No	1, 2, 3, 4, 7, 8, 10, 14, 17	☒ Yes ☐ No	River is large enough to support fish populations. Water quality is high
4	☒ Yes ☐ No	2, 6, 7, 8, 9, 10, 13	☒ Yes ☐ No	Wetland is located in 100-year floodplain of Blackwater River and provides flood storage value
5	☒ Yes ☐ No	1, 2, 4, 7	☐ Yes ☒ No	Wetland is associated with a perennial stream. Sandy soils present nearby
6	☐ Yes ☒ No		☐ Yes ☐ No	No records of T&E species
7	☒ Yes ☐ No	1, 3, 4, 5, 12, 13	☒ Yes ☐ No	Wetland provides flood storage and retains water from flood events
8	☒ Yes ☐ No	1, 6, 7, 10	☐ Yes ☒ No	Wetland and stream provide wildlife food sources and fish habitat
9	☒ Yes ☐ No	1, 4, 8	☒ Yes ☐ No	Wetland is easily viewed from Route 4
10	☒ Yes ☐ No	1, 2, 3, 5, 8, 10, 12	☒ Yes ☐ No	Wetland provides flood storage and likely also retains sediment during flood events
11	☒ Yes ☐ No	3, 4, 6, 9, 12, 14	☒ Yes ☐ No	Vegetation on banks provide shoreline stabilization and protection during flood events
12	☒ Yes ☐ No	4, 7, 12, 14, 16, 18, 19, 22, 27	☒ Yes ☐ No	Wetland is designated as Prime Wetland by Town of Andover
13	☒ Yes ☐ No	2, 5, 6, 7, 8, 9	☒ Yes ☐ No	Blackwater River is used for canoeing/kayaking. Fishing opportunities also likely
14	☒ Yes ☐ No	2, 5, 6, 7, 8, 13	☒ Yes ☐ No	Blackwater River is a Class A water. Surrounding upland is mostly undeveloped

SECTION 5 - VERNAL POOL SUMMARY (Env-Wt 311.10)
Delineations of vernal pools shall be based on the characteristics listed in the definition of "vernal pool" in Env-Wt 104.44. To assist in the delineation, individuals may use either of the following references: • *Identifying and Documenting Vernal Pools in New Hampshire 3rd Ed.*, 2016, published by the New Hampshire Fish and Game Department; or • The USACE *Vernal Pool Assessment* draft guidance dated 9-10-2013 and form dated 9-6-2016, Appendix L of the USACE New England District *Compensatory Mitigation Guidance*. All vernal pool ID numbers are to be displayed and located on the wetland delineation of the subject property. "Important Notes" are to include documented reproductive and wildlife values, landscape context, and relationship to other vernal pools/wetlands. Note: For projects seeking federal approval from the USACE, please attach a completed copy of The USACE "Vernal Pool Assessment" form dated 9-6-2016, Appendix L of the USACE New England District *Compensatory Mitigation Guidance*.

VERNAL POOL ID NUMBER	DATE(S) OBSERVED	PRIMARY INDICATORS PRESENT (LIST)	SECONDARY INDICATORS PRESENT (LIST)	LENGTH OF HYDROPERIOD	IMPORTANT NOTES
1					
2					
3					
4					
5					

SECTION 6 - STREAM RESOURCES SUMMARY	
DESCRIPTION OF STREAM: perennial	STREAM TYPE (ROSGEN): E/F
HAVE FISHERIES BEEN DOCUMENTED? ☒ Yes ☐ No	DOES THE STREAM SYSTEM APPEAR STABLE? ☒ Yes ☐ No
OTHER KEY ON-SITE FUNCTIONS OF NOTE:	
The following table can be used to compile data on stream resources. "Important Notes" are to include characteristics the evaluator used to determine principal function and value of each stream. The functions and values reference number are defined in Section 4.	

FUNCTIONS/ VALUES	SUITABILITY (Y/N)	RATIONALE	PRINCIPAL FUNCTION/VALUE? (Y/N)	IMPORTANT NOTES
1	☐ Yes ☐ No	Stream resources assessed under Section 4	☐ Yes ☐ No	
2	☐ Yes ☐ No		☐ Yes ☐ No	
3	☐ Yes ☐ No		☐ Yes ☐ No	
4	☐ Yes ☐ No		☐ Yes ☐ No	
5	☐ Yes ☐ No		☐ Yes ☐ No	
6	☐ Yes ☐ No		☐ Yes ☐ No	
7	☐ Yes ☐ No		☐ Yes ☐ No	
8	☐ Yes ☐ No		☐ Yes ☐ No	
9	☐ Yes ☐ No		☐ Yes ☐ No	
10	☐ Yes ☐ No		☐ Yes ☐ No	
11	☐ Yes ☐ No		☐ Yes ☐ No	
12	☐ Yes ☐ No		☐ Yes ☐ No	
13	☐ Yes ☐ No		☐ Yes ☐ No	
14	☐ Yes ☐ No		☐ Yes ☐ No	

SECTION 7 - ATTACHMENTS (USACE HIGHWAY METHODOLOGY; Env-Wt 311.10)

☒ Wildlife and vegetation diversity/abundance list.

☒ Photograph of wetland.

☒ Wetland delineation plans showing wetlands, vernal pools, and streams in relation to the impact area and surrounding landscape. Wetland IDs, vernal pool IDs, and stream IDs must be indicated on the plans.

☐ For projects in tidal areas only: additional information required by Env-Wt 603.03/603.04. Please refer to the Coastal Area Worksheet (NHDES-W-06-079) for more information.

APPENDIX C

Prime Wetland Map

Andover 40392 - Prime Wetlands

Legend

- Additional Lines
- City/Town
- Prime Wetlands
- Prime Wetlands with 100
- Peatland
- Flood Plain Wetlands Adj
- Marsh-Scrub / Shrub Wet

Map Scale

1: 3,247

Map Generated: 1/22/2024

Notes

National Flood Hazard Layer FIRMette

FEMA

71°46'56"W 43°25'32"N

71°46'18"W 43°25'6"N

Feet

0 250 500 1,000 1,500 2,000

1:6,000

Basemap Imagery Source: USGS National Map 2023

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- B 20.2 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- 8 Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

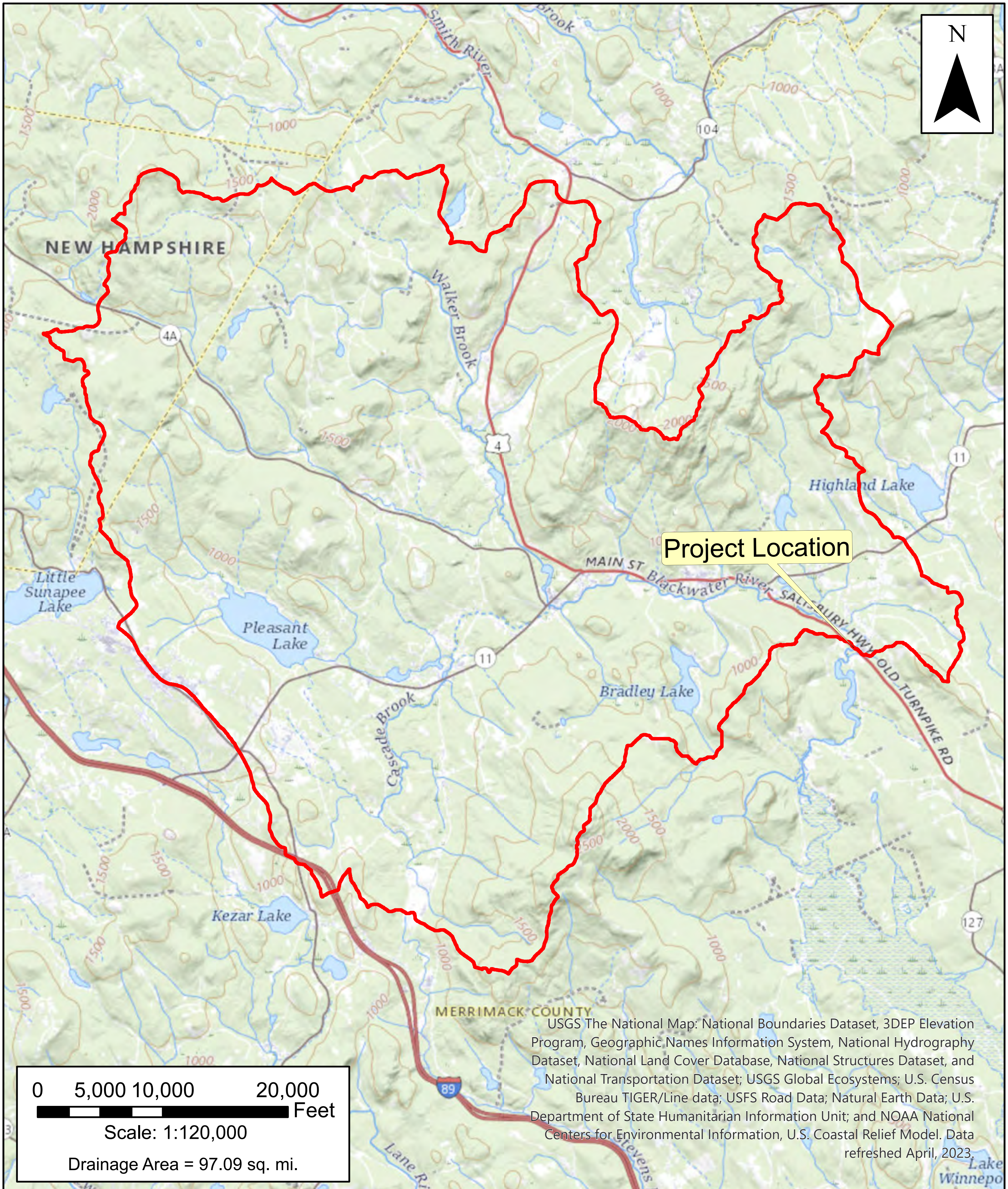
N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 1/18/2024 at 2:23 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.



USGS The National Map: National Boundaries Dataset, 3DEP Elevation Program, Geographic Names Information System, National Hydrography Dataset, National Land Cover Database, National Structures Dataset, and National Transportation Dataset; USGS Global Ecosystems; U.S. Census Bureau TIGER/Line data; USFS Road Data; Natural Earth Data; U.S. Department of State Humanitarian Information Unit; and NOAA National Centers for Environmental Information, U.S. Coastal Relief Model. Data refreshed April, 2023.

GM2

Watershed Map
Andover 40392
US Route 4 over Blackwater River
Andover, NH

New Hampshire DOT Department of Transportation

Stream Crossing Rules (Env-Wt 900)
TECHNICAL REPORT

The proposed project involves the replacement of the existing bridge (Bridge No. 143/077) that carries US Route 4 over the Blackwater River in the Town of Andover, NH. The existing structure is a through-plate girder, 70-foot single-span bridge (67-foot clear span). The substructure consists of concrete gravity-type abutments and U-back wingwalls. The bridge was built in 1933 and is currently on the State Red List due to its deteriorated condition.

Proposed work includes the replacement of the existing bridge with a 104-foot span bridge (100.5-foot clear span). The new abutments will be constructed behind the existing abutments. The existing abutments will be cut at the ground level and stone will be placed at the edges of the channel for scour protection. The bridge will be widened 8 feet and approximately 500 feet of roadway widening will occur at each end of the bridge. The roadway will also be raised 4.5 feet near the bridge. The bridge will be closed during construction and traffic will be detoured.

Since the project involves the replacement of an existing Tier 3 crossing, this report addresses the applicable stream crossing rules under Env-Wt 904.09.

Env-Wt 904.09 – Repair, Rehabilitation, or Replacement of Tier 3 and Tier 4 Existing Legal Crossings

Env-Wt 904.09(a) – The repair, rehabilitation, or replacement of tier 3 stream crossings shall be limited to existing legal crossings where the tier classification is based only on the size of the contributing watershed.

The US Route 4/Blackwater River crossing is an existing, legal crossing. It is a Tier 3 crossing based on watershed size (62,138 acres). The crossing is also located within a 100-year floodplain and prime wetlands.

A project shall qualify under this section only if a professional engineer certifies, and provides supporting analyses to show, that:

Env-Wt 904.09(c)(1) – The existing crossing does not have a history of causing or contributing to flooding that damages the crossing or other human infrastructure or protected species.

The existing crossing does not have a history of causing or contributing to flooding that damages the crossing, human infrastructure, or protected species. The section of US Route 4 near the bridge is known to overtop during major flood events. This is due to the low elevation of the roadway rather than the crossing. Although the existing bridge is undersized and does not accommodate the 100-year flood, hydraulic analysis showed that even with the proposed larger opening, the approach roadways are expected to still overtop due to their low elevations.

Env-Wt 904.09(c)(2)(a) – The proposed alternative meets the general design criteria established in Env-Wt 904.01

Env-Wt 904.01 General Design Considerations

(a) All stream crossings, whether over tidal or non-tidal waters, shall be designed and constructed so as to:

1. Not be a barrier to sediment transport;

The existing 67-foot clear span bridge will be replaced with a 100.5-foot clear span bridge. This is expected to improve sediment transport since the existing undersized bridge likely retains sediment upstream of the crossing. Stone will be placed at the edges of the stream channel for scour protection, but the center of the channel will remain undisturbed and will consist of natural streambed material.

2. ***Not restrict high flows and maintain existing low flows;***

The hydraulic analysis completed for the project indicates that the proposed crossing will convey the 100-year storm with one foot of freeboard and will convey the 500-year storm with no freeboard. The existing crossing does not convey the 100-year storm.

Although the proposed bridge will have a larger hydraulic opening, this is not anticipated to impact low flows given the extensive wetland system upstream and downstream of the crossing.

3. ***Not obstruct or otherwise substantially disrupt the movement of aquatic organisms indigenous to the waterbody beyond the actual duration of construction;***

The project is expected to improve aquatic organism passage by increasing the clear span at the crossing from 67 feet to 100.5 feet. The placement of stone riprap is required for scour protection adjacent to the bridge abutments, but the majority of the channel will remain undisturbed. Streambed simulation over the stone riprap in the channel is not proposed since the slopes are too steep for the material to remain in place. The flatter areas at the top of the slopes next to the abutments will be backfilled with finer material to create wildlife crossing shelves.

4. ***Not cause an increase in the frequency of flooding or overtopping of banks;***

The project will not cause an increase in the frequency of flooding and overtopping of the banks due to the larger hydraulic opening. The existing bridge does not convey the 100-year storm. The hydraulic analysis completed for the project indicates that the proposed bridge will accommodate the 100-year design storm with one foot of freeboard. For the proposed 100-year event, the water surface elevation upstream of the bridge is expected to decrease slightly (0.1 feet).

Although the longer span of the proposed structure will allow for more flow to pass through the bridge, overtopping of the roadway within the vicinity of the crossing is still expected to occur. Approximately 0.5 mile of the approach roadway would need to be raised to prevent overtopping of the roadway. This was determined to be beyond the scope of the project.

5. ***Maintain or enhance geomorphic compatibility by:***

    a) ***Minimizing the potential for inlet obstruction by sediment, wood, or debris; and***
    b) ***Preserving the natural alignment of the stream channel;***

The project will enhance the geomorphic compatibility by lengthening the crossing from 67 feet to 100.5 feet to span the bankfull width (78 feet). The existing natural alignment of the stream will be preserved. Impacts will be located at the edges of the channel and the middle of the channel will remain undisturbed.

6. ***Preserve watercourse connectivity where it currently exists;***

   The existing watercourse connectivity within the project area will not be altered.

7. ***Restore watercourse connectivity where:***

   a. ***Connectivity previously was disrupted as a result of human activity(ies); and***
   b. ***Restoration of connectivity will benefit aquatic organisms upstream or downstream of the crossing, or both;***

   N/A

8. ***Not cause erosion, aggradation, or scouring upstream or downstream of the crossing; and***

   The project is anticipated to decrease water velocity at the crossing due to the larger opening of the proposed structure. The following table shows the hydraulic analysis results for the 50-year, 100-year, and 500-year storm events. Stone riprap is proposed near the new bridge abutments to protect against scour. Since the center of the channel will remain undisturbed and the project is expected to slightly decrease water velocities, the replacement bridge is not anticipated to cause erosion or aggradation.

Maximum Water Velocity at Bridge

	Existing	**Proposed**
50-year storm	4.5 ft/s	3.8 ft/s
100-year storm	4.4 ft/s	3.7 ft/s
500-year storm	4.4 ft/s	3.5 ft/s

9. ***Not cause water quality degradation.***

   The project is not anticipated to cause any permanent impacts to water quality. Widening of the bridge and roadway will increase the amount of impervious surface (pavement) by approximately 6,235 square feet. A stormwater treatment swale is proposed northwest of the bridge. Erosion and sediment controls will be used to minimize temporary impacts during construction.

Env-Wt 904.09(c)(2)(b) – The proposed stream crossing will maintain or enhance the hydraulic capacity of the stream crossing.

The proposed stream crossing will enhance the hydraulic capacity at the crossing by providing a longer span than the existing bridge. The proposed crossing will accommodate the 100-year storm event with one foot of freeboard. The existing crossing does not convey the 100-year storm event.

Env-Wt 904.09(c)(2)(c) – The proposed stream crossing will maintain or enhance the capacity of the crossing to accommodate aquatic organism passage.

The project will increase the span at the crossing from 67 feet to 100.5 feet. This will enhance aquatic organism passage since the new bridge will span the bankfull width. The riprap under the bridge abutments will be backfilled with finer material to create wildlife crossing shelves.

The replacement of the bridge abutments and placement of stone for scour protection will cause temporary disturbance to aquatic organism passage. Impacts will be located at the edges of the channel and the center of the channel will remain undisturbed.

Env-Wt 904.09(c)(2)(d) – The proposed stream crossing will maintain or enhance the connectivity of the stream reaches upstream or downstream of the crossing.

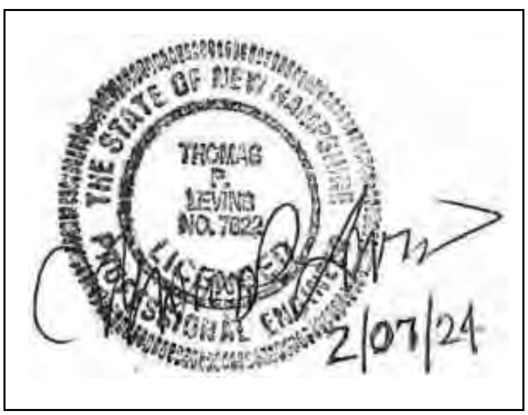
The project will enhance the connectivity of the stream by replacing an undersized bridge with a bridge that spans the bankfull width.

Env-Wt 904.09(c)(2)(e) – The proposed stream crossing will not cause or contribute to the increase in the frequency of flooding or overtopping of the banks upstream or downstream of the crossing.

The hydraulic analysis completed for the project indicates that the proposed bridge will accommodate the 100-year storm event with one foot of freeboard and the 500-year storm with no freeboard. The existing bridge does not have adequate capacity to convey the 100-year flood. Since the proposed bridge will increase the hydraulic capacity of the crossing, no increase in the frequency of flooding or overtopping of banks is anticipated. According to the hydraulic analysis, for the 100-year flood event under proposed conditions, the water surface elevation upstream of the bridge is predicted to decrease slightly (0.1 feet) and no appreciable change is predicted downstream of the bridge.

Although the replacement bridge will convey the 100-year and 500-year storm events, overtopping of the US Route 4 roadway is still anticipated post-construction. This is due to the low elevation of the roadway approaches relative to the floodplain. The proposed bridge replacement will not contribute to an increase in roadway flooding.

As required by Env-Wt 904.09(c), this report has been certified by a Professional Engineer.



Certified By:
Thomas P. Levins, PE

WETLANDS PERMIT APPLICATION
STREAM CROSSING WORKSHEET
Water Division/Land Resources Management
Wetlands Bureau

RSA/Rule RSA 482-A/ Env-Wt-900

This worksheet can be used to accompany Wetlands Permit Applications when proposing stream crossings.

SECTION 1 - TIER CLASSIFICATIONS

Determine the contributing watershed size at USGS StreamStats.

Note: Plans for tier 2 and 3 crossings shall be designed and stamped by a professional engineer who is licensed under RSA 310-A to practice in New Hampshire.

Size of contributing watershed at the crossing location: 62,138 acres

☐ **Tier 1**: A tier 1 stream crossing is a crossing located on a watercourse where the contributing watershed size is less than or equal to 200 acres.

☐ **Tier 2**: A tier 2 stream crossing is a crossing located on a watercourse where the contributing watershed size is greater than 200 acres and less than 640 acres.

☒ **Tier 3**: A tier 3 stream crossing is a crossing that meets **any** of the following criteria:

- ☒ On a watercourse where the contributing watershed is more than 640 acres.
- ☐ Within a designated river corridor unless:
  a. The crossing would be a tier 1 stream based on contributing watershed size, or
  b. The structure does not create a direct surface water connection to the designated river as depicted on the national hydrography dataset as found on GRANIT.
- ☒ Within a 100-year floodplain (see Section 2 below).
- ☐ In a jurisdictional area having any protected species or habitat (NHB DataCheck).
- ☒ In a prime wetland or within a duly-established 100-foot buffer, unless a waiver has been granted pursuant to RSA 482-A:11, IV(b) and Env-Wt 706. Review the Wetlands Permit Planning Tool (WPPT) for town prime wetland and prime wetland buffer maps to determine if your project is within these areas.

☐ **Tier 4**: A tier 4 stream crossing is a crossing located on a tidal watercourse.

SECTION 2 - 100-YEAR FLOODPLAIN

Use the FEMA Map Service Center to determine if the crossing is located within a 100-year floodplain. Please answer the questions below:

☐ **No**: The proposed stream crossing *is not* within the FEMA 100-year floodplain.

☒ **Yes**: The proposed project *is* within the FEMA 100-year floodplain. Zone = A

Elevation of the 100-year floodplain at the inlet: N/A feet (FEMA El. or Modeled El.)

SECTION 3 - CALCULATING PEAK DISCHARGE

Existing 100-year peak discharge (Q) calculated in cubic feet per second (CFS): 7,930 CFS	Calculation method: USGS StreamStats
Estimated bankfull discharge at the crossing location: 2,858.5 CFS	Calculation method: NH Regional Curves

lrm@des.nh.gov or (603) 271-2147
NHDES Wetlands Bureau, 29 Hazen Drive, PO Box 95, Concord, NH 03302-0095
www.des.nh.gov

→ *Note: If tier 1, then skip to Section 10* ←

SECTION 4 - PREDICTED CHANNEL GEOMETRY BASED ON REGIONAL HYDRAULIC CURVES *For **tier 2**, **tier 3** and **tier 4** crossings only.*	
Bankfull Width: 117 feet	Mean Bankfull Depth: 4.3 feet
Bankfull Cross Sectional Area: 507.6 square feet (SF)	

SECTION 5 - CROSS SECTIONAL CHANNEL GEOMETRY: MEASUREMENTS OF THE EXISTING STREAM WITHIN A REFERENCE REACH *For **tier 2**, **tier 3** and **tier 4** crossings only.*
Describe the reference reach location: CS1: DS of bridge, CS2: 1900' DS, CS3: 3000' US
Reference reach watershed size: 62,138 acres

Parameter	**Cross Section 1** Describe bed form (*e.g. pool, riffle, glide*)	**Cross Section 2** Describe bed form (*e.g. pool, riffle, glide*)	**Cross Section 3** Describe bed form (*e.g. pool, riffle, glide*)	**Range**
Bankfull Width	75 feet	73 feet	93 feet	73-93 feet
Bankfull Cross Sectional Area	SF	SF	SF	SF
Mean Bankfull Depth	~5 feet	~5 feet	~3 feet	3-5 feet
Width to Depth Ratio	~15	~15	~31	15-31
Max Bankfull Depth	8 feet	9 feet	4 feet	4-9 feet
Flood Prone Width	2,600 feet	1,470 feet	102 feet	102-2,600 feet
Entrenchment Ratio	35	20	1.1	1.1-35

*Use **Figure 1** below to determine the measurements of the Reference Reach Attributes*

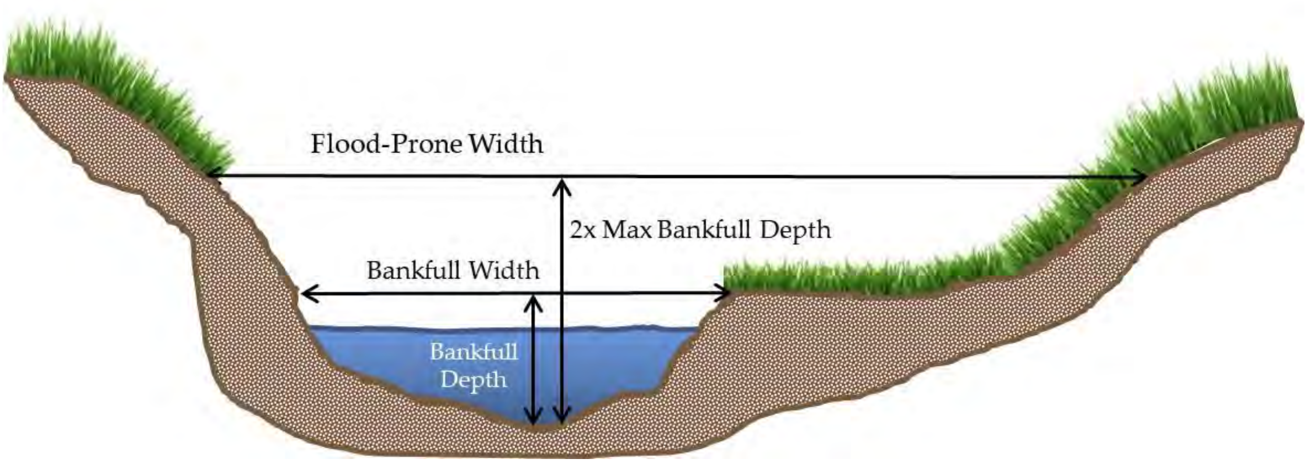


Figure 1: Determining the Reference Reach Attributes.

SECTION 6 - LONGITUDINAL PARAMETERS OF THE REFERENCE REACH AND CROSSING LOCATION *For **tier 2**, **tier 3** and **tier 4** crossings only.*
Average Channel Slope of the Reference Reach:
Average Channel Slope at the Crossing Location:

SECTION 7 - PLAN VIEW GEOMETRY Note: Sinuosity is measured a distance of at least 20 times bankfull width, or 2 meander belt widths. *For **tier 2**, **tier 3** and **tier 4** crossings only.*
Sinuosity of the Reference Reach: 1.97

Sinuosity of the Crossing Location: 1.06	
SECTION 8 - SUBSTRATE CLASSIFICATION BASED ON FIELD OBSERVATIONS *For **tier 2, tier 3** and **tier 4** crossings only.*	
% of reach that is bedrock:	**0** %
% of reach that is boulder:	**0** %
% of reach that is cobble:	**0** %
% of reach that is gravel:	**0** %
% of reach that is sand:	**70** %
% of reach that is silt:	**30** %
SECTION 9 - STREAM TYPE OF REFERENCE REACH *For **tier 2, tier 3** and **tier 4** crossings only.*	
Stream Type of Reference Reach:	F / E

*Refer to Rosgen Classification Chart (**Figure 2**) below:*

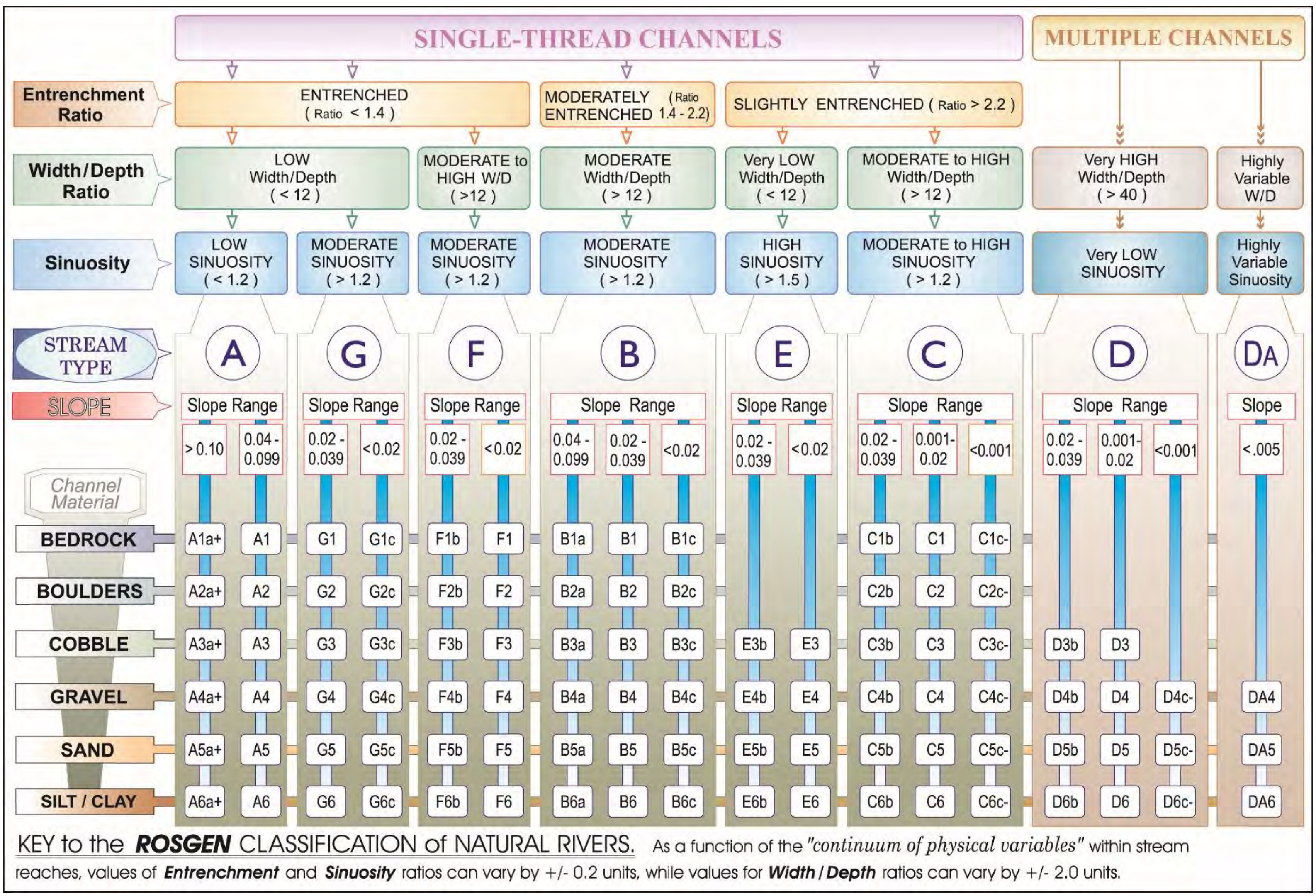


Figure 2: Reference from Applied River Morphology, Rosgen, 1996.

SECTION 10 - CROSSING STRUCTURE METRICS						
Existing Conditions	**Existing Structure Type:**	☒ Bridge span ☐ Pipe arch ☐ Open-bottom culvert ☐ Closed-bottom culvert ☐ Closed-bottom culvert with stream simulation ☐ Other:				
	Existing Crossing Span: *(perpendicular to flow)* 67 feet	**Culvert Diameter:** feet **Inlet Elevation:** El. feet				
	Existing Crossing Length: *(parallel to flow)* 24 feet	**Outlet Elevation:** El. feet **Culvert Slope:**				
Proposed Conditions	**Proposed Structure Type:**	**Tier 1**	**Tier 2**	**Tier 3**	**Alternative Design**	
	Bridge Span	☐	☐	☒	☐	
	Pipe Arch	☐	☐		☐	
	Closed-bottom Culvert	☐	☐		☐	
	Open-bottom Culvert	☐	☐	☐	☐	
	Closed-bottom Culvert with stream simulation	☐	☐	☐	☐	
	Proposed Structure Span: *(perpendicular to flow)* 100.5 feet	**Culvert Diameter:** feet **Inlet Elevation:** El. feet				
	Proposed Structure Length: *(parallel to flow)* 32 feet	**Outlet Elevation:** El. feet **Culvert Slope:**				
	Proposed Entrenchment Ratio:* 1.3 *For **Tier 2**, **Tier 3** and **Tier 4** Crossings Only. To accommodate the entrenchment ratio, floodplain drainage structures may be utilized.*					

** Note: Proposed Entrenchment Ratio must meet the minimum ratio for each stream type listed in **Figure 3**, otherwise the applicant must address the Alternative Design criteria listed in Env-Wt 904.10.*

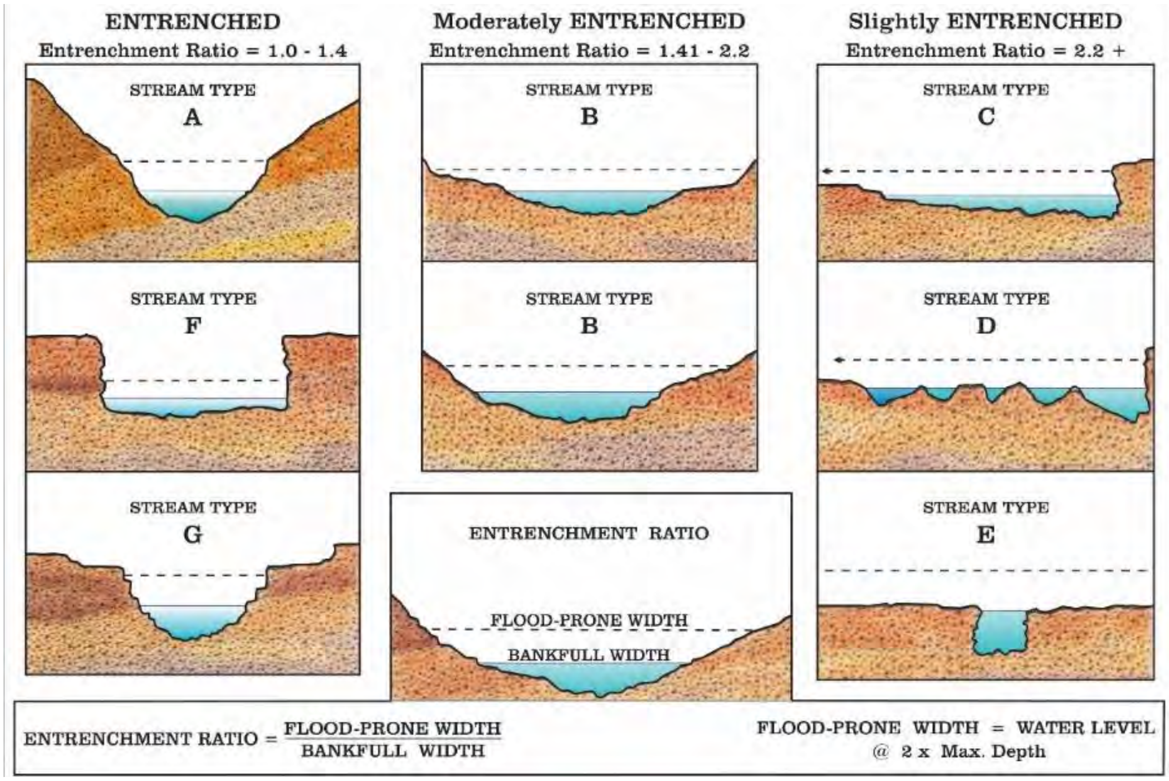


Figure 3: Reference from Applied River Morphology, Rosgen, 1996.

SECTION 11 - CROSSING STRUCTURE HYDRAULICS		
	Existing	**Proposed**
100 year flood stage elevation at inlet:	608.0 ft	607.9 ft
Flow velocity at outlet in feet per second (FPS):	4.4	3.7
Calculated 100 year peak discharge (Q) for the *proposed* structure in CFS:		7,930
Calculated 50 year peak discharge (Q) for the *proposed* structure in CFS:		6,800

SECTION 12 - CROSSING STRUCTURE OPENNESS RATIO

*For **tier 2**, **tier 3** and **tier 4** crossings only.*

Crossing Structure Openness Ratio* = N/A
* Openness box culvert = (height x width)/length
Openness round culvert = (3.14 x radius^2)/length

SECTION 13 - GENERAL DESIGN CONSIDERATIONS

Env-Wt 904.01 requires all stream crossings to be designed and constructed according to the following requirements. Check each box if the project meets these general design considerations.

All stream crossings shall be designed and constructed so as to:

☒ Not be a barrier to sediment transport.

☒ Prevent the restriction of high flows and maintain existing low flows.

☒ Not obstruct or otherwise substantially disrupt the movement of aquatic life indigenous to the waterbody beyond the actual duration of construction.

☒ Not cause an increase in the frequency of flooding or overtopping of banks.

☒ Maintain or enhance geomorphic compatibility by:

a. Minimizing the potential for inlet obstruction by sediment, wood, or debris, and

b. Preserving the natural alignment of the stream channel.

☒ Preserve watercourse connectivity where it currently exists.

☐ Restore watercourse connectivity where:

a. Connectivity previously was disrupted as a result of human activity(ies), and

b. Restoration of connectivity will benefit aquatic life upstream or downstream of the crossing, or both.

☒ Not cause erosion, aggradation, or scouring upstream or downstream of the crossing.

☒ Not cause water quality degradation.

SECTION 14 - TIER-SPECIFIC DESIGN CRITERIA

Stream crossings must be designed in accordance with the tier specific design criteria listed in Part Env-Wt 904.

☒ The proposed project meets the tier specific design criteria listed in Part Env-Wt 904 and each requirement has been addressed in the plans and as part of the wetland application.

SECTION 15 - ALTERNATIVE DESIGN

NOTE: If the proposed crossing does not meet all of the general design considerations, the tier specific design criteria, or the minimum entrenchment ratio for each given stream type listed in **Figure 3**, then an alternative design plan and associated requirements must be addressed pursuant to Env-Wt 904.10.

☐ I have submitted an alternative design and addressed each requirement listed in Env-Wt 904.10.

Hydrologic and Hydraulic Study

US Route 4 over Blackwater River
Andover, NH

Prepared for

GM2 Associates, Inc.

December 2020
Revised January 2021

STATE OF NEW HAMPSHIRE
KAYLA
M.
HAMPE
No. 15789
LICENSED
PROFESSIONAL ENGINEER

1/28/2021

Prepared by

Hoyle, Tanner & Associates, Inc.

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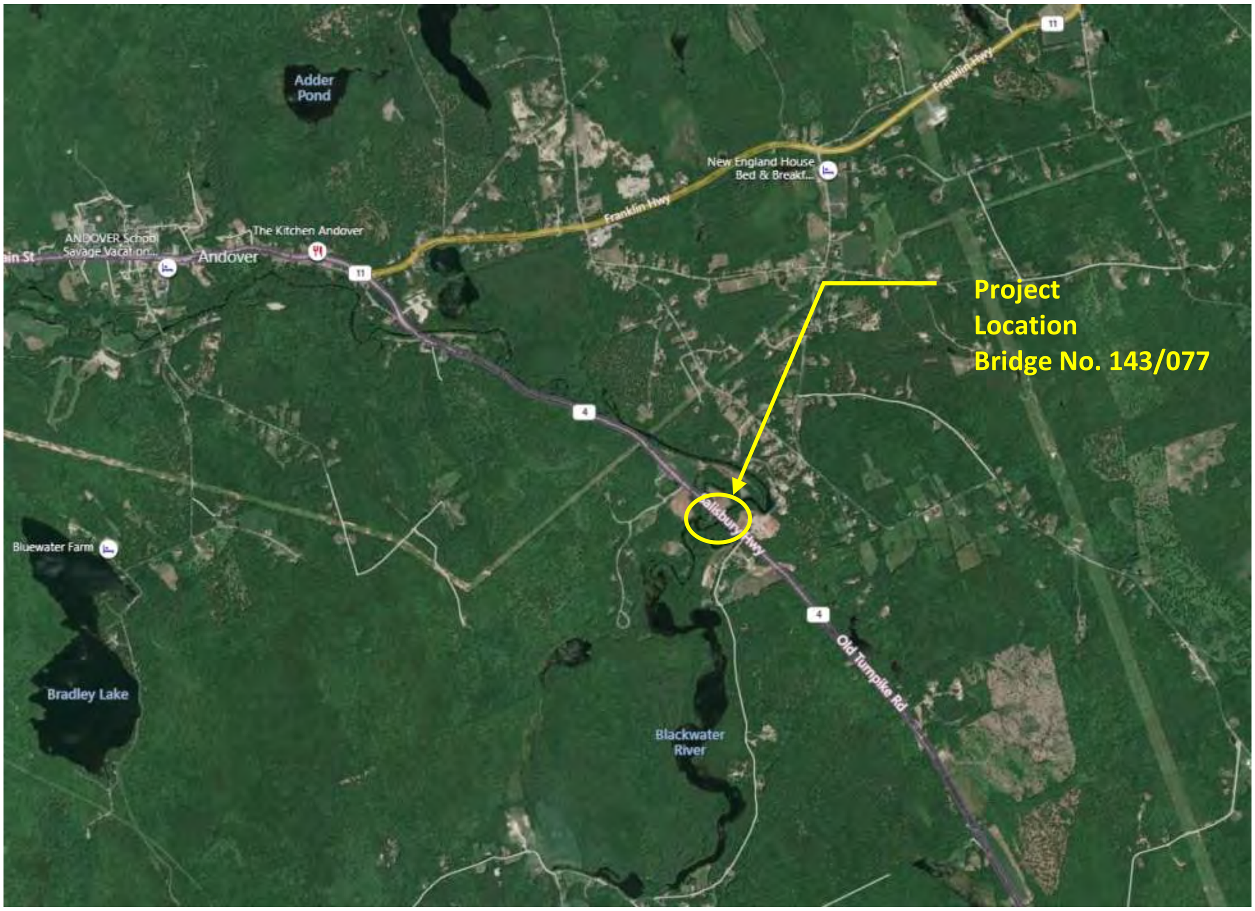
LOCATION MAP



Source: Bing Maps 07/2020

US Route 4 Bridge over Blackwater River Andover, NH	Hoyle, Tanner & Associates, Inc.	**File Name:** US Route 4 H&H Study.docx	
		Date: 01/2021	**Page:** 1

1 EXECUTIVE SUMMARY

The purpose of this report is to present the results of a Study evaluating the hydraulic performance of the proposed replacement structure included in the Type, Size, and Location (TS&L) study. This investigation was conducted in a manner consistent with American Association of State Highway Officials (AASHTO), Federal Highway Administration (FHWA), and New Hampshire Department of Transportation (NHDOT) guidelines for preparation of hydraulic studies at bridge sites.

NHDOT proposes to replace the existing 70' single-span bridge conveying US Route 4 over the Blackwater River in the Town of Andover, New Hampshire due to its deteriorated condition. The existing bridge has an AASHTO sufficiency rating of 41.4% and a National Bridge Inspection Standards (NBIS) Item 113 (Scour Critical Bridges) rating of 8, which is defined as: bridge foundations determined to be stable for the assessed or calculated scour condition; scour is determined to be above the top of footing by assessment, by calculation or by installation of properly designed countermeasures. The bridge is on the State Red List because the deck and superstructure are both rated 4, poor, and the substructure is rated 5, fair. The proposed replacement structure is a 100' single-span steel plate girder bridge with composite reinforced concrete deck superstructure supported on deep foundations.

The bridge crosses the Blackwater River, a tributary of the Contoocook River and part of the Merrimack River watershed. The segment of the Blackwater River at the subject crossing was not studied in the 1980 National Flood Insurance Program (NFIP) Flood Insurance Study (FIS) completed within the Town of Andover.

The scope of work for this investigation consisted of review of pertinent hydrologic and hydraulic data for the Blackwater River at the subject crossing, as well as at the upstream and downstream confluences with the Blackwater River, and completion of a detailed two-dimensional hydraulic analysis. Data collected as part of this Study and the hydraulic model computer input/output are presented in the appendices of this report. A narrative discussion of the problem statement, engineering methods, as well as results and conclusions of the hydraulic evaluation follow.

Based on the hydrologic and hydraulic analyses, the existing hydraulic capacity of the US Route 4 Bridge was found to be insufficient to provide a minimum of 1' of freeboard for the 100-year flood event. The low chord elevation of the proposed 100' span replacement bridge should be set at or above elevation 608.9' to provide 1' minimum freeboard for the 100-year flood event, and to accommodate the 500-year flood event. The floodplain of the Blackwater River near the bridge, including the US Route 4 roadway approaches, is relatively flat and is located below the flood elevation; therefore, the roadway will still experience overtopping in the proposed condition during the 100-year and 500-year flood events even with the low chord raised to elevation 608.9'. To prevent overtopping of the roadway, approximately one-half mile of approach roadway profile adjustment would be required. Roadway reconstruction of this extent is understood to be outside the scope of work for this footprint bridge replacement project and was not considered in this Study.

2 PROJECT DESCRIPTION

Hoyle, Tanner & Associates, Inc. (Hoyle, Tanner) has been retained by GM2 Associates, Inc. (GM2) to perform a Hydrologic and Hydraulic Study (Study) for the US Route 4 Bridge (no. 143/077) over the Blackwater River. This Study was compiled utilizing existing conditions data including topographic survey, photographs and other information collected during site visits conducted by NHDOT and GM2, as well as hydrologic and hydraulic analyses completed by Hoyle, Tanner. The goal of this Study is to evaluate the hydraulic performance of the existing bridge and to determine the required low chord elevation of the proposed replacement structure in accordance with NHDOT design requirements (1' minimum freeboard for the 100-year flood event and accommodation of the 500-year flood event).


Upstream (North) Elevation

The subject bridge in the Town of Andover, New Hampshire carries US Route 4 over the Blackwater River and is designated as NHDOT Bridge No. 143/077. The bridge was constructed in 1933 and has not been rehabilitated except for modifications to the bottom flanges of the through plate girders and minor abutment repairs. The bridge is a single-span through plate girder structure with steel floorbeams and a cast-in-place concrete deck. The substructure consists of concrete gravity-type abutments and U-back wingwalls. The substructure is not skewed to the roadway. The span length of the bridge is 70'-0" with a clear span of 67'-0". The bridge provides a total paved roadway width of 24'-0", with no sidewalks, and a total width of 26'-8" (center-to-center of girder centerline). The bridge is structurally deficient and is on the State Red List. Further information on the existing structure is included in Appendix A.


Downstream (South) Elevation

US Route 4 is classified as a Rural, Major Collector roadway, which is a Tier 2 highway in NH. The latest Bridge Inspection Report, dated November 6, 2020, lists a 2018 annual average daily traffic (AADT) volume of 2,367 vehicles per day, 4% of which may be trucks.

The principal project objective is to replace the existing deteriorated structure with one that meets current bridge, highway, and environmental standards. From the Type, Size and Location (TS&L) Plans prepared by GM2 (Appendix B), the existing structure will be replaced with a 100'-0" long single-span bridge with a clear waterway span of 97'-0". The bridge will carry two travel lanes on a total paved width of 31'-0". The superstructure will most likely consist of steel plate girders composite with a reinforced concrete deck. The replacement substructure will most likely consist of integral abutments. The increase in span length from 67' to 100' is to allow the new abutments to be constructed behind existing abutments. The replacement structure is proposed to be square with the Blackwater River.

3 HYDROLOGY

3.1 Blackwater River Watershed

The Blackwater River originates in the western portion of the Town of Andover at the confluence of Cascade Brook and Frazier Brook. The Cascade Brook watershed extends to the west toward the towns of New London and Sutton, and the Frazier Brook watershed extends to the north toward the towns of Springfield and Danbury. The Blackwater River flows easterly and then southerly through the Town of Andover, then continues south through the towns of Salisbury, Webster, and Hopkinton before ultimately discharging into the Contoocook River approximately 18.5 miles downstream of the US Route 4 Bridge (as measured along the centerline of the river). The watershed encompasses a combination of suburban and wooded areas within a hilly to mountainous terrain. The drainage area at the subject bridge crossing is about 99.1 square miles and contains small ponds and small areas of wetlands, resulting in a storage area of 5%. The watershed delineation is presented in Appendix C and additional watershed basin characteristics are included in the StreamStats reports in Appendix D.

Blackwater River Downstream of US Route 4 Bridge

Land use near the bridge is mostly agricultural, but also includes a lumber yard to the east and areas of forest cover and wetlands. Based on information from the Multi-Resolution Land Characteristics (MRLC) Consortium National Land Cover Database (NLCD), the land cover in the project area has remained relatively unchanged over the last 20 years. Additional information on land use compiled as part of the qualitative geomorphic analyses is presented in the Appendix F.

3.2 Historic Hydraulic Performance

The Blackwater River was not studied in the 1980 National Flood Insurance Program (NFIP) Flood Insurance Study (FIS) conducted in the Town of Andover. Currently, the Blackwater River in the Town of Andover is located within Special Flood Hazard Area (SFHA) Zone A without base flood elevations, as seen on the Flood Insurance Rate Map (FIRM) panel 33013C0145E (included in Appendix E).

According to discussions between GM2 and NHDOT, the roadway approaches to the US Route 4 bridge overtop during major storm events. The most recent significant flood event at this crossing was the May 2006 flood, and the photo below (taken during an NHDOT inspection) shows roadway overtopping of the east approach during this event. This photo illustrates well the elevation of the bridge relative to the roadway approaches, with the roadway overtopping but not the bridge. Information on the high-water elevation and peak discharge of the 2006 flood at the project site were not discovered in the research performed for this Study.

US Route 4 Looking Southeast:
Water Over Roadway – Road Closed and Barricaded (May 16, 2006)

As noted on the NHDOT structure Flat Card (Appendix A), the flood of record for this structure is reported as the flood of 1936, which occurred in March. The flooding was attributed to saturated ground, warm temperatures, melting snow, filled storage areas, and two successive heavy rainfall events according to the FIS narrative (Appendix E). During this event, the water at the bridge rose to approximately 3' above the top of the bridge deck (based on the NHDOT Flat Card notes). There is a stream gage located approximately 10 miles downstream of the crossing with records of the mean average daily discharge dating back to 1936, but peak discharge values were not recorded and are unknown at this crossing for the 1936 event. The FIS reports that the "1936 flood exceeded the 100-year event for the Towns of Allenstown, Boscawen, Bow, Canterbury, Hooksett, and Pembroke, and the City of Concord. This same 1936 flood was a 90-year event for the City of Franklin and the Town of Northfield." Although the Town of Andover is not listed, these are communities in the vicinity of the Blackwater River and it is reasonable to assume the 1936 flood was a 90-year or greater event in Andover. The Blackwater Dam in the Town of Webster was constructed for flood control after the 1936 flooding.

3.3 Hydrologic Analysis

The hydrologic analysis performed for this Study calculated flood flow values using methods recommended in Section 2.7 of the NHDOT Bridge Design Manual, Volume 2, and as recommended by the NHDOT Manual on Drainage Design for Highways. Stream gage data, if available, is typically the most reliable source of hydrologic information. Approximately 10 miles downstream of the subject crossing there is a USGS stream gage on the Blackwater River. However, the Blackwater Dam is located approximately 2 miles upstream of this gage, and it is a regulated dam constructed for the purpose of flood control, as previously noted. Therefore, flow data from this gage, adjusted with the drainage-area relationship method, is not a reliable method for estimating flows at the subject crossing, and the Blackwater River is considered ungaged at this location.

Per the Bridge Design Manual, the preferred method for obtaining hydrologic flows for ungaged streams is to use the United States Geological Survey (USGS) StreamStats program for New Hampshire. StreamStats is a web-based program that uses geographic information systems (GIS) terrain data, raster imaging, and other data and software to determine the variables needed for the 2009 USGS regression equations. StreamStats uses these state-specific equations to predict the instantaneous peak flood discharges for unregulated rural streams for the 2-year, 5-year, 10-year, 25-year, 50-year, 100-year and 500-year return period events. Variables used in the USGS regression equations include drainage area, mean April precipitation, percentage of wetland/storage area, and main channel slope.

The Bridge Design Manual also requires that the preferred hydrologic method be checked using two alternate methods. As previously noted, the FIS completed in 1980 did not include a detailed study along the Blackwater River at the subject bridge, and therefore FIS flows are not available for use as a check method. Without gage data or FIS flows, the most appropriate check methods remaining are the Federal Highway Administration (FHWA) regression equations (the 5- and 7-Parameter Methods), and the New England Hill and Lowlands (NEHL) and Adirondack White Mountains (AWM) Method.

Flows from both check methods, for both the 50-year and 100-year storm events, were calculated to be greater than flows calculated with StreamStats. However, the NEHL/AWM method is becoming outdated (it was first developed in the 1950's), and the size of the subject watershed (99.1 sq. mi.) is much larger than the recommended maximum of 50 sq. mi. for the FHWA regression equations, although NHDOT recognizes it to be an acceptable check method for watersheds up to 100 sq. mi. For these reasons, the check flow methods are considered less accurate than the USGS Regression equations, and the StreamStats values are used for the hydraulic analysis of the existing and proposed conditions.

Two smaller watersheds discharge into the Blackwater River within the limits of the hydraulic model, one via a confluence with an unnamed brook 3,500' upstream of the bridge and the other via a confluence with an unnamed brook 1,700' downstream of the bridge. These tributary streams are relatively small with drainage areas less than 2 square miles each. Therefore, the discharges for these tributaries were determined using StreamStats but not checked with the alternative methods. The StreamStats report for each stream is included in Appendix D.

Table 3.1, below, summarizes the peak discharges and Annual Exceedance Probability (AEP), or the likelihood that the corresponding storm event will occur within a given year, for the Blackwater River. The full hydrologic analysis is in Appendix D.

Table 3.1 – AEP, Storm Event and Peak Discharge Comparison – Blackwater River

Annual Exceedance Probability	Storm Event/ Return Interval	Peak Discharge (Cubic Feet per Second - CFS)
50%	2-year	2,450
20%	5-year	3,670
10%	10-year	4,630
4%	25-year	5,840
2%	50-year	6,800
1%	100-year	7,930
0.2%	500-year	10,500

4 HYDRAULICS

4.1 Modeling Software

Steady state hydraulic analyses were performed for the US Route 4 bridge over the Blackwater River. Water surface profiles were developed using the United States Bureau of Reclamation's Sedimentation and River Hydraulics – Two-Dimensional model (SRH-2D) and Aquaveo's surface-water modeling solution program (SMS) computer applications. Aquaveo's SMS was utilized to develop the mesh and input (boundary conditions, material properties, etc.) necessary to run the SRH-2D models. The program allows the user to develop a two-dimensional (2D) hydraulic, sediment, temperature, and vegetation model that incorporates the Finite Volume method in conjunction with implicit first- and second-order numerical schemes to approximate a solution for the 2D depth averaged Saint Venant equations.

Water surface profiles for the 50-year, 100-year, and 500-year flood events were developed as part of this Study. The 50-year storm is included as it is often used as a reference flood event. The 100-year and 500-year events are included as the design flood event and the check flood event, respectively, as required by the NHDOT Bridge Design Manual Table 2.7.5-1 for a Tier 2 roadway. Pertinent information for the model development is included in Appendix G, and a detailed summary of the Existing and Proposed Hydraulic Analyses can be found in Appendix H and I, respectively.

4.2 Model Surfaces

The existing condition model surface was created by combining multiple elevation data sources into a single surface: bathymetric survey, conventional topographic survey, LiDAR (Light Detecting and Ranging), and approximate channel bathymetry. Limited detailed topographic survey was performed at the bridge, and bathymetric survey data was collected within the Blackwater River for a length of 6,000', extending approximately 4,000' upstream and 2,000' downstream of the subject bridge. LiDAR was utilized for topography outside of the detailed and bathymetric survey areas. The underwater geometry of the river channel in the LiDAR survey area, where LiDAR data cannot be collected, was modeled by assuming channel geometry similar to that within the limits of the bathymetric survey and stamping that geometry into the LiDAR data.

The proposed condition model was created from a copy of the existing condition model with modifications as necessary to reflect the proposed condition. For this model, the channel geometry under the bridge was modified for the proposed conditions by stamping channel banks to reflect the approximate grading depicted in the TS&L plans (Appendix B).

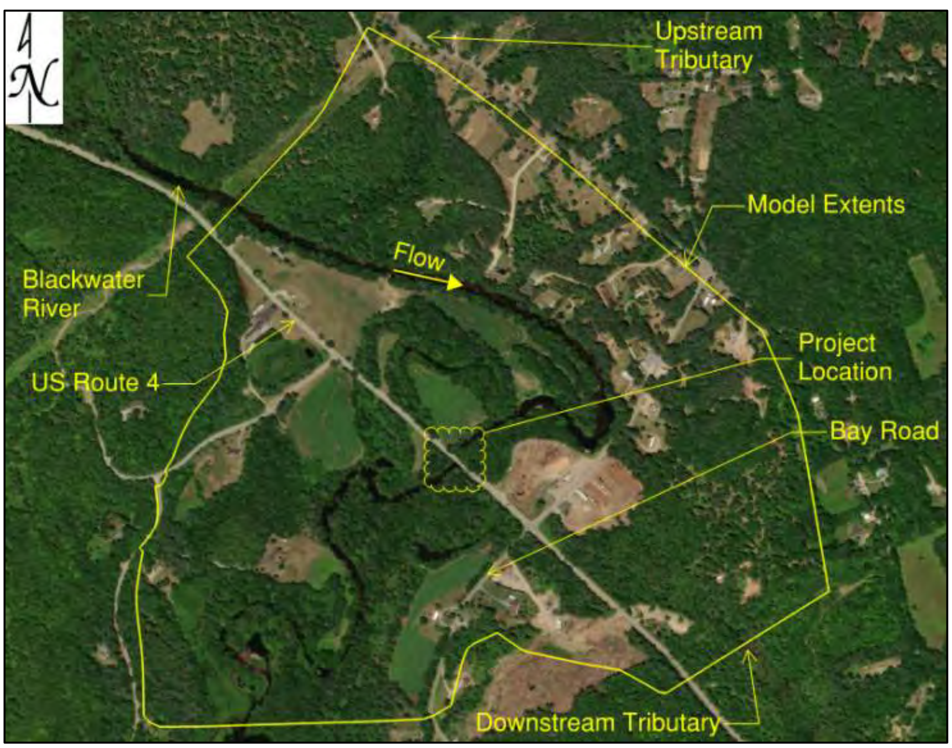
Aerial imagery was used to determine the roughness coefficient (Manning's n) for the land cover. The Blackwater River channel was assigned a roughness coefficient of 0.04 corresponding to a clean, winding river with some shoals and pools. A summary of all the roughness coefficients used in the model, including the areas to which they were assigned, is included in Appendix G.

4.3 Model Boundary Conditions

The inlet boundary conditions for the Blackwater River and both tributaries were all assumed to be a subcritical condition with constant discharges, as previously discussed in the Hydrology section. The downstream outlet boundary condition also assumed to be subcritical condition, but with a constant water surface elevation (WSEL). The WSEL is calculated by the software using the model surface/topography, total model discharge (from both the main river and tributaries), a composite roughness coefficient of 0.06 for the channel and overbanks, and a normal channel slope of 0.0005 ft/ft (determined from the known topography and bathymetry). The computed WSEL for the 50-, 100- and 500-year storms are 604.46', 604.89', and 605.77', respectively.

The exact low chord elevation of the existing bridge was not included in the limited survey; therefore, a low chord elevation of 606.6' was estimated using roadway elevations, the original design drawings, and the NHDOT Flat Card (note that the original drawings, dated 1933, utilize an assumed datum with an unknown relationship to the NAVD 88 datum on which the existing condition model is based). The existing bridge was modeled as a pressure flow condition because initial modeling results showed the WSEL for the 50-, 100-, and 500-year events rising above this estimated low chord elevation.

The downstream tributary stream passes through two culverts, one crossing under US Route 4 and the other under Bay Road, before reaching the confluence with the Blackwater River. The extent of the model encompasses these crossings, but these structures are not entered as culverts in the model because geometric information for these structures (such as inverts, diameter, length, slope, and material) was not available during modeling. This is a conservative simplification because the storage capacity of these culverts is not considered since they are not included in the model, and the tributary discharges unencumbered through these roadway crossings. Neglecting these culverts, however, has minimal impact on the modeling results because the magnitude of flow in this confluence is relatively small compared to flow in the Blackwater River, and these culverts are located in the upper section of the tributary (away from the subject bridge).



2D Hydraulic Model Extents

There is a history of beaver activity in the tributaries within the model domain; however, detailed information about potential existing beaver dams is not available, and it is likely that the location and extent of any beaver dams will change over time. The effect of these beaver dams on the hydraulic performance of the bridge is considered minimal and these features are not considered in the model. Review of aerial imagery indicates there is a culvert that conveys flow under NH Route 4 located approximately 800' northwesterly from the bridge. Information for this culvert does not appear to be included in the public version of the New Hampshire Statewide Asset Data Exchange System (NH SADES) and therefore details about the culvert (including size and material) could not be confirmed. The culvert is assumed, by observation, to be too small to impact hydraulic performance at the bridge and therefore is not considered in the model. This approach is conservative because any flow conveyed by this structure will bypass the subject bridge.

The Blackwater flood control reservoir, created by the downstream Blackwater Dam, extends upstream of the dam approximately 7 miles, but does not enter the limits of the hydraulic model (see FIRM in Appendix E). Therefore, it is not necessary to consider operation of this dam in the hydraulic model boundary conditions. Additional information on the Blackwater Dam is in Appendix D.

4.4 Model Verification

As previously discussed, the roadway approaches to the US Route 4 bridge are reported to experience overtopping during some flood events. The most recent flood event to cause significant overtopping was the 2006 flood, but the discharge and recurrence interval of this flood is unknown. Results from the existing condition hydraulic model show overtopping of the approach roadways during the 50-year and greater flood events; this hydraulic performance is generally in-line with historic accounts, but further model calibration and verification was deemed necessary.

No calibration data is available for the model, so sensitivity analyses were conducted to verify model convergence. Convergence occurs when a downstream boundary condition, roughness, or mesh resolution is changed but the solution at the point of interest (i.e. the subject bridge) remains similar. The sensitivity analyses included testing mesh element size, material roughness, boundary conditions, and the material roughness of the bridge under pressure flow. The sensitivity analyses were conducted with the 50-year and 100-year events; the model is more sensitive to lower flows, so these events provide more insight to the model convergence. The sensitivity analyses results are included in Appendix G.

The first sensitivity analysis tested the refinement of the mesh for both the 50-year and 100-year events, focusing on the portion of US Route 4 where overtopping occurs. Modeling results were essentially unchanged regardless of mesh size/resolution; therefore, the original mesh was used for the final analyses.

The second sensitivity analysis was used to test the sensitivity of the model to changes in the material roughness coefficients for the 50-year event. Various combinations of material adjustments were made including changing the grass cover coefficient from 0.04 to 0.03, changing the dense trees coefficient from 0.10 to 0.12, and changing the Blackwater River channel coefficient from 0.04 to 0.033. Modeling results were nearly identical regardless of the coefficients assigned for material coverage; therefore, the coefficients assigned in the original model were retained for the final analyses.

Model convergence was evaluated for the third sensitivity analysis, testing model response to changes in the downstream boundary conditions for the 50-year event. The WSEL at the downstream boundary condition was first lowered by 2', then raised by 1', and finally raised by 2'. The results near the bridge were nearly identical when the WSEL was lowered by 2' and raised by 1'; however, the WSEL at the bridge increased approximately 0.4' when the WSEL at the downstream boundary was raised by 2'. A two-fold increase in discharge would be necessary to increase the Blackwater River WSEL by 2' at the downstream boundary, and the magnitude of that increase is considered too extreme for this model convergence evaluation. Therefore, the WSEL originally calculated for the downstream boundary was considered acceptable for final analyses based on the no-change results for the -2' and +1' WSEL adjustments.

The fourth sensitivity analysis tested the material roughness coefficient used for pressure flow at the existing bridge. The value was changed from 0.012 to 0.05 with no appreciable change in results; therefore, the roughness coefficient used in the original model was accepted for the final analyses.

4.5 Existing Hydraulic Conditions

Existing condition modeling results summarized in Table 4.1, below, indicate that the low chord of the existing bridge is inundated during the 50-year and greater storm events, and the roadway approaches are overtopped, but the roadway over the bridge deck is not fully submerged. Graphical results for the WSEL, velocities, and shear stresses are presented in Appendix H.

Table 4.1 – Existing Hydraulic Data: 50-year, 100-year, and 500-year Flood Events

	50-year	100-year	500-year
Drainage Area (sq. mi.)	99.1	99.1	99.1
Flow (cfs)	6,800	7,930	10,500
Roadway Surface Elevation[1] (ft.)	610.1	610.1	610.1
Bridge Low Chord Elevation[2] (ft.)	606.6	606.6	606.6
Water Surface Elevation (ft.)	607.6	608.0	608.9
Freeboard (ft.)	Submerged	Submerged	Submerged
Max Velocity at Bridge (fps)	4.5	4.4	4.4
Bridge Opening[3] (sq. ft)	900	900	900
Flow Area Through Bridge during Flood Event (sq. ft)	900	900	900
% Opening Full During Flood Event	100%	100%	100%

1. Based on limited topography data
2. Estimated based on limited topography data and information from existing plans
3. Approximate opening at the centerline of the bridge based on the bathymetric survey completed May 2020. The structure Flat Card, dated June 17, 1940, notes the area as 800 +/- square feet; however, bathymetric survey is used as it is the most current information. The increase in area is most likely due to degradation of the stream over time.

4.6 Proposed Hydraulic Conditions

The proposed conditions model was generated by modifying the geometry of the US Route 4 bridge section in the existing conditions model to reflect the configuration of the proposed bridge's waterway opening. The downstream boundary condition remained the same, and the manning's n values were adjusted to reflect the proposed bridge configuration. Pressure flow was also considered for the proposed conditions model.

Proposed condition modeling results summarized in Table 4.2, below, indicate that a minimum low chord elevation of 608.9' is necessary to provide 1' of freeboard during the 100-year storm event; this minimum low chord elevation would pass the 500-year storm event with no freeboard. The roadway approaches would still overtop due to the lower elevations. The graphical results for the WSEL, velocities, and shear stresses are presented in Appendix I.

Table 4.2 – Proposed Hydraulic Data: 50-year, 100-year, and 500-year Flood Events

	50-year	100-year	500-year
Drainage Area (sq. mi.)	99.1	99.1	99.1
Flow (cfs)	6,800	7,930	10,500
Roadway Surface Elevation[1] (ft.)	610.1	610.1	610.1
Bridge Low Chord Elevation (ft.)	608.9	608.9	608.9
Water Surface Elevation (ft.)	607.5	607.9	608.9
Freeboard (ft.)	1.4	1.0	0
Max Velocity at Bridge (fps)	3.8	3.7	3.5
Bridge Opening[2] (sq. ft)	1,240	1,240	1,240
Flow Area Through Bridge during Flood Event (sq. ft)	1,100	1,140	1,240
% Opening Full During Flood Event	89%	92%	100%

1. Based on limited topography data
2. Approximate opening at the centerline of the bridge based on TS&L plans

The proposed condition modeling results indicate that the hydraulic performance of this crossing is relatively unchanged by increasing the waterway opening of the bridge from 67' to 97'. For the 100-year event, the water surface elevation upstream of the bridge decreases slightly (-0.1'), and velocities in the bridge decrease from approximately 4.4 ft/sec to 3.7 ft/sec. The longer span of the replacement structure opening allows for more flow to pass through the bridge, but overtopping of the roadway approaches still conveys the majority of flow at this crossing during significant flood events.

4.7 Floodplain Development Ordinances and Regulations

This crossing is located within an approximated FEMA Special Flood Hazard Area (SFHA) Zone A. The Town of Andover Zoning Ordinance Article XIII, Section G.2 and the federal floodplain management regulations, specifically 44 CFR §60.3(b)(7), state: *"Assure that the flood carrying capacity within the altered or relocated portion of any watercourse is maintained."*

Additionally, the Town of Andover Zoning Ordinance Article XIII, Section G.3 states:

> *"No encroachments, including fill, new construction, substantial improvements, and other development are allowed within the floodway that would result in any increase in flood levels within the community during the base flood discharge."*

The hydraulic analysis for the proposed conditions demonstrates that flood capacity within the altered section of the river will be increased which exceeds the requirement of these regulations. The water surface elevations immediately upstream of the bridge are slightly decreased during the 50- and 100-year events, and there is no appreciable change in the downstream water surface elevations.

4.8 Geomorphic Analysis

A qualitative geomorphic analysis was completed for the Blackwater River for the project location following the guidelines for a Level 1 assessment, as outlined in the FHWA Hydraulic Engineering Circular number 20 (HEC-20); refer to Appendix F for the complete analysis.

The Blackwater River is a perennial stream that flows year-round and is considered a small river since it is less than 100' wide. It is situated in a moderate relief valley with a wide floodplain. The banks of the river have mature trees, but many are leaning toward the river indicating the banks are eroding; these leaning trees are a source of potential future debris within the river. Additionally, review of the original design drawings from 1933 indicates the channel both upstream and downstream of the bridge has widened by approximately 10'. Although the channel appears to be widening, the general lateral geometry of the river near the bridge appears to be stable based on a review of the available current and historical aerial images and topographical maps.

There is limited historical information on the bathymetry of the channel at the bridge or within the length of river considered in this Study. Comparison of the profile views from the 1933 plans and the 1940 NHDOT Flat Card (Appendix A) to the bathymetry obtained from the survey completed for the project indicates that, overall, there has been little vertical change in the streambed elevation.

The Blackwater River in the vicinity of the US Route 4 bridge has characteristics of both a stable and an unstable stream. Based on the streambed information, low velocities, and no previous reports of scour issues, scour is not anticipated to be of concern for the proposed bridge, and a full Level 2 qualitative analysis is not warranted. However, anticipated scour depths shall be calculated for use in substructure design as well as riprap revetment for scour countermeasure design.

4.9 Scour Evaluation

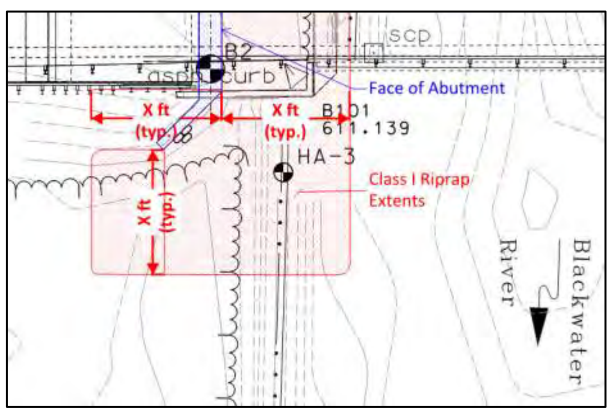
Per the NHDOT Bridge Design Manual Table 2.7.5-1, the design flood for scour for all highway tiers is the 100-year event, and the check flood for scour for the extreme limit state is the 500-year event. Scour for this project was calculated in accordance with FHWA HEC-18, Evaluating Scour at Bridges. In the evaluation process, long-term stream bed elevation changes (aggradation or degradation), contraction (conveyance reduction) scour, and local (vortex induced) scour depths are summed to estimate the total potential depth of scour along the bridge's foundation. The analysis indicates that the predominate form of scour is live bed, with total scour depths of approximately 2.6' for the 100-year storm and 4.8' for the 500-year storm. The complete scour analysis is included in Appendix J.

Soil information for use in scour evaluation, including grain size analyses, was provided by NHDOT for three hand auger samples collected at the site, near the eastern bank of the river. The streambed material is comprised of mostly poorly graded fine sand with some silt and gravel. A median particle size of 0.24mm was assumed for scour calculations.

4.10 Scour Countermeasure Design

Erosion along the channel banks in the vicinity of the proposed bridge can be controlled by installing Class I riprap with a median diameter (D50) of 6”. Per Table 4.1.3a of the NHDOT Manual on Drainage Design for Highways, the permissible shear stress for stone with a median diameter of 6” is 2.40 lb/ft^2; this stone size is appropriate for this site because the maximum expected shear stress at the banks in the proposed condition is calculated at about 1.1 lb/ft^2; refer to Appendix J for additional information. A separate design should be completed for any erosion stone or riprap necessary to mitigate potential erosion from stormwater, such as for locations in the approach roadway with concentrated discharge of stormwater runoff.

The NHDOT Bridge Design Manual 2.7.7(C) states that “Riprap protection against scour damage shall be provided in the design of all bridge piers and abutments within the flood plain unless directed otherwise by the Design Chief”. Although the abutment piles will be designed for the maximum calculated scour depth and thus scour countermeasure is not required for bridge performance, the intent of this statement is likely to require abutment and wingwall slope protection be provided for all projects. Per the NHDOT Bridge Design Manual, channel protection shall be designed following FHWA HEC-23 and NCHRP Report 568. Following these documents, the required riprap size is Class I riprap with a median diameter (D50) of 6”. The minimum thickness of the riprap blanket is 12” if placed in the dry. When underwater placement must occur, the riprap thickness should be increased by 50%. This riprap design is based on scour, but other considerations, such as ice, may warrant either larger stone size or blanket thickness. Additionally, it is becoming more common to bury the riprap for environmental considerations.



Riprap Extents for Typical Bridge Quadrant

The extent of the riprap based on HEC-23 guidance seems excessive for the proposed bridge since it will have deep foundations designed to resist scour. It would be more prudent for the riprap limits to be based on the NHDOT Bridge Design Manual Figure 2.7.7-1 with the slope in front of the abutments protected with riprap and the riprap keyed into the streambed. This figure and corresponding Section in the Manual do not provide guidance for the layout of the riprap around the wingwalls. Therefore, it is proposed to use the width of the riprap in front of the face of the abutment, “X” as shown in the Riprap Extents sktch, for the distance the riprap extends beyond the end of the wingwall and behind the face of the abutment.

The final design and detailing of the riprap size, thickness, and layout may need to be adjusted based on other considerations. These include, but are not limited to, ice and debris, environmental impacts, and site grading. See Appendix J for the calculations and details for the riprap design and extents.

5 SUMMARY OF HYDROLOGIC AND HYDRAULIC ANALYSES

The hydrologic and hydraulic analyses presented within this Study have been completed using the following: USGS StreamStats, survey data, available LiDAR data, existing structure information, project TS&L plans, and general assumptions made by Hoyle, Tanner personnel. Based on the existing conditions model, the low chord of the existing bridge is submerged at the 50-year and greater storm events and the roadway approaches are overtopped. The low chord of the proposed replacement structure should be located at or above elevation 608.9' to provide 1' of freeboard for the 100-year storm event and to pass the 500-year storm event. Overtopping will occur in the roadway approaches in the proposed condition during flood events because they are lower than the up- and downstream water surface elevations and significant roadway profile adjustments are not proposed as part of this project. The Department may want to consider installation of erosion stone in the areas of overtopping to protect roadway embankments during overtopping events; evaluation and design could be included as part of the final design phase of the bridge replacement project.

Results and conclusions of the hydrologic and hydraulic analyses completed for this Study are as follows:

- Blackwater River Drainage Area at US Route 4 Crossing – 99.1 sq. mi.
- 50-Year Storm Event Discharge – 6,800 cfs
- 100-Year Storm Event Discharge – 7,930 cfs
- 500-Year Storm Event Discharge – 10,500 cfs
- Proposed Structure and Clear Span – Steel plate girder bridge and reinforced concrete deck with a 97' clear span
- Proposed Low Chord Elevation –608.9'
- Proposed Structure Passes 50-Year Storm Event – 1.4' of freeboard
- Proposed Structure Passes 100-Year Storm Event – 1.0' of freeboard
- Proposed Structure Passes 500-Year Storm Event – 0.0' of freeboard
- Riprap Protection Against Scour Damage – Class I Riprap, 12" thick minimum (assuming placement in the dry)
- FEMA SFHA Zone – A
- Conditional Letter of Map Revision (CLOMR) Required? – No
- Letter of Map Revision (LOMR) Required? – Not Anticipated *(coordinate with FEMA to confirm)*

6 RECOMMENDATIONS

For this crossing, Hoyle, Tanner recommends that the low chord elevation of the proposed 100’ single-span structure be set at or above elevation 608.9’ to provide the required minimum 1’ of freeboard for the 100-year storm event. If this is not feasible due to roadway geometry, a request can be submitted to the NHDOT Design Chief to revise the method of measuring the freeboard, or to decrease the freeboard measurement according to Section 2.7.6.A.1 of the NHDOT Bridge Design Manual. A reduction in low chord elevation could impact serviceability of the proposed replacement structure but is unlikely to impact the overall hydraulic performance of the crossing because of the magnitude of flow overtopping the roadway in both approaches during larger flood events.

The Blackwater River has characteristics of both a stable and an unstable river. The banks show some signs of erosion, but further erosion of the overbanks near the bridge due to overtopping could be controlled by installing Class I riprap. The streambed appears to be vertically stable based on review of available information, and scour has not been observed near the foundations of the existing structure. Based on the relatively shallow calculated scour depth (2.6’ for the 100-year storm and 4.8’ for the 500-year storm), the bridge substructures can likely be designed to meet the scour requirements without the need for scour countermeasures for bridge performance. Installation of a 12” thick (minimum, if placed in the dry) blanket of Class I riprap on abutment slopes and around wingwalls is recommended to protect against scour attack and meet NHDOT standards.

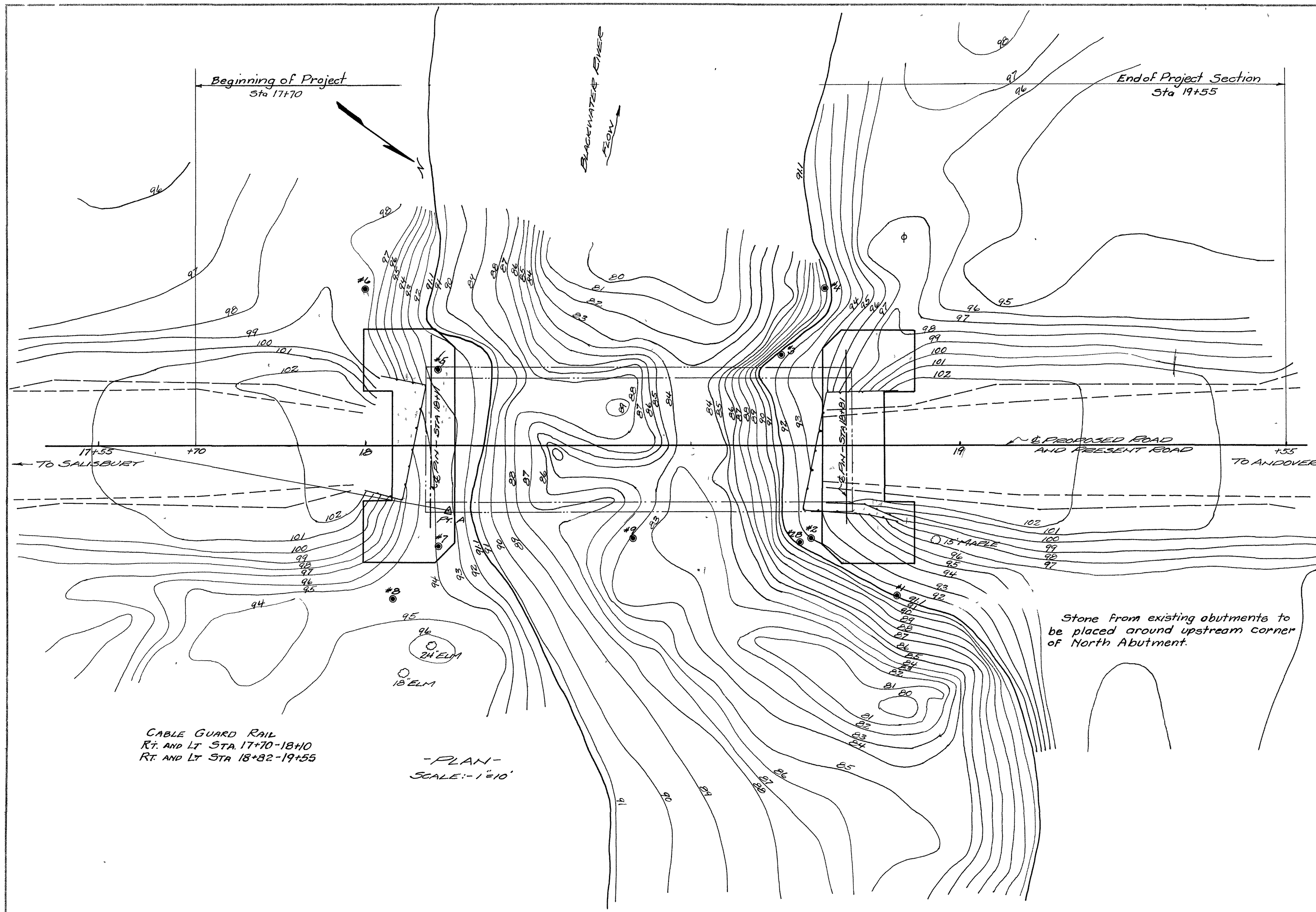
7 REFERENCES

Reference No.	Title
1.	State of New Hampshire State Highway Department, N.R.S. Project No. 253, dated October 1933 (Existing Plans)
2.	Structure Flat Card: Bridge No. 143/077, Andover, NH, US Route 4 over the Blackwater River, dated June 17, 1940
3.	New Hampshire Division of Historical Resources Individual Inventory Form, #AND0029, last updated June 2015
4.	New Hampshire Department of Transportation Bridge Inspection Report for Bridge No. 143/077 dated November 20, 2019, and Inspection Photos through March 14, 2017.
5.	Merrimack County, New Hampshire (All Jurisdictions) Flood Insurance Study (FIS), Effective April 19, 2010
6.	NHDOT Bridge Design Manual, Version 2, January 2015
7.	NHDOT Manual on Drainage Design for Highways, 2015 Draft
8.	United States Geological Survey (USGS), USGS StreamStats Version 4 for New Hampshire; website: https://streamstats.usgs.gov/ss/
9.	US Bureau of Reclamation (USBR) Sediment and River Hydraulics, Two-Dimensional (SRH-2D), Version 3.2.
10.	Aquaveo, LLC., Surface-Water Modeling System (SMS), Version 13.0
11.	Federal Highway Administration (FHWA), Hydraulic Engineering Circular, HEC-18 Evaluating Scour at Bridges, 5th Edition, April 2012
12.	Federal Highway Administration (FHWA), Hydraulic Engineering Circular, HEC-20 Stream Stability at Highway Structures, 4th Edition, April 2012
13.	Federal Highway Administration (FHWA), Hydraulic Engineering Circular, HEC-23 Bridge Scour and Stream Instability Countermeasures Experience, Selection, and Design Guidance, 3rd Edition, September 2009
14.	NH GRANIT LiDAR Distribution Site, http://lidar.unh.edu/map/

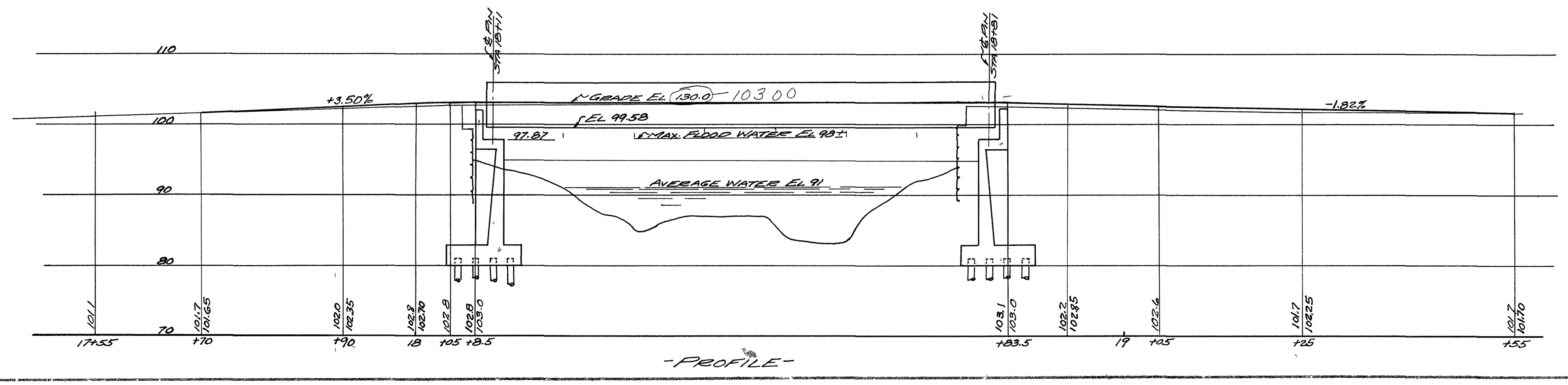
APPENDIX A

Existing Structure Information

FED. ROAD DIST. NO.	STATE	FED. AID PRO. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
9	N. H.	NRS253	1933	29	34



-PLAN-
SCALE:- 1"=10'



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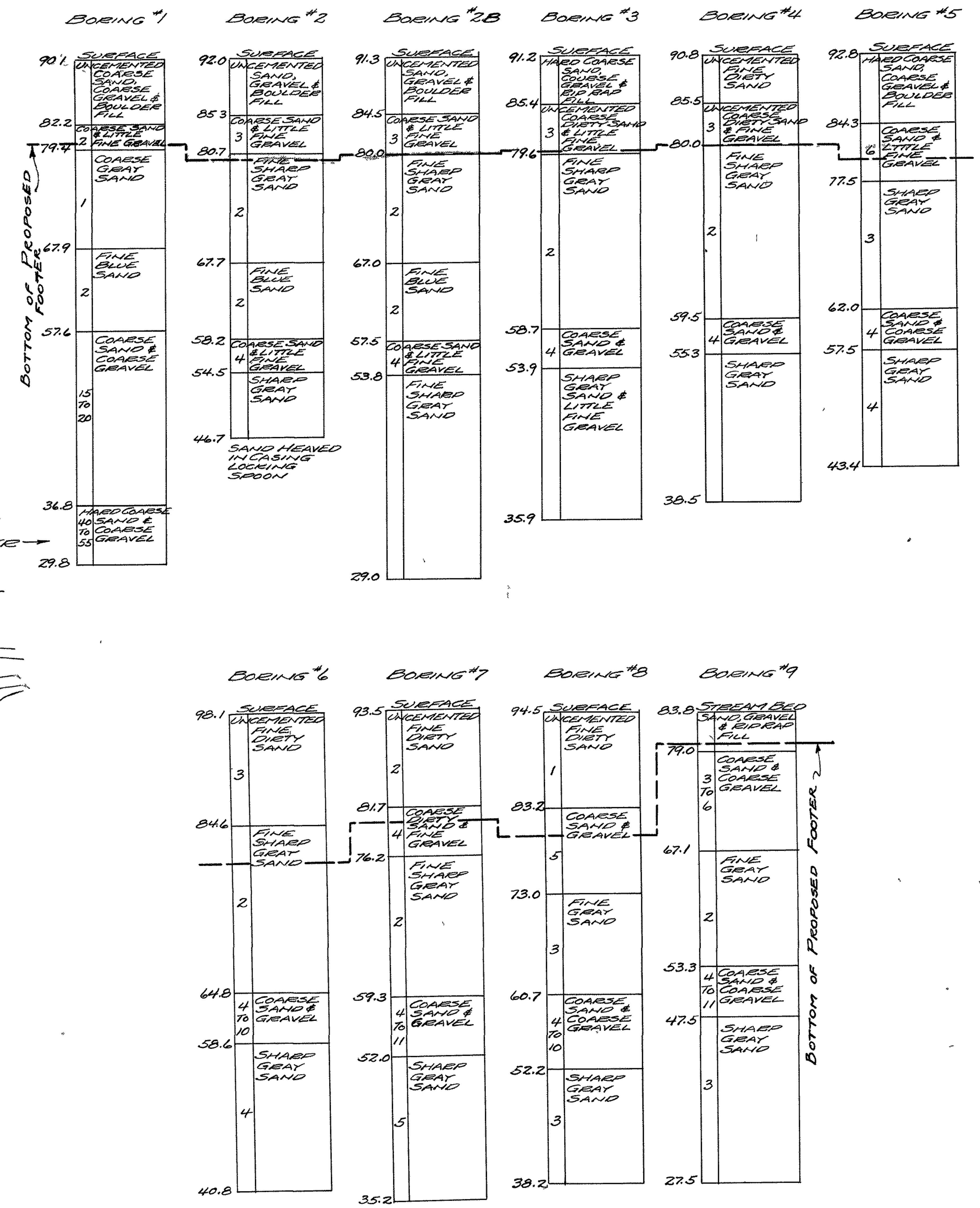


WASH BORINGS TAKEN AUG 1933

NOTE:- UNABLE TO OBTAIN DEFINITELY NUMBER OF BLOWS IN LOWEST STRATUM OF BORINGS NO 2, 2B AND 3 ON ACCOUNT OF SAND HEAVING IN CASING, BUT BELIEVE SAND TO BE FIRM.

BORINGS TAKEN FOR PURPOSE OF DESIGN AND SHOW CONDITIONS AT BORING POINTS ONLY, BUT DO NOT NECESSARILY SHOW NATURE OF MATERIAL TO BE ENCOUNTERED IN CONNECTION WITH CONSTRUCTION OF THE BRIDGE.

VERTICAL SCALE 1"=10'

143/077

BRIDGE B AND APPROACHES

STATE OF NEW HAMPSHIRE
HIGHWAY DEPARTMENT

TOWN ANDOVER
PROJECT N.R.S. 253
LOCATION STA 17+70 TO 19+55
ROAD SALISBURY CUTOFF
STREAM BLACKWATER RIVER
SURVEYED BY F.A.B. DATE 8-9-33
DRAWN BY H.A.E. R.D.F. DATE
TRACED BY H.H.E. DATE 9-22-33
CHECKED BY W.A.S. DATE 9-26-33
SHEET 1 OF 5 SHEETS

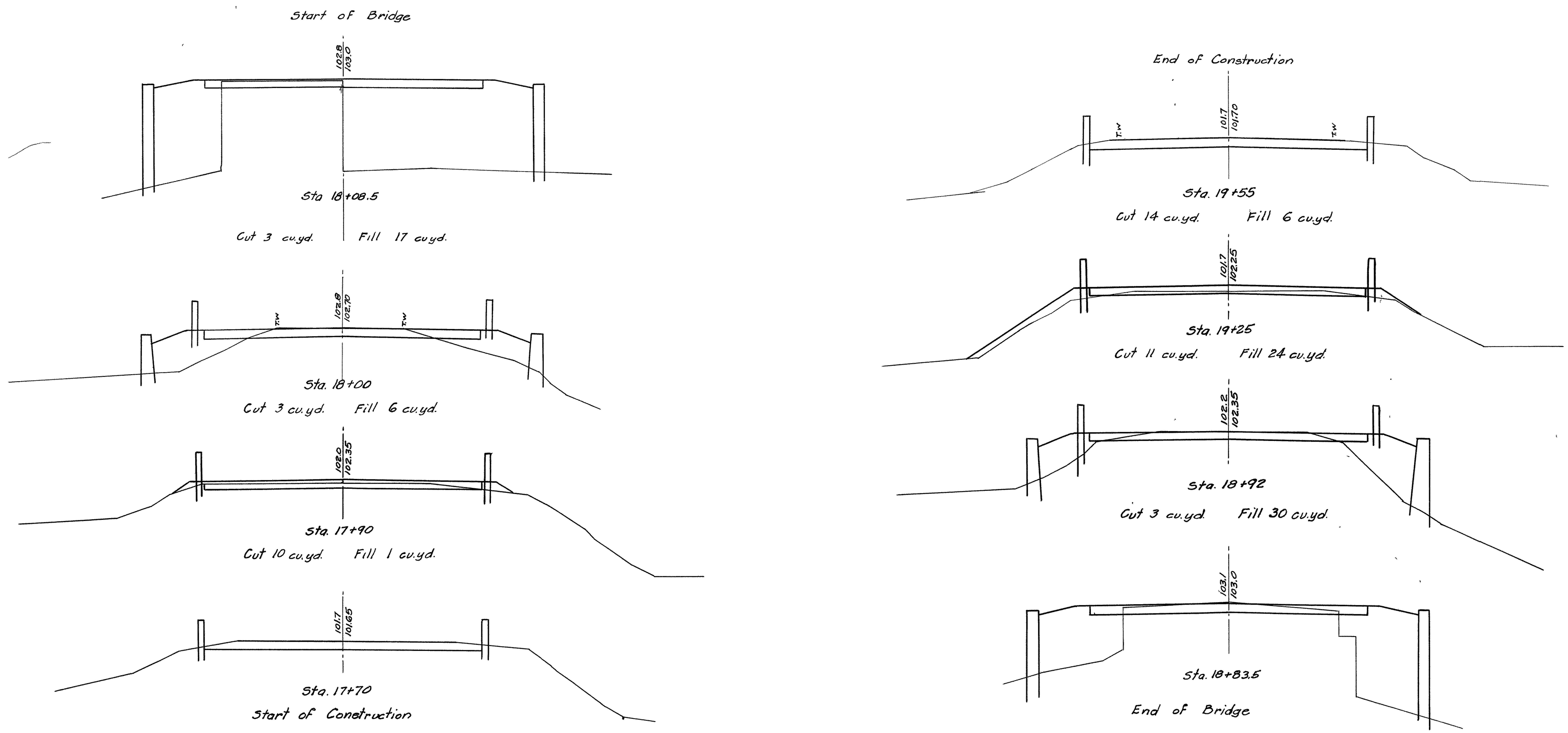
CORRECT BY John W. Childs DATE 10-4-33
BRIDGE ENGINEER

APPROVED BY F.H. Dickinson DATE 10-5-33
CHIEF ENGINEER

Revisions After Proposal		
Date	Station	From or To
Orig.		
Rev.		
Orig.		
Rev.		
Orig.		
Rev.		
Orig.		
Rev.		

Traced by ___ Date ___
Checked by ___ Date ___

F.D. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
9	N. H.	N.R.S 253	1933	30	34



143/077

BRIDGE B AND APPROACHES

STATE OF NEW HAMPSHIRE
HIGHWAY DEPARTMENT

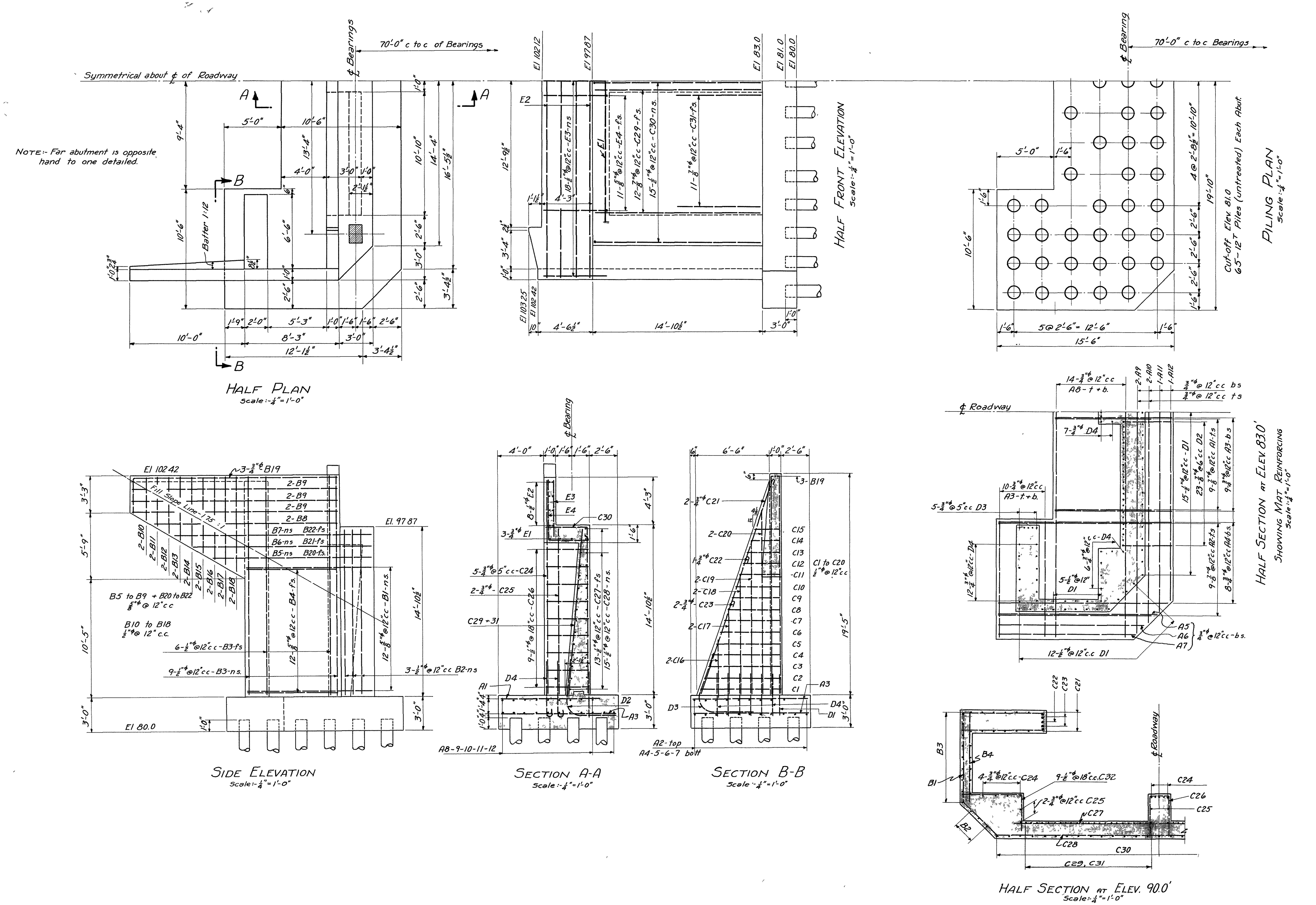
TOWN ANDOVER
PROJECT N.R.S. 253
LOCATION STA. 17+70 TO 19+55
ROAD SALISBURY CUTOFF
STREAM BLACKWATER RIVER

SURVEYED BY F.A.B. DATE 8-9-33
DRAWN BY R.D.F. DATE
TRACED BY M.P.S. DATE 9-28-33
CHECKED BY W.A.S. DATE 9-26-33

SHEET 2 OF 5 SHEETS.

Traced by Date
Checked by Date

FED ROAD DIST NO	STATE	FED AID PROJ NO	FISCAL YEAR	SHEET NO	TOTAL SHEETS
9	N. H.	N.R.S253	1933	31	34



NOTES

- ns = near side
- fs = far side
- ts = top of slab
- bs = bottom of slab
- t.+b = top + bottom of slab
- No concrete to be poured until steel has been checked by engineer
- 4" Tile Drains to be placed at 10'± c c thru abutments at such elevation as to best drain backfill. Backfill to be of stone around drains.
- All exposed corners of concrete to be chamfered 1/2".
- Bearing areas for plate girders to be dressed to exact grade and finished to a smooth true surface
- All concrete on this sheet to be Class "C" Concrete (2000#) with a minimum cement factor = 1.30
- All reinforcing steel 2" clear from face of concrete unless otherwise noted

143/077

BRIDGE B AND APPROACHES

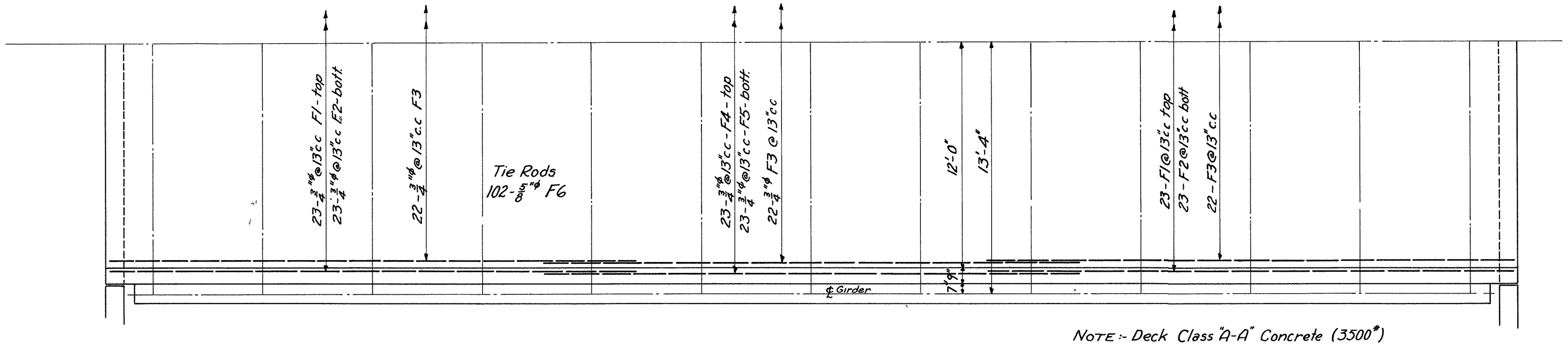
STATE OF NEW HAMPSHIRE
HIGHWAY DEPARTMENT

TOWN: ANDOVER
PROJECT: N.R.S. 253
LOCATION: Sta. 17+70 to 19+55
ROAD: SALISBURY CUT-OFF
STREAM: BLACKWATER RIVER

Designed by RDJ Date 9-12-33
Drawn by RDJ Date 9-15-33
Traced by RDJ Date 9-18-33
Checked by WAS Date 9-26-33

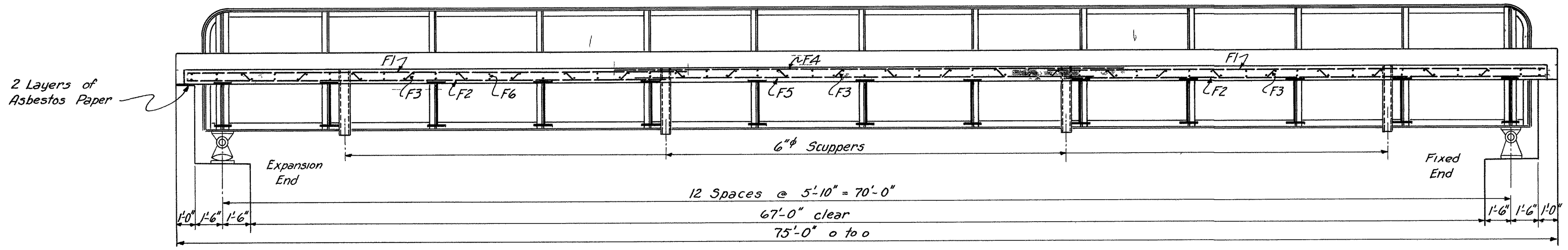
Sheet 3 of 5 Sheets.

FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
9	N. H.	NRS 253	1933	32	34



NOTE:- Deck Class "A-A" Concrete (3500#)
Minimum Cement Factor = 2.00

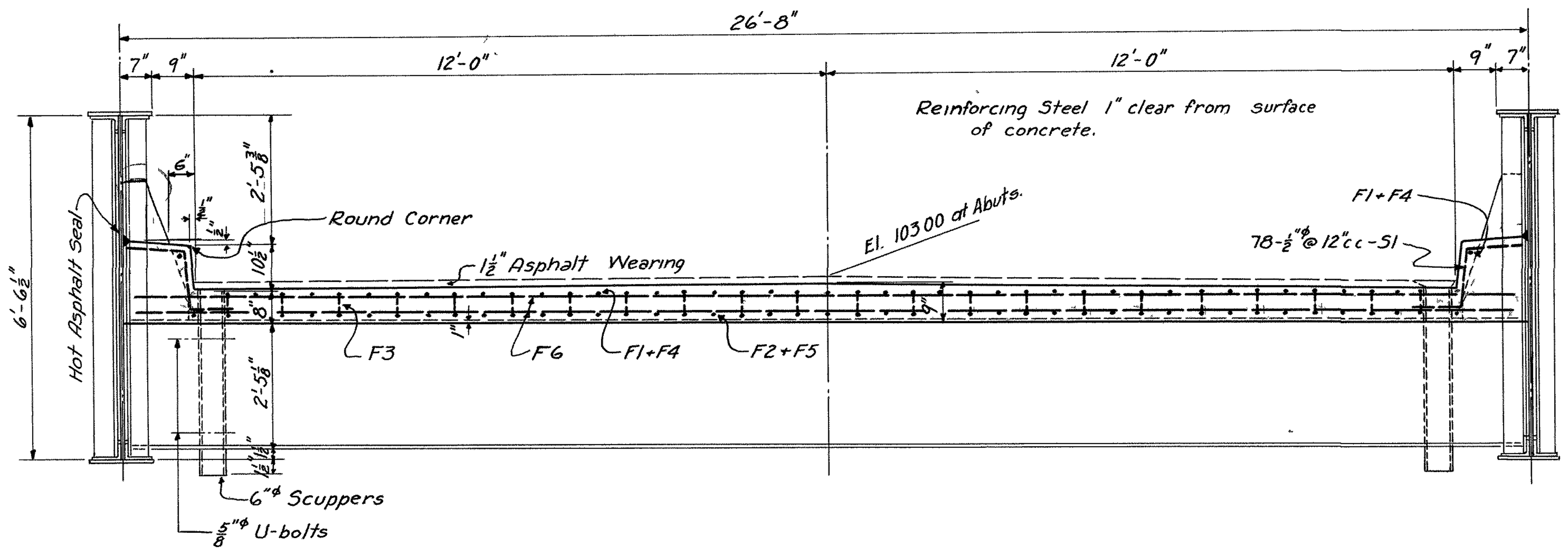
DECK PLAN
Scale:- ¼"=1'-0"



LONGITUDINAL SECTION
Scale:- ¼"=1'-0"

ESTIMATE OF QUANTITIES		
No.	ITEM	QUANTITIES
2	Fine Grading	425 sq.yd.
8	Structure Excavation - Earth below El. 910	515 cu.yd.
	" " " above El 910	250 cu.yd.
	" " Ledge above El 910	150 cu.yd.
12	Gravel Base Course	41 cu.yd.
18	Gravel Surface Course	32 cu.yd.
27	Concrete - Class "C" (2000#)	266 cu.yd.
29	Reinforcing Steel	31760 lb.
30	Structural Steel	93000 lb.
36	Bearing Piles (untreated wooden)	3900 l.f.
46	Cable Guard Rail	226 l.f.
48	Cable Guard Rail Anchorages	4
63	Concrete - Class "A-A" (3500#)	59 cu.yd.
70	Temporary Bridge	Lump Sum
72	Asphalt Wearing Surface	200 sq.yd.
82	Removal of existing Superstructure	Lump Sum.
83	Expansion Bearing (complete)	2
84	Fixed Bearing (complete)	2
1	Roadway Excavation (Earth)	44 cu.yd.

Weight of One Girder 12 Tons.



TRANSVERSE SECTION
Scale:- ½"=1'-0"

143/077

BRIDGE B AND APPROACHES

STATE OF NEW HAMPSHIRE
HIGHWAY DEPARTMENT

TOWN ANDOVER
PROJECT N.R.S 253
LOCATION Sta 17+70 to 19+55
ROAD SALISBURY CUT-OFF
STREAM BLACKWATER RIVER

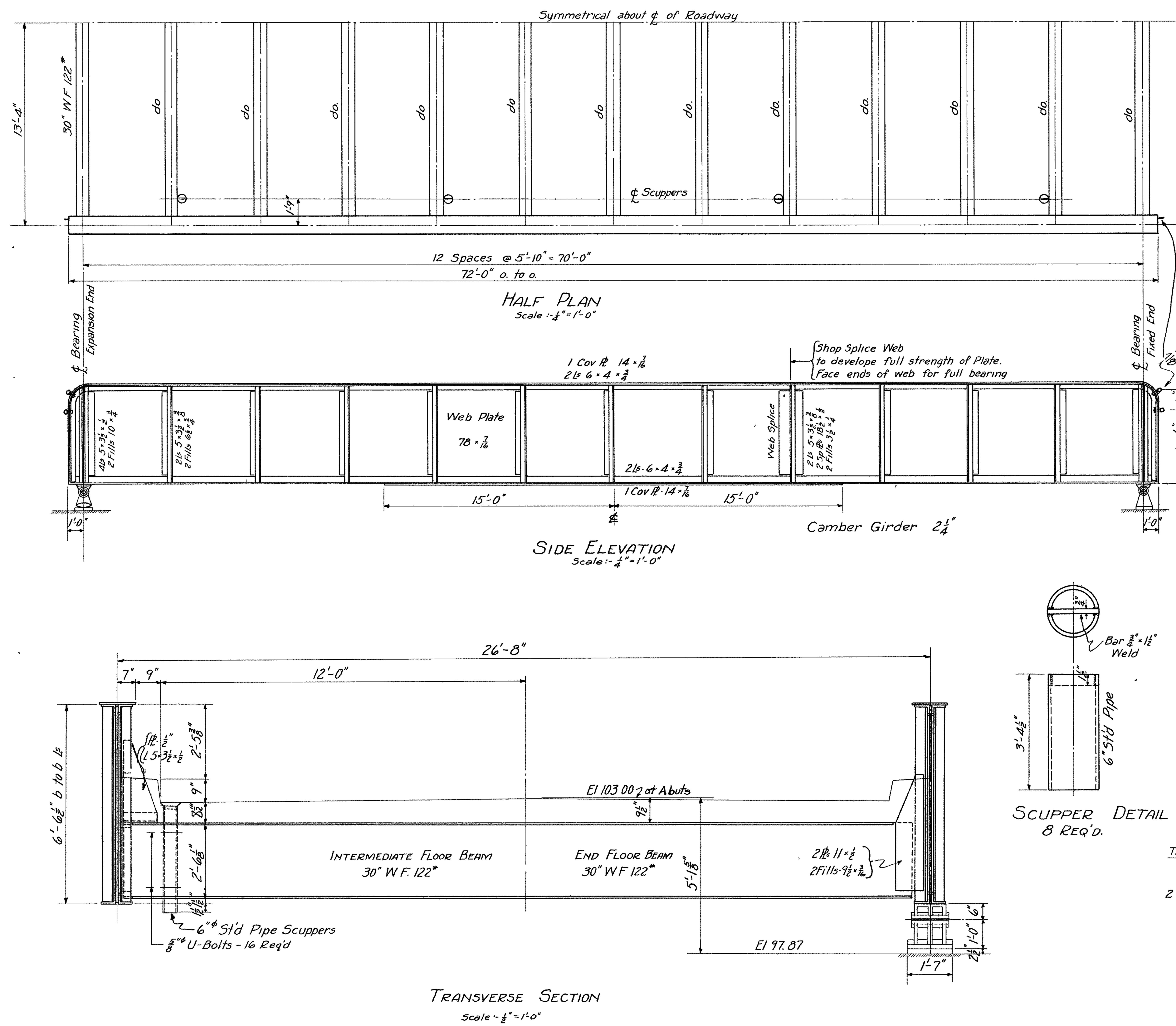
Designed by RDT Date 9-12-33
Drawn by RDT Date 9-13-33
Traced by RDT Date 9-21-33
Checked by W.M. Date 9-26-33

Sheet 4 of 5 Sheets.

Orig.	Rev.	Orig.	Rev.	Orig.	Rev.	Orig.	Rev.
Date	Station	From or to					

Traced by Date
Checked by Date

FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
9	N. H.	NR.S253	1933	33	34



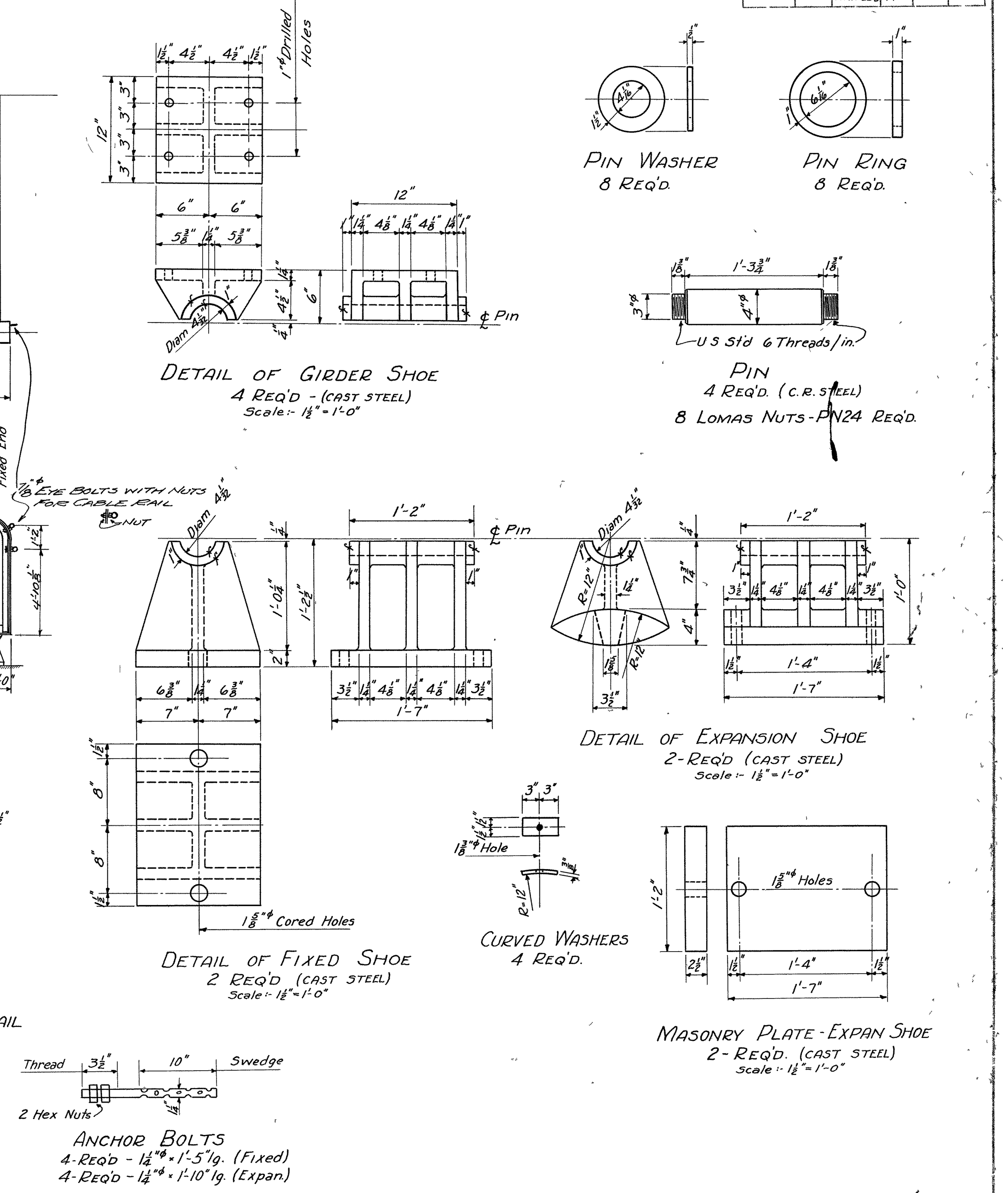


TABLE OF MOMENTS & SHEARS FOR GIRDER

	End	1/8 Point	1/4 Point	3/8 Point	Center
Moment	0	1,370,000#	2,350,000#	2,935,000#	3,154,000#
Shear	198,100#	157,200#	117,700#	79,900#	44,000#

End Reaction of floor beam = 92,700#

NOTES

Specifications - N. H. H. D. + A.A.S.H.O. 1931 Stand Specifications.
Design Loading - H15
Rivets - 7/8"φ
Shop Paint - One coat red lead + oil.
Field Paint - One coat aluminum paint.
The contractor shall furnish the state with tracings of shop drawings before final payment is made.

143/577

BRIDGE B AND APPROACHES

STATE OF NEW HAMPSHIRE
HIGHWAY DEPARTMENT

CITY ANDOVER
PROJECT N.R.S. 253
LOCATION Sta. 17+70 to Sta. 19+55
ROAD SALISBURY CUT-OFF
STREAM BLACKWATER RIVER

Designed by RDG Date 9-6-33
Drawn by RDG Date 9-12-33
Traced by RDG Date 9-20-33
Checked by WB Date 9-26-33

Sheet 5 of 5 Sheets

Orig.	Rev.	Orig.	Rev.	Orig.	Rev.	Orig.	Rev.
Date	Station	From or to					

Traced by Date
Checked by Date

DATE 6/17/40 STATE HIGHWAY DEPT. Div. 5 NH. STEEL SPANS MADE W.H.P. CHECKED CARD 1 OF 2

TOWN Andover NO. 143/077 BRIDGE OVER Blackwater River SPAN NO.

RATING H-15 MEMBER DESIGN LIVE LOAD H-15 REQUIRED LIVE LOAD POSTED LIVE LOAD — YEAR BUILT 1933

NO. AND TYPE SPANS 1- Thru Plate Girder TOTAL LENGTH 75-0" o-o backwalls

SKEW — SUPERELEVATION — CROWN 1" in 12'-0" APPROACH PAVEMENT S.T.G.

GENERAL	ALIGNMENT	GRADE	SIGHT DISTANCE	SPAN LENGTH		WIDTH		CLEARANCE	ROADWAY	RAILROAD	HIGH WATER
BRIDGE	tan.	Level		C. C. BEARINGS	70'-0"	BETWEEN CURBS	24-0"				
SE REAR APPROACH	"	+3.5% → W		O. O. FLOOR	75'-0"	BETWEEN RAILS		HORIZONTAL	25'-6"		
NW FORWARD APPROACH	"	+1.82% → E		CLEAR SPAN	67'-0"	WALKS	—	VERTICAL	open		1'-8" AV

DESIGNED BY HIGHWAY DEPT. ✓ CONS. ENG. BUILT BY NHHD

MAINTAINED BY STATE ✓ ~~TOWN~~ RAILROAD PLANS ON FILE ✓ N-3 ~~NOT ON FILE~~ ~~TOLL OR~~ FREE

PROJECT NO. NRS 253-C Br. B CONTRACTOR Erected by McClintock-Marshall Corp.

TOTAL COST STEEL COST FLOOR SLAB COST

TRAFFIC SURVEY DATA A B 90.54 C D F G H I

WATERWAY. ELEVATION LOW BRIDGE 99.58 ELEVATION MAXIMUM HIGH WATER 106.0 1936 Flood AREA BRIDGE OPENING 800□'±

ALIGNMENT AND CHARACTER CHANNEL D.A = 64,300 acres. Wooded slopes.
F.G. to stream bed 19'-0"± max. Cl. Water Ht = 15'-6" max. 8'-6" min.

REMARKS Overflows N.W. approach abt 2' deep average spring. Area is too small.

SUBSTRUCTURE	MATERIAL	TYPE	HEIGHT	SUPPORTING MATERIAL	PILES—TYPE	NO.	SIZE	LENGTH	CAPS
SE REAR ABUTMENT	Rein Conc	Counterfort	14-10½	sand + gravel	wood untreated	65	12"	15' AV.	12" in Conc
NW FORWARD ABUTMENT	"	"		"	"	"	"	"	"
PIERS OR BENTS									

WINGS Rein Conc. parallel. Set on piles (included in abuts)

REMARKS Condition very good. 4" tile drains 10'-0" c-c in abuts.

Postindex PAT. APR. 3, '23 FEB. 8, '27 96-C-7396-14

SUPERSTRUCTURE. MATERIAL Struct Steel + Rein. Conc. SPAN TYPE Thru. Plate Girder

GRADE TO BRIDGE SEAT 5'-1⅜" @ abuts GRADE TO LOW STEEL 3'-5½"

DEPTH 6-6½ b-b Ls PANELS AT PAINT 5/9/40

	WEARING COURSE	FLOOR	CURBS	ROAD RAIL	WALK RAIL	BEARINGS EXPANSION	BEARINGS FIXED
MATERIAL	Asphalt	Rein Conc	Rein Conc	Steel			
TYPE		Flat slab	mono	Girder		4" pin + rocker	4" pin + pedestal
HEIGHT			0-9"	2'-5¾" above curb		1-2 x 1-7 brg PL	1-2 x 1-7 brg
THICKNESS	1½"	8" @ curb					
FASTENINGS						1¼" swedge A. bolts	1¼" swedge A. bolts

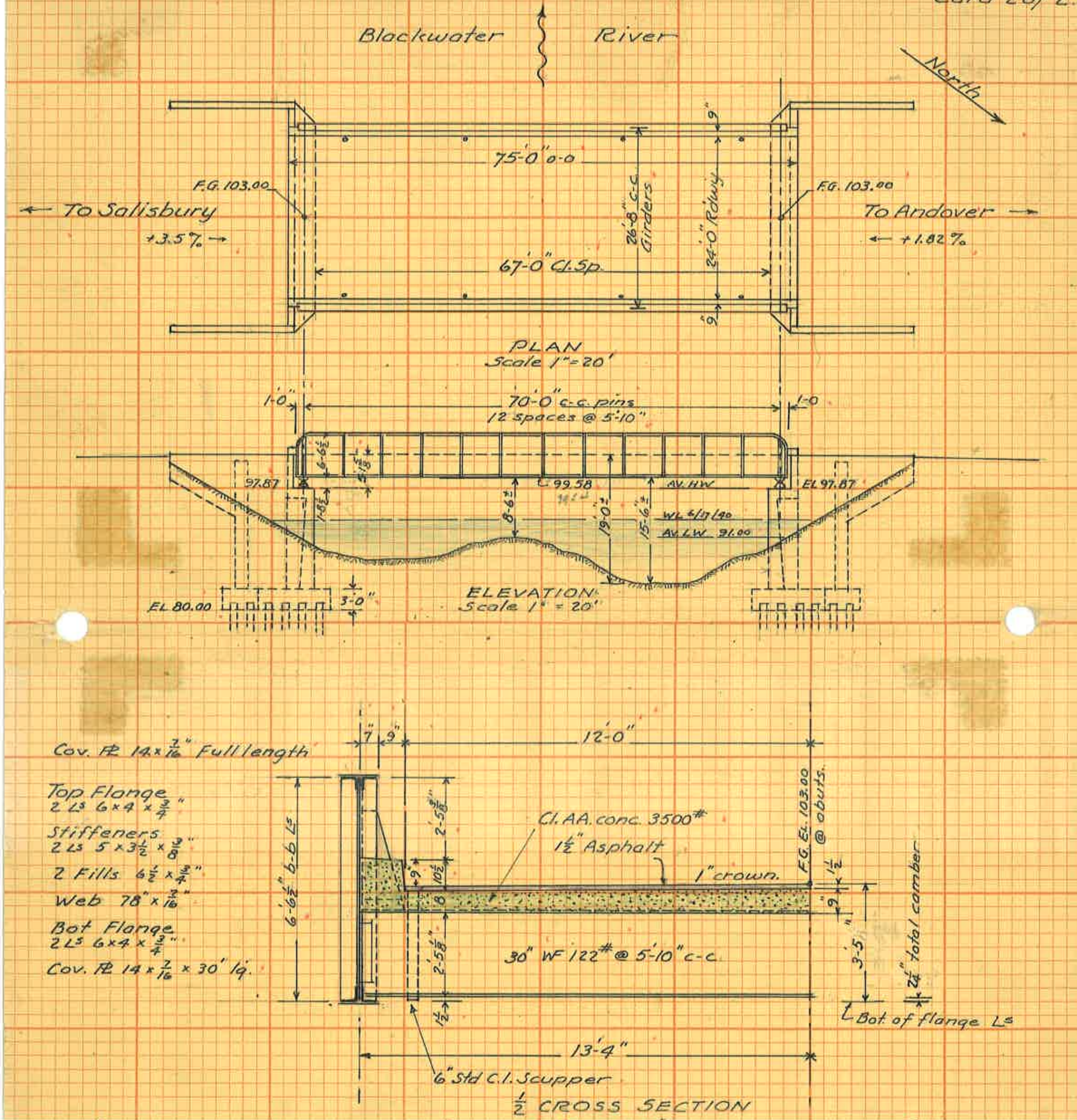
FLOOR DRAINAGE 6" Std C.I. Scuppers 3'-4½" lg. 4 each side

REMARKS General condition very good.

Floor Bms 30" WF 122# @ 5'-10" c-c.
Girders have 2¼" camber Web 78" x 7/16", Flange Ls 6x4x¾", t + b.
Stiffener Ls 5 x 3½ x ⅜", Fills 6½ x ¾"
Top Cover PL 14 x 7/16", full length + over ends.
Bot " " 30' lg.

Wt of each girder = 12 Ton. McClintock Marshall - lifting wt 10 T

1991 RePaiR ABUT seat



Blackwater River
North
75'-0" o-o
F.G. 103.00
← To Salisbury
+3.5% →
26'-8" c-c Girders
24'-0" R'dwy
F.G. 103.00
To Andover →
← +1.82%
67'-0" Cl. Sp.
9"
9"
PLAN
Scale 1" = 20'
1'-0"
70'-0" c-c pins
12 spaces @ 5'-10"
1'-0"
6'-6½"
5'-1½"
97.87
99.58
AV. HW.
EL 97.87
1'-8±
8'-6±
19'-0±
15'-6±
WL 6/17/40
AV. LW. 91.00
EL 80.00
3'-0"
ELEVATION
Scale 1" = 20'
Cov. PL 14 x 7/16" Full length
Top Flange 2 Ls 6 x 4 x 3/4"
Stiffeners 2 Ls 5 x 3½ x 3/8"
2 Fills 6½ x 3/4"
Web 78" x 7/16"
Bot. Flange 2 Ls 6 x 4 x 3/4"
Cov. PL 14 x 7/16 x 30' lg.
7" 9"
12'-0"
6'-6½" b-b Ls
2'-5⅝"
Cl. AA. conc. 3500#
1½" Asphalt
1" crown.
F.G. El. 103.00 @ abuts.
9"
10½"
8
1½
9"
2'-5⅝"
30" WF 122# @ 5'-10" c-c.
3'-5"
2¼" total camber
1½
Bot. of flange Ls
13'-4"
6" Std C.I. Scupper
½ CROSS SECTION

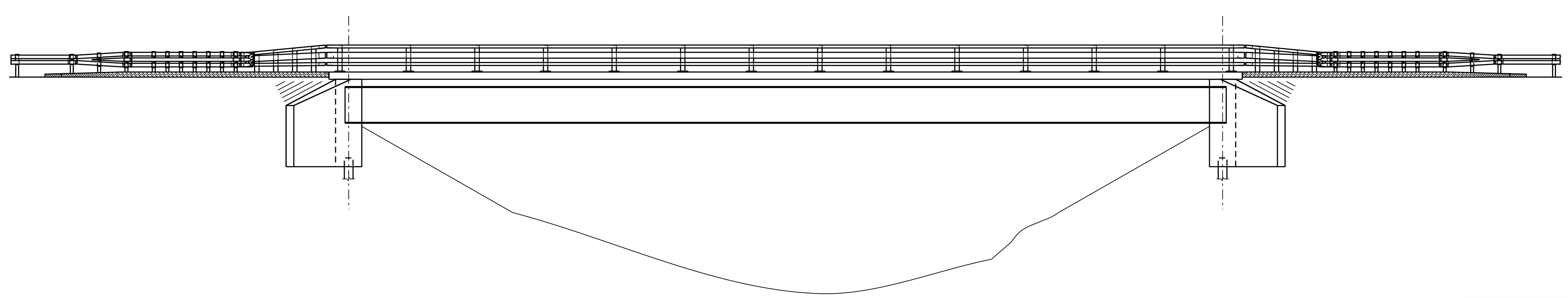
ANDOVER 143/077

Upstream Side.

APPENDIX B

Type, Size and Location Plans

PLAN



ELEVATION

PRELIMINARY PLANS
SUBJECT TO CHANGE
DATE 5/10/2019

GM2 ASSOCIATES

SUBDIRECTORY	.DGN LOCATOR	SHEET SCALE
BRC/PRELIM	40392_GenPlan	1" = 10'-0"

STATE OF NEW HAMPSHIRE

DEPARTMENT OF TRANSPORTATION * BUREAU OF BRIDGE DESIGN

TOWN ANDOVER BRIDGE NO. 143/077 STATE PROJECT 40392

LOCATION US ROUTE 4 OVER BLACKWATER RIVER

GENERAL PLAN AND ELEVATION

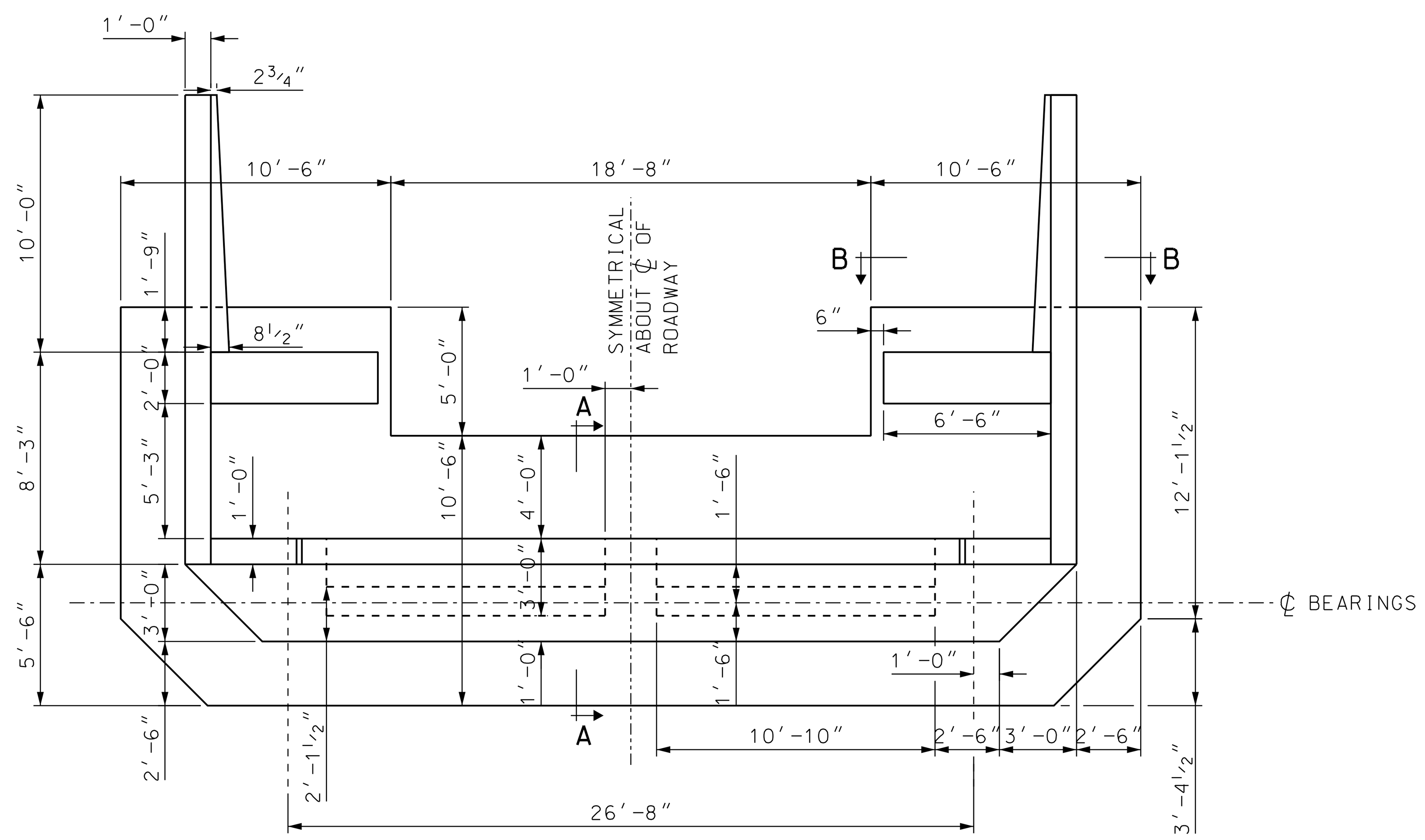
BRIDGE SHEET XX OF

FILE NUMBER

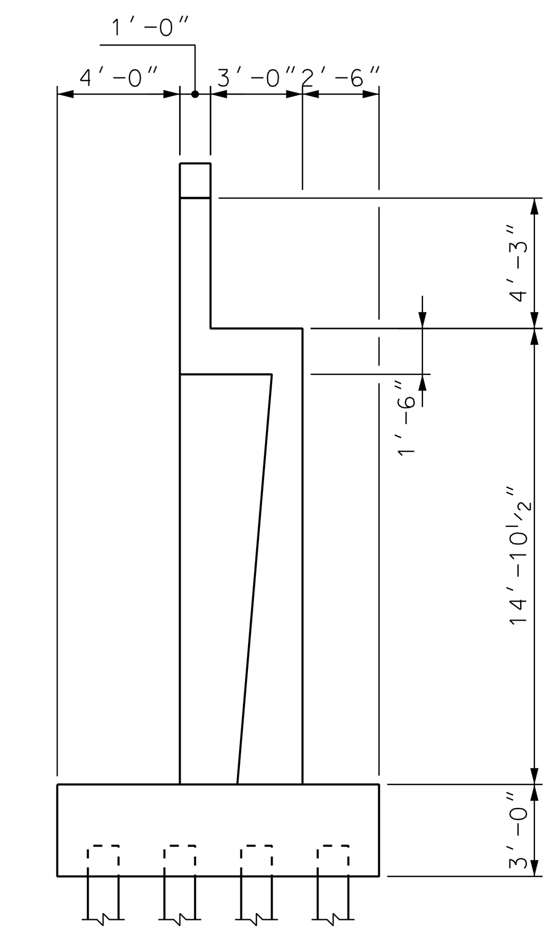
REVISIONS AFTER PROPOSAL

	BY	DATE		BY	DATE
DESIGNED	TEM	12/18	CHECKED	TPL	12/18
DRAWN	TEM	12/18	CHECKED	TPL	12/18
QUANTITIES	TEM	12/18	CHECKED	TPL	12/18

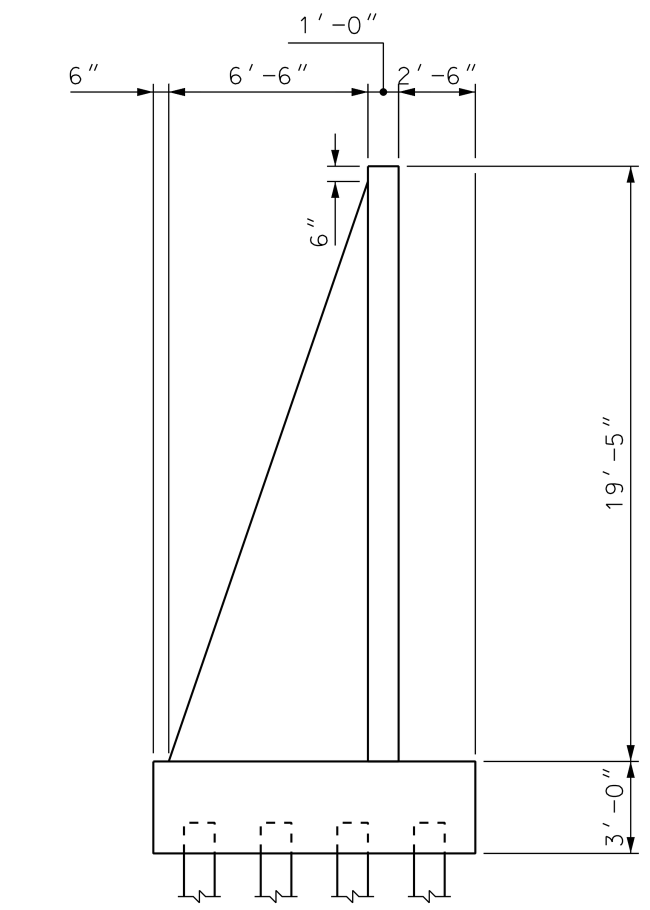
ISSUE DATE	FEDERAL PROJECT NO.	SHEET NO.	TOTAL SHEETS
REV. DATE	X-A004(384)	1	3



PLAN



SECTION A-A



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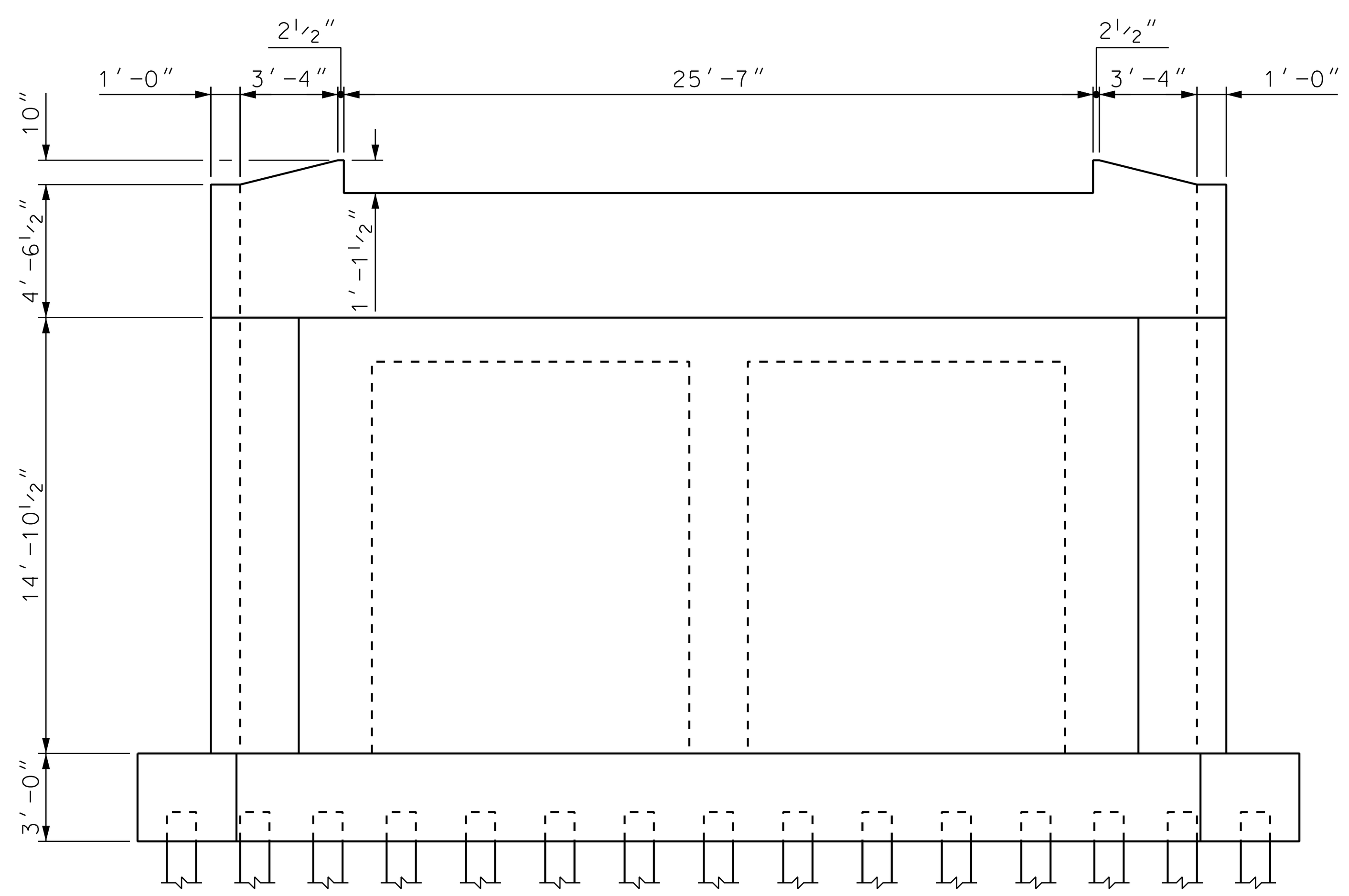
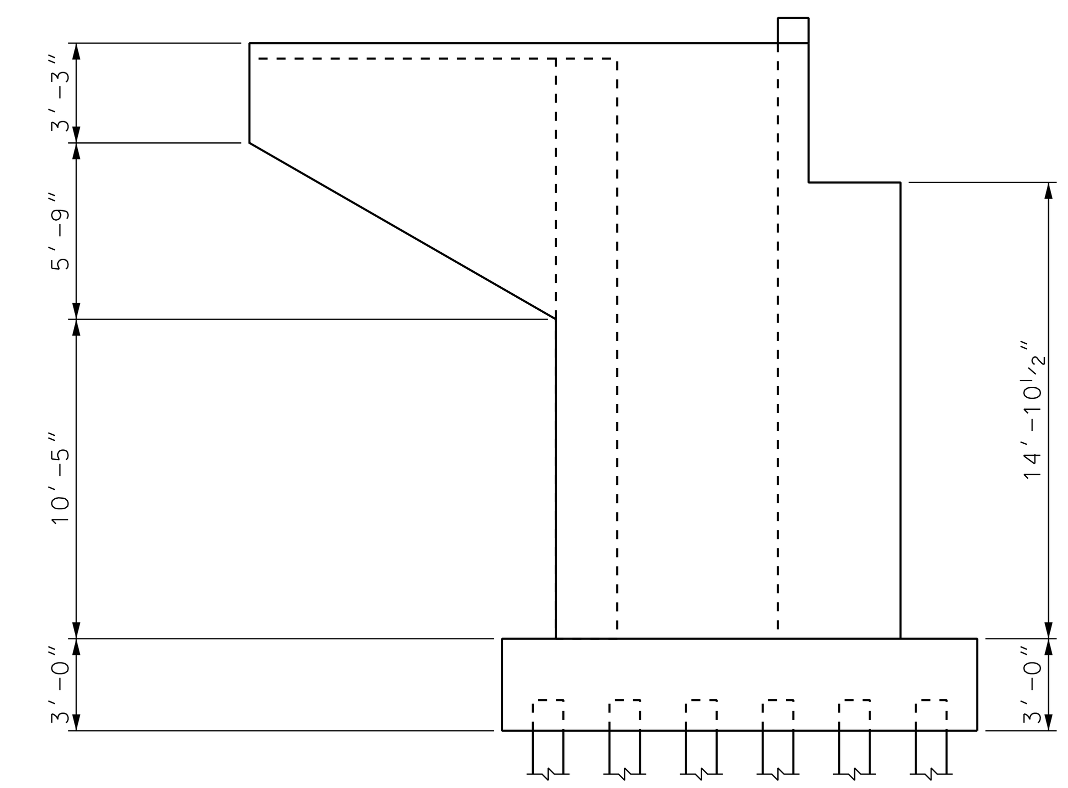
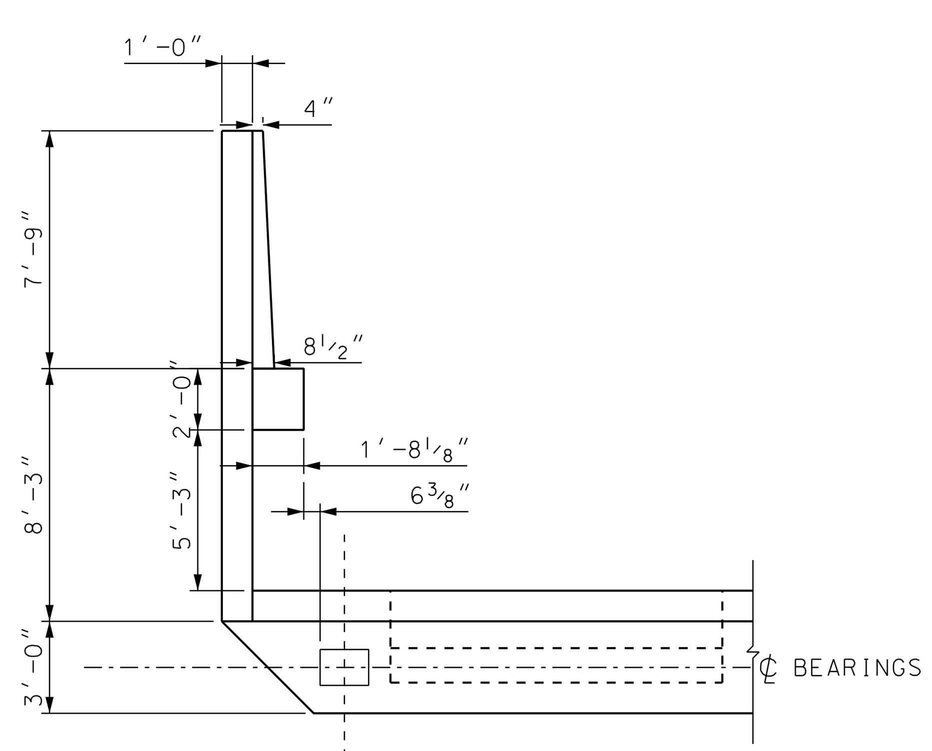


FRONT ELEVATION



SIDE ELEVATION



HALF SECTION AT ELEV. 97.87

PRELIMINARY PLANS
SUBJECT TO CHANGE
DATE 5/10/2019

GM2 ASSOCIATES

SUBDIRECTORY	.DGN LOCATOR	SHEET SCALE
BRC\ABUTA	40392Abut	3/16" = 1'-0"

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION * BUREAU OF BRIDGE DESIGN

TOWN ANDOVER — BRIDGE NO. 143/077 — STATE PROJECT 40392

LOCATION US ROUTE 4 OVER BLACKWATER RIVER

EXISTING ABUTMENT DETAILS

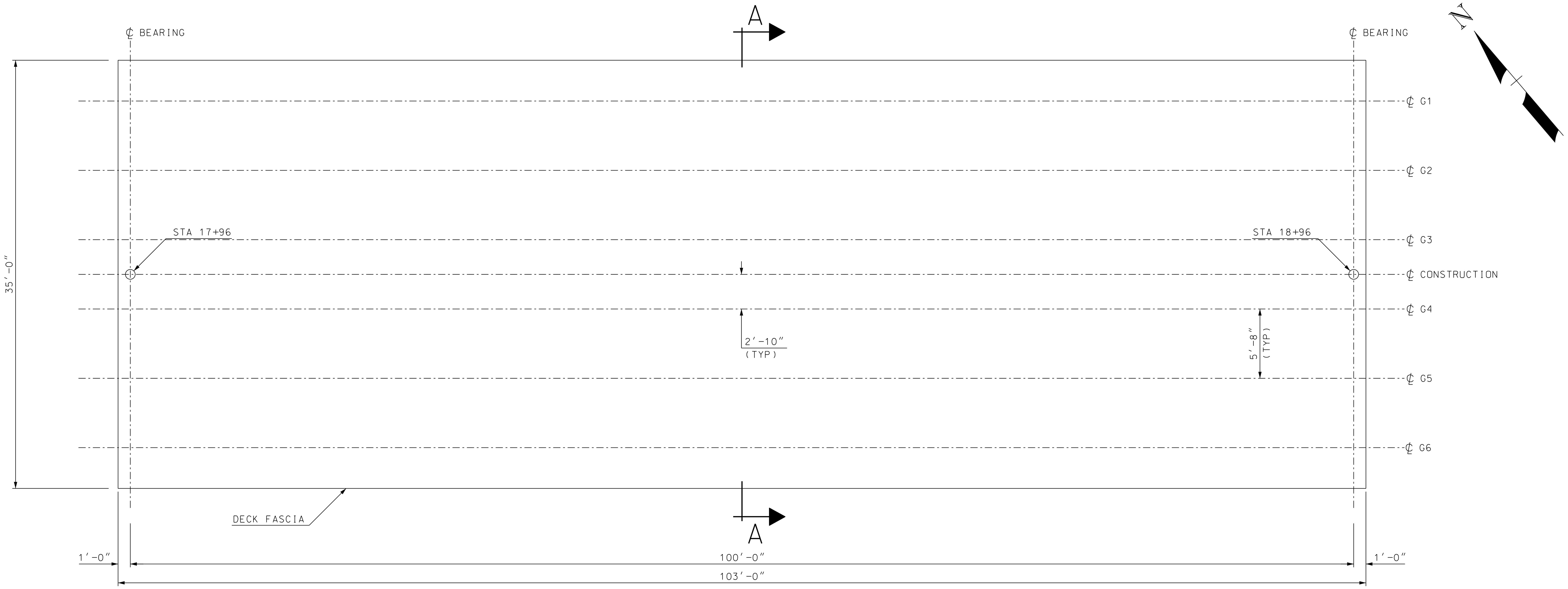
BRIDGE SHEET XX OF

FILE NUMBER

REVISIONS AFTER PROPOSAL

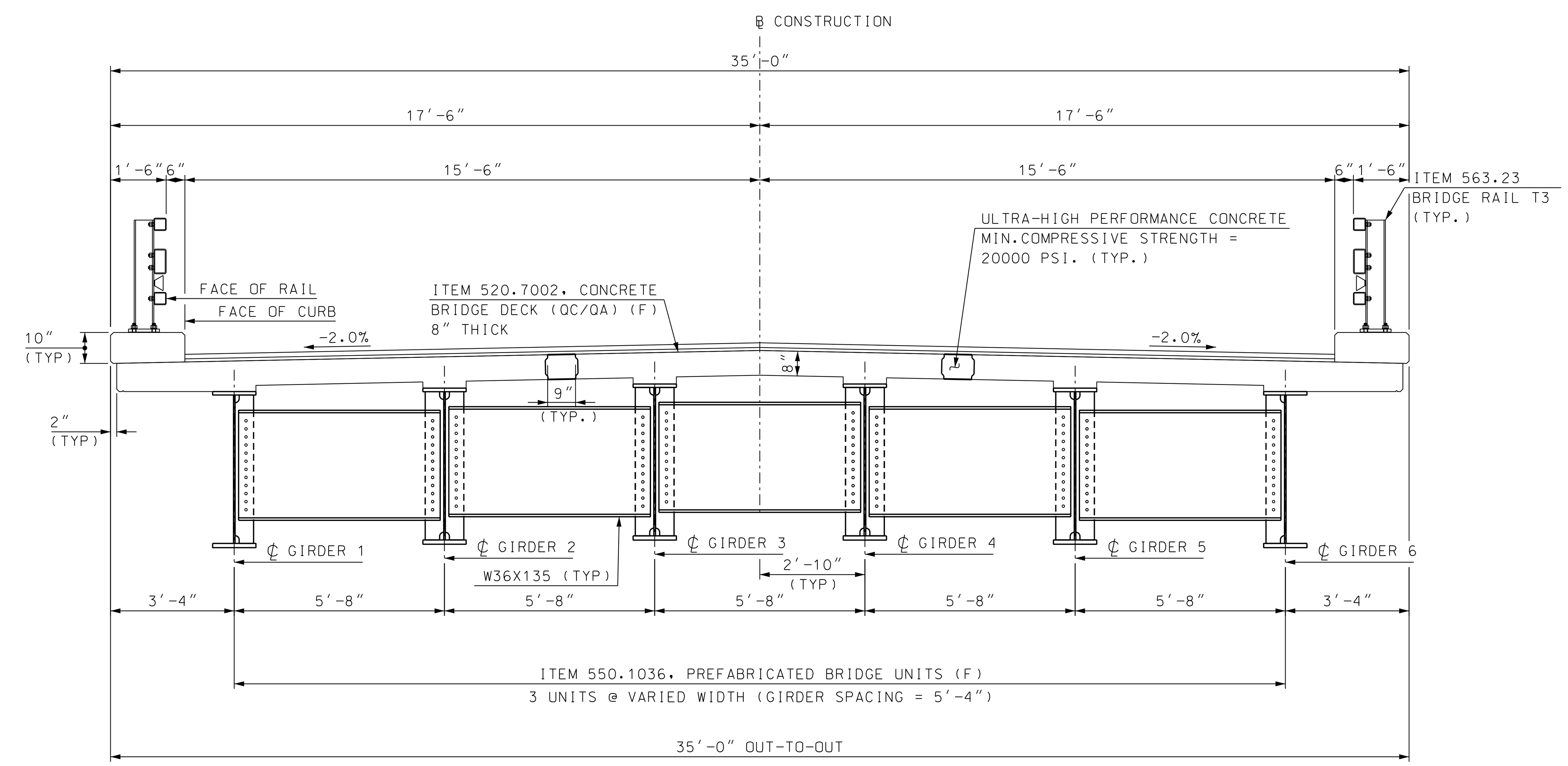
	BY	DATE		BY	DATE
DESIGNED	TEM	12/18	CHECKED	TPL	12/18
DRAWN	TEM	12/18	CHECKED	TPL	12/18
QUANTITIES	TEM	12/18	CHECKED	TPL	12/18

ISSUE DATE	FEDERAL PROJECT NO.	SHEET NO.	TOTAL SHEETS
REV. DATE	X-A004(384)	2	3



PLAN

SCALE: 3/16" = 1'-0"



SECTION A-A

SCALE: 3/8" = 1'-0"

PRELIMINARY PLANS
SUBJECT TO CHANGE
DATE 5/10/2019

GM2 ASSOCIATES

SUBDIRECTORY	.DGN LOCATOR	SHEET SCALE
BRC\Prelim	40392Typ	AS NOTED

STATE OF NEW HAMPSHIRE

DEPARTMENT OF TRANSPORTATION * BUREAU OF BRIDGE DESIGN

TOWN ANDOVER | BRIDGE NO. 143/077 | STATE PROJECT 40392

LOCATION US ROUTE 4 OVER BLACKWATER RIVER

SUPERSTRUCTURE LAYOUT AND TYPICAL SECTION

BRIDGE SHEET XX OF

FILE NUMBER

REVISIONS AFTER PROPOSAL

	BY	DATE		BY	DATE
DESIGNED	TEM	5/19	CHECKED	TPL	5/19
DRAWN	TEM	5/19	CHECKED	TPL	5/19
QUANTITIES	TEM	5/19	CHECKED	TPL	5/19

ISSUE DATE	FEDERAL PROJECT NO.	SHEET NO.	TOTAL SHEETS
REV. DATE	X-A004(384)	3	3

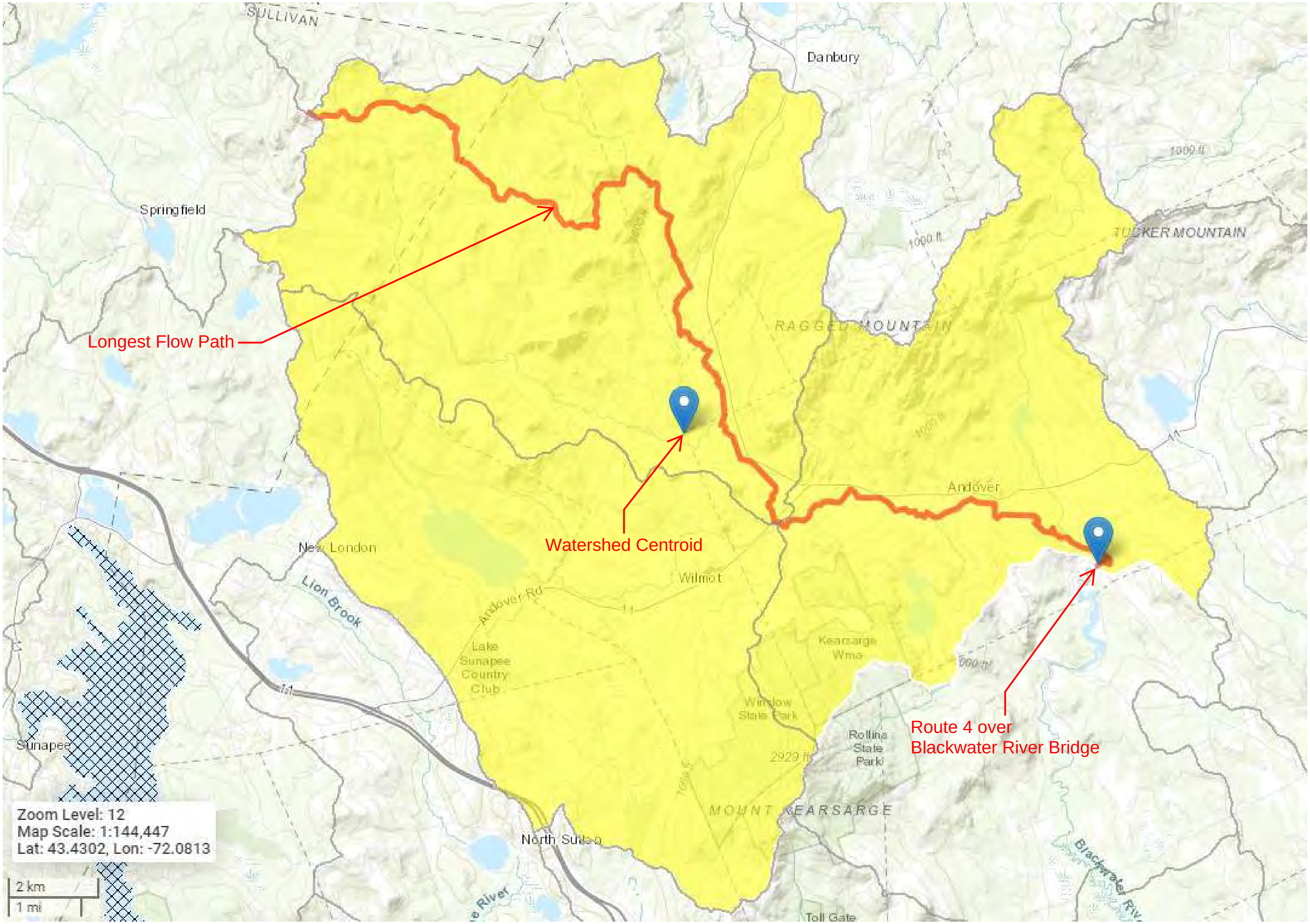
APPENDIX C

Watershed Basin Characteristics

Hoyle, Tanner & Associates, Inc.

Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077
Check Watershed Basin

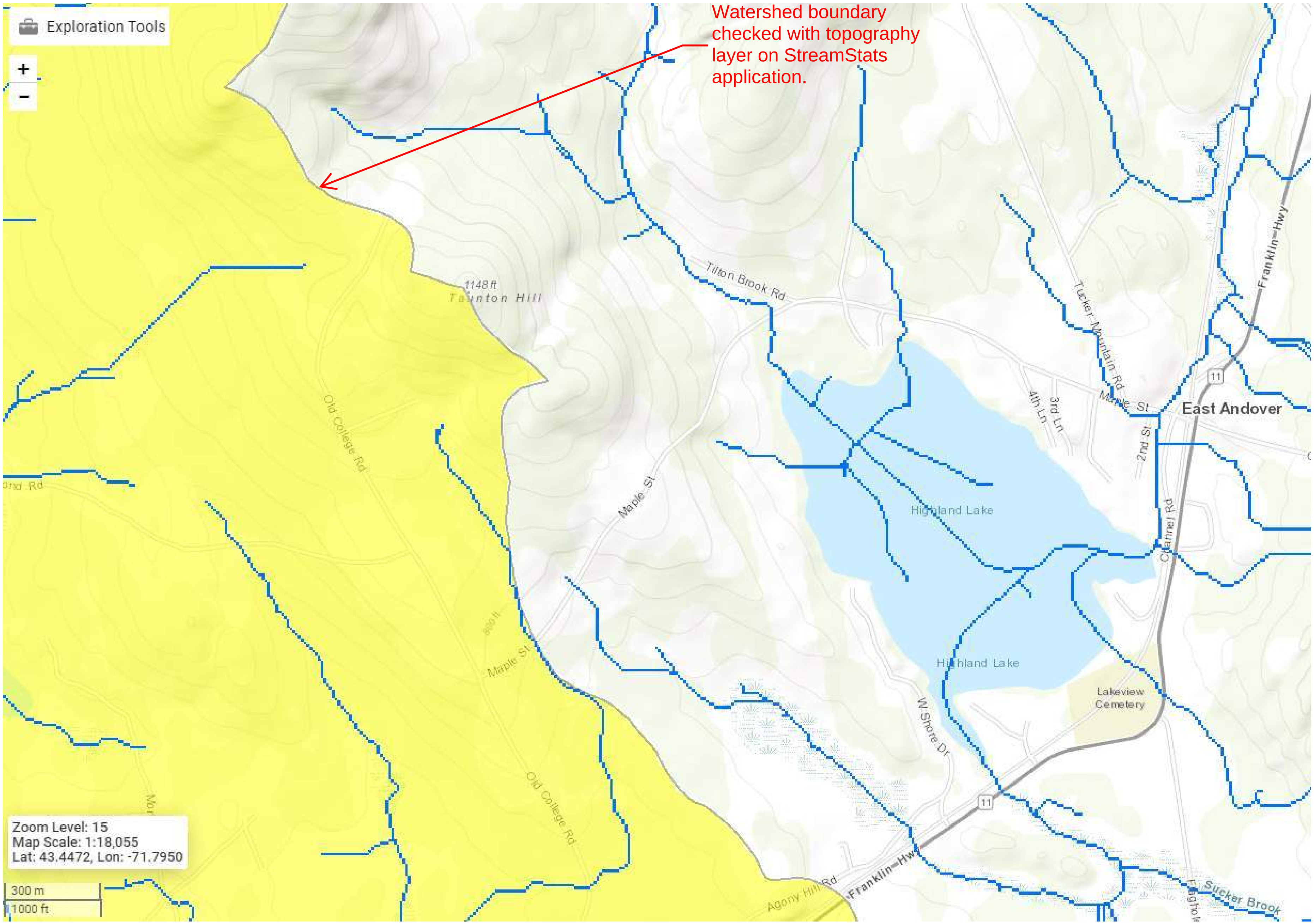
Done By: KMH Date: 6/2020
Checked By: AML Date: 7/2020



Hoyle, Tanner & Associates, Inc.

Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077
Check Watershed Basin

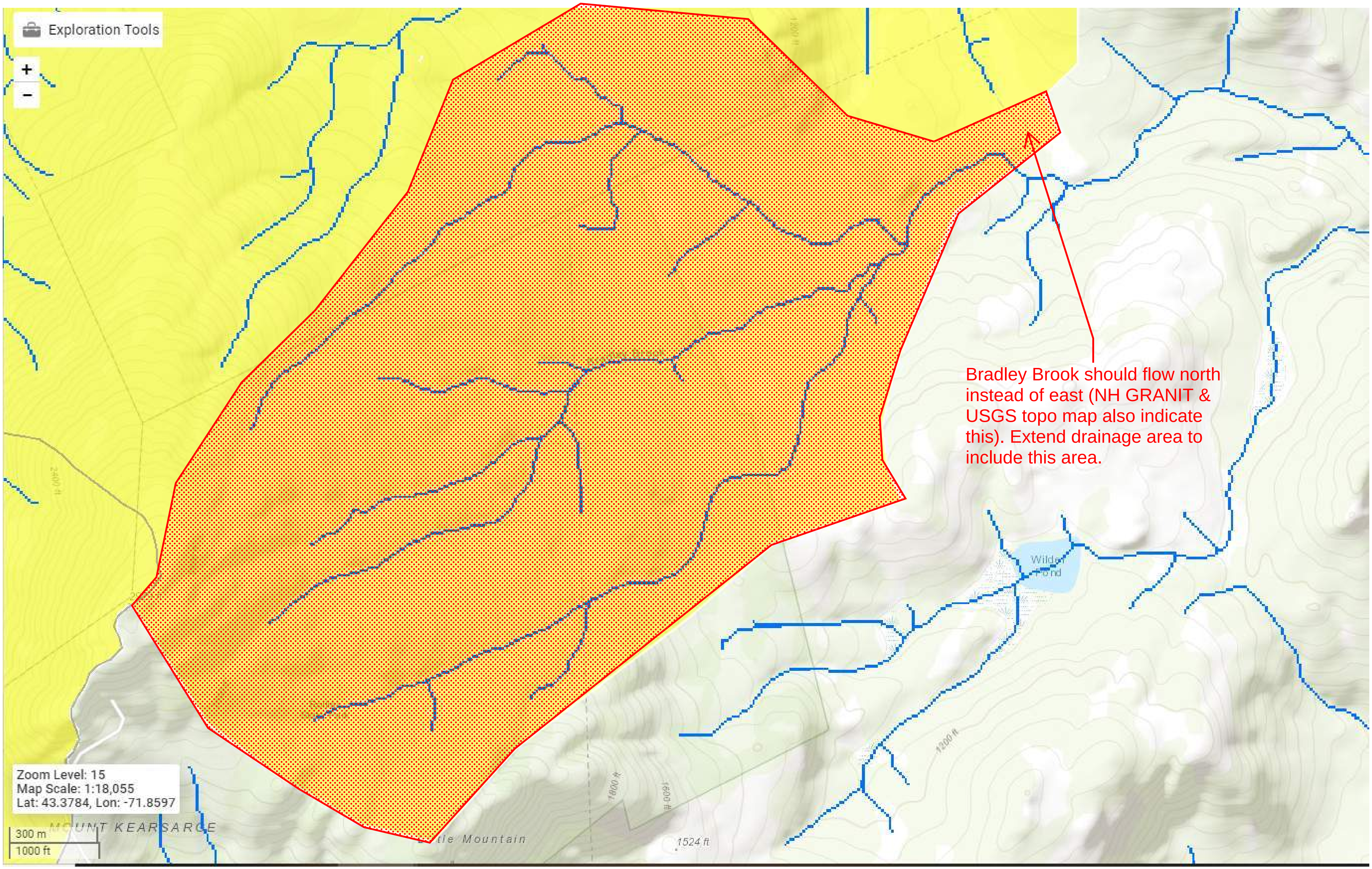
Done By: KMH Date: 6/2020
Checked By: AML Date: 7/2020



Hoyle, Tanner & Associates, Inc.

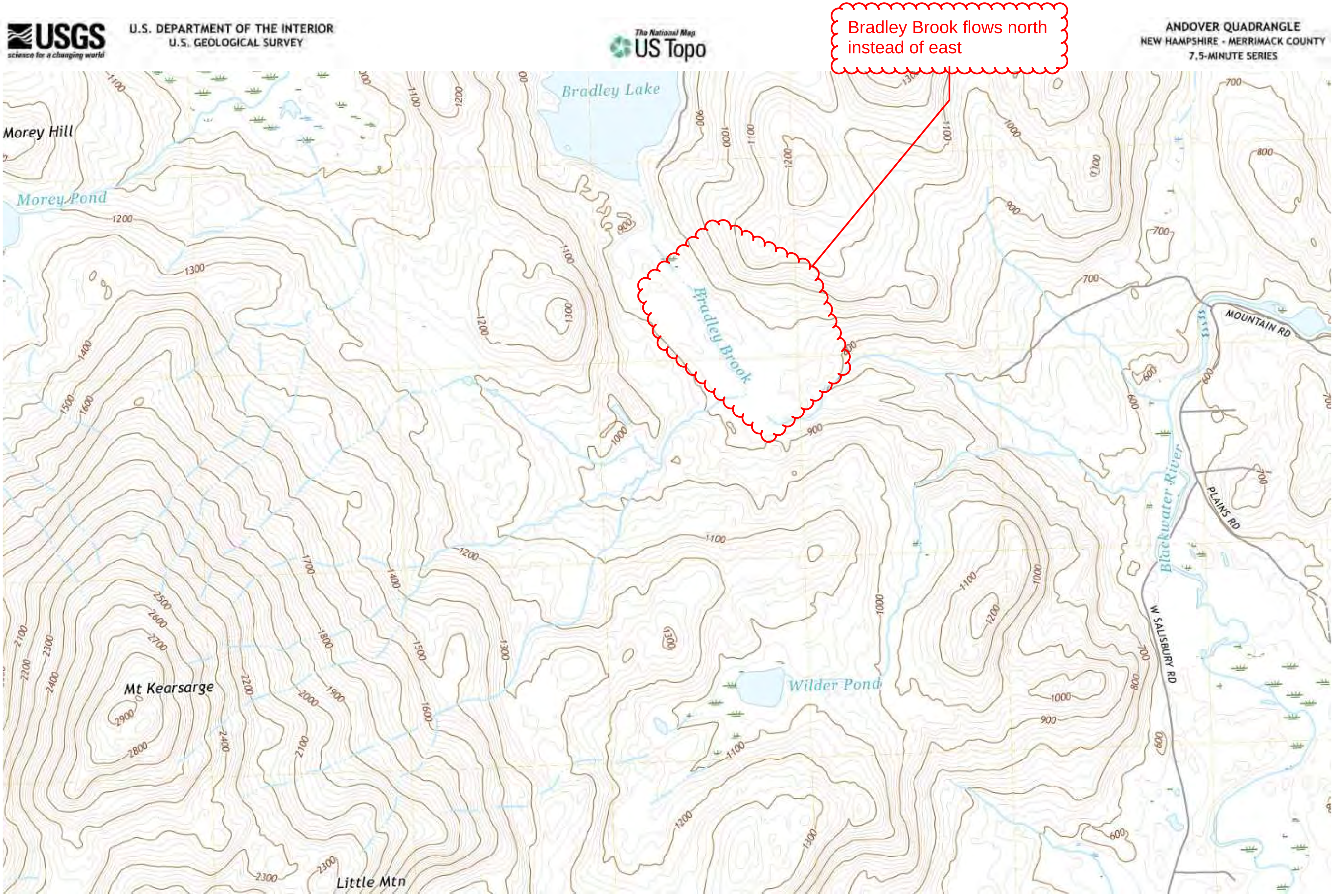
Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077
Check Watershed Basin

Done By: KMH Date: 6/2020
Checked By: AML Date: 7/2020



Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077
Check Watershed Basin

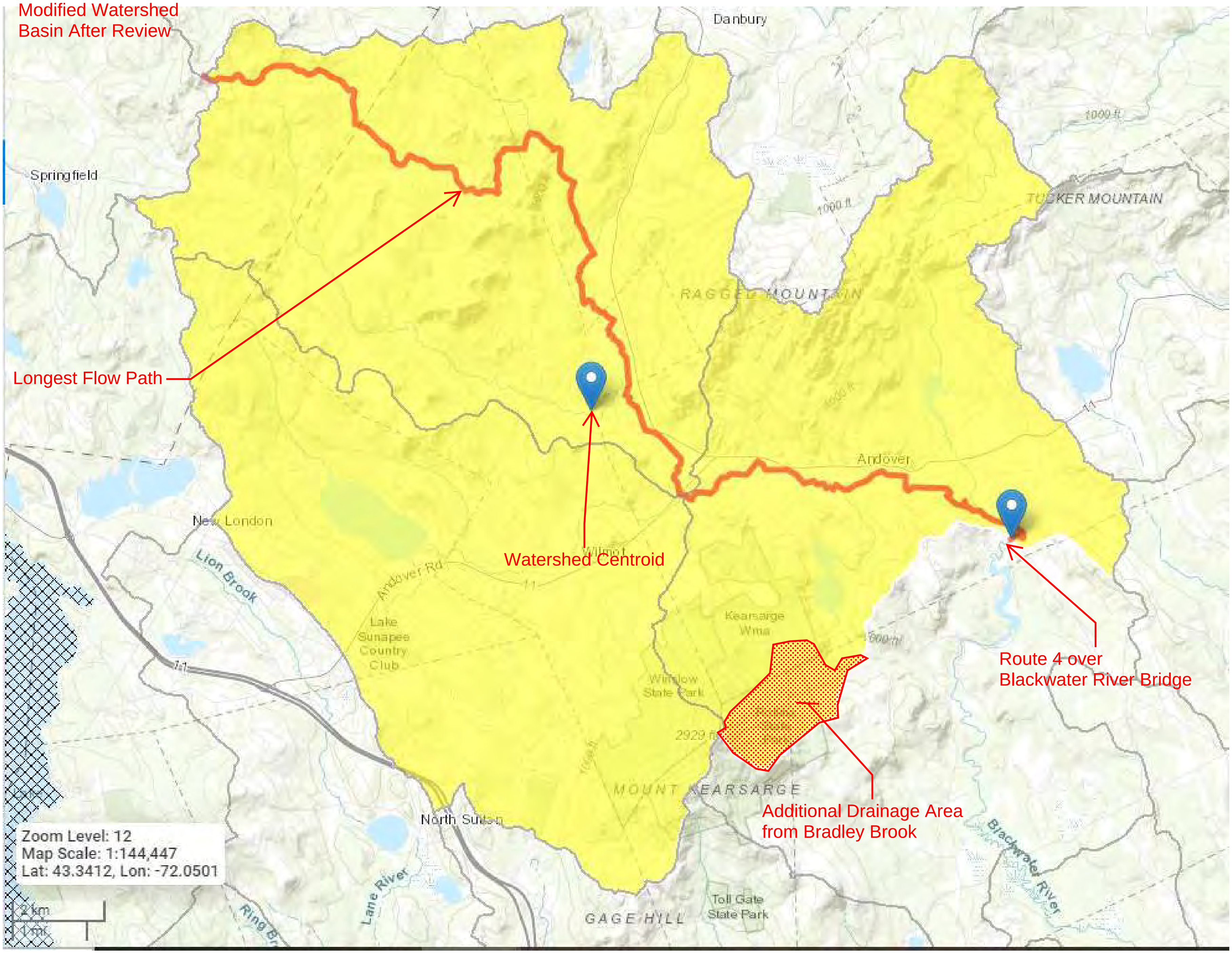
Done By: KMH Date: 6/2020
Checked By: AML Date: 7/2020



Hoyle, Tanner & Associates, Inc.

Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077
Check Watershed Basin

Done By: KMH Date: 6/2020
Checked By: AML Date: 7/2020

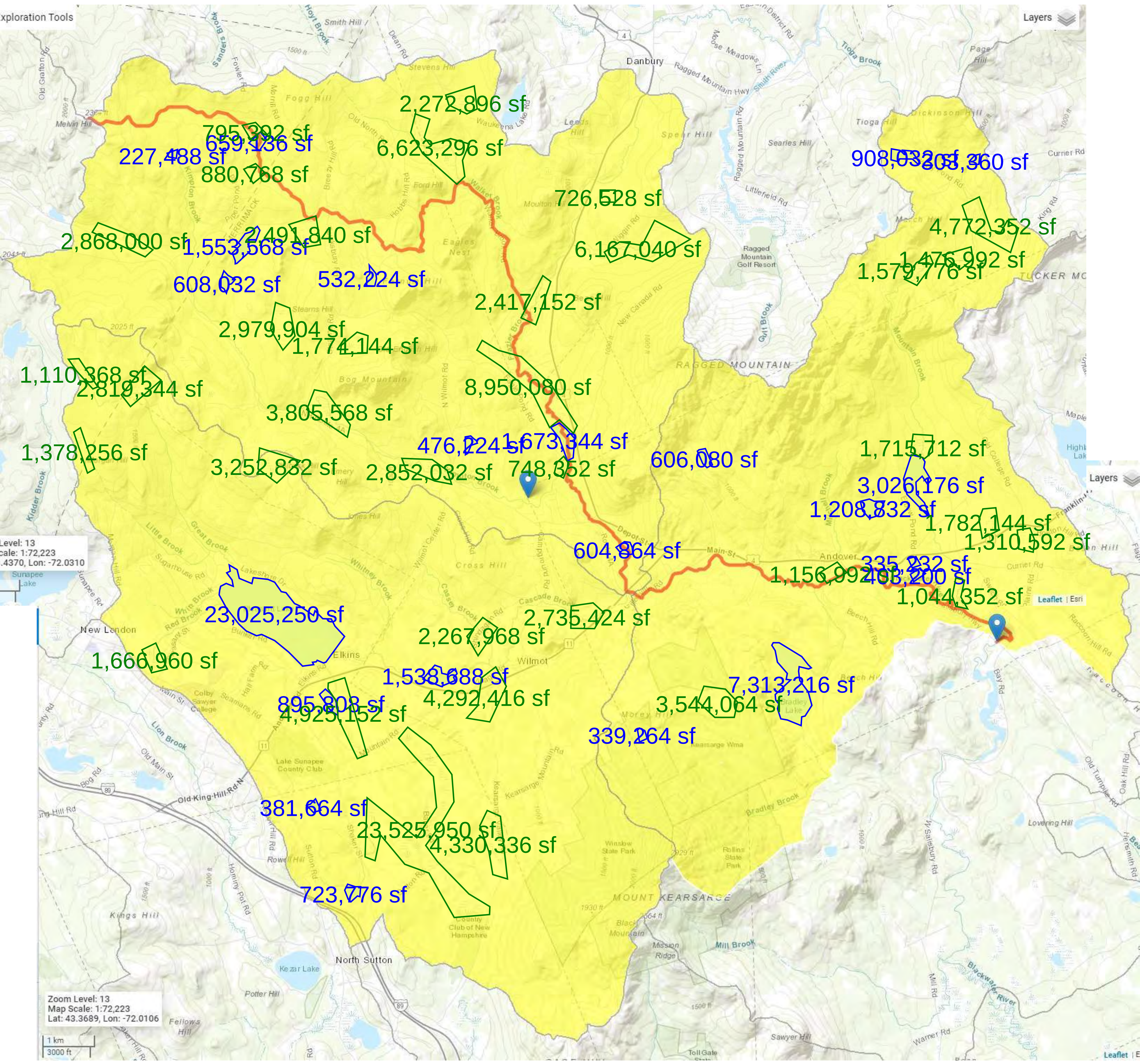


Hoyle, Tanner & Associates, Inc.

Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077
Check Watershed Storage

Done By: KMH Date: 6/2020
Checked By: AML Date: 7/2020

Estimate the amount of storage in the watershed:
Blue = Lakes & Ponds
Green = Wetlands



Hoyle, Tanner & Associates, Inc.

Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077
Check Watershed Storage

Done By: KMH Date: 6/2020
Checked By: AML Date: 7/2020

Lakes & Ponds		47,343,840.00 sf
Area Measurement	Lakes & Ponds	723,872.00 sf
Area Measurement	Lakes & Ponds	381,632.00 sf
Area Measurement	Lakes & Ponds	895,840.00 sf
Area Measurement	Lakes & Ponds	1,538,624.00 sf
Area Measurement	Lakes & Ponds	23,025,310.00 sf
Area Measurement	Lakes & Ponds	476,288.00 sf
Area Measurement	Lakes & Ponds	607,936.00 sf
Area Measurement	Lakes & Ponds	1,553,632.00 sf
Area Measurement	Lakes & Ponds	532,160.00 sf
Area Measurement	Lakes & Ponds	227,488.00 sf
Area Measurement	Lakes & Ponds	1,673,152.00 sf
Area Measurement	Lakes & Ponds	606,080.00 sf
Area Measurement	Lakes & Ponds	303,872.00 sf
Area Measurement	Lakes & Ponds	908,288.00 sf
Area Measurement	Lakes & Ponds	3,026,304.00 sf
Area Measurement	Lakes & Ponds	1,208,704.00 sf
Area Measurement	Lakes & Ponds	334,976.00 sf
Area Measurement	Lakes & Ponds	403,072.00 sf
Area Measurement	Lakes & Ponds	7,313,152.00 sf
Area Measurement	Lakes & Ponds	339,264.00 sf
Area Measurement	Lakes & Ponds	604,992.00 sf
Area Measurement	Lakes & Ponds	659,200.00 sf

= 1.7 sq. mi.

1.7/99.1 = 1.7%

Wetlands		117,041,600.00 sf
Area Measurement	Wetlands	23,525,950.00 sf
Area Measurement	Wetlands	4,330,304.00 sf
Area Measurement	Wetlands	4,925,120.00 sf
Area Measurement	Wetlands	4,292,544.00 sf
Area Measurement	Wetlands	2,268,032.00 sf
Area Measurement	Wetlands	1,666,944.00 sf
Area Measurement	Wetlands	1,378,240.00 sf
Area Measurement	Wetlands	1,110,376.00 sf
Area Measurement	Wetlands	2,819,376.00 sf
Area Measurement	Wetlands	3,805,568.00 sf
Area Measurement	Wetlands	1,774,144.00 sf
Area Measurement	Wetlands	2,979,968.00 sf
Area Measurement	Wetlands	2,868,016.00 sf
Area Measurement	Wetlands	2,491,776.00 sf
Area Measurement	Wetlands	880,672.00 sf
Area Measurement	Wetlands	795,360.00 sf
Area Measurement	Wetlands	6,623,232.00 sf
Area Measurement	Wetlands	2,273,024.00 sf
Area Measurement	Wetlands	6,166,912.00 sf
Area Measurement	Wetlands	726,528.00 sf
Area Measurement	Wetlands	2,417,280.00 sf
Area Measurement	Wetlands	8,950,080.00 sf
Area Measurement	Wetlands	2,851,968.00 sf
Area Measurement	Wetlands	748,352.00 sf
Area Measurement	Wetlands	4,772,480.00 sf
Area Measurement	Wetlands	1,476,736.00 sf
Area Measurement	Wetlands	1,579,776.00 sf
Area Measurement	Wetlands	1,715,840.00 sf
Area Measurement	Wetlands	1,310,720.00 sf
Area Measurement	Wetlands	1,782,400.00 sf
Area Measurement	Wetlands	1,044,480.00 sf
Area Measurement	Wetlands	1,157,248.00 sf
Area Measurement	Wetlands	3,544,000.00 sf
Area Measurement	Wetlands	2,735,360.00 sf
Area Measurement	Wetlands	3,252,800.00 sf

= 4.2 sq. mi.

4.2/99.1 = 4.2%

TOTAL:

5.9 sq. mi.
5.9 / 99.1 = 6.0%

vs StreamStats = 5.0%

Say OK!

APPENDIX D

Hydrology Calculations

NOTES AND ASSUMPTIONS

- The replacement structure will be designed to have 1-foot of freeboard for the 100-year storm event per NHDOT Bridge Manual and to accommodate the 500-year storm event per the "New Hampshire Stream Crossing Guidelines" and NHDES Environmental Rules.

- There is a stream gage on the Blackwater River located approximately 10 miles downstream of the Route 4 bridge. However, there is a regulated dam located 2 miles upstream of the stream gage, which means the drainage area relationship method cannot be used to determine the flows at the crossing. Additional information on the Blackwater Dam is located at the end of these calculations.

- Per the NHDOT Bridge Design Manual, Volume 2, for ungaged sites, the preferred method for obtaining hydrologic flows is to use the USGS StreamStats program for NH. The preferred method shall be checked using two other methods.

- StreamStats flows are included as the preferred method.

- The Federal Emergency Management Agency (FEMA) completed a Flood Insurance Study (FIS) for Merrimack County, New Hampshire that has an effective date 2010. The FIS did not complete a detailed study along the Blackwater River at the Route 4 crossing. The Flood Insurance Rate Map (FIRM) indicates the area to be a Special Flood Hazard Area Zone A indicating that a detailed hydraulic analysis has not been completed as part of the FIS in this area and therefore, base flood elevations and flows have not been determined. The two check methods shall be the Federal Highway Administration (FHWA) regression equations (the 5- and 7-Parameter Methods), and the New England Hill and Lowlands (NEHL) and Adirondack White Mountains (AWM) Method.

- The first check method shall therefore be the FHWA Runoff Estimates for Small Rural Watersheds and Development of a Sound Method. The 5-parameter regression equation is intended for use with watersheds smaller than 50 square miles. However, NHDOT Bridge Manual Table 2.7.5-3, Methods for Checking Runoff Rates/Volumes, notes that it can be used for drainage areas less than 100 square miles. The FHWA 7-Parameter method is used for fragmented channels with more than one main channel or for several branching tributaries upstream of the crossing.

- The second check method shall be the New England Hill and Lowland (NEHL) / Adirondack-White Mountain-Maine Woods (AWM) method. This method can be used when the drainage area is between 1 square mile and 1,000 square miles.

- The tributary streams at the upstream and downstream confluences are relatively small with drainage areas less than 2 square miles each. Therefore, only the discharges determined from StreamStats will be considered for the hydraulic analyses.

- Discharges for the Blackwater River are calculated for the following methods:

  1. StreamStats
  2a. FHWA 5-Parameter Method
  2b. FHWA 7-Parameter Method
  3. NEHL-AWM Method

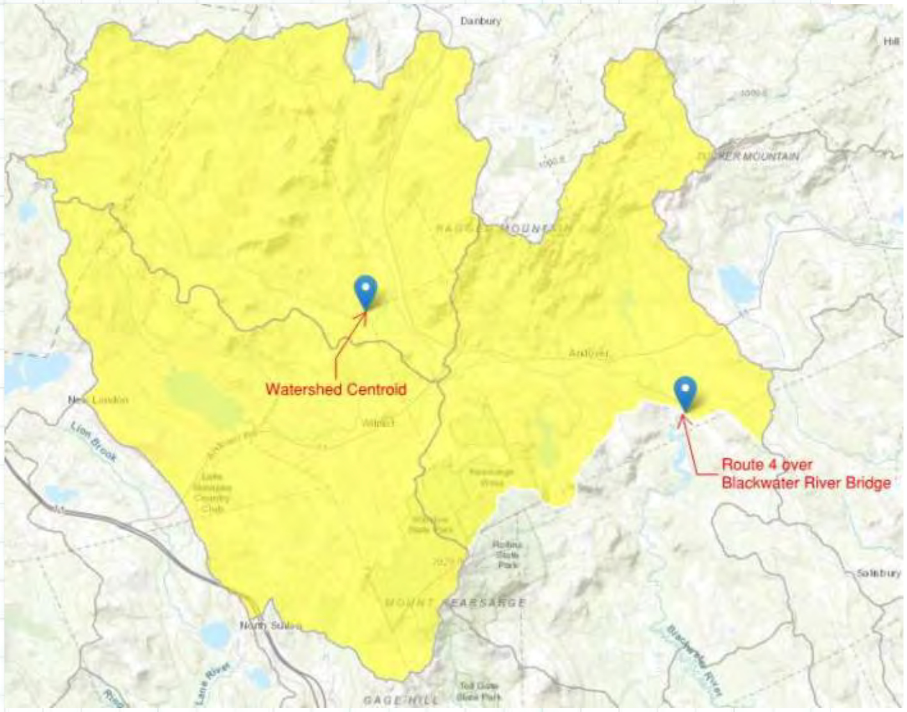
REFERENCES

1. NHDOT Manual on Drainage Design for Highways, 1998 and 2015 Draft
2. NHDOT Bridge Design Manual, Version 2
3. USGS StreamStats Version 4 for New Hampshire.
4. FEMA FIS Merrimack County, New Hampshire All Jurisdic+ons, Study No. 33013CV001A, April 19, 2010
5. FHWA-RD-77-159, Runoff Es+mates for Small Rural Watersheds and Development of a Sound Design Method.
6. VTrans Hydraulic Manual, 2015.

BLACKWATER RIVER DISCHARGES

METHOD No. 1: Determine Discharges from StreamStats

- StreamStats Ungaged Site Report for the original watershed basin is below and includes peak flows for 2, 5, 10, 25, 50, 100 and 500-year flood events.
- It appears that Bradley Brook near Mount Kearsarge at the south of the basin was not accounted for in the watershed delineation. This area was added and the modified drainage area is presented on the next sheet.



Peak-Flow Statistics Parameters (Peak Flow Statewide SIR2008 5206)

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	97.09	square miles	0.7	1290
APRAVPRE	Mean April Precipitation	3.64	inches	2.79	6.23
WETLAND	Percent Wetlands	5.0516	percent	0	21.8
CSL10_85	Stream Slope 10 and 85 Method	46.6	feet per mi	5.43	543

Peak-Flow Statistics Flow Report (Peak Flow Statewide SIR2008 5206)

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	Plu	SEp	Equiv. Yrs.
2 Year Peak Flood	2390	ft^3/s	1480	3870	30.1	3.2
5 Year Peak Flood	3580	ft^3/s	2190	5860	31.1	4.7
10 Year Peak Flood	4520	ft^3/s	2710	7530	32.3	6.2
25 Year Peak Flood	5700	ft^3/s	3310	9800	34.3	8
50 Year Peak Flood	6640	ft^3/s	3750	11700	36.4	9
100 Year Peak Flood	7740	ft^3/s	4240	14200	38.6	9.8
500 Year Peak Flood	10200	ft^3/s	5170	20200	44.1	11

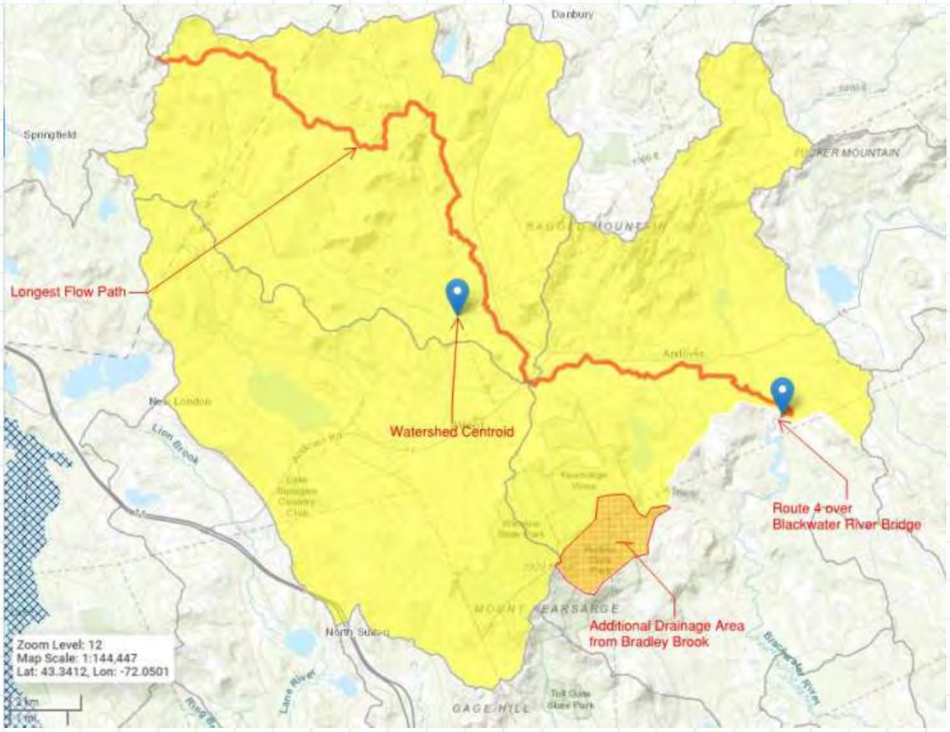
Peak-Flow Statistics Citations

Olson, S.A.,2009, Estimation of flood discharges at selected recurrence intervals for streams in New Hampshire: U.S.Geological Survey Scientific Investigations Report 2008-5206, 57 p.

BLACKWATER RIVER DISCHARGES (CONT.)

METHOD No. 1: Determine Discharges from StreamStats (Cont.)

- Modified watershed basin to include Bradley Brook near Mount Kearsarge.



Peak-Flow Statistics Parameters (Peak Flow Statewide SIR2008 5206)

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	99.07	square miles	0.7	1290
APRAVPRE	Mean April Precipitation	3.642	inches	2.79	6.23
WETLAND	Percent Wetlands	4.9603	percent	0	21.8
CSL10_85	Stream Slope 10 and 85 Method	46.6	feet per mi	5.43	543

Peak-Flow Statistics Flow Report (Peak Flow Statewide SIR2008 5206)

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	Plu	SEp	Equiv. Yrs.
2 Year Peak Flood	2450	ft^3/s	1520	3970	30.1	3.2
5 Year Peak Flood	3670	ft^3/s	2240	6010	31.1	4.7
10 Year Peak Flood	4630	ft^3/s	2780	7720	32.3	6.2
25 Year Peak Flood	5840	ft^3/s	3400	10000	34.3	8
50 Year Peak Flood	6800	ft^3/s	3840	12000	36.4	9
100 Year Peak Flood	7930	ft^3/s	4340	14500	38.6	9.8
500 Year Peak Flood	10500	ft^3/s	5300	20700	44.1	11

- The full StreamStats report is included at the end of these calculations.

BLACKWATER RIVER DISCHARGES (CONT.)

METHOD No. 2a & 2b: Determine Discharges by the FHWA 5- and 7-Parameter Method

STEP 1 DELINEATE WATERSHED:

- The watershed basin delineated by StreamStats appears to be correct after inspection of the topography around the basin.

$$A_{basin} := 99.1\ mi^2$$

STEP 2 DETERMINE THE PROBABLE MAXIMUM RUNOFF PEAK, Qp (max):

$$Q_{pmax} := 10^{\left(3.92 + 0.812 \cdot \log\left(\frac{A_{basin}}{mi^2}, 10\right) - 0.0325 \cdot \left(\log\left(\frac{A_{basin}}{mi^2}, 10\right)\right)^2\right)} \cdot cfs$$

FHWA-RD-77-159, Sheet 3

$$Q_{pmax} = 257823.044\ cfs$$

STEP 3 DETERMINE THE REQUIRED HYDROPHYSIOGRAPHIC PARAMETERS:

a. Iso-erodent factor, R, from Iso-erodent Map: Sheet DC-9

$$R := 89.75$$

b. Elevation Difference of main channel, DH, from USGS Map: Sheet DC-10

$$EL_{high} := 2440\ ft \qquad EL_{low} := 593\ ft$$

$$DH := EL_{high} - EL_{low} = 1847.000\ ft$$

c. Percent of Water Storage Area, S, from USGS SUSR:

$$storage := 5.0\%$$

Sheet DC-4

d. Hydrophsiographic Zone:

All of New Hampshire is in Zone 9. Use this zone when determining which 10-year runoff peak equation to use.

BLACKWATER RIVER DISCHARGES (CONT.)

METHOD No. 2a & 2b: Determine Discharges by the FHWA 5- and 7-Parameter Method (Cont.)

STEP 3 DETERMINE THE REQUIRED HYDROPHYSIOGRAPHIC PARAMETERS (CONT.):

e. Principal Drainage Channel Length, L, from NH GRANIT Application:

$L_{main} := 97516\ ft$ Sheet DC-11

$L_{main} = 18.469\ mi$

f. Cumulative Channel Lengths, LL, from NH GRANIT Topo Map:

$LL := 849592\ ft$ Sheet DC-11

$LL = 160.908\ mi$

g. 10-year, 10-minute Rainfall Intensity, P_{10}, From Appendix D, FHWA Manual:

$P_{10} := 4.69$ Sheet DC-12

h. 10-year, 60-minute Rainfall Intensity, P_{60}, From Appendix D, FHWA Manual:

$P_{60} := 1.68$ Sheet DC-13

BLACKWATER RIVER DISCHARGES (CONT.)

METHOD No. 2a & 2b: Determine Discharges by the FHWA 5- and 7-Parameter Method (Cont.)

STEP 4 DETERMINE THE ESTIMATED 10-YEAR RUNOFF PEAK, q_{10}:

5-Parameter:

$$q_{10\_5} := 7.7165\ cfs \cdot \left(\frac{A_{basin}}{mi^2}\right)^{0.5814} \cdot R^{0.0547} \cdot \left(\frac{DH}{ft}\right)^{0.3865} \cdot \left(\frac{L_{main}}{mi}\right)^{0.0990} \cdot P_{60}^{\ 0.8217}$$

FHWA-RD-77-159, Sheet 9

$$q_{10\_5} = 5342.843\ cfs$$

7-Parameter:

$$q_{10\_7} := 50.8080\ cfs \cdot \left(\frac{A_{basin}}{mi^2}\right)^{0.3799} \cdot R^{-0.1432} \cdot \left(\frac{DH}{ft}\right)^{0.3401} \cdot \left(\frac{L_{main}}{mi}\right)^{0.0917} \cdot \left(\frac{LL}{mi}\right)^{0.2879} \cdot P_{10}^{\ -0.9655} \cdot P_{60}^{\ 1.8748}$$

$$q_{10\_7} = 6626.587\ cfs$$

FHWA-RD-77-159, Sheet 10

Adjust q_{10} for storage correct factor, SCF (Figure 5):

- Per section 3.2 of the NHDOT Drainage Manual, a storage correction factor can be applied if the total storage area of ponds, lakes and swamps is greater than 1% of the watershed.

$$SCF := 0.96$$

Sheet DC-14

5-Parameter: $q_{hat\_10\_5} := q_{10\_5} \cdot SCF = 5129.129\ cfs$

7-Parameter: $q_{hat\_10\_7} := q_{10\_7} \cdot SCF = 6361.523\ cfs$

STEP 5 DETERMINE RETURN PERIOD, TD:

This is specified by NHDOT as 50 years for this bridge.

BLACKWATER RIVER DISCHARGES (CONT.)

METHOD No. 2a & 2b: Determine Discharges by the FHWA 5- and 7-Parameter Method (Cont.)

STEP 6 PREPARE THE EXTRAPOLATION CURVE FOR DETERMINATION QTD:

See FHWA-RD-77-159, Sheet 16 for equations.

5-Parameter:

$$Q_{2.33\_FHWA\_5} := 0.46921\ cfs \cdot \left(\frac{q_{hat\_10\_5}}{cfs}\right)^{1.00243} = 2457.120\ cfs$$ Discharge at 2.33 years

$$Q_{50\_FHWA\_5} := 1.45962\ cfs \cdot \left(\frac{q_{hat\_10\_5}}{cfs}\right)^{1.02342} = 9144.768\ cfs$$ Discharge at 50 years

$$Q_{100\_FHWA\_5} := 1.64380\ cfs \cdot \left(\frac{q_{hat\_10\_5}}{cfs}\right)^{1.02918} = 10818.118\ cfs$$ Discharge at 100 years

7-Parameter:

$$Q_{2.33\_FHWA\_7} := 0.46921\ cfs \cdot \left(\frac{q_{hat\_10\_7}}{cfs}\right)^{1.00243} = 3049.096\ cfs$$ Discharge at 2.33 years

$$Q_{50\_FHWA\_7} := 1.45962\ cfs \cdot \left(\frac{q_{hat\_10\_7}}{cfs}\right)^{1.02342} = 11399.357\ cfs$$ Discharge at 50 years

$$Q_{100\_FHWA\_7} := 1.64380\ cfs \cdot \left(\frac{q_{hat\_10\_7}}{cfs}\right)^{1.02918} = 13501.997\ cfs$$ Discharge at 100 years

BLACKWATER RIVER DISCHARGES (CONT.)

METHOD No. 2a & 2b: Determine Discharges by the FHWA 5- and 7-Parameter Method (Cont.)

New Hampshire DOT Department of Transportation

Manual on Drainage Design for Highways
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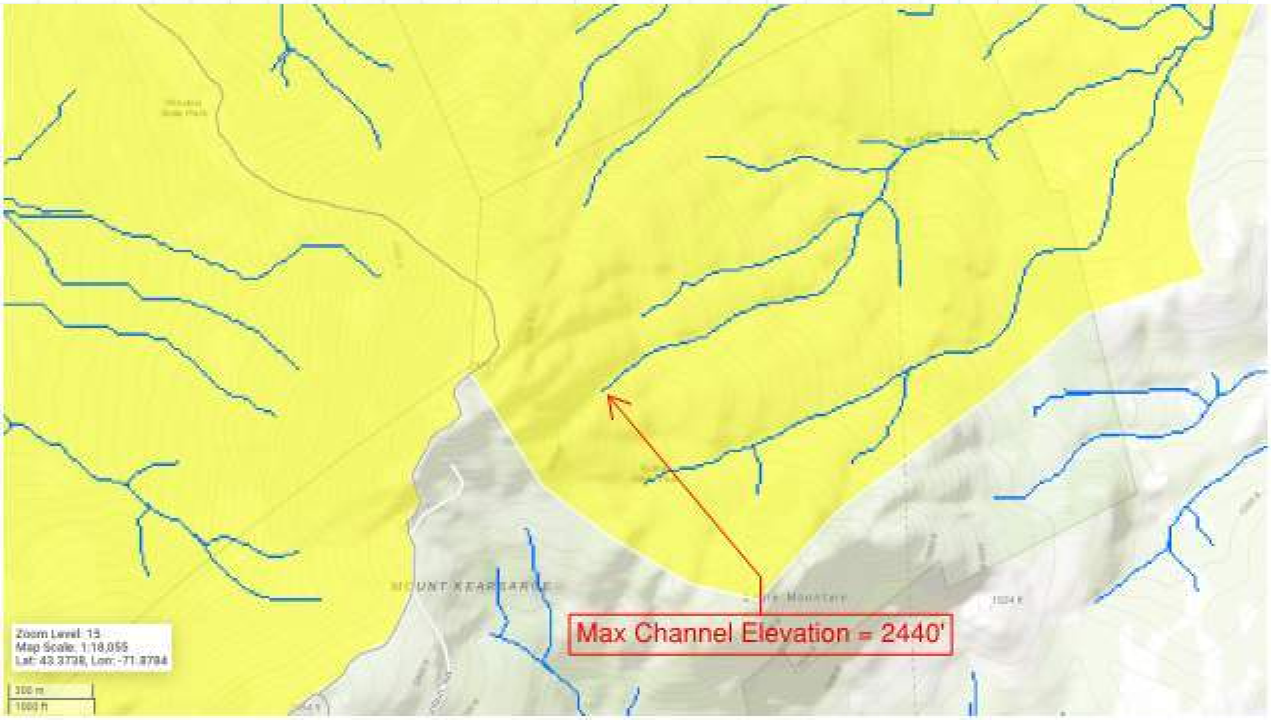
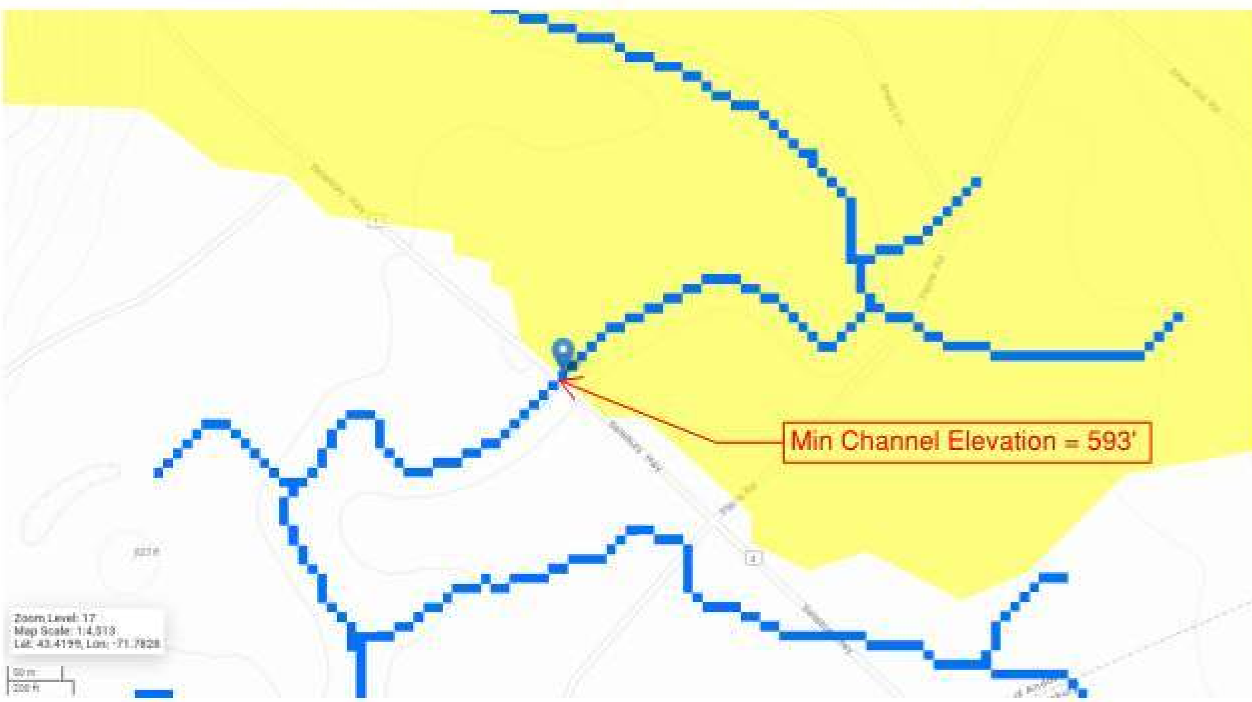
Fig. 3.2d (R parameter superimposed on District map)

BLACKWATER RIVER DISCHARGES (CONT.)

METHOD No. 2a & 2b: Determine Discharges by the FHWA 5- and 7-Parameter Method (Cont.)

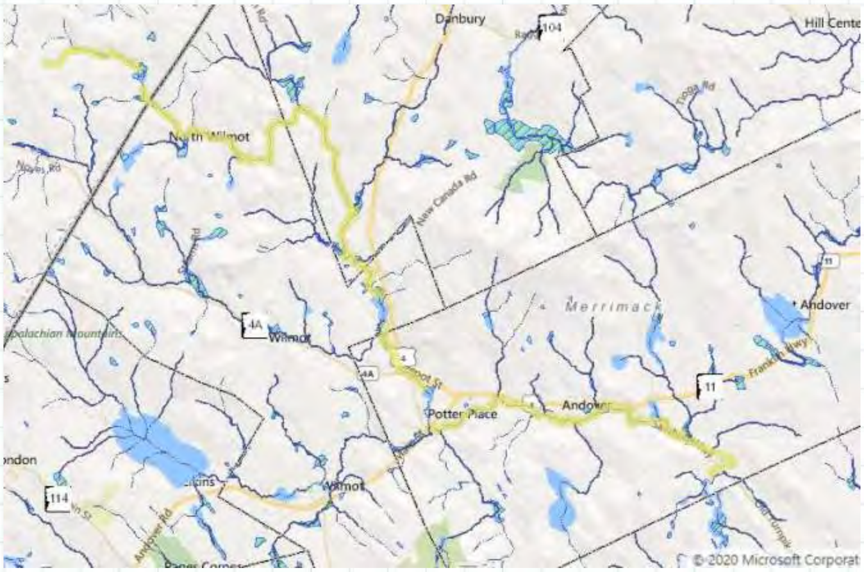




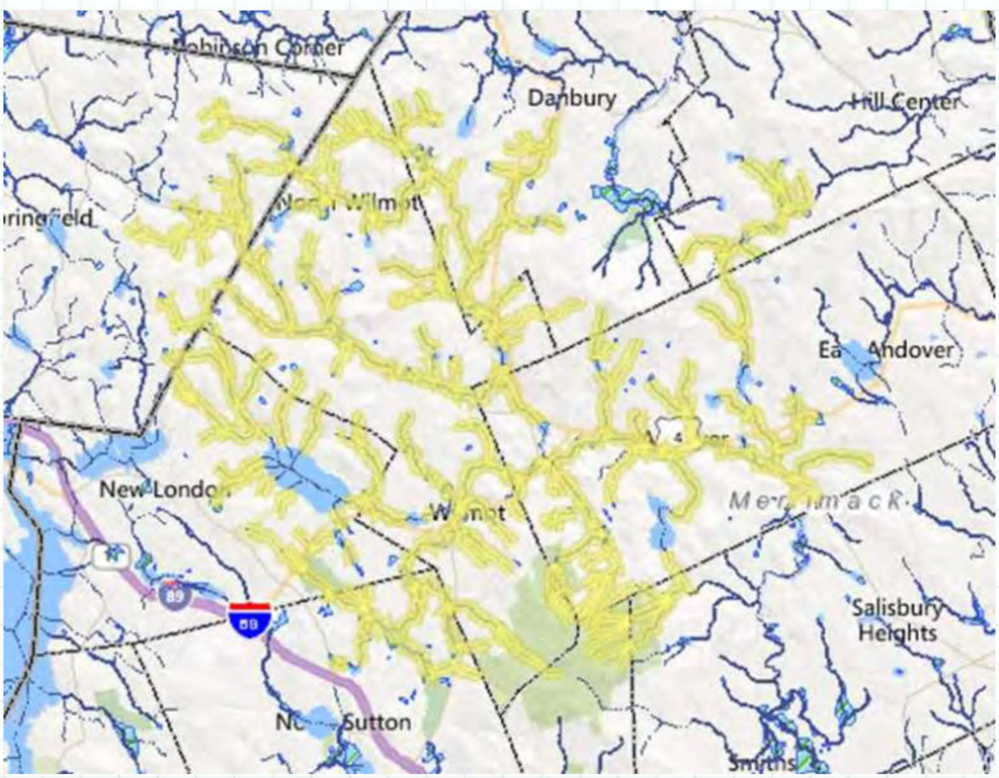
BLACKWATER RIVER DISCHARGES (CONT.)

METHOD No. 2a & 2b: Determine Discharges by the FHWA 5- and 7-Parameter Method (Cont.)

- Main Channel length (yellow path)



- Cumulative Channel length (yellow paths)

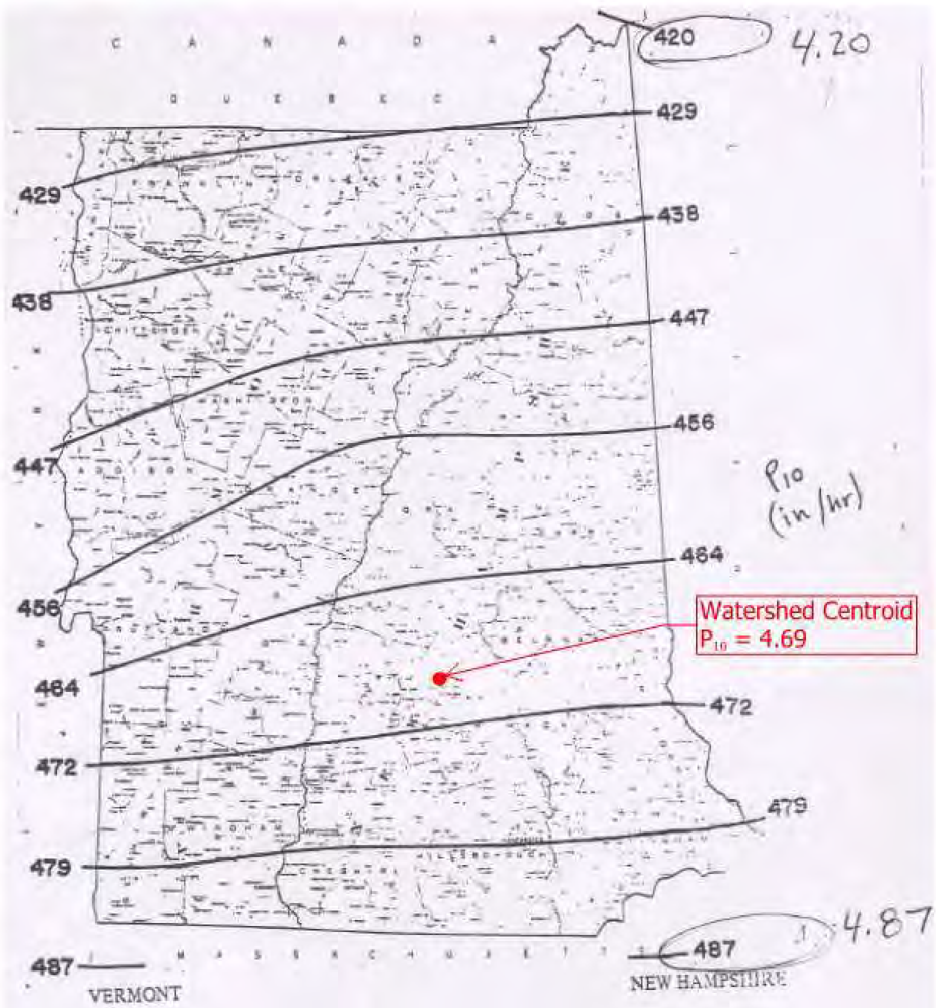


BLACKWATER RIVER DISCHARGES (CONT.)

METHOD No. 2a & 2b: Determine Discharges by the FHWA 5- and 7-Parameter Method (Cont.)

New Hampshire DOT Department of Transportation

Manual on Drainage Design for Highways
Section 3 Surface Hydrology



Appendix E-33. Isohyetal map of 10-year, 10-minute rainfall intensity for New Hampshire.
Appendix E-50. Isohyetal map of 10-year, 10-minute rainfall intensity for Vermont.

Fig 3.2g: 10 yr peak precipitation parameter in inches/hr (P_{10})

BLACKWATER RIVER DISCHARGES (CONT.)

METHOD No. 2a & 2b: Determine Discharges by the FHWA 5- and 7-Parameter Method (Cont.)

New Hampshire DOT Department of Transportation

Manual on Drainage Design for Highways
Section 3 Surface Hydrology

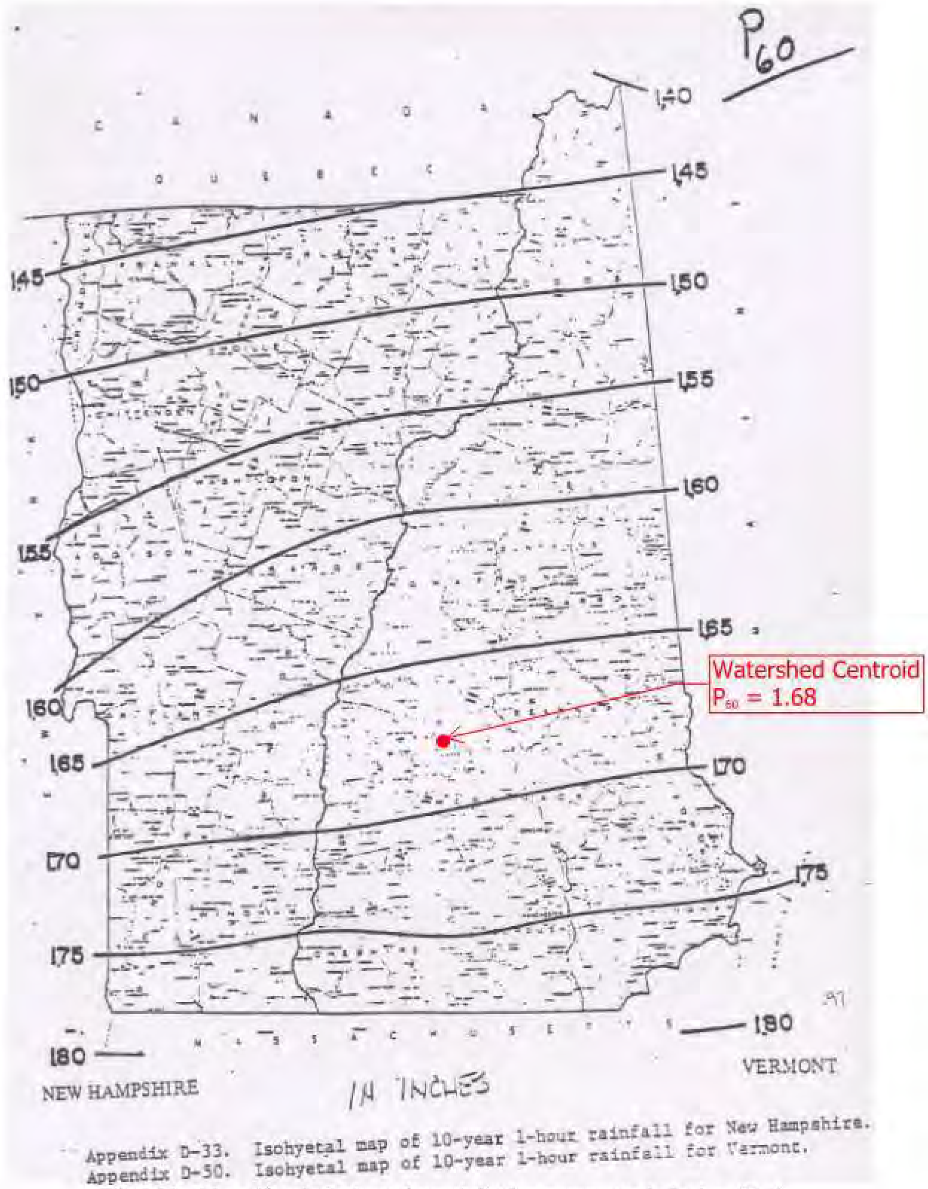


Fig 3.2j: 10 yr 60 min Isohyetal precipitation parameter in inches (P_{60})

BLACKWATER RIVER DISCHARGES (CONT.)

METHOD No. 2a & 2b: Determine Discharges by the FHWA 5- and 7-Parameter Method (Cont.)

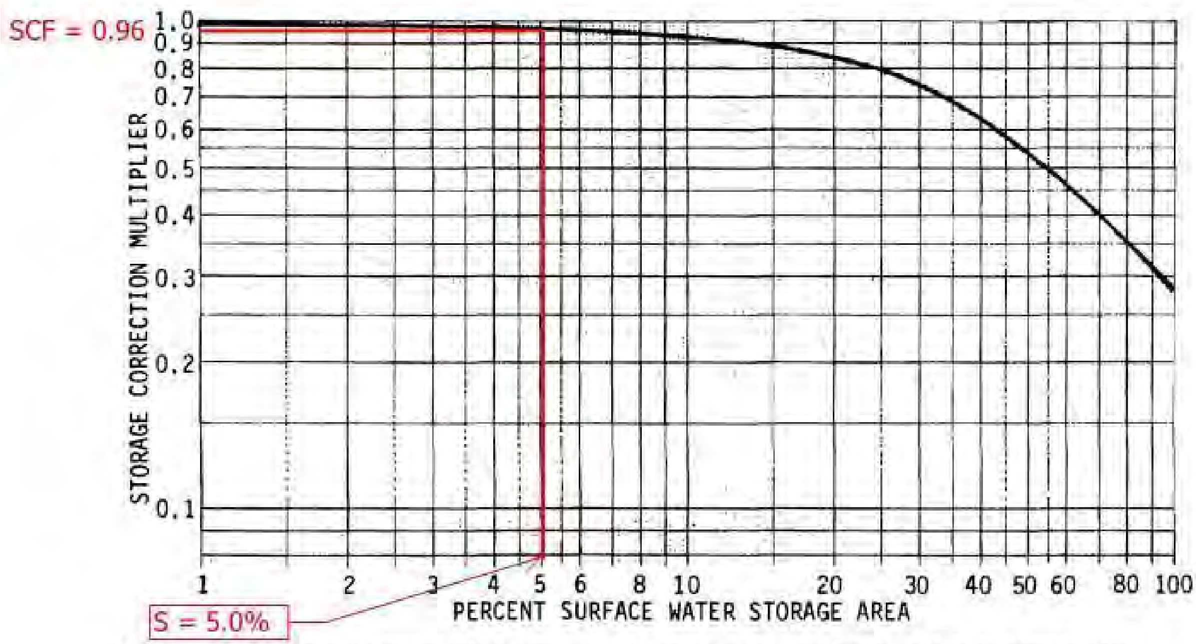


Figure 5. Storage correction curve. (Defines the relationship between the percentage of watershed area covered by lakes, ponds, swamps, playas, etc. and the multiplication factor required to correct a peak runoff estimate for storage.)

in which

n	=	the usable lifetime of the structure in years
k	=	the number of flood events that exceed the T year flood event
$\binom{n}{k}$	=	the binomial coefficient, $\frac{n!}{k!\,(n-k)!}$
p	=	the probability of the nominally specified design flood (p = 1/T)
P_R	=	the probability that exactly k flood events exceed the T-year flood in n years

If we define the exceedence risk, R_e, as the probability that a T-year flood will be exceeded one or more times in n years,

$$R_e = 1 - P_0 = 1 - \left(1 - \frac{1}{T}\right)^n \quad \ldots\ldots\ldots \quad (6)$$

in which

P_0 = the probability of no events exceeding the T-year flood and all other symbols are as previously defined

Equation 6 may be used directly to evaluate the risk of exceedance to ascertain its acceptability for the particular circumstances. If so, then the

BLACKWATER RIVER DISCHARGES (CONT.)

METHOD No. 3: Determine Discharges by the NEHL/AWM Method

STEP 1 DELINEATE WATERSHED:

See above $A_{basin} = 99.100\ mi^2$

STEP 2 DETERMINE THE RAINFALL INDEX, P:

From Drainage Design Manual (1998), Figure 2-10: $P := 1.64$ Sheet DC-16

STEP 3 DETERMINE STORAGE INDEX, K:

From USGS SUSR:

Since the watershed centroid is located in the NEHL region (see Figure 2-10 on Sheet DC-15), use either Chart 3 (Fig. 2-8) or Chart 4 (Fig. 2-9) depending on the watershed storage.

Storage Index: $K := storage = 5.0\%$

$$Figure := \begin{array}{l} \text{if } K \geq 4.5\% \\ \quad \text{“Use Figure 2–8 (Chart 3)”} \\ \text{else} \\ \quad \text{“Use Figure 2–9 (Chart 4)”} \end{array} = \text{“Use Figure 2–8 (Chart 3)”}$$

STEP 4 DETERMINE PEAK RUNOFF:

From Drainage Design Manual (1998), Figure 2-8: Sheet DC-17

$Q_{10\_NEHL} := 5800\ cfs$

$Q_{50\_NEHL} := 10500\ cfs$

- Since NEHL-AWM Method only provides design flows for the 10-year and 50-year events, the Q_{10} _NEHL and the Q_{50} _NEHL will be plotted on Gumbel Probability Paper to determine the other flows. See the plot on DC-18.

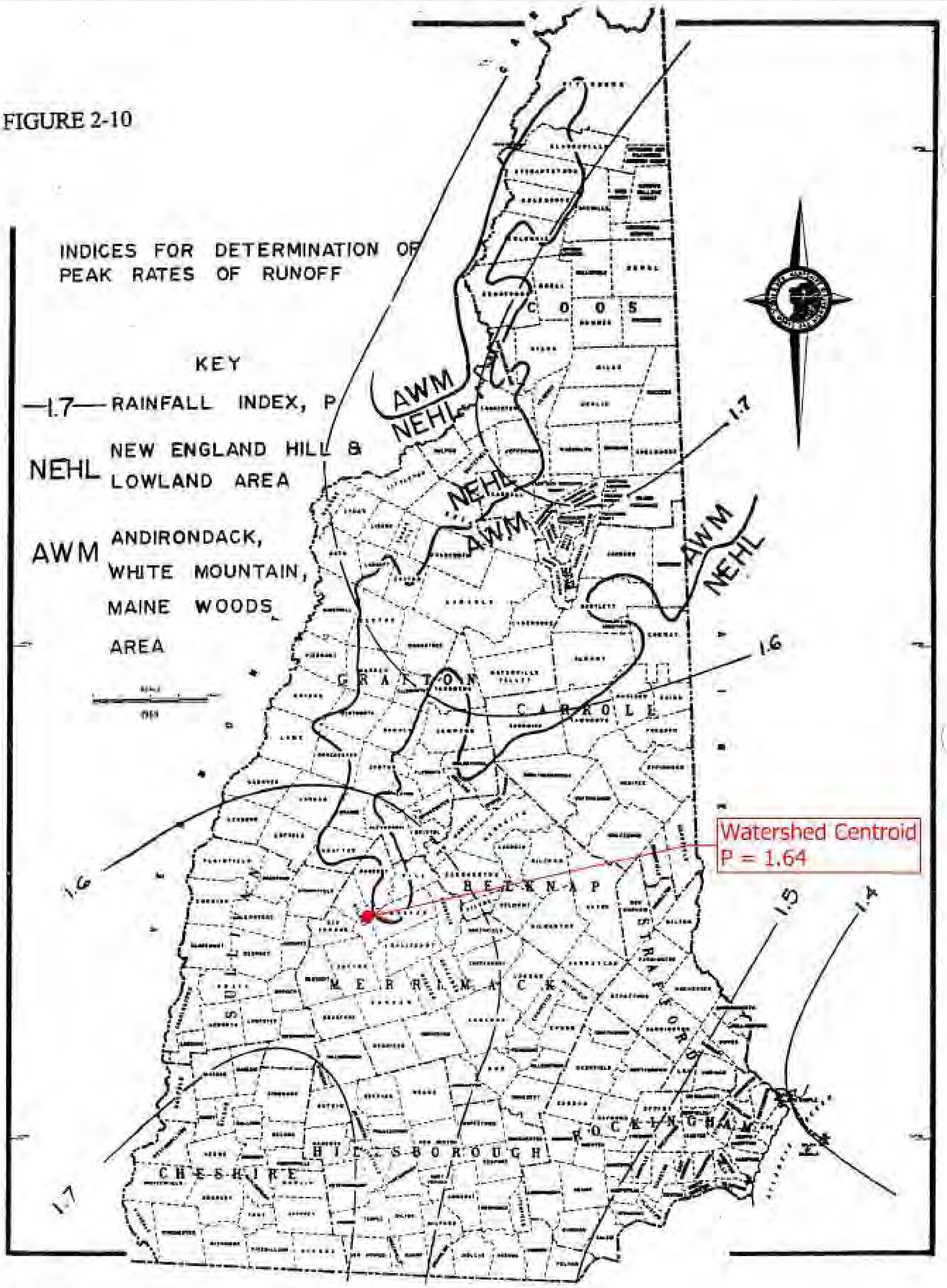
$Q_{2.33\_NEHL} := 1000\ cfs$ Sheet DC-18

$Q_{100\_NEHL} := 12400\ cfs$ Sheet DC-18

BLACKWATER RIVER DISCHARGES (CONT.)

METHOD No. 3: Determine Discharges by the NEHL/AWM Method (Cont.)

FIGURE 2-10

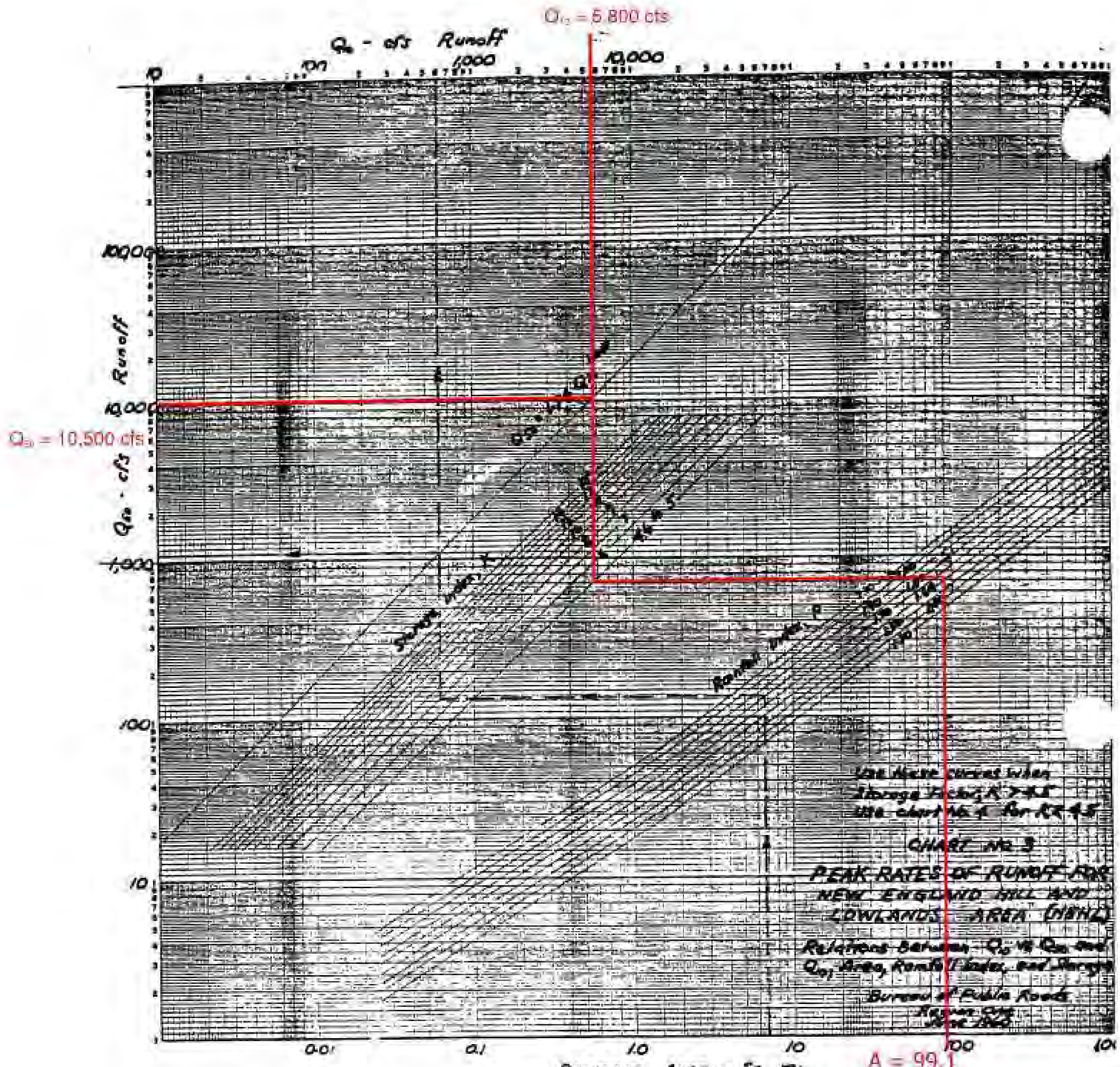


NOTE: METRIC CONVERSION: 1 INCH = 25.4 mm
1mm = 0.0394 IN.

2-38

BLACKWATER RIVER DISCHARGES (CONT.)

METHOD No. 3: Determine Discharges by the NEHL/AWM Method (Cont.)



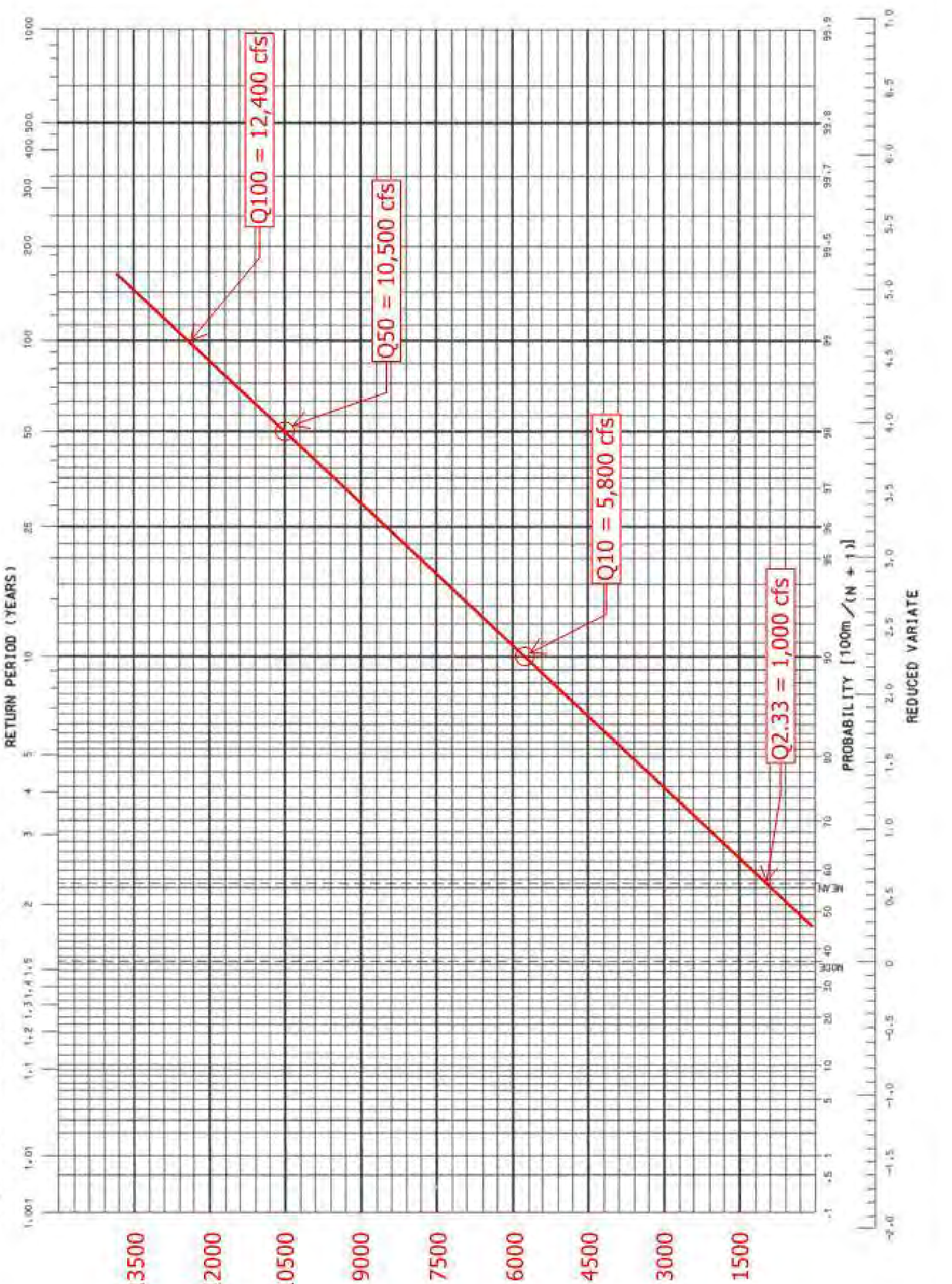
NOTE: METRIC CONVERSION 1 in = 25.4 mm
1 ft = 0.3048 m

FIGURE 2-8

BLACKWATER RIVER DISCHARGES (CONT.)

METHOD No. 3: Determine Discharges by the NEHL/AWM Method (Cont.)

4-36



VTrans Hydraulics Manual, 2015
Figure 4-6. Gumbel Probability Paper

Chapter 4 Hydrology

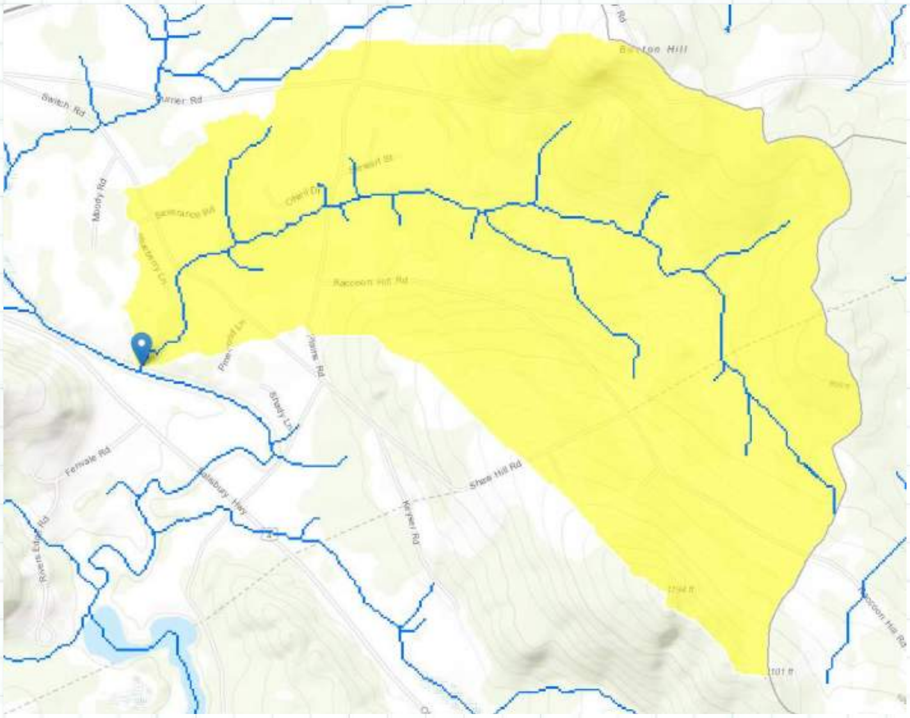
COMPARISON OF BLACKWATER RIVER DISCHARGES

		Blackwater River Flow at Route 4 (cfs)			
Method #		**1**	**2a**	**2b**	**3**
Source of Flow Data		**StreamStats (Modified Basin)**	**FHWA Runoff Estimates for Small Rural Watersheds (1977)**		**NHDOT Drainage Design Manual (1998)**
Method of Flow Calc.		Olson, S.A., 2009	7-parameter method	5-parameter method	NEHL/AWM Method
DA		99.1 mi^2	99.1 mi2	99.1 mi2	99.1 mi2
Recurrence Interval (yrs)	2	2450	-	-	-
	2.33	-	3049	2457	1000
	5	3670	-	-	-
	10	4630	-	-	5800
	25	5840	-	-	-
	50	6800	11399	9145	10500
	100	7930	13502	10818	12400
	500	10500	-	-	-
% Higher than StreamStats (Q50)		0%	68%	34%	54%

- The flows are variable among the different methods for each recurrence interval. It should be noted though that the drainage area for the FHWA method is on the upper limit of it's use and the NEHL-AWM Method is based on outdated information. However, both the FHWA and NEHL-AWM flow values are within the upper confidence interval for the StreamStats values. Therefore, use the StreamStats values from the modified basin for the hydraulic analysis.

TRIBUTARY STREAM DISCHARGES AT UPSTREAM CONFLUENCE

- The upstream confluence with the unnamed brook is located approximately 3,500' from the bridge.



Peak-Flow Statistics Parameters[Peak Flow Statewide SIR2008 5206]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.68	square miles	0.7	1290
APRAVPRE	Mean April Precipitation	3.635	inches	2.79	6.23
WETLAND	Percent Wetlands	2.8531	percent	0	21.8
CSL10_85	Stream Slope 10 and 85 Method	90.9	feet per mi	5.43	543

Peak-Flow Statistics Flow Report[Peak Flow Statewide SIR2008 5206]

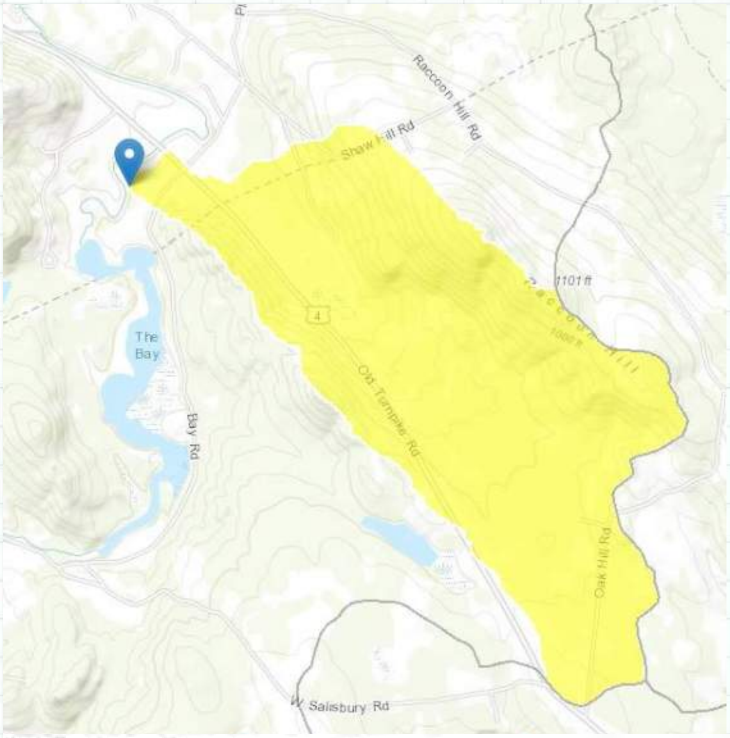
PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp	Equiv. Yrs.
2 Year Peak Flood	63.6	ft^3/s	38.9	104	30.1	3.2
5 Year Peak Flood	108	ft^3/s	64.8	178	31.1	4.7
10 Year Peak Flood	145	ft^3/s	85.9	246	32.3	6.2
25 Year Peak Flood	199	ft^3/s	113	348	34.3	8
50 Year Peak Flood	243	ft^3/s	135	440	36.4	9
100 Year Peak Flood	298	ft^3/s	159	557	38.6	9.8
500 Year Peak Flood	434	ft^3/s	213	882	44.1	11

- The full StreamStats report is included at the end of these calculations.

TRIBUTARY STREAM DISCHARGES AT DOWNSTREAM CONFLUENCE

- The downstream confluence with the unnamed brook is located approximately 1,700' from the bridge.



Peak-Flow Statistics Parameters [Peak Flow Statewide SIR2008 5206]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.7	square miles	0.7	1290
APRAVPRE	Mean April Precipitation	3.692	inches	2.79	6.23
WETLAND	Percent Wetlands	7.3674	percent	0	21.8
CSL10_85	Stream Slope 10 and 85 Method	95.3	feet per mi	5.43	543

Peak-Flow Statistics Flow Report [Peak Flow Statewide SIR2008 5206]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	Plu	SEp	Equiv. Yrs.
2 Year Peak Flood	51.5	ft^3/s	31.6	83.9	30.1	3.2
5 Year Peak Flood	87.4	ft^3/s	52.9	144	31.1	4.7
10 Year Peak Flood	118	ft^3/s	70.1	199	32.3	6.2
25 Year Peak Flood	161	ft^3/s	92.4	281	34.3	8
50 Year Peak Flood	197	ft^3/s	110	354	36.4	9
100 Year Peak Flood	240	ft^3/s	129	447	38.6	9.8
500 Year Peak Flood	348	ft^3/s	173	703	44.1	11

- The full StreamStats report is included at the end of these calculations.

DISCHARGES AND BOUNDARY CONDITIONS FOR HYDRAULIC MODEL

- The flows for the Blackwater River and the two tributaries used in the hydraulic model will be based on the StreamStats values as previously explained.

- The flow for the Blackwater River is input into the model upstream of the upstream confluence, so it should have the flow from the upstream tributary stream subtracted from it. However, because the StreamStats flows were lower than the check methods and the discharge from the tributary is minimal in comparison, the full flow is used.

- In the model, the inlet boundary conditions for the Blackwater River and both tributaries were all assumed to be a subcritical condition with constants flows.

- The flow used to determine the downstream boundary condition is based on the summation of the three discharges (see table below).

- The downstream outlet boundary condition also assumed a subcritical condition, but used a constant water surface elevation, which the program determined using the topography, the flow of the river and tributaries, a composite roughness coefficient of 0.06 for the channel (n=0.04) and overbanks (n=0.06 to 0.10), and a normal channel slope of 0.0005 ft/ft based on the known topography and bathymetry (see next sheet).

Storm Event	Blackwater River*	US Tributary	DS Tributary	Total
Q2	2450	63.6	51.5	2565
Q5	3670	108	87.4	3865
Q10	4630	145	118	4893
Q25	5840	199	161	6200
Q50	6800	243	197	7240
Q100	7930	298	240	8468
Q500	10500	434	348	11282

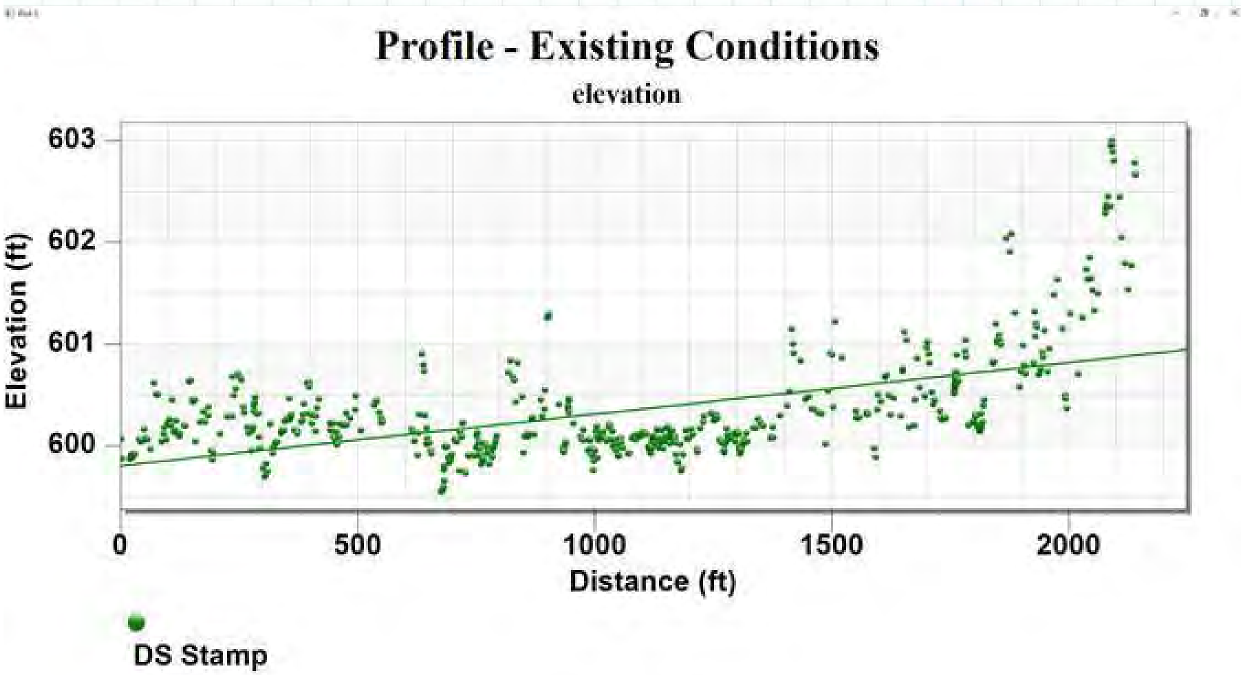
*Modified Basin, DA = 99.1 sq. mi.

DISCHARGES AND BOUNDARY CONDITIONS FOR HYDRAULIC MODEL (CONT.)

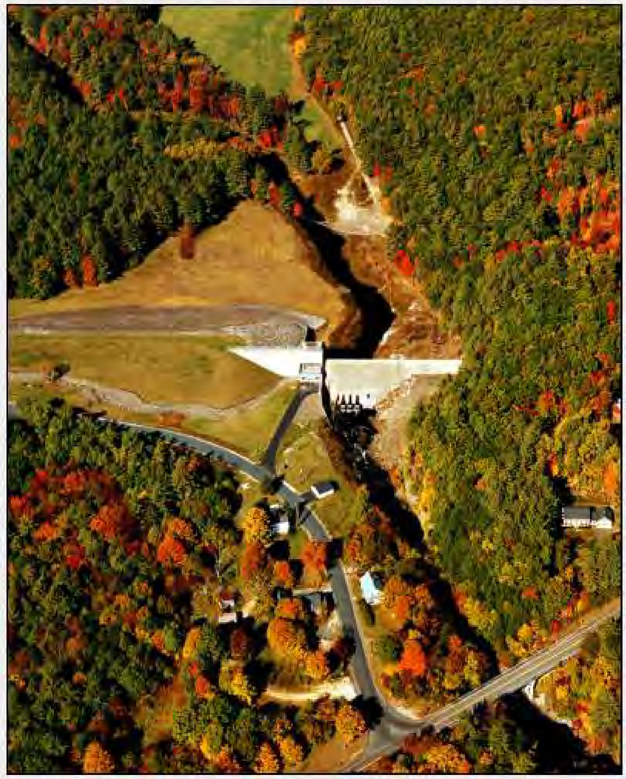
- The slope of the downstream length of the channel (beyond the bathymetric survey) is based on the best fit line of the LiDAR data along the length of the river. The graph below is based on observation data from the hydraulic model.

Slope:

$$n := \frac{600.5\ ft - 600\ ft}{1400\ ft - 400\ ft} = 0.0005\ \frac{ft}{ft}$$



Blackwater Dam Flood Risk Management Project



Blackwater Dam in Webster is located on the Blackwater River, about 18 miles northwest of Concord. From Concord, it can be reached by taking U.S. Route 93 to U.S. Route 4 west, then south on Route 127.

Blackwater Dam significantly reduces flooding in the downstream communities on the Blackwater and Contoocook rivers, including Webster, Hopkinton, and Boscawen. In conjunction with the Franklin Falls Dam and the dams at Hopkinton and Everett Lakes, Blackwater Dam also reduces flooding in the major industrial, commercial, and residential centers on the Merrimack River, including Concord, Manchester, and Nashua, and the Massachusetts cities of Lowell, Lawrence, and Haverhill.

Construction of Blackwater Dam began in May 1940 and was completed in November 1941 at a cost of $1.3 million. The project consists of an earthfill dam with stone slope protection. The dam is 1,150 feet long with a maximum height of 75 feet; there are two earthfill dikes with stone slope protection totaling 1,650 feet. Little Hill Dike, located about three miles northwest of the dam, is 1,230 feet long and has a maximum height of 28 feet; and Dodge Dike, situated about .5 mile west of the dam, is 420 feet long with a maximum height of 20 feet. There are three gated rectangular conduits. Each conduit measures five feet three inches high, three feet six inches wide, and 65 feet long. A fourth ungated rectangular conduit was permanently plugged in 1951 to increase the effectiveness of the reservoir during flood periods. A spillway is cut in rock with a 240-foot-long concrete weir. The weir's crest elevation is 18 feet lower than the top of the dam. The work included relocating about three miles of Route 127 and constructing smaller roads adjacent to the project. The project has prevented $77.4 million in flood damages since it was built (as of September 2011).

There is no lake at Blackwater Dam. The flood storage area of the project covers approximately 3,280 acres and extends upstream about seven miles through Salisbury, having a maximum width of one mile. The entire project, including all associated lands, covers 3,580 acres. Blackwater Dam can store up to 15 billion gallons of water for flood control purposes. This is equivalent to 6.7 inches of water covering its drainage area of 128 square miles.

The **Reservoir Control Center (RCC)** is the "nerve center" for the New England flood control dams such as Blackwater Dam. Using radio and satellite communications, the team constantly monitors river levels and weather conditions that influence flood control decisions. The Reservoir Control Center provides information about river flows, dam operations, snow depths, recreational water releases, and more.

For more information, or for recreation opportunities call (603) 648-6028 or visit the website at: **http://www.nae.usace.army.mil/Missions/Recreation/BlackwaterDam.aspx.**

- Updated: 7 April 2016

https://www.nae.usace.army.mil/Missions/Civil-Works/Flood-Risk-Management/New-Hampshire/Blackwater/

BLACKWATER RIVER DAM & ROUTE 4 BRIDGE OVER BLACKWATER RIVER LOCATION MAP

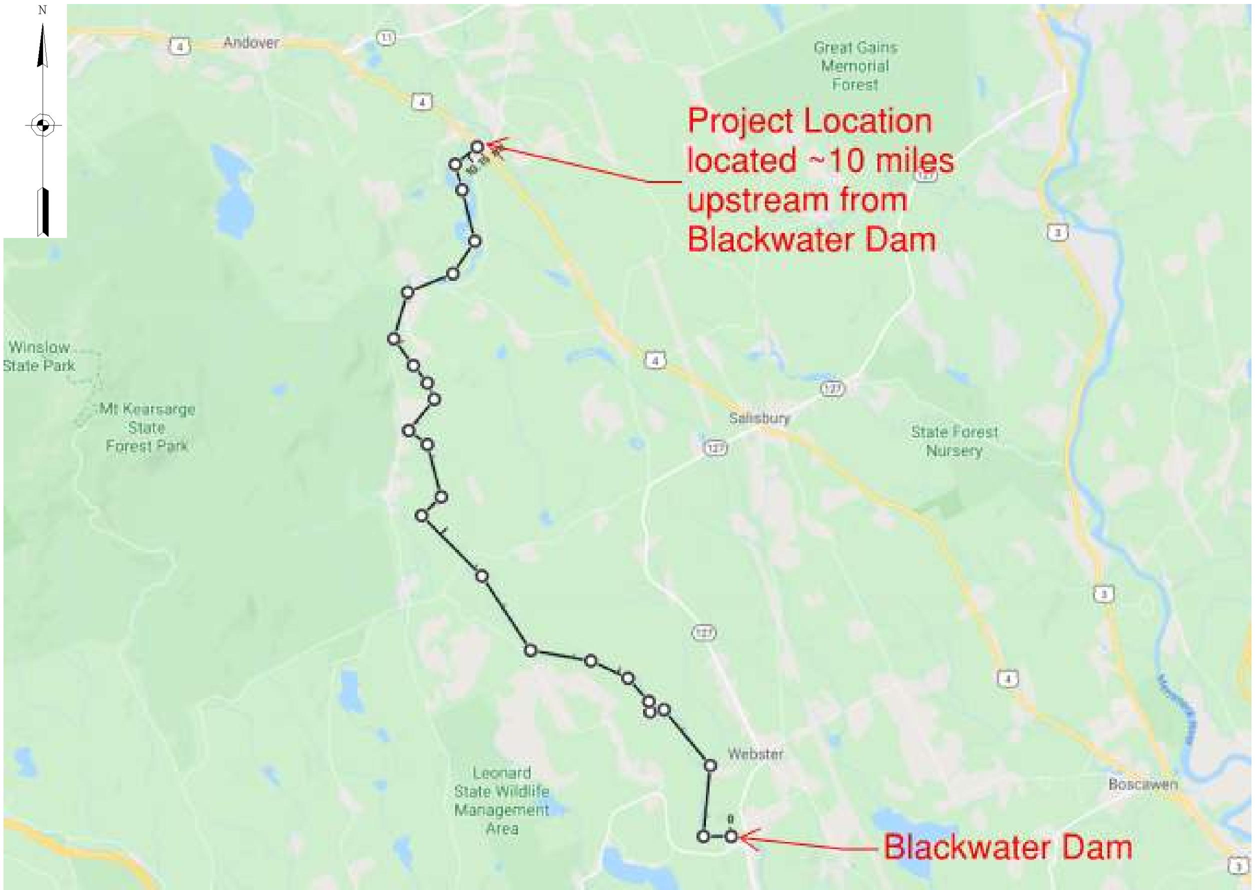


Image Source: Google Maps 07/2020

Route 4 over Blackwater River StreamStats Report - MODIFIED BASIN

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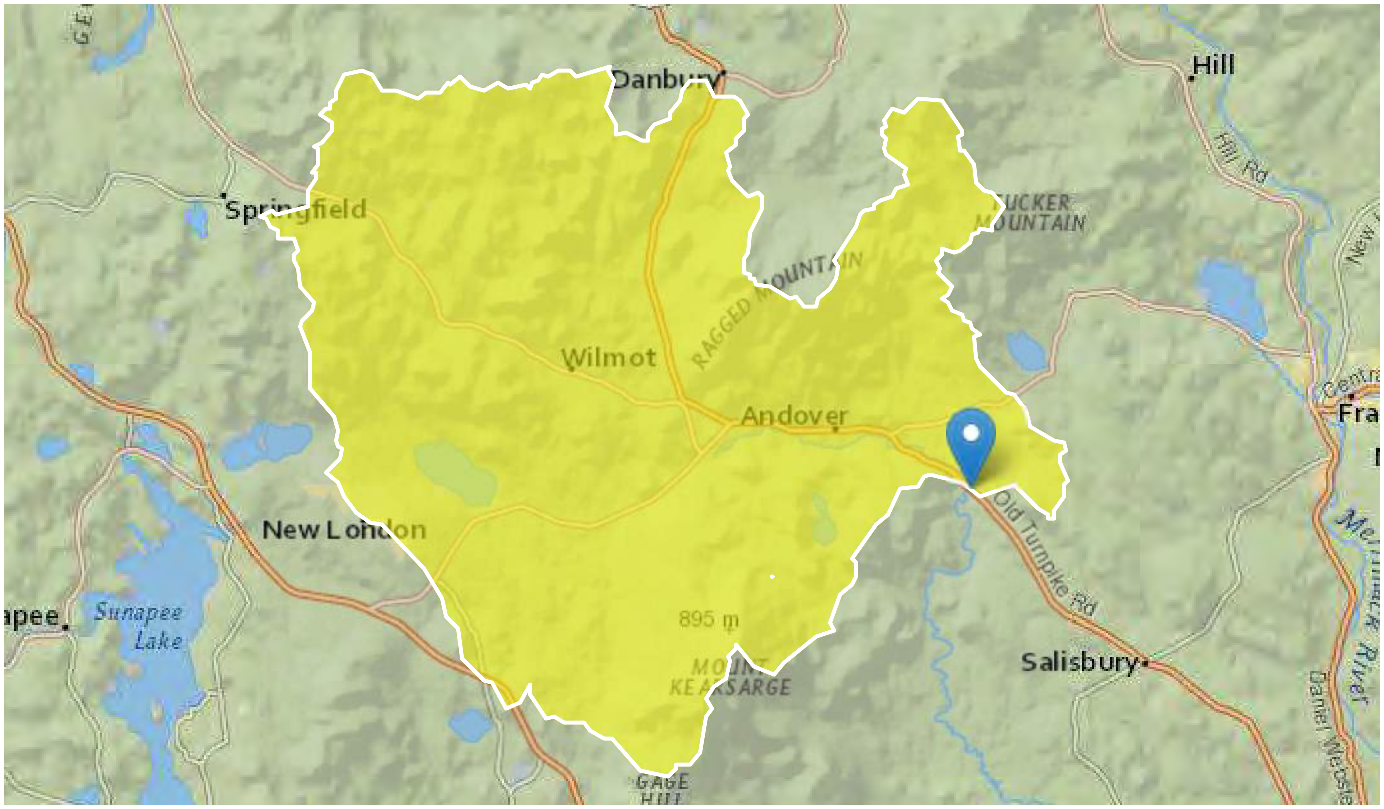

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	99.06	square miles
CONIF	Percentaqe of land surface covered by coniferous forest	23.2265	percent
PREBC0103	Mean annual precipitation of basin centroid for January 1 to March 15 winter period	7.32	inches
BSLDEM30M	Mean basin slope computed from 30 m DEM	13.583	percent

Parameter Code	Parameter Description	Value	Unit
MIXFOR	Percentage of land area covered by mixed deciduous and coniferous forest	30.3453	percent
PREG_03_05	Mean precipitation at gaging station location for March 16 to May 31 spring period	9.1	inches
TEMP	Mean Annual Temperature	43.781	degrees F
TEMP_06_10	Basinwide average temperature for June to October summer period	60.034	degrees F
PREG_06_10	Mean precipitation at gaging station location for June to October summer period	18.1	inches
ELEVMAX	Maximum basin elevation	2923.955	feet
APRAVPRE	Mean April Precipitation	3.642	inches
WETLAND	Percentage of Wetlands	4.9608	percent
CSL10_85	Change in elevation divided by length between points 10 and 85 percent of distance along main channel to basin divide - main channel method not known	46.6	feet per mi
PRECIPOUT	Mean annual precip at the stream outlet (based on annual PRISM precip data in inches from 1971-2000)	43.1	inches
MINTEMP_W	Mean winter minimum air temperature over basin surface area	12.091	degrees F
SNOFALL	Mean Annual Snowfall	91.548	inches
PREBC_1112	Mean annual precipitation of basin centroid for November 1 to December 31 period	7.72	inches
PRECIPCENT	Mean Annual Precip at Basin Centroid	41.9	inches
CENTROIDX	Basin centroid horizontal (x) location in state plane coordinates	924141.8	meters
CENTROIDY	Basin centroid vertical (y) location in state plane units	345495.2	meters
LC11DEV	Percentage of developed (urban) land from NLCD 2011 classes 21-24	4.35	percent
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset	0.75	percent
OUTLETX	Basin outlet horizontal (x) location in state plane coordinates	954975	feet
OUTLETY	Basin outlet vertical (y) location in state plane coordinates	336015	feet

General Disclaimers

This watershed has been edited, computed flows may not apply.

Seasonal Flow Statistics Parameters[Low Flow Statewide]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	99.06	square miles	3.26	689
CONIF	Percent Coniferous Forest	23.2265	percent	3.07	56.2
PREBC0103	Jan to Mar Basin Centroid Precip	7.32	inches	5.79	15.1
BSLDEM30M	Mean Basin Slope from 30m DEM	13.583	percent	3.19	38.1
MIXFOR	Percent Mixed Forest	30.3453	percent	6.21	46.1
PREG_03_05	Mar to May Gage Precipitation	9.1	inches	6.83	11.5
TEMP	Mean Annual Temperature	43.781	degrees F	36	48.7
TEMP_06_10	Jun to Oct Mean Basinwide Temp	60.034	degrees F	52.9	64.4
PREG_06_10	Jun to Oct Gage Precipitation	18.1	inches	16.5	23.1
ELEVMAX	Maximum Basin Elevation	2923.955	feet	260	6290

Seasonal Flow Statistics Flow Report[Low Flow Statewide]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SE	SEp
Jan to Mar15 60 Percent Flow	69.1	ft^3/s	48	95.7	21.2	21.2
Jan to Mar15 70 Percent Flow	59.4	ft^3/s	41.7	81.6	20.7	20.7
Jan to Mar15 80 Percent Flow	49.8	ft^3/s	36.5	66.1	18.2	18.2
Jan to Mar15 90 Percent Flow	39.5	ft^3/s	28.4	53.3	19.3	19.3
Jan to Mar15 95 Percent Flow	31.6	ft^3/s	22.2	43.4	20.7	20.7

Statistic	Value	Unit	PIl	PIu	SE	SEp
Jan to Mar15 98 Percent Flow	25.2	ft^3/s	15.8	37.8	27.1	27.1
Jan to Mar15 7 Day 2 Year Low Flow	51	ft^3/s	38.1	66.3	17.2	17.2
Jan to Mar15 7 Day 10 Year Low Flow	30.8	ft^3/s	21.4	42.6	21.5	21.5
Mar16 to May 60 Percent Flow	239	ft^3/s	194	290	12.2	12.2
Mar16 to May 70 Percent Flow	189	ft^3/s	155	226	11.4	11.4
Mar16 to May 80 Percent Flow	141	ft^3/s	115	172	12.4	12.4
Mar16 to May 90 Percent Flow	97.6	ft^3/s	77.3	121	13.7	13.7
Mar16 to May 95 Percent Flow	71.1	ft^3/s	55.4	89.6	14.8	14.8
Mar16 to May 98 Percent Flow	51.2	ft^3/s	37.6	67.8	18.1	18.1
Mar16 to May 7 Day 2 Year Low Flow	74.8	ft^3/s	58.6	93.6	14.5	14.5
Mar16 to May 7 Day 10 Year Low Flow	43.4	ft^3/s	32.9	55.7	16.2	16.2
Jun to Oct 60 Percent Flow	27.7	ft^3/s	14.6	47.3	36.7	36.7
Jun to Oct 70 Percent Flow	21.2	ft^3/s	10.6	37.7	39.9	39.9
Jun to Oct 80 Percent Flow	17.1	ft^3/s	7.88	32.2	44.5	44.5
Jun to Oct 90 Percent Flow	11.8	ft^3/s	4.88	23.7	50.7	50.7
Jun to Oct 95 Percent Flow	9.27	ft^3/s	3.43	19.8	57	57
Jun to Oct 98 Percent Flow	7	ft^3/s	2.42	15.6	61.1	61.1
Jun to Oct 7 Day 2 Year Low Flow	12.6	ft^3/s	4.67	26.2	55.6	55.6
Jun to Oct 7 Day 10 Year Low Flow	7.17	ft^3/s	1.79	17.7	78.5	78.5
Nov to Dec 60 Percent Flow	90.2	ft^3/s	60.4	129	23.3	23.3
Nov to Dec 70 Percent Flow	72.7	ft^3/s	46.5	107	25.9	25.9
Nov to Dec 80 Percent Flow	57.4	ft^3/s	35.5	86.8	27.8	27.8
Nov to Dec 90 Percent Flow	40.9	ft^3/s	23.6	65	31.6	31.6
Nov to Dec 95 Percent Flow	31.4	ft^3/s	16.1	54.2	38.3	38.3
Nov to Dec 98 Percent Flow	23.9	ft^3/s	9.82	47.2	50.6	50.6
Oct to Nov 7 Day 2 Year Low Flow	57.9	ft^3/s	38.8	82	23.3	23.3
Oct to Nov 7 Day 10 Year Low Flow	29.6	ft^3/s	15.6	49.4	36.6	36.6

Seasonal Flow Statistics Citations

Flynn, R.H. and Tasker, G.D.,2002, Development of Regression Equations to Estimate Flow Durations and Low-Flow-Frequency Statistics in New Hampshire Streams: U.S.Geological

Survey Scientific Investigations Report 02-4298, 66 p. (http://pubs.water.usgs.gov/wrir02-4298)

Flow-Duration Statistics Parameters[Low Flow Statewide]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	99.06	square miles	3.26	689
PREG_06_10	Jun to Oct Gage Precipitation	18.1	inches	16.5	23.1
TEMP	Mean Annual Temperature	43.781	degrees F	36	48.7

Flow-Duration Statistics Flow Report[Low Flow Statewide]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SE	SEp
60 Percent Duration	69.1	ft^3/s	50.8	91.5	18	18
70 Percent Duration	48.2	ft^3/s	33.8	66.3	20.6	20.6
80 Percent Duration	32.1	ft^3/s	19.8	48.9	28	28
90 Percent Duration	19.1	ft^3/s	9.91	32.9	37.5	37.5
95 Percent Duration	13.2	ft^3/s	6.09	24.5	44.1	44.1
98 Percent Duration	9.53	ft^3/s	3.69	19.8	54.3	54.3

Flow-Duration Statistics Citations

Flynn, R.H. and Tasker, G.D.,2002, Development of Regression Equations to Estimate Flow Durations and Low-Flow-Frequency Statistics in New Hampshire Streams: U.S.Geological Survey Scientific Investigations Report 02-4298, 66 p. (http://pubs.water.usgs.gov/wrir02-4298)

Low-Flow Statistics Parameters[Low Flow Statewide]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	99.06	square miles	3.26	689
TEMP	Mean Annual Temperature	43.781	degrees F	36	48.7

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
PREG_06_10	Jun to Oct Gage Precipitation	18.1	inches	16.5	23.1

Low-Flow Statistics Flow Report[Low Flow Statewide]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SE	SEp
7 Day 2 Year Low Flow	13	ft^3/s	4.85	26.7	55.7	55.7
7 Day 10 Year Low Flow	7.44	ft^3/s	1.82	18.6	79.4	79.4

Low-Flow Statistics Citations

Flynn, R.H. and Tasker, G.D.,2002, Development of Regression Equations to Estimate Flow Durations and Low-Flow-Frequency Statistics in New Hampshire Streams: U.S.Geological Survey Scientific Investigations Report 02-4298, 66 p. (http://pubs.water.usgs.gov/wrir02-4298)

Peak-Flow Statistics Parameters[Peak Flow Statewide SIR2008 5206]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	99.06	square miles	0.7	1290
APRAVPRE	Mean April Precipitation	3.642	inches	2.79	6.23
WETLAND	Percent Wetlands	4.9608	percent	0	21.8
CSL10_85	Stream Slope 10 and 85 Method	46.6	feet per mi	5.43	543

Peak-Flow Statistics Flow Report[Peak Flow Statewide SIR2008 5206]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp	Equiv. Yrs.
2 Year Peak Flood	2450	ft^3/s	1520	3970	30.1	3.2
5 Year Peak Flood	3670	ft^3/s	2240	6010	31.1	4.7
10 Year Peak Flood	4630	ft^3/s	2780	7710	32.3	6.2

Statistic	Value	Unit	PIl	PIu	SEp	Equiv. Yrs.
25 Year Peak Flood	5840	ft^3/s	3400	10000	34.3	8
50 Year Peak Flood	6800	ft^3/s	3840	12000	36.4	9
100 Year Peak Flood	7930	ft^3/s	4340	14500	38.6	9.8
500 Year Peak Flood	10500	ft^3/s	5300	20700	44.1	11

Peak-Flow Statistics Citations

Olson, S.A.,2009, Estimation of flood discharges at selected recurrence intervals for streams in New Hampshire: U.S.Geological Survey Scientific Investigations Report 2008-5206, 57 p. (http://pubs.usgs.gov/sir/2008/5206/)

Recharge Statistics Parameters[Groundwater Recharge Statewide 2004 5019]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
PRECIPOUT	Mean Annual Precip at Gage	43.1	inches	35.83	53.11
TEMP	Mean Annual Temperature	43.781	degrees F	36.05	48.69
MINTEMP_W	Mean Winter Min Temperature	12.091	degrees F	0.8	19.88
CONIF	Percent Coniferous Forest	23.2265	percent	3.07	56.18
PREG_03_05	Mar to May Gage Precipitation	9.1	inches	6.83	11.54
SNOFALL	Mean Annual Snowfall	91.548	inches	54.46	219.07
PREG_06_10	Jun to Oct Gage Precipitation	18.1	inches	16.46	23.11
MIXFOR	Percent Mixed Forest	30.3453	percent	6.21	46.13
PREBC_1112	Nov to Dec Basin Centroid Precip	7.72	inches	6.57	15.2
PRECIPCENT	Mean Annual Precip at Basin Centroid	41.9	inches	37.44	75.91

Recharge Statistics Flow Report[Groundwater Recharge Statewide 2004 5019]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
GW_Recharge_Jan_to_Mar15	4.49	in	15.5
GW_Recharge_Mar16_to_May	8.39	in	12.4

Statistic	Value	Unit	SEp
GW_Recharge_Jun_to_Oct	3.15	in	26.5
GW_Recharge_Nov_to_Dec	3.1	in	15.8
GW_Recharge_Ann	18.7	in	12.4

Recharge Statistics Citations

Flynn, R.H. and Tasker, G.D.,2004, Generalized Estimates from Streamflow Data of Annual and Seasonal Ground-Water-Recharge Rates for Drainage Basins in New Hampshire, U.S. Geological Survey Scientific Investigations Report 2004-5019, 67 p. (http://pubs.usgs.gov/sir/2004/5019/http://pubs.usgs.gov/sir/2004/5019/)

Application Version: 4.3.11

Brook @ US Confluence StreamStats Report

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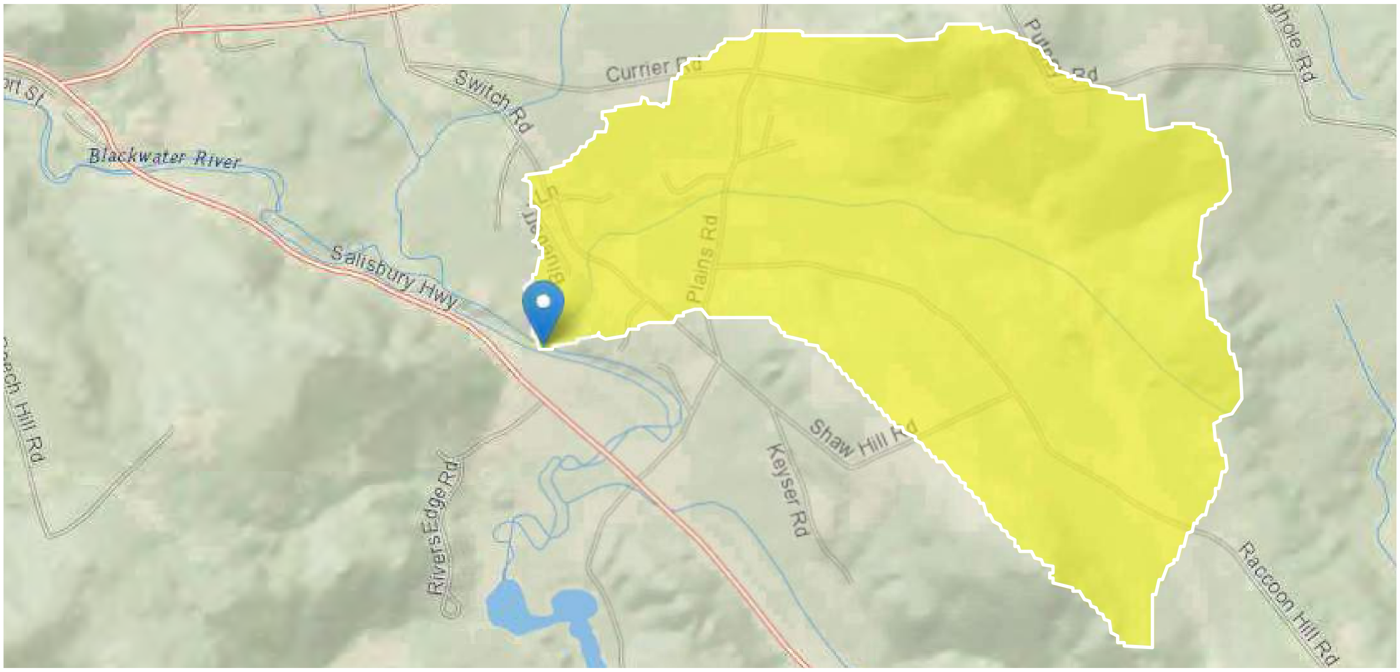


Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	1.68	square miles
CONIF	Percentaqe of land surface covered by coniferous forest	28.5123	percent
PREBC0103	Mean annual precipitation of basin centroid for January 1 to March 15 winter period	7.87	inches
BSLDEM30M	Mean basin slope computed from 30 m DEM	8.517	percent
MIXFOR	Percentage of land area covered by mixed deciduous and coniferous forest	29.0086	percent
PREG_03_05	Mean precipitation at gaging station location for March 16 to May 31 spring period	9.1	inches
TEMP	Mean Annual Temperature	43.971	degrees F
TEMP_06_10	Basinwide average temperature for June to October summer period	60.301	degrees F
PREG_06_10	Mean precipitation at gaging station location for June to October summer period	18.1	inches
ELEVMAX	Maximum basin elevation	1184.138	feet

Parameter Code	Parameter Description	Value	Unit
APRAVPRE	Mean April Precipitation	3.635	inches
WETLAND	Percentage of Wetlands	2.8531	percent
CSL10_85	Change in elevation divided by length between points 10 and 85 percent of distance along main channel to basin divide - main channel method not known	90.9	feet per mi
PRECIPOUT	Mean annual precip at the stream outlet (based on annual PRISM precip data in inches from 1971-2000)	43.2	inches
MINTEMP_W	Mean winter minimum air temperature over basin surface area	11.848	degrees F
SNOFALL	Mean Annual Snowfall	85.886	inches
PREBC_1112	Mean annual precipitation of basin centroid for November 1 to December 31 period	8.19	inches
PRECIPCENT	Mean Annual Precip at Basin Centroid	43.1	inches

Seasonal Flow Statistics Parameters[Low Flow Statewide]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.68	square miles	3.26	689
CONIF	Percent Coniferous Forest	28.5123	percent	3.07	56.2
PREBC0103	Jan to Mar Basin Centroid Precip	7.87	inches	5.79	15.1
BSLDEM30M	Mean Basin Slope from 30m DEM	8.517	percent	3.19	38.1
MIXFOR	Percent Mixed Forest	29.0086	percent	6.21	46.1
PREG_03_05	Mar to May Gage Precipitation	9.1	inches	6.83	11.5
TEMP	Mean Annual Temperature	43.971	degrees F	36	48.7
TEMP_06_10	Jun to Oct Mean Basinwide Temp	60.301	degrees F	52.9	64.4
PREG_06_10	Jun to Oct Gage Precipitation	18.1	inches	16.5	23.1
ELEVMAX	Maximum Basin Elevation	1184.138	feet	260	6290

Seasonal Flow Statistics Disclaimers[Low Flow Statewide]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Seasonal Flow Statistics Flow Report[Low Flow Statewide]

Statistic	Value	Unit
Jan to Mar15 60 Percent Flow	0.947	ft^3/s
Jan to Mar15 70 Percent Flow	0.791	ft^3/s
Jan to Mar15 80 Percent Flow	0.691	ft^3/s
Jan to Mar15 90 Percent Flow	0.524	ft^3/s
Jan to Mar15 95 Percent Flow	0.418	ft^3/s

Statistic	Value	Unit
Jan to Mar15 98 Percent Flow	0.35	ft^3/s
Jan to Mar15 7 Day 2 Year Low Flow	0.702	ft^3/s
Jan to Mar15 7 Day 10 Year Low Flow	0.38	ft^3/s
Mar16 to May 60 Percent Flow	3.32	ft^3/s
Mar16 to May 70 Percent Flow	2.62	ft^3/s
Mar16 to May 80 Percent Flow	2.01	ft^3/s
Mar16 to May 90 Percent Flow	1.45	ft^3/s
Mar16 to May 95 Percent Flow	1.09	ft^3/s
Mar16 to May 98 Percent Flow	0.767	ft^3/s
Mar16 to May 7 Day 2 Year Low Flow	1.04	ft^3/s
Mar16 to May 7 Day 10 Year Low Flow	0.561	ft^3/s
Jun to Oct 60 Percent Flow	0.205	ft^3/s
Jun to Oct 70 Percent Flow	0.146	ft^3/s
Jun to Oct 80 Percent Flow	0.117	ft^3/s
Jun to Oct 90 Percent Flow	0.071	ft^3/s
Jun to Oct 95 Percent Flow	0.0467	ft^3/s
Jun to Oct 98 Percent Flow	0.0391	ft^3/s
Jun to Oct 7 Day 2 Year Low Flow	0.0812	ft^3/s
Jun to Oct 7 Day 10 Year Low Flow	0.0254	ft^3/s
Nov to Dec 60 Percent Flow	1.48	ft^3/s
Nov to Dec 70 Percent Flow	1.09	ft^3/s
Nov to Dec 80 Percent Flow	0.791	ft^3/s
Nov to Dec 90 Percent Flow	0.487	ft^3/s
Nov to Dec 95 Percent Flow	0.301	ft^3/s
Nov to Dec 98 Percent Flow	0.176	ft^3/s
Oct to Nov 7 Day 2 Year Low Flow	0.786	ft^3/s
Oct to Nov 7 Day 10 Year Low Flow	0.288	ft^3/s

Seasonal Flow Statistics Citations

Flynn, R.H. and Tasker, G.D.,2002, Development of Regression Equations to Estimate Flow Durations and Low-Flow-Frequency Statistics in New Hampshire Streams: U.S.Geological Survey Scientific Investigations Report 02-4298, 66 p. (http://pubs.water.usgs.gov/wrir02-4298)

Flow-Duration Statistics Parameters[Low Flow Statewide]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.68	square miles	3.26	689
PREG_06_10	Jun to Oct Gage Precipitation	18.1	inches	16.5	23.1

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
TEMP	Mean Annual Temperature	43.971	degrees F	36	48.7

Flow-Duration Statistics Disclaimers[Low Flow Statewide]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Flow-Duration Statistics Flow Report[Low Flow Statewide]

Statistic	Value	Unit
60 Percent Duration	0.827	ft^3/s
70 Percent Duration	0.545	ft^3/s
80 Percent Duration	0.301	ft^3/s
90 Percent Duration	0.144	ft^3/s
95 Percent Duration	0.0845	ft^3/s
98 Percent Duration	0.0499	ft^3/s

Flow-Duration Statistics Citations

Flynn, R.H. and Tasker, G.D.,2002, Development of Regression Equations to Estimate Flow Durations and Low-Flow-Frequency Statistics in New Hampshire Streams: U.S.Geological Survey Scientific Investigations Report 02-4298, 66 p. (http://pubs.water.usgs.gov/wrir02-4298)

Low-Flow Statistics Parameters[Low Flow Statewide]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.68	square miles	3.26	689
TEMP	Mean Annual Temperature	43.971	degrees F	36	48.7
PREG_06_10	Jun to Oct Gage Precipitation	18.1	inches	16.5	23.1

Low-Flow Statistics Disclaimers[Low Flow Statewide]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Low-Flow Statistics Flow Report[Low Flow Statewide]

Statistic	Value	Unit
7 Day 2 Year Low Flow	0.079	ft^3/s
7 Day 10 Year Low Flow	0.0244	ft^3/s

Low-Flow Statistics Citations

Flynn, R.H. and Tasker, G.D.,2002, Development of Regression Equations to Estimate Flow Durations and Low-Flow-Frequency Statistics in New Hampshire Streams: U.S.Geological Survey Scientific Investigations Report 02-4298, 66 p. (http://pubs.water.usgs.gov/wrir02-4298)

Peak-Flow Statistics Parameters[Peak Flow Statewide SIR2008 5206]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.68	square miles	0.7	1290
APRAVPRE	Mean April Precipitation	3.635	inches	2.79	6.23
WETLAND	Percent Wetlands	2.8531	percent	0	21.8
CSL10_85	Stream Slope 10 and 85 Method	90.9	feet per mi	5.43	543

Peak-Flow Statistics Flow Report[Peak Flow Statewide SIR2008 5206]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	PIu	SEp	Equiv. Yrs.
2 Year Peak Flood	63.6	ft^3/s	38.9	104	30.1	3.2
5 Year Peak Flood	108	ft^3/s	64.8	178	31.1	4.7
10 Year Peak Flood	145	ft^3/s	85.9	246	32.3	6.2
25 Year Peak Flood	199	ft^3/s	113	348	34.3	8
50 Year Peak Flood	243	ft^3/s	135	440	36.4	9
100 Year Peak Flood	298	ft^3/s	159	557	38.6	9.8
500 Year Peak Flood	434	ft^3/s	213	882	44.1	11

Peak-Flow Statistics Citations

Olson, S.A.,2009, Estimation of flood discharges at selected recurrence intervals for streams in New Hampshire: U.S.Geological Survey Scientific Investigations Report 2008-5206, 57 p. (http://pubs.usgs.gov/sir/2008/5206/)

Recharge Statistics Parameters[Groundwater Recharge Statewide 2004 5019]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
PRECIPOUT	Mean Annual Precip at Gage	43.2	inches	35.83	53.11
TEMP	Mean Annual Temperature	43.971	degrees F	36.05	48.69
MINTEMP_W	Mean Winter Min Temperature	11.848	degrees F	0.8	19.88
CONIF	Percent Coniferous Forest	28.5123	percent	3.07	56.18
PREG_03_05	Mar to May Gage Precipitation	9.1	inches	6.83	11.54
SNOFALL	Mean Annual Snowfall	85.886	inches	54.46	219.07
PREG_06_10	Jun to Oct Gage Precipitation	18.1	inches	16.46	23.11
MIXFOR	Percent Mixed Forest	29.0086	percent	6.21	46.13
PREBC_1112	Nov to Dec Basin Centroid Precip	8.19	inches	6.57	15.2
PRECIPCENT	Mean Annual Precip at Basin Centroid	43.1	inches	37.44	75.91

Recharge Statistics Flow Report[Groundwater Recharge Statewide 2004 5019]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
GW_Recharge_Jan_to_Mar15	4.25	in	15.5
GW_Recharge_Mar16_to_May	7.97	in	12.4
GW_Recharge_Jun_to_Oct	3.16	in	26.5
GW_Recharge_Nov_to_Dec	3.08	in	15.8
GW_Recharge_Ann	18.4	in	12.4

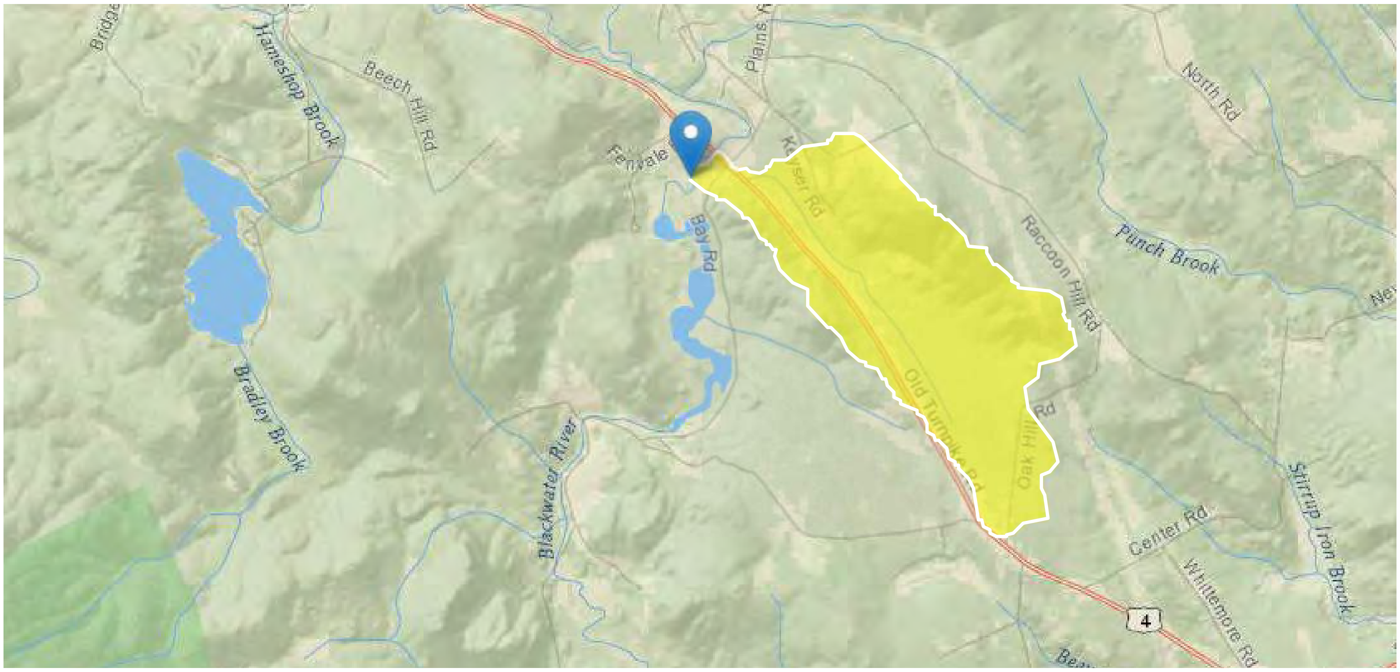
Recharge Statistics Citations

Flynn, R.H. and Tasker, G.D.,2004, Generalized Estimates from Streamflow Data of Annual and Seasonal Ground-Water-Recharge Rates for Drainage Basins in New Hampshire, U.S. Geological Survey Scientific Investigations Report 2004-5019, 67 p. (http://pubs.usgs.gov/sir/2004/5019/http://pubs.usgs.gov/sir/2004/5019/)

Application Version: 4.3.11

Brook @ DS Confluence StreamStats Report

Region ID: NH
Workspace ID: NH20200514122647777000
Clicked Point (Latitude, Longitude): 43.41967, -71.77896
Time: 2020-05-14 08:27:04 -0400



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	1.7	square miles
CONIF	Percentaqe of land surface covered by coniferous forest	24.1165	percent
PREBC0103	Mean annual precipitation of basin centroid for January 1 to March 15 winter period	7.83	inches
BSLDEM30M	Mean basin slope computed from 30 m DEM	11.038	percent
MIXFOR	Percentage of land area covered by mixed deciduous and coniferous forest	37.6468	percent
PREG_03_05	Mean precipitation at gaging station location for March 16 to May 31 spring period	9.1	inches
TEMP	Mean Annual Temperature	44.06	degrees F
TEMP_06_10	Basinwide average temperature for June to October summer period	60.371	degrees F
PREG_06_10	Mean precipitation at gaging station location for June to October summer period	18.1	inches
ELEVMAX	Maximum basin elevation	1184.138	feet

Parameter Code	Parameter Description	Value	Unit
APRAVPRE	Mean April Precipitation	3.692	inches
WETLAND	Percentage of Wetlands	7.3674	percent
CSL10_85	Change in elevation divided by length between points 10 and 85 percent of distance along main channel to basin divide - main channel method not known	95.3	feet per mi
PRECIPOUT	Mean annual precip at the stream outlet (based on annual PRISM precip data in inches from 1971-2000)	43.1	inches
MINTEMP_W	Mean winter minimum air temperature over basin surface area	12.003	degrees F
SNOFALL	Mean Annual Snowfall	83.436	inches
PREBC_1112	Mean annual precipitation of basin centroid for November 1 to December 31 period	8.15	inches
PRECIPCENT	Mean Annual Precip at Basin Centroid	43.1	inches

Seasonal Flow Statistics Parameters[Low Flow Statewide]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.7	square miles	3.26	689
CONIF	Percent Coniferous Forest	24.1165	percent	3.07	56.2
PREBC0103	Jan to Mar Basin Centroid Precip	7.83	inches	5.79	15.1
BSLDEM30M	Mean Basin Slope from 30m DEM	11.038	percent	3.19	38.1
MIXFOR	Percent Mixed Forest	37.6468	percent	6.21	46.1
PREG_03_05	Mar to May Gage Precipitation	9.1	inches	6.83	11.5
TEMP	Mean Annual Temperature	44.06	degrees F	36	48.7
TEMP_06_10	Jun to Oct Mean Basinwide Temp	60.371	degrees F	52.9	64.4
PREG_06_10	Jun to Oct Gage Precipitation	18.1	inches	16.5	23.1
ELEVMAX	Maximum Basin Elevation	1184.138	feet	260	6290

Seasonal Flow Statistics Disclaimers[Low Flow Statewide]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Seasonal Flow Statistics Flow Report[Low Flow Statewide]

Statistic	Value	Unit
Jan to Mar15 60 Percent Flow	1	ft^3/s
Jan to Mar15 70 Percent Flow	0.84	ft^3/s
Jan to Mar15 80 Percent Flow	0.73	ft^3/s
Jan to Mar15 90 Percent Flow	0.549	ft^3/s
Jan to Mar15 95 Percent Flow	0.437	ft^3/s

Statistic	Value	Unit
Jan to Mar15 98 Percent Flow	0.363	ft^3/s
Jan to Mar15 7 Day 2 Year Low Flow	0.735	ft^3/s
Jan to Mar15 7 Day 10 Year Low Flow	0.397	ft^3/s
Mar16 to May 60 Percent Flow	3.64	ft^3/s
Mar16 to May 70 Percent Flow	2.86	ft^3/s
Mar16 to May 80 Percent Flow	2.11	ft^3/s
Mar16 to May 90 Percent Flow	1.48	ft^3/s
Mar16 to May 95 Percent Flow	1.08	ft^3/s
Mar16 to May 98 Percent Flow	0.751	ft^3/s
Mar16 to May 7 Day 2 Year Low Flow	1.08	ft^3/s
Mar16 to May 7 Day 10 Year Low Flow	0.579	ft^3/s
Jun to Oct 60 Percent Flow	0.213	ft^3/s
Jun to Oct 70 Percent Flow	0.152	ft^3/s
Jun to Oct 80 Percent Flow	0.117	ft^3/s
Jun to Oct 90 Percent Flow	0.071	ft^3/s
Jun to Oct 95 Percent Flow	0.0466	ft^3/s
Jun to Oct 98 Percent Flow	0.0389	ft^3/s
Jun to Oct 7 Day 2 Year Low Flow	0.0813	ft^3/s
Jun to Oct 7 Day 10 Year Low Flow	0.0254	ft^3/s
Nov to Dec 60 Percent Flow	1.52	ft^3/s
Nov to Dec 70 Percent Flow	1.13	ft^3/s
Nov to Dec 80 Percent Flow	0.823	ft^3/s
Nov to Dec 90 Percent Flow	0.511	ft^3/s
Nov to Dec 95 Percent Flow	0.318	ft^3/s
Nov to Dec 98 Percent Flow	0.187	ft^3/s
Oct to Nov 7 Day 2 Year Low Flow	0.811	ft^3/s
Oct to Nov 7 Day 10 Year Low Flow	0.303	ft^3/s

Seasonal Flow Statistics Citations

Flynn, R.H. and Tasker, G.D.,2002, Development of Regression Equations to Estimate Flow Durations and Low-Flow-Frequency Statistics in New Hampshire Streams: U.S.Geological Survey Scientific Investigations Report 02-4298, 66 p. (http://pubs.water.usgs.gov/wrir02-4298)

Flow-Duration Statistics Parameters[Low Flow Statewide]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.7	square miles	3.26	689
PREG_06_10	Jun to Oct Gage Precipitation	18.1	inches	16.5	23.1

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
TEMP	Mean Annual Temperature	44.06	degrees F	36	48.7

Flow-Duration Statistics Disclaimers[Low Flow Statewide]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Flow-Duration Statistics Flow Report[Low Flow Statewide]

Statistic	Value	Unit
60 Percent Duration	0.838	ft^3/s
70 Percent Duration	0.551	ft^3/s
80 Percent Duration	0.303	ft^3/s
90 Percent Duration	0.144	ft^3/s
95 Percent Duration	0.0847	ft^3/s
98 Percent Duration	0.0499	ft^3/s

Flow-Duration Statistics Citations

Flynn, R.H. and Tasker, G.D.,2002, Development of Regression Equations to Estimate Flow Durations and Low-Flow-Frequency Statistics in New Hampshire Streams: U.S.Geological Survey Scientific Investigations Report 02-4298, 66 p. (http://pubs.water.usgs.gov/wrir02-4298)

Low-Flow Statistics Parameters[Low Flow Statewide]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.7	square miles	3.26	689
TEMP	Mean Annual Temperature	44.06	degrees F	36	48.7
PREG_06_10	Jun to Oct Gage Precipitation	18.1	inches	16.5	23.1

Low-Flow Statistics Disclaimers[Low Flow Statewide]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Low-Flow Statistics Flow Report[Low Flow Statewide]

Statistic	Value	Unit
7 Day 2 Year Low Flow	0.0793	ft^3/s
7 Day 10 Year Low Flow	0.0244	ft^3/s

Low-Flow Statistics Citations

Flynn, R.H. and Tasker, G.D.,2002, Development of Regression Equations to Estimate Flow Durations and Low-Flow-Frequency Statistics in New Hampshire Streams: U.S.Geological Survey Scientific Investigations Report 02-4298, 66 p. (http://pubs.water.usgs.gov/wrir02-4298)

Peak-Flow Statistics Parameters[Peak Flow Statewide SIR2008 5206]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.7	square miles	0.7	1290
APRAVPRE	Mean April Precipitation	3.692	inches	2.79	6.23
WETLAND	Percent Wetlands	7.3674	percent	0	21.8
CSL10_85	Stream Slope 10 and 85 Method	95.3	feet per mi	5.43	543

Peak-Flow Statistics Flow Report[Peak Flow Statewide SIR2008 5206]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp	Equiv. Yrs.
2 Year Peak Flood	51.5	ft^3/s	31.6	83.9	30.1	3.2
5 Year Peak Flood	87.4	ft^3/s	52.9	144	31.1	4.7
10 Year Peak Flood	118	ft^3/s	70.1	199	32.3	6.2
25 Year Peak Flood	161	ft^3/s	92.4	281	34.3	8
50 Year Peak Flood	197	ft^3/s	110	354	36.4	9
100 Year Peak Flood	240	ft^3/s	129	447	38.6	9.8
500 Year Peak Flood	348	ft^3/s	173	703	44.1	11

Peak-Flow Statistics Citations

Olson, S.A.,2009, Estimation of flood discharges at selected recurrence intervals for streams in New Hampshire: U.S.Geological Survey Scientific Investigations Report 2008-5206, 57 p. (http://pubs.usgs.gov/sir/2008/5206/)

Recharge Statistics Parameters[Groundwater Recharge Statewide 2004 5019]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
PRECIPOUT	Mean Annual Precip at Gage	43.1	inches	35.83	53.11
TEMP	Mean Annual Temperature	44.06	degrees F	36.05	48.69
MINTEMP_W	Mean Winter Min Temperature	12.003	degrees F	0.8	19.88
CONIF	Percent Coniferous Forest	24.1165	percent	3.07	56.18
PREG_03_05	Mar to May Gage Precipitation	9.1	inches	6.83	11.54
SNOFALL	Mean Annual Snowfall	83.436	inches	54.46	219.07
PREG_06_10	Jun to Oct Gage Precipitation	18.1	inches	16.46	23.11
MIXFOR	Percent Mixed Forest	37.6468	percent	6.21	46.13
PREBC_1112	Nov to Dec Basin Centroid Precip	8.15	inches	6.57	15.2
PRECIPCENT	Mean Annual Precip at Basin Centroid	43.1	inches	37.44	75.91

Recharge Statistics Flow Report[Groundwater Recharge Statewide 2004 5019]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
GW_Recharge_Jan_to_Mar15	4.44	in	15.5
GW_Recharge_Mar16_to_May	8	in	12.4
GW_Recharge_Jun_to_Oct	2.8	in	26.5
GW_Recharge_Nov_to_Dec	3.27	in	15.8
GW_Recharge_Ann	19.2	in	12.4

Recharge Statistics Citations

Flynn, R.H. and Tasker, G.D.,2004, Generalized Estimates from Streamflow Data of Annual and Seasonal Ground-Water-Recharge Rates for Drainage Basins in New Hampshire, U.S. Geological Survey Scientific Investigations Report 2004-5019, 67 p. (http://pubs.usgs.gov/sir/2004/5019/http://pubs.usgs.gov/sir/2004/5019/)

Application Version: 4.3.11

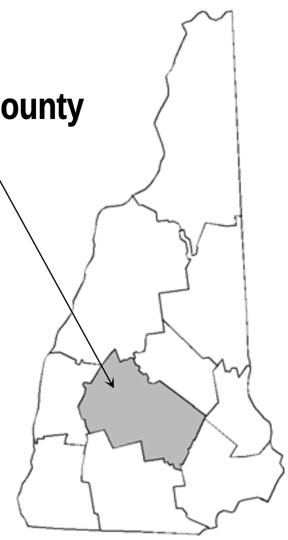
APPENDIX E

FEMA/FIS Excerpts

FLOOD INSURANCE STUDY

VOLUME 1 OF 2

MERRIMACK COUNTY, NEW HAMPSHIRE
(ALL JURISDICTIONS)



COMMUNITY NAME	COMMUNITY NUMBER
ALLENSTOWN, TOWN OF	330103
ANDOVER, TOWN OF	330104
BOSCAWEN, TOWN OF	330105
BOW, TOWN OF	330107
BRADFORD, TOWN OF	330106
CANTERBURY, TOWN OF	330108
CHICHESTER, TOWN OF	330109
CONCORD, CITY OF	330110
DANBURY, TOWN OF	330111
DUNBARTON, TOWN OF	330202
EPSOM, TOWN OF	330112
FRANKLIN, CITY OF	330113
HENNIKER, TOWN OF	330114
HILL, TOWN OF	330214
HOOKSETT, TOWN OF	330115
HOPKINTON, TOWN OF	330116
LOUDON, TOWN OF	330117
NEW LONDON, TOWN OF	330230
NEWBURY, TOWN OF	330226
NORTHFIELD, TOWN OF	330118
PEMBROKE, TOWN OF	330119
PITTSFIELD, TOWN OF	330120
SALISBURY, TOWN OF	330121
SUTTON, TOWN OF	330122
WARNER, TOWN OF	330123
WEBSTER, TOWN OF	330236
WILMOT, TOWN OF	330124

EFFECTIVE:
APRIL 19, 2010

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
33013CV001A

400 feet through the study area and is generally open or wooded with some residential development.

2.3 Principal Flood Problems

In the Towns of Allenstown, Boscawen, Bow, Canterbury, Hooksett, and Pembroke, and the Cities of Concord and Franklin major floods occur on the Merrimack River during the spring, fall, and winter seasons. Some of the more severe flooding occurs in early spring as a result of snowmelt and heavy rains in conjunction with ice jams. Autumn is another critical season for flood danger because of heavy rainfall associated with storms of tropical origin. Minor flooding incidences in the Towns of Allenstown, Boscawen, Bow, Canterbury, Hooksett, Northfield, and Pembroke, and the Cities of Concord and Franklin can occur at any time of the year, as even heavy thunderstorms can result in rapid runoff and flooding in the downstream portion of the small streams.

Repeated damage to structures in the floodplains has occurred in 1936, 1938, 1951, 1953, and 1960; with the 1936 flood being the largest of these floods (USGS, 1974). Analysis of USGS gage station records for the Merrimack River at Goffs Falls (No. 01092000) and other stages (discharge record maintained by Public Service Company of New Hampshire for Garvins Falls) indicates that this 1936 flood exceeded the 100-year event for the Towns of Allenstown, Boscawen, Bow, Canterbury, Hooksett, and Pembroke, and the City of Concord. This same 1936 flood was a 90-year event for the City of Franklin and the Town of Northfield. The estimated frequency of this flood was based on natural discharges, unmodified for the effects of upstream flood control structures built after 1936. Damage due to the 1936 flood was estimated (1936 dollars) at 35 million dollars over the entire Merrimack River watershed (USACE, 1973).

The USGS has operated 2 stream gage stations in the Warner River basin. Gage station No. 01085800 on the West Branch of Warner River near Bradford (drainage area 5.75 square miles) started operating in 1962. During the period from 1962 to 1988, the maximum flood peak recorded was 800 cubic feet per second (cfs). This flood occurred on May 29, 1984. Gage station No. 01086000, on the Warner River at Davisville (drainage area 146 square miles) was operated from 1939 through 1978. During the period of record, the maximum flood peak recorded was 4,510 cfs. This flood occurred on March 27, 1953.

Notable flooding occurred in the Town of Bradford in 1987. According to local residents and officials at the New Hampshire Department of Water Resources, peak elevations of 674.3 feet NAVD and 642.5 feet NAVD occurred on Todd Lake and Lake Massasecum, respectively. The 1987 flood elevations on Todd Lake and Lake Massasecum are less than those expected for a flood with a recurrence interval of 100 years. During flood events extensive low-lying areas along the shores of the Warner River, Todd Lake, and Lake Massasecum are subject to flooding.

In the Town of Chichester, flooding along the Suncook River may occur during all seasons of the year. Frequent flooding occurs along the Suncook River at its junctions with Perry Brook and Sanders Brook. At these locations, water overflows the banks of the Suncook River, flooding the surrounding lowlands.

In March 1936, two floods occurred resulting in one of the largest floods of record for the Towns of Chichester and Pittsfield. The second of these floods was larger and produced the more severe flood conditions. A combination of saturated ground, warm temperatures, melting snow, filled lakes and reservoirs, high river flows from the past storm, and heavy rains from the second storm resulted in a peak discharge of 12,900 cfs at a gage station in North Chichester along the Suncook River. Train service in the area was disrupted and the Suncook Bridge was destroyed. Another large flood resulted from hurricane rains falling on saturated ground in September of 1938. This produced a peak discharge of 12,100 cfs at the gage station. The earliest recorded major flood occurred in 1896.

In the Town of Epsom, flooding along the Suncook and Little Suncook Rivers may occur during all seasons of the year. Some natural floodwater storage exists in the upper portions of the Suncook River. Considerable storage exists in drainage areas contributing to the Little Suncook River. However, at the Little Suncook River confluence with the Suncook River there is considerable flooding. Flood problems also exist at the outlet of Northwood Lake.

Flooding occurred in Epsom on March 13 and 14, 1977, along the Suncook River at Bear Island Park, Epsom-Four Corners, and at the camps along Buck Street Extension.

In the Town of Henniker, flooding along the Contoocook River may occur throughout the year. River stages can rise from normal elevations to extreme flood stages in a relatively short period of time, due to the numerous steep tributaries. The watershed is hilly and largely forest-covered; other than the Edward MacDowell Reservoir on Nubanusit Brook, there is little effective pond or valley storage. During the 1936 flood, the USACE records at the USGS gage in Penacook indicate the Contoocook River was approximately an 80-year event.

One of the largest floods of record occurred along the Contoocook River, which resulted from the September 1938 hurricane (USGS, 1940).

Another large flood occurred in March 1936, which resulted from two closely occurring storms combined with considerable snowmelt. In addition, huge ice flows jammed at bridges and dams, with devastating effects (USGS, 1937).

Extensive flooding occurred in the flat area surrounding the Contoocook Valley Paper Company during both these floods. The State Route 114 bridge in the center of Henniker was destroyed during the 1938 flood.

2.4 Flood Protection Measures

There are five dams designed for flood control on the Merrimack River. They were constructed and are being operated by the New England Division, U.S. Army Corps of Engineers (USACE). These structures are the Franklin Falls Dam on the Pemigewasset River, the Edward MacDowell Dam on Nubanusit Brook, the Blackwater Dam on the Blackwater River, and two dams controlling Hopkinton-Everett Reservoir: Everett Dam on the Piscataquog River and the Hopkinton Flood Control Dam on the Contoocook River.

In 1950, the USACE completed the Edward MacDowell Dam, thereby creating MacDowell Reservoir, most of which lies in the Town of Peterborough, Hillsborough County. The Reservoir was built to protect properties along Nubanusit Brook, the Contoocook River, and the Merrimack River from extensive floodflows.

In 1962, the USACE completed the Hopkinton-Everett Reservoir, consisting of a dam, a canal, two large dikes, and a spillway in the Contoocook River watershed; and a dam, a spillway, and two large dikes in the Piscataquog River watershed. The two storage areas formed have a capacity of 70,800 acre-feet in the Contoocook River watershed and 86,500 acre-feet in the Piscataquog River watershed. These areas are connected by a second canal, 13,900 feet long, so that the floodwaters may be transferred. The project provided general protection for property along the Contoocook, Piscataquog, and Merrimack Rivers. The Hopkinton-Everett Reservoir provides no flood protection for the Town of Henniker, with the exception of the reservoir easement. The reservoir easement prevents the building of homes and businesses in areas which would be inundated if the reservoir reaches full capacity.

No flood protection measures exist on the Suncook River in the Towns of Allenstown and Pembroke and no plans have been disclosed for the implementation of any future flood protection measures. In addition, no flood protection measures exist on the Soucook River in the Town of Pembroke and no plans have been disclosed for the implementation of any future flood protection measures.

There are no formal flood fighting or emergency evacuation plans for the Town of Boscawen. The town's Civil Defense Office is responsible for alerting residents of impending disasters and coordinating any emergency operations with town and state public service agencies.

No flood protection measures exist on Tannery Brook, Glines Brook, Tributary A, or Allen Brook in the Town of Boscawen and no plans were disclosed for the implementation of any future flood protection measures.

The Garvins Falls Dam in the Town of Bow is not a flood control structure.

There are no flood protection measures in or affecting the Town of Bradford.

There are no formal flood fighting or emergency evacuation plans for the Town of Canterbury.

There are no flood protection measures on streams in the Town of Chichester. Some natural floodwater storage would occur, however, where wide floodplains or swamp areas exist along the Suncook River and Sanders Brook.

In the City of Concord, no flood protection measures exist on the Soucook River or on streams studied by approximate methods, and no plans have been disclosed for the implementation of any future flood protection measures. However, the city has prepared an emergency evacuation plan for the protection of its residents.

There are no significant flood protection structures on streams in the Town of Epsom. Although not a flood control structure, the dam on Northwood Lake could offer some degree of flood storage on the Little Suncook River.

The rivers and lakes of the Winnipesaukee River Basin undergo an intense degree of recreational usage. The New Hampshire Water Resources Board operates dams at Lakeport, Laconia, and Lochmere in order to regulate flow in the Winnipesaukee River and maintain the levels of Silver Lake, Lake Winnisquam, and Lake Winnipesaukee for recreational uses. Thus, natural flow conditions on the Winnipesaukee River are significantly modified by the interaction of these dams and lakes.

No flood protection measures other than this regulation exist on the Winnipesaukee River. Chance Pond Brook in the City of Franklin also has no flood protection measures. No plans have been disclosed for the implementation of any future flood protection measures on either of these streams.

In the Town of Hookset, no flood protection measures exist on Messer Brook, Dalton Brook, or Peters Brook, and no plans have been disclosed for the implementation of any future flood protection measures.

In the Town of New London, the dam at Sunapee Lake is operated and maintained by the Water Resources Division of the New Hampshire Department of Environmental Services. Sunapee Lake is used for recreational purposes and does not have flood control storage. However, the lake is drawn down in anticipation of floods to maintain the integrity of the structure. Conversion of Wendall Marsh Dam to hydropower will have a negligible effect on flood control. No other major structural flood protection measures exist or are planned for the Town of New London.

In the Town of Northfield, no flood protection measures exist on the Tioga River or Williams Brook, and no plans have been disclosed for the implementation of any future flood protection measures. The Town of Northfield has no formal flood fighting or emergency evacuation plans.

There are no flood protection measures on streams in the Town of Pittsfield. The Pittsfield Dam, located on the Suncook River above the Main Street Bridge, is not a flood control structure and affords only a small degree of flood storage.

There are no structural flood protection measures in the Town of Warner. The Wagner Dam and an unnamed dam located on the Warner River are recreational and were constructed for hydro-power for mills. They do not act as flood control structures or provide additional storage area.

In the Town of Webster, a major flood protection measure existing at this time, which affects flooding along the Blackwater River, is the Blackwater Reservoir. Built in 1941 by the USACE, this Flood Control Reservoir has a capacity of 1.5 billion gallons.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the county, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this FIS. Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10-, 2-, 1-, and 0.2-percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (1-percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the county at the time of completion of this FIS. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for the flooding sources studied in detail affecting the county.

Precountywide Analyses

Each incorporated community within Merrimack County, with the exceptions of the Towns of Andover, Danbury, Dunbarton, Hill, Loudon, Newbury, Salisbury, Sutton, and Wilmot, has a previously printed FIS report. The hydrologic analyses described in those reports have been compiled and are summarized below.

In the Towns of Allenstown, Bow, Hooksett, and Pembroke the principal sources of information for the Merrimack River were the discharges used in the Floodplain Information studies published by the USACE (USACE, 1972; USACE, 1976), the rating curves from the Master Regulation Manual for flood control reservoirs (USACE, 1953), and the Water Resources Investigation publication for the Merrimack River (USACE, 1972). The discharge values were developed by a log-Pearson Type III analysis using the 39-year record of flood data from the USGS

TABLE 3 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
BLACKWATER RIVER					
At confluence with Contoocook River	136.00	2,550	2,620	3,280	3,400
At USGS gage station No. 0108700	129.00	*	*	2,600	*
CHANCE POND BROOK					
At outlet of Webster Lake	17.29	402	586	653	847
COLD BROOK					
At confluence with Tannery Brook	2.14	230	460	580	980
CONTOOCOOK RIVER					
At confluence with Merrimack River	766.00	8,000	15,000	23,300	33,000
At Concord-Hopkinton corporate limits	747.00	8,000	15,000	23,300	33,000
At confluence of Blackwater River	591.00	7,900	12,600	19,300	28,000
At confluence of Warner River	439.00	7,200	7,300	9,500	13,000
At State Route 114 bridge	378.30	9,280	17,330	22,020	34,660
At USGS gage station No. 01085000	368.00	9,100	17,000	21,600	34,000
At upstream Town of Henniker corporate limit	365.30	9,050	16,910	21,490	33,830
DALTON BROOK					
At confluence with Merrimack River	1.40	138	271	339	580
At Londonderry Turnpike (Bypass 28)	1.06	100	210	260	440
GLINES BROOK					
At confluence with Merrimack River	1.52	225	475	590	1,010
LAKE MASSACECUM					
At mouth of outlet stream	10.00	*	*	1,490	*

~10 miles DS from crossing & ~2 miles DS from dam

*Data not available

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Blackwater River								
A	1,300	90	1,659	1.80	359.7	359.3[2]	360.3	1.0
B	2,850	158	1,962	1.50	359.7	359.4[2]	360.4	1.0
C	4,910	85	1,639	1.80	359.7	359.6[2]	360.6	1.0
D	6,730	614	6,406	0.50	359.7	359.7[2]	360.7	1.0
E	8,110	457	4,781	0.60	359.7	359.7[2]	360.7	1.0
F	10,435	44	527	13.90	362.3	362.3	362.3	0.0
G	10,493	250	1,895	1.40	362.3	362.3	362.3	0.0
H	11,660	140	1,601	1.60	362.4	362.4	362.4	0.0
I	15,260	150	1,561	1.70	362.7	362.7	362.7	0.0
J	18,260	135	1,365	1.90	362.9	362.9	363.0	0.1
K	20,460	193	1,533	1.70	363.3	363.3	363.5	0.2
L	24,260	178	1,447	1.80	364.4	364.4	364.7	0.3
M	29,060	209	1,550	1.70	365.9	365.9	366.4	0.5
N	31,460	55	731	3.60	367.1	367.1	367.6	0.5
O	31,520	133	927	2.80	367.1	367.1	367.6	0.5
P	32,960	153	319	8.20	383.1	383.1	383.1	0.0
Q	34,660	173	633	4.10	408.0	408.0	408.0	0.0
R	36,560	108	295	8.80	423.9	423.9	423.9	0.0
S	37,735	41	261	10.00	435.4	435.4	435.7	0.3
T	41,560	57	560	4.40	444.8	444.8	445.3	0.5
U	41,608	84	666	3.90	445.1	445.1	445.7	0.6
V	44,160	86	266	9.80	460.5	460.5	460.5	0.0
W	48,085	83	846	3.10	470.7	470.7	471.5	0.8
X	50,285	82	707	3.70	471.8	471.8	472.6	0.8

[1]Feet above confluence with Contoocook River
[2]Elevation computed without consideration of backwater effects from Contoocook River

~9.5 miles; project location is ~18.5 miles above the confluence with the Contoocook RIver

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

MERRIMACK COUNTY, NH (ALL JURISDICTIONS)

FLOODWAY DATA

BLACKWATER RIVER

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was New Hampshire State Plane (FIPSZONE 2800). The **horizontal datum** was NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of the FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713-3242**, or visit its website at http://www.ngs.noaa.gov/.

Base map information shown on this FIRM was derived from U.S. Geological Survey Digital Orthophoto Quadrangles produced at a scale of 1:12,000 from photography dated 1998 or later. These images were recast by NH GRANIT onto the NH State Plane coordinate system.

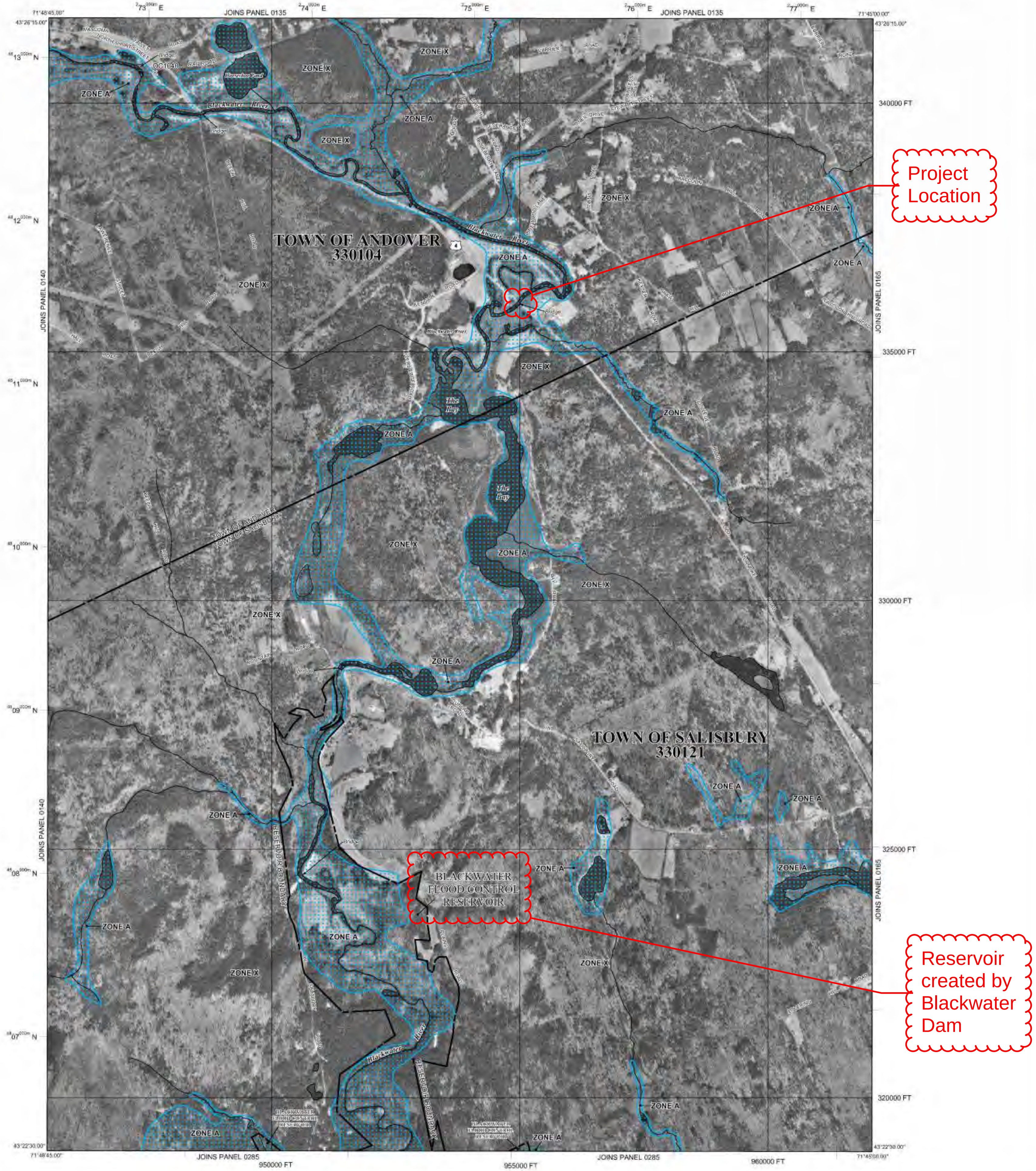
This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables *in the Flood Insurance Study report (which contains authoritative hydraulic data)* may reflect stream channel distances that differ from what is shown on this map.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a *Flood Insurance Study report*, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at http://www.msc.fema.gov/.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary
0.2% annual chance floodplain boundary
Floodway boundary
Zone D boundary
CBRS and OPA boundary
Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

A — A	Cross section line
23 - - - 23	Transect line
97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
4275000mN	1000-meter Universal Transverse Mercator grid ticks, zone 19
6000000 FT	5000-foot grid values: New Hampshire State Plane coordinate system, (FIPSZONE 2800), Transverse Mercator
DX5510	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
April 19, 2010
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 1000'
500 0 1000 2000 FEET
300 0 300 600 METERS

NFIP

PANEL 0145E

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP
MERRIMACK COUNTY, NEW HAMPSHIRE
(ALL JURISDICTIONS)

PANEL 145 OF 705
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
ANDOVER, TOWN OF	330104	0145	E
SALISBURY, TOWN OF	330121	0145	E

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
33013C0145E

EFFECTIVE DATE
APRIL 19, 2010

Federal Emergency Management Agency

APPENDIX F

Qualitative Geomorphic Analyses

INTRODUCTION

NOTES AND ASSUMPTIONS

- Consider the stability of the Blackwater River in the vicinity of the Route 4 crossing.
- The stability analysis is completed in accordance with Federal Highway Administration (FHWA) Hydraulic Engineering Circular No. 20 (HEC-20).
- A Level 1 qualitative geomorphic analysis is completed first following Figure 4.1 from HEC-20 (see below).

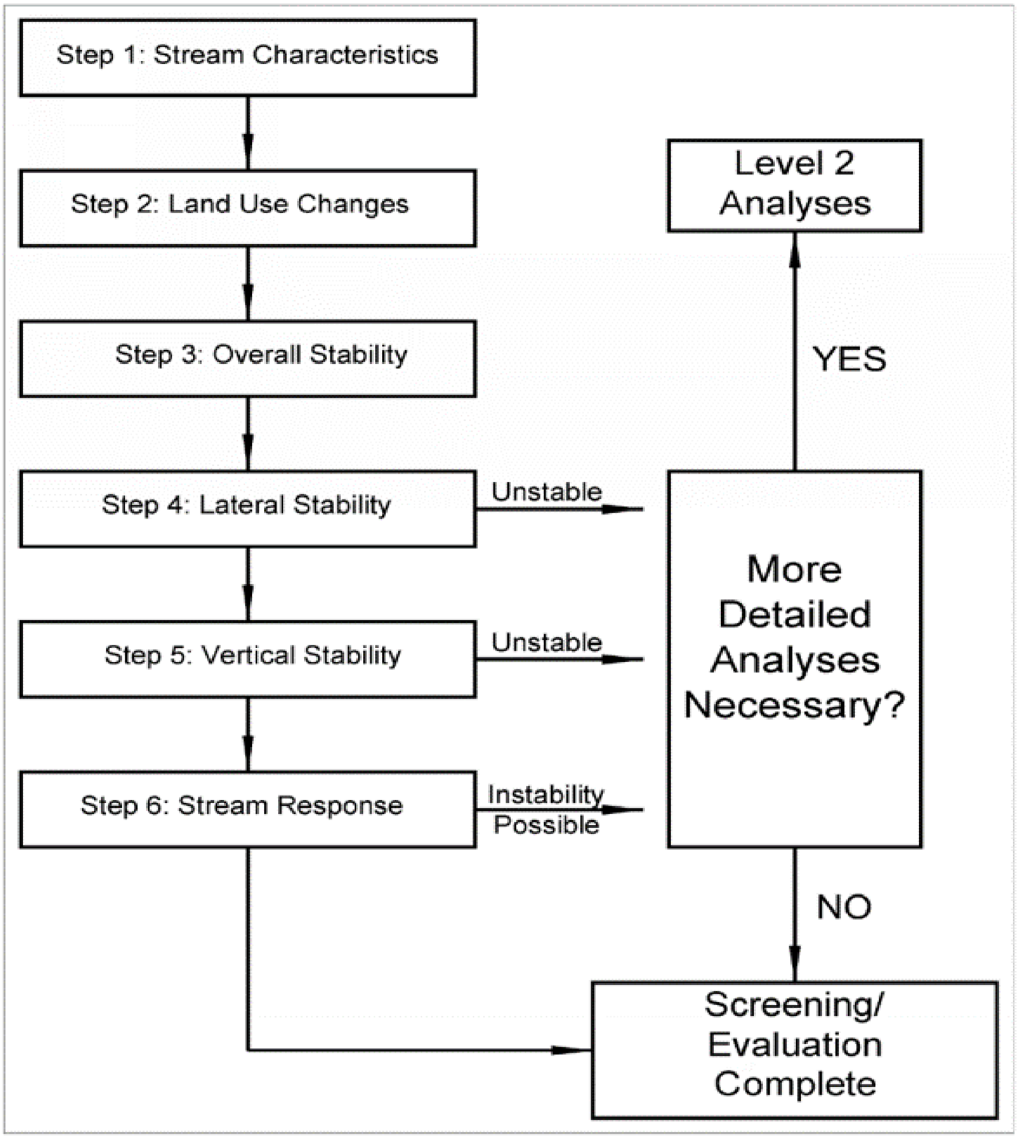


Figure 4.1. Flow chart for Level 1: Qualitative Geomorphic Analyses.

STEP 1: STREAM CHARACTERISTICS

NOTES

- Identify stream geomorphic characteristics per Chapter 2, Geomorphic Factors and Principles.
- HEC-20 Figure 2.6 summarizes and depicts the different characteristics.

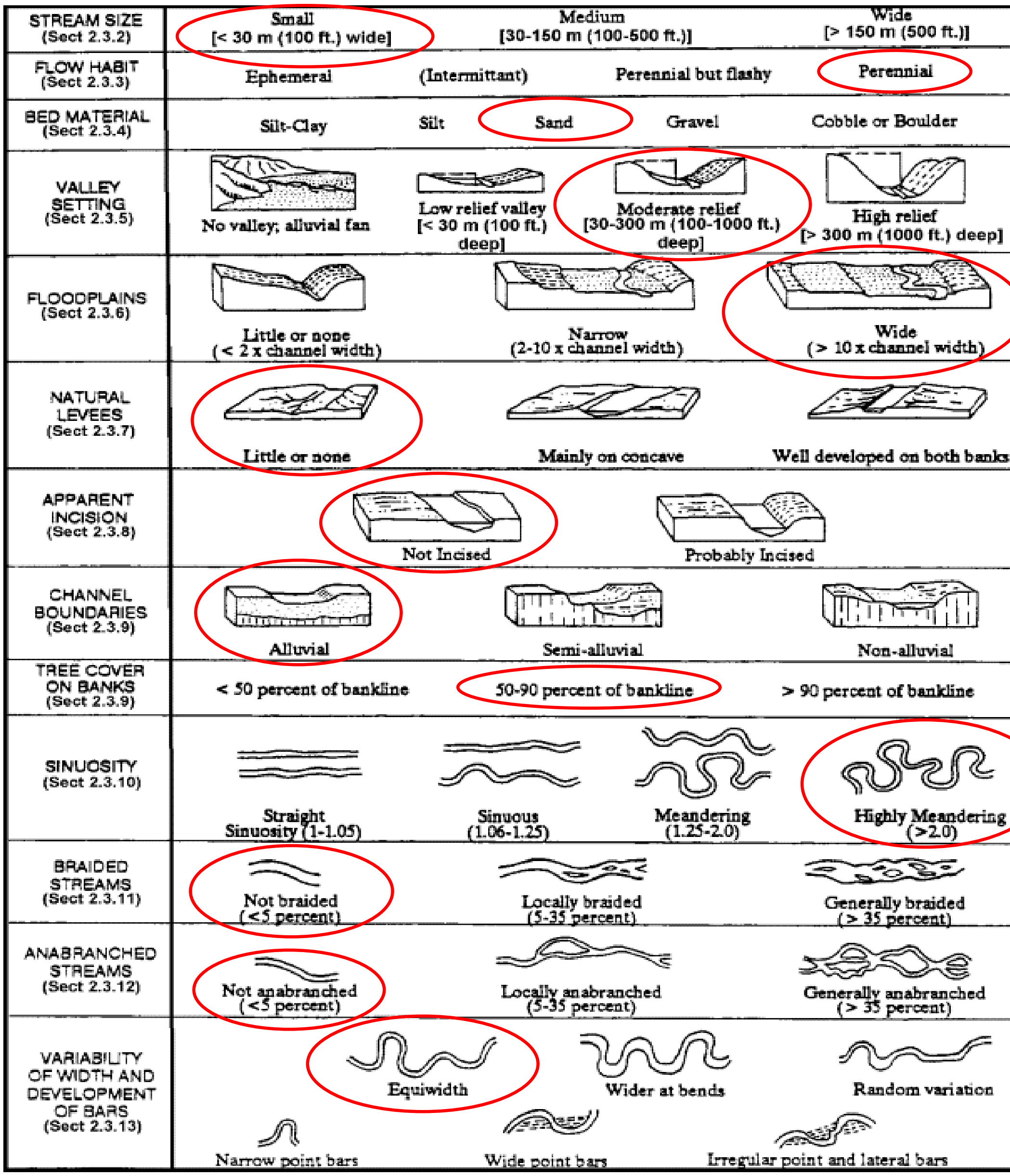


Figure 2.6. Geomorphic factors that affect stream stability (adapted from FHWA 1978a).

Stream Size (Sect. 2.3.2)

- The Blackwater River is "Small" based on width:

  W = 80 ft < 100 ft -> Small

- Lateral migration increases with stream size. A smaller river therefore migrates less.

STEP 1: STREAM CHARACTERISTICS

Flow Habit (Sect. 2.3.3)

- The Blackwater River is a perennial stream that flows all of the year. It is most likely not a flashy stream.
- Perennial streams may be relatively stable or unstable, depending on other factors such as channel boundaries and bed material.

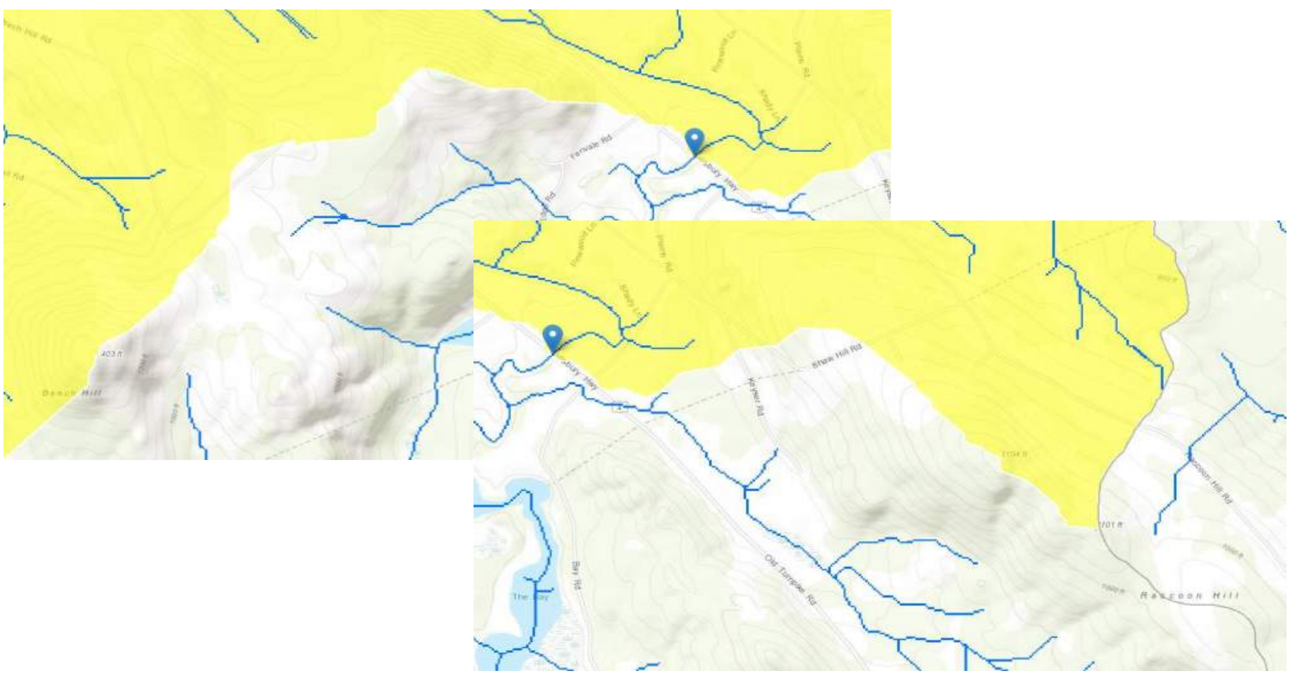
Bed Material (Sect. 2.3.4)

- Based on the three hand auger samples taken, the stream bed is mostly fine sand (poorly graded) with some silt and gravel.
- Scour is more probable in fine bed material.

Valley Setting (Sect. 2.3.5)

- The Blackwater River is in a moderate relief valley:

Elev. @ Bridge =	603	ft	
Elev. @ East =	1194	ft	(Raccoon Hill)
Elev. @ West =	1403	ft	(Beech Hill)
Max Elev. Difference =	800	ft	-> Moderate Relief (100 ft to 1000 ft deep)



- Streams in regions of lower relief are usually alluvial and exhibit more problems because of lateral erosion in the channels.

Floodplains (Sect. 2.3.6)

- The Blackwater River is in a wide floodplain:

Floodplain Width =	1500	ft
Channel Width =	80	ft
Floodplain is	18.75	times the channel width -> Wide (> 10x channel width)

- Vegetative cover, land use, and flow depth on the floodplain are significant factors in stream channel stability.

STEP 1: STREAM CHARACTERISTICS

Natural Levees (Sect. 2.3.7)

• The Blackwater River has little to no natural levees.
• Streams without natural levees are more likely to have variable width and migrate laterally.

Apparent Incision (Sect. 2.3.8)

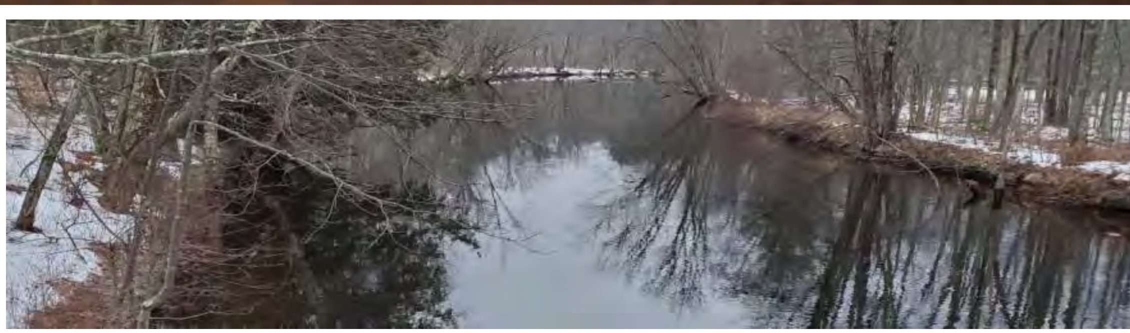
• The Blackwater River appears to not be incised.
• Streams not incised are more likely to change position and shift in alignment at a bridge.

Channel Boundaries and Vegetation (Sect. 2.3.9)

• The Blackwater River appears to be an alluvial channel because bedrock is not evident in this area.
• Alluvial streams are susceptible to more hydraulic problems than non-alluvial streams.
• Changes in channel geometry with time are particularly significant during periods when alluvial channels are subjected to high flows.

• The most significant property of material of which channel boundaries are comprised is particle size.
• Based on photographs, it appears the bank is mainly comprised of sand and silt with some gravel and cobbles.

• Based on photos, the banks appear to have a slope greater than 30 percent, which would indicate they are unstable.
• Although there are mature trees along the banks, which can indicate stability, the stream banks appear to be eroding by evidence of exposed roots and trees leaning into the river. Tree cover is approximately 50-90 percent of bankline.
• Eroding banks are a source of debris when trees fall as they are undermined.

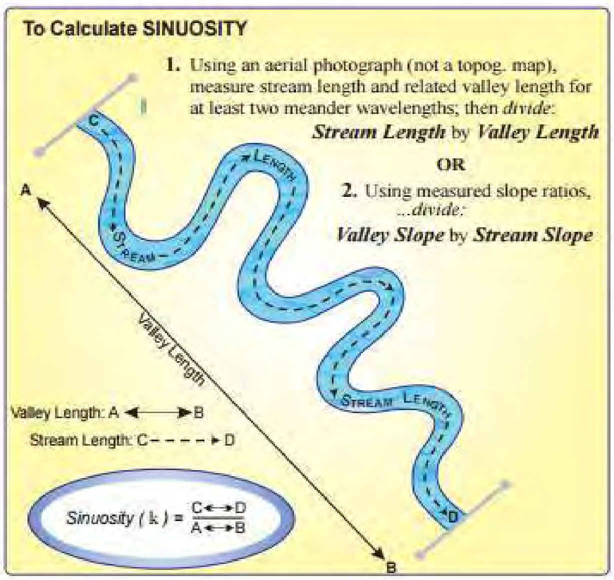


STEP 1: STREAM CHARACTERISTICS

Sinuosity (Sect. 2.3.10)

• The Blackwater River is highly meandering:

Stream Length =	8814	ft	
Valley Length =	3545	ft	
Sinuosity =	2.49		> 2.0 -> Highly Meandering



• There is little relation between degree of sinuosity, as considered apart from other properties, and lateral stream stability.

Braided Streams (Sect. 2.3.11)

• The Blackwater River is not a braided stream in the vicinity of the crossing.

Anabranched Streams (Sect. 2.3.12)

• The Blackwater River is not an anabranched stream in the vicinity of the crossing.

Variability of Width and Development of Bars (Sect. 2.3.13)

• The Blackwater River is considered to be of uniform width because the unvegetated width at bends is not more than 1.5 times the average width at the narrowest places.
• Based on aerial photos, there are minimal point bars and no alternate bars apparent in this reach of the Blackwater River.

• In general, equiwidth streams having narrow point bars are the most stable laterally.

STEP 2: LAND USE CHANGES

NOTES

- Land use changes are based on a review of the available historical aerial images and land use data.
- Historical aerial images are accessed via Google Earth.
- Historical land use data is from the Multi-Resolution Land Characteristics (MRLC) Consortium via www.mrlc.gov/viewer/.

  The MRLC consortium is a group of federal agencies who coordinate and generate consistent and relevant land cover information at the national scale for a wide variety of environmental, land management, and modeling applications. The creation of this consortium has resulted in the mapping of the lower 48 United States, Hawaii, Alaska and Puerto Rico into a comprehensive land cover product termed, the National Land Cover Database (NLCD), from decadal Landsat satellite imagery and other supplementary datasets.

- From HEC-20, the stability of the stream is related to land use as follows:

4.5.2 Step 2. Evaluate Land Use Changes

Water and sediment yield from a watershed is a function of land-use practices. Thus, knowledge of the land use and historical changes in land use is essential to understanding conditions of stream stability and potential stream response to natural and human-induced changes.

The presence or absence of vegetative growth can have a significant influence on the runoff and erosional response of a fluvial system. Large scale changes in vegetation resulting from fire, logging, land conversion and urbanization can either increase or decrease the total water and sediment yield from a watershed. For example, fire and logging tend to increase water and sediment yield, while urbanization promotes increased water yield and peak flows, but decreased sediment yield from the watershed. Urbanization may increase sediment yield from the channel.

Information on land use history and trends can be found in Federal, State and Local government documents and reports (i.e., census information, zoning maps, future development plans, etc.). Additionally, analysis of historical aerial photographs can provide significant insight on land use changes. Land use change due to urbanization can be classified based on estimated changes in pervious and impervious cover. Changes in vegetative cover can be classified as simply as no change, vegetation increasing, vegetation damaged and vegetation destroyed. The relationship or correlation between changes in channel stability and land use changes can contribute to a qualitative understanding of system response mechanisms.

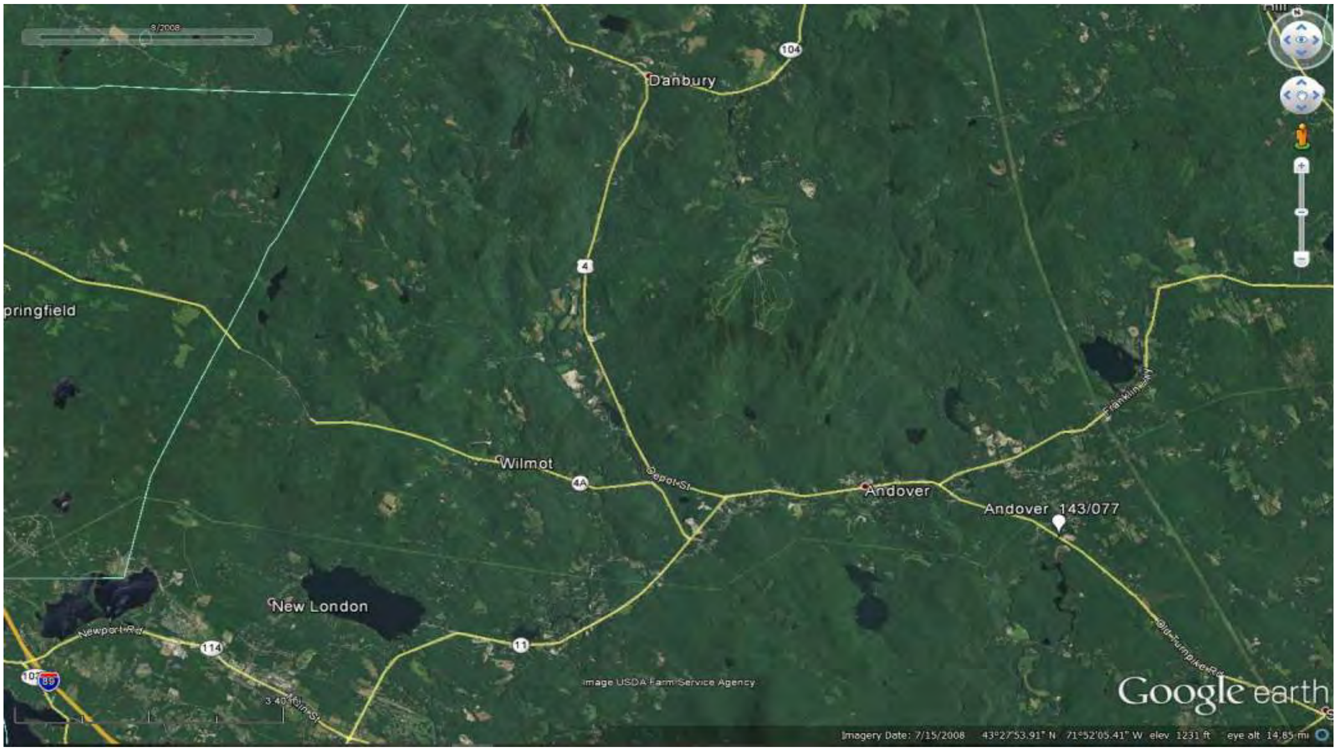
- The historical images are on the following pages.
- From the aerial images, the vegetative cover appears to not be changing.
- From the MRLC NLCD Imperious Surface images, the impervious surface appears to have minimal changes.
- From the MRLC NLCD Land Cover images and Land Cover Change Index, the land cover appears to have minimal changes.

- The Town of Andover, NH Master Plan states that the current Zoning Ordinance "looks much the same as the original adopted in 1974.' This indicates that the land use has been consistent and is not likely to change significantly in the future.
- Additionally, the Town's Master Plan states that the overall goal of the community is to maintain the rural character, farming, forestry, and open spaces that exist in the Town now. Therefore, no major commercial or residential development that would significantly change land cover is anticipated. It is assumed that the surrounding communities within the Blackwater rivershed would be the same.
- Clips from the Master Plan are included at the end of Step 2.

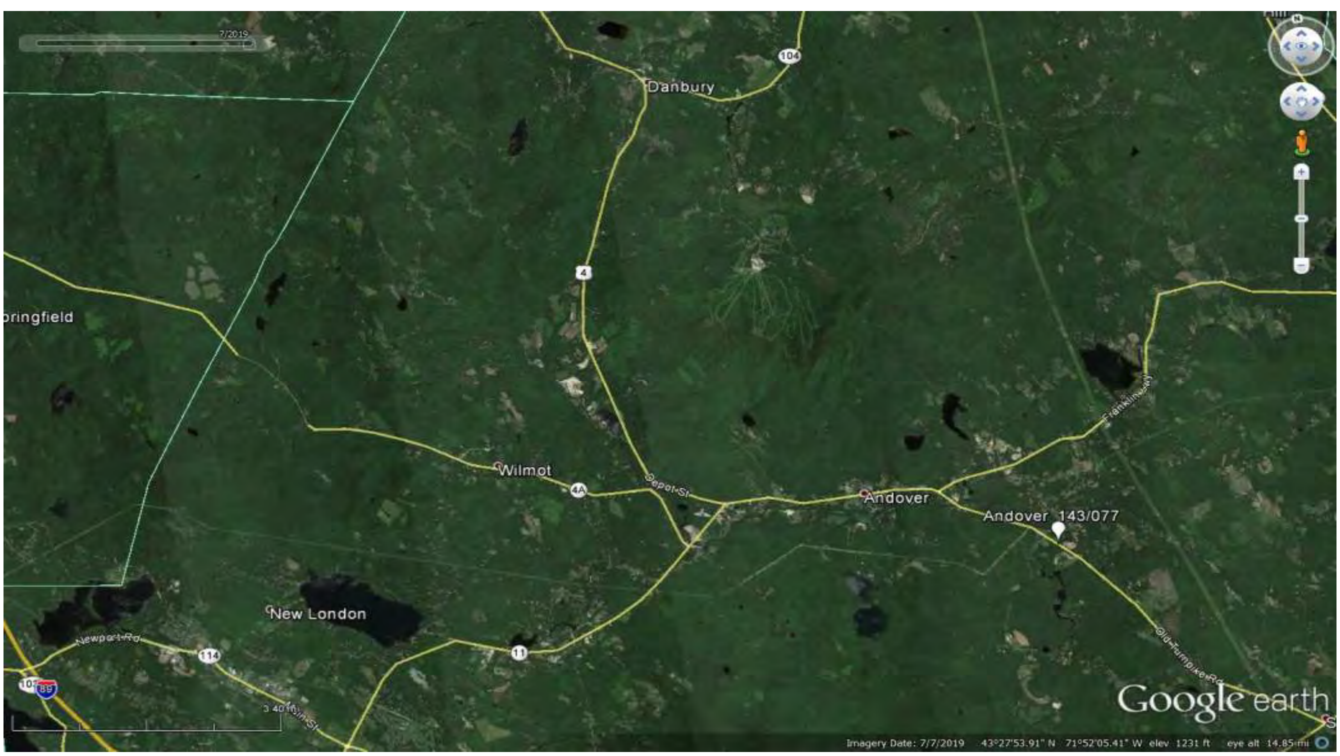
- Therefore, land use is most likely not going to greatly affect the stability of the Blackwater River.

STEP 2: LAND USE CHANGES

• Google Earth Image from 7/15/2008:

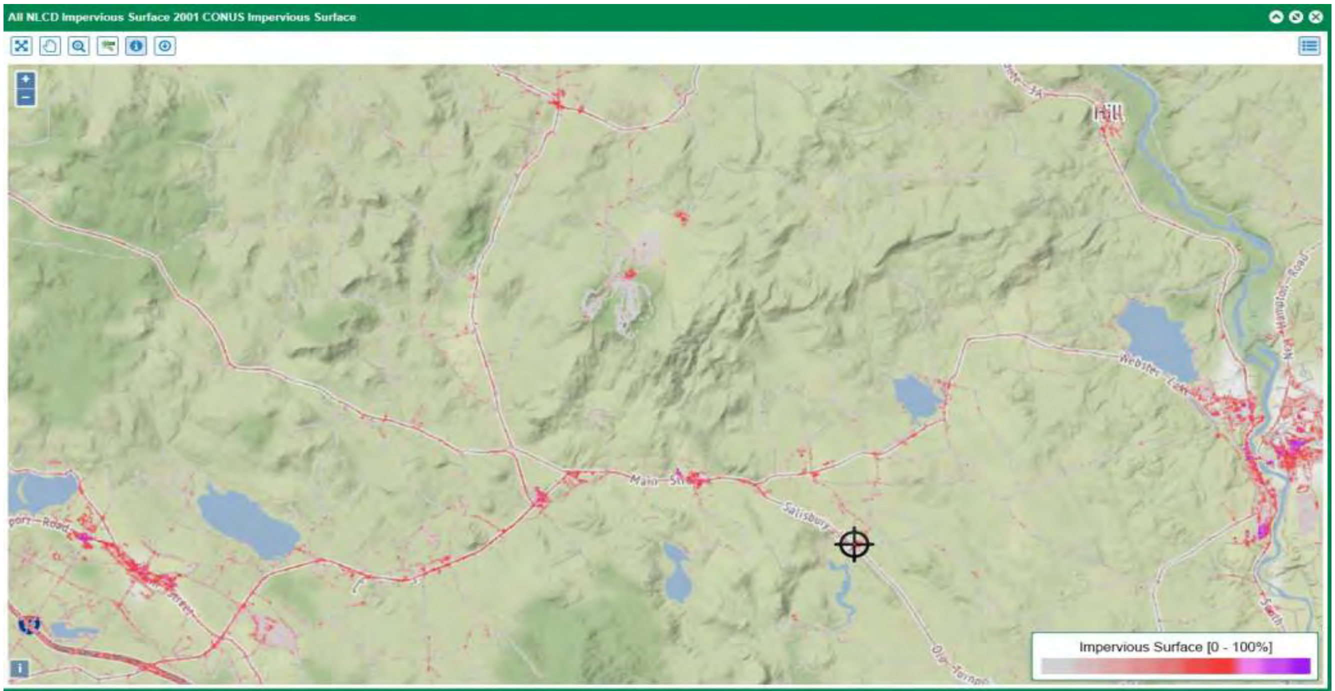


• Google Earth Image from 7/7/2019:

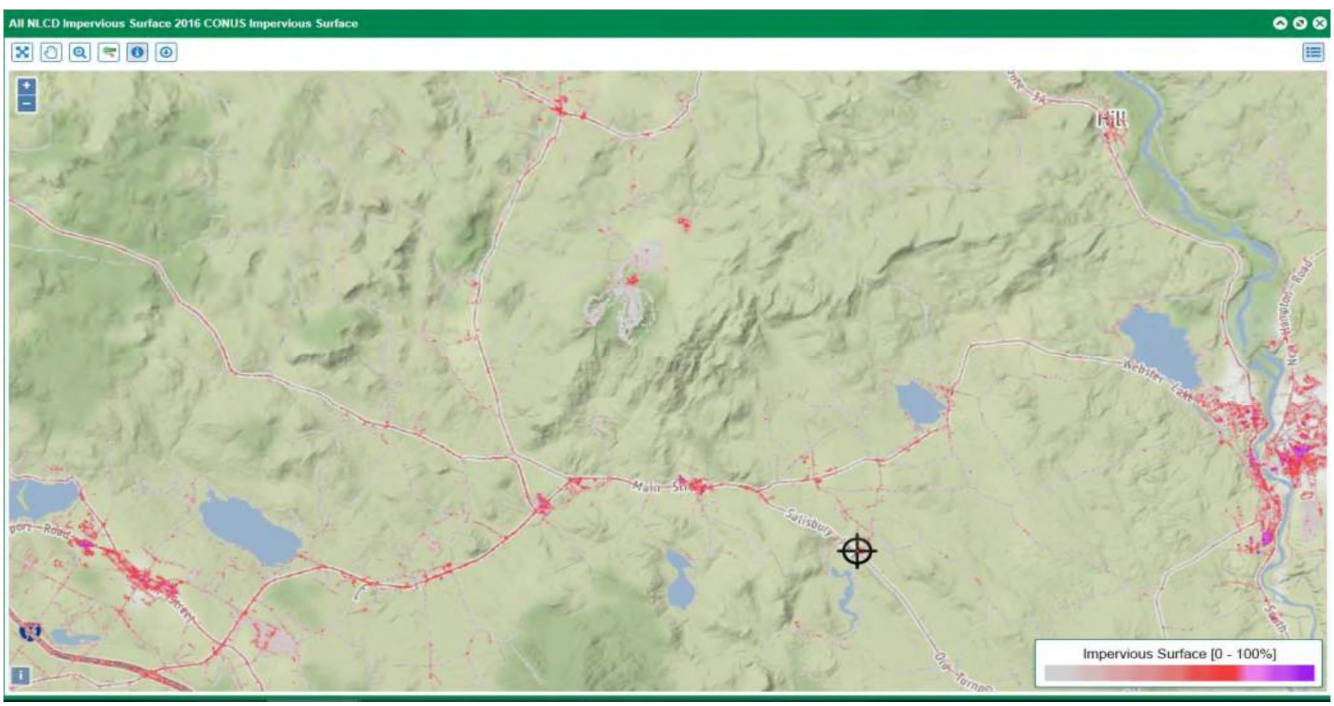


STEP 2: LAND USE CHANGES

• MRLC NLCD Imperious Surface from 2001:

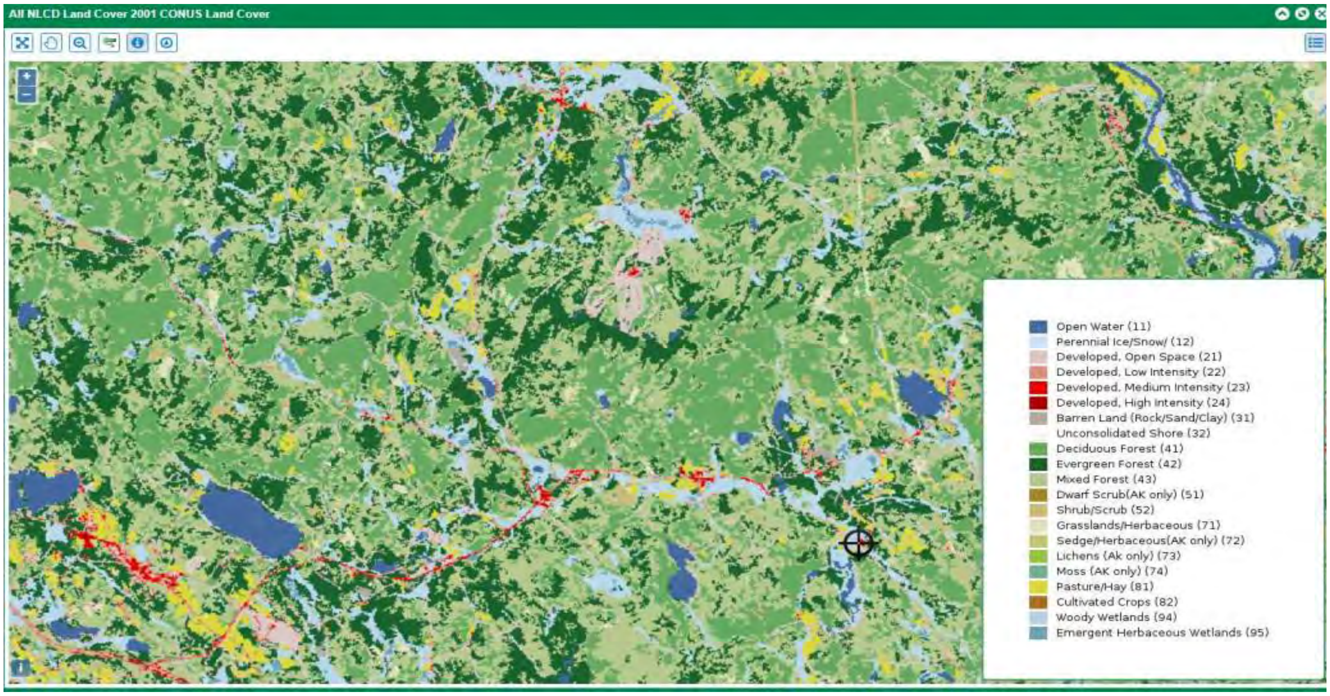


• MRLC NLCD Imperious Surface from 2016:

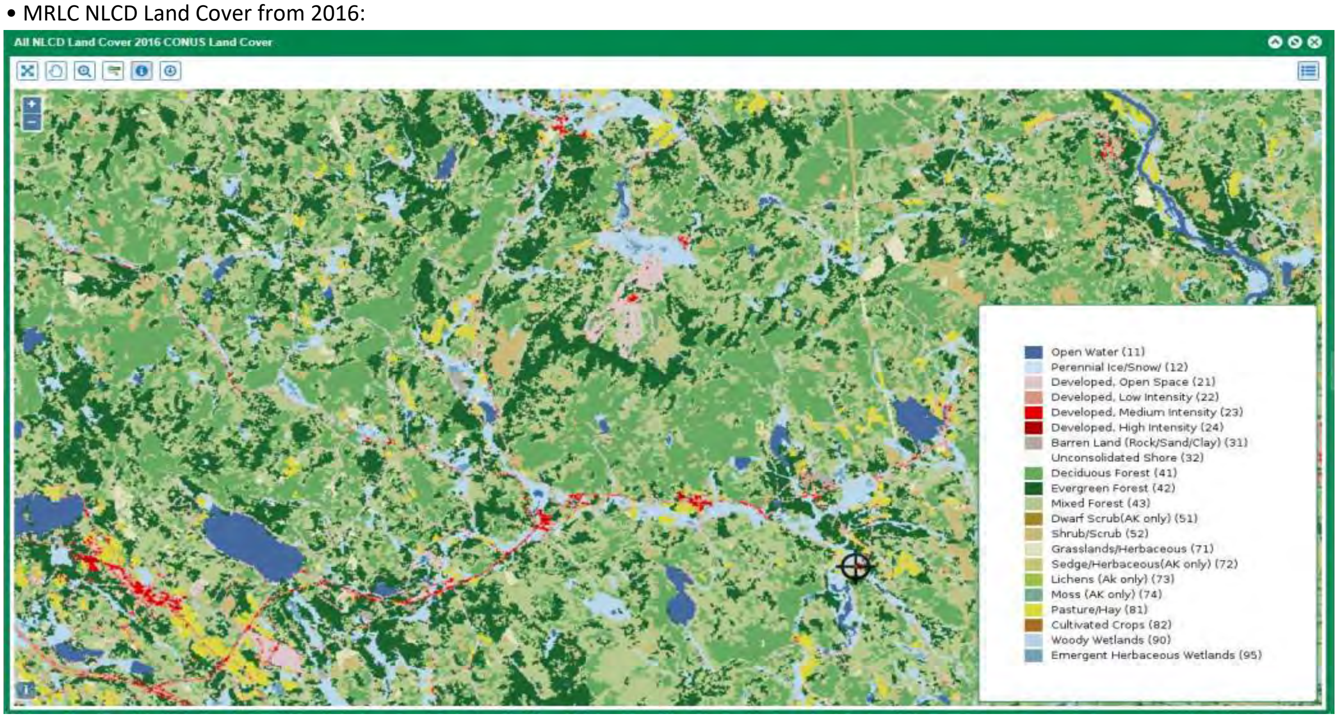


STEP 2: LAND USE CHANGES

- MRLC NLCD Land Cover from 2001:

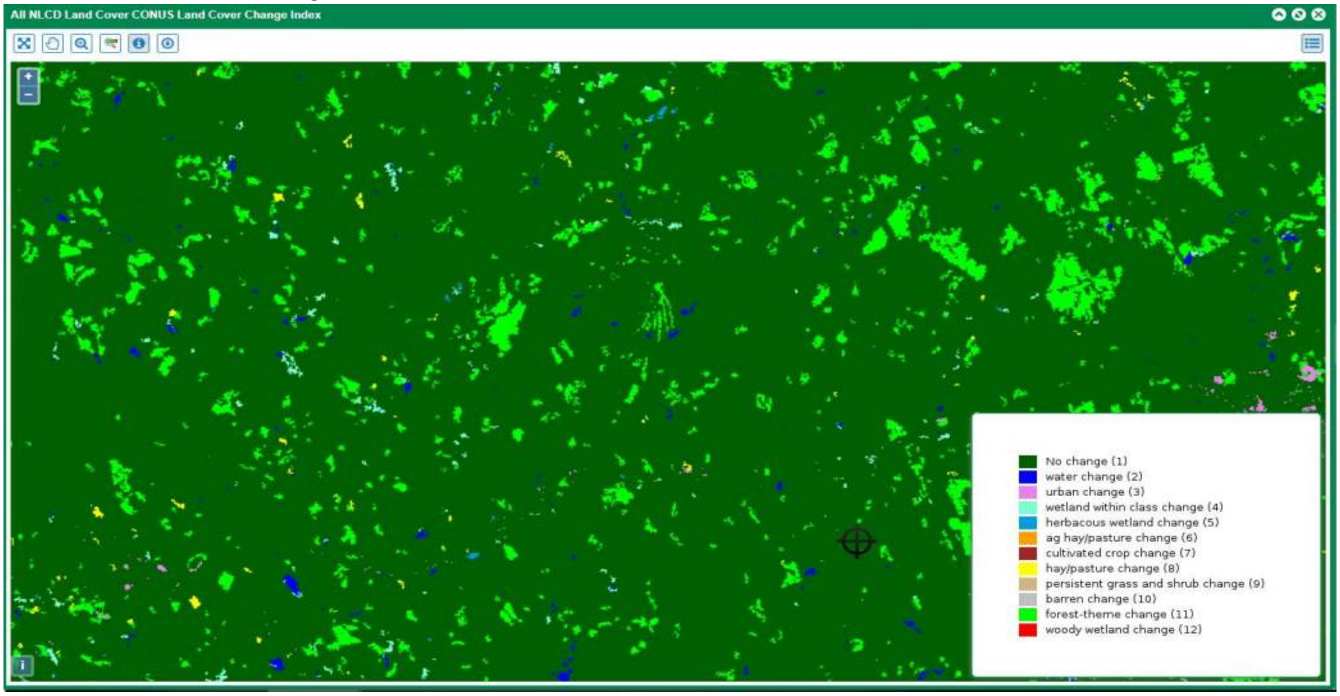


- MRLC NLCD Land Cover from 2016:



STEP 2: LAND USE CHANGES

• MRLC NLCD Land Cover Change Index:



• Town of Andover, NH Master Plan:
https://www.andover-nh.gov/planning-board/pages/master-plan

from pg 5:

3. Current Land Use Regulations

No substantive changes were made to the zoning ordinance or other land use regulations as a result of the 1992 Master Plan. Today, Andover has a Zoning Ordinance that looks much the same as the original adopted in 1974. A table of the permitted uses and special exceptions in the current zoning ordinance, unchanged since 1974, can be found in Appendix III. Over time, amendments have been adopted to regulate citing of cell towers, the Federal Flood Insurance Program, the provision for site plan review and others. The Planning Board has adopted Subdivision Regulations. See Appendix IV for the text of Andover's current ordinances and regulations. Map I shows the boundaries of current zoning districts.

from pg 9:

B. Guiding Principles

The ten guiding principles below were distilled by the Master Plan Committee as described above, from the records of visioning activities described in the process summary above. The bold text identifies the key words and concepts in each guiding principle.

1. **Maintain Andover's small town, rural character** with village centers and generally open spaces elsewhere. Desired location and size of village areas should be identified.
2. **Encourage commercial activity that builds on the regional recreation and tourism economy** that emphasizes Andover's location in the Lakes Region, near summer and winter recreation places including Highland Lake and Ragged Mountain ski area.
3. **Promote and preserve farming and forestry** where small-scale agriculture is encouraged and forests are managed for forest products while protecting natural resources. Examples might be farmer's markets, sugar houses, small sawmills, firewood harvest and sale, hayfields, orchards, and specialty farms.
4. **Create specific zones where small-scale light industry and commercial activities are not only allowed, but encouraged.**
5. **Preserve views, especially along Andover's major highways** – US Routes 4, 4A, and NH Route 11 – including both the near-field views (by maintaining buffers between roads and buildings) and the far-field views (such as Mt. Kearsarge, wooded hills and ridges, and Ragged Mtn.)

STEP 3: OVERALL STABILITY

NOTES

- Based on HEC-20 Figure 4.2, the Blackwater River in the vicinity of the crossing appears to be a 3a to 3b type channel and therefore, is moderately stable.
- This is also supported by reviewing HEC-20 Table 4.3 (see next sheet). There is a mix of characteristics that are stable and unstable.
    - The bridge is not on an alluvial fan.
    - There is no upstream dam nor reservoir, and the downstream dam is about 10 miles away and will not affect the crossing.
    - The river is meandering, has some bank erosion, with vegetated banks.
    - There are no diversions of the channel in the vicinity of the crossing.
    - The change in bed material size is unknown.

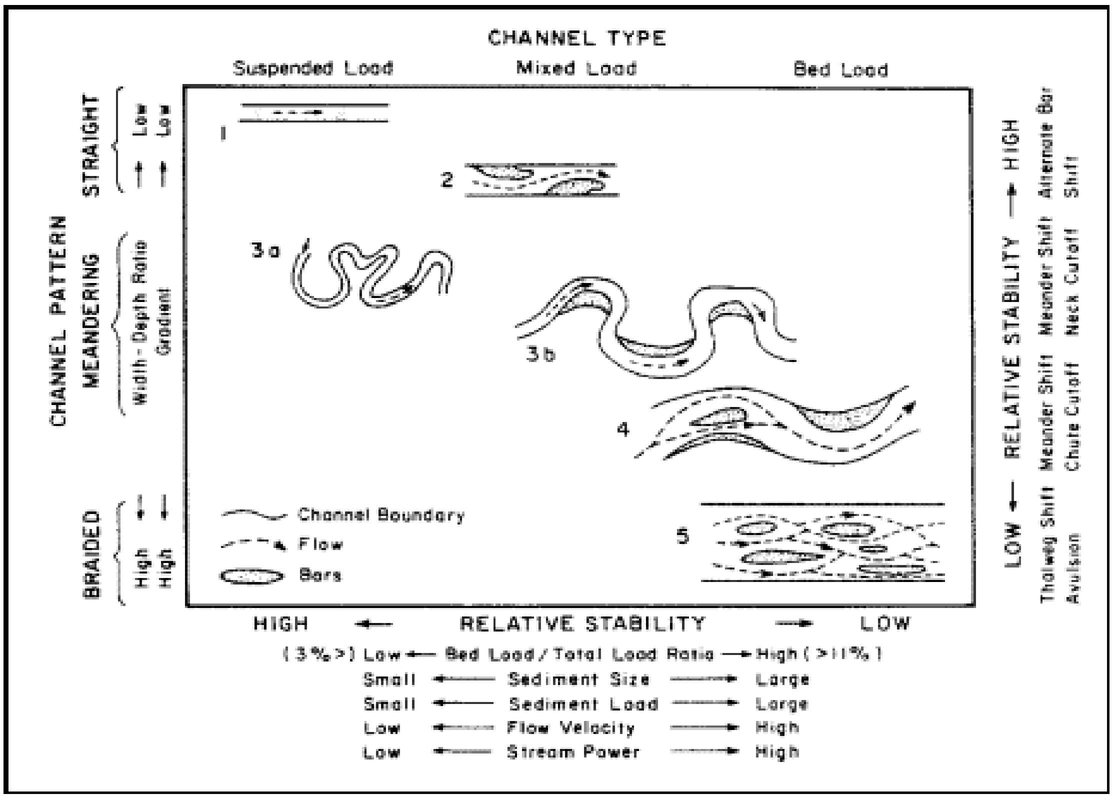


Figure 4.2. Channel classification and relative stability as hydraulic factors are varied (after FHWA 1981).

STEP 3: OVERALL STABILITY

Table 4.3. Interpretation of Observed Data (after FHWA 1980b).

		Channel Response			
	Observed Condition	Stable	Unstable	Degrading	Aggrading
Alluvial Fan[1]	Upstream		X		X
	Downstream		X	X	
Dam and Reservoir	Upstream		X		X
	Downstream		X	X	
River Form	Meandering	X	X	Unknown	Unknown
	Straight		X	Unknown	Unknown
	Braided		X	Unknown	Unknown
	Bank Erosion		X	Unknown	Unknown
	Vegetated Banks	X		Unknown	Unknown
	Head Cuts		X	X	
Diversion	Clear water diversion		X		X
	Overloaded w/sediment		X	X	
	Channel Straightened		X	X	
	Deforest Watershed		X		X
	Drought Period	X			X
	Wet Period		X	X	
Bed Material Size	Increase		X		X
	Decrease		X	Unknown	X

[1]The observed condition refers to location of the bridge on the alluvial fan, i.e., on the upstream or downstream portion of the fan.

STEP 4: LATERAL STABILITY

NOTES

• The proposed bridge design should consider the lateral stability of the river. HEC-20 Figure 4.3 (below) presents potential hydraulic problems at bridges attributed to erosion at a bend or to lateral migration of the channel.

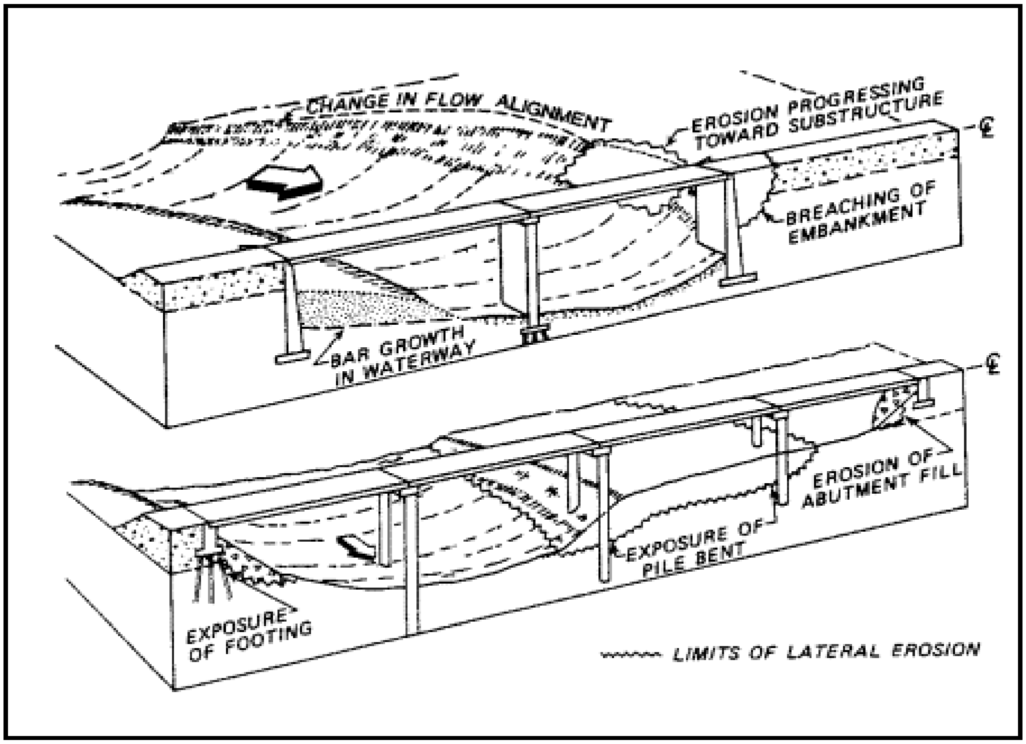
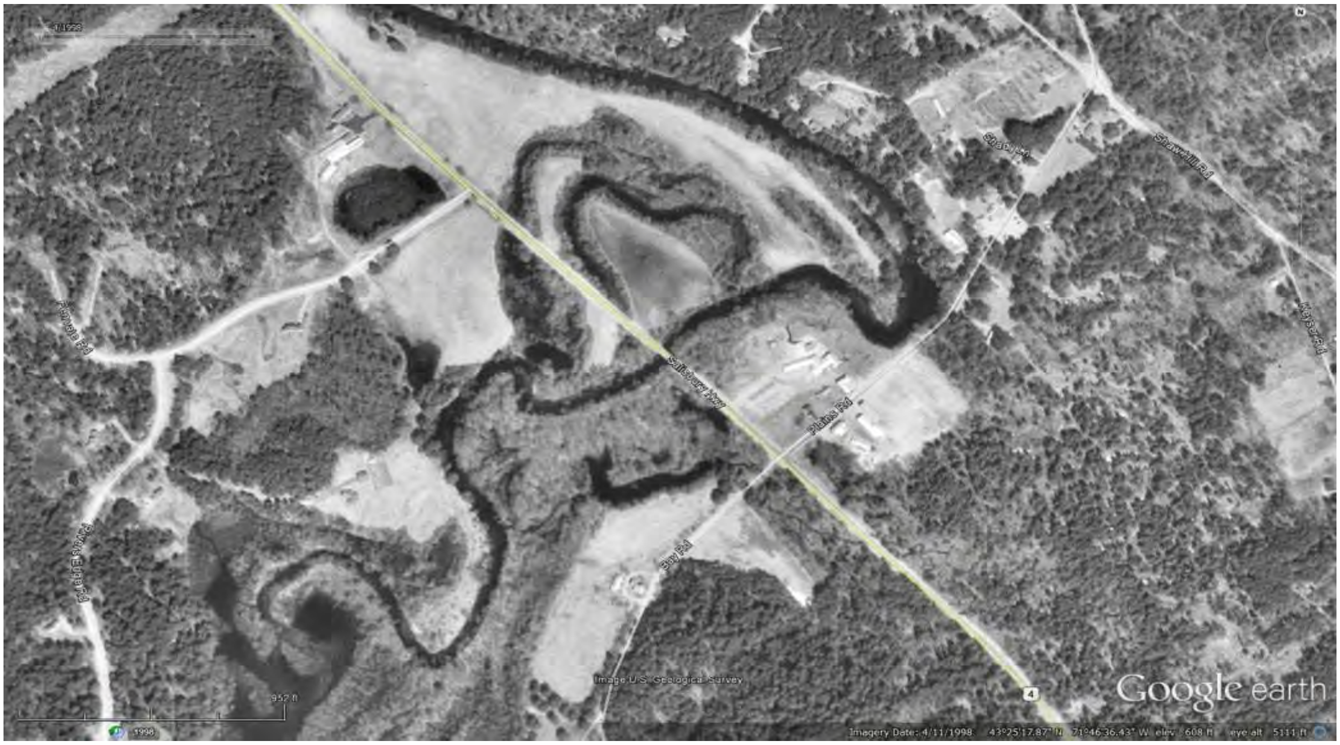


Figure 4.3. Hydraulic problems at bridges attributed to erosion at a bend or to lateral migration of the channel (after FHWA 1978a and b).

• Google Earth aerial images and the existing plans are used to review the past lateral migration of the Blackwater River. Relevant images are on the following pages
• The Route 4 bridge over the Blackwater River is located at a fairly straight portion of the river and not at a bend.
• The earliest aerial image available on Google Earth is from April of 1998 and the most recent aerial image without foliage is from April 2016.
    • Overall, the river appears to be stable at the crossing over the last 20 years. However, there is evidence of bank erosion and widening of the channel, especially upstream of the bridge.
• Based on the existing plans, the Blackwater River was approximately 70' wide upstream and downstream of the bridge and 50' at the crossing. In comparison, from the bathymetric survey completed for this project, the width of the river is approximately 80' wide upstream and 75' wide downstream of the bridge. The current width of the river at the bridge is the clear span of the existing structure.
    • Overall, the river appears to be widening, especially upstream of the bridge.
• The New Hampshire Division of Historical Resources (NHDHR) Individiual Inventory Form (#AND0029) dated 6/2015 for the subject bridge includes historical atlas and topo maps from 1892, 1928, and 1956. In reviewing these historical documents, it appears that the general geometry of the Blackwater River is stable.

STEP 4: LATERAL STABILITY

• Google Earth Image from 4/11/1998:



• Google Earth Image from 4/27/2016:

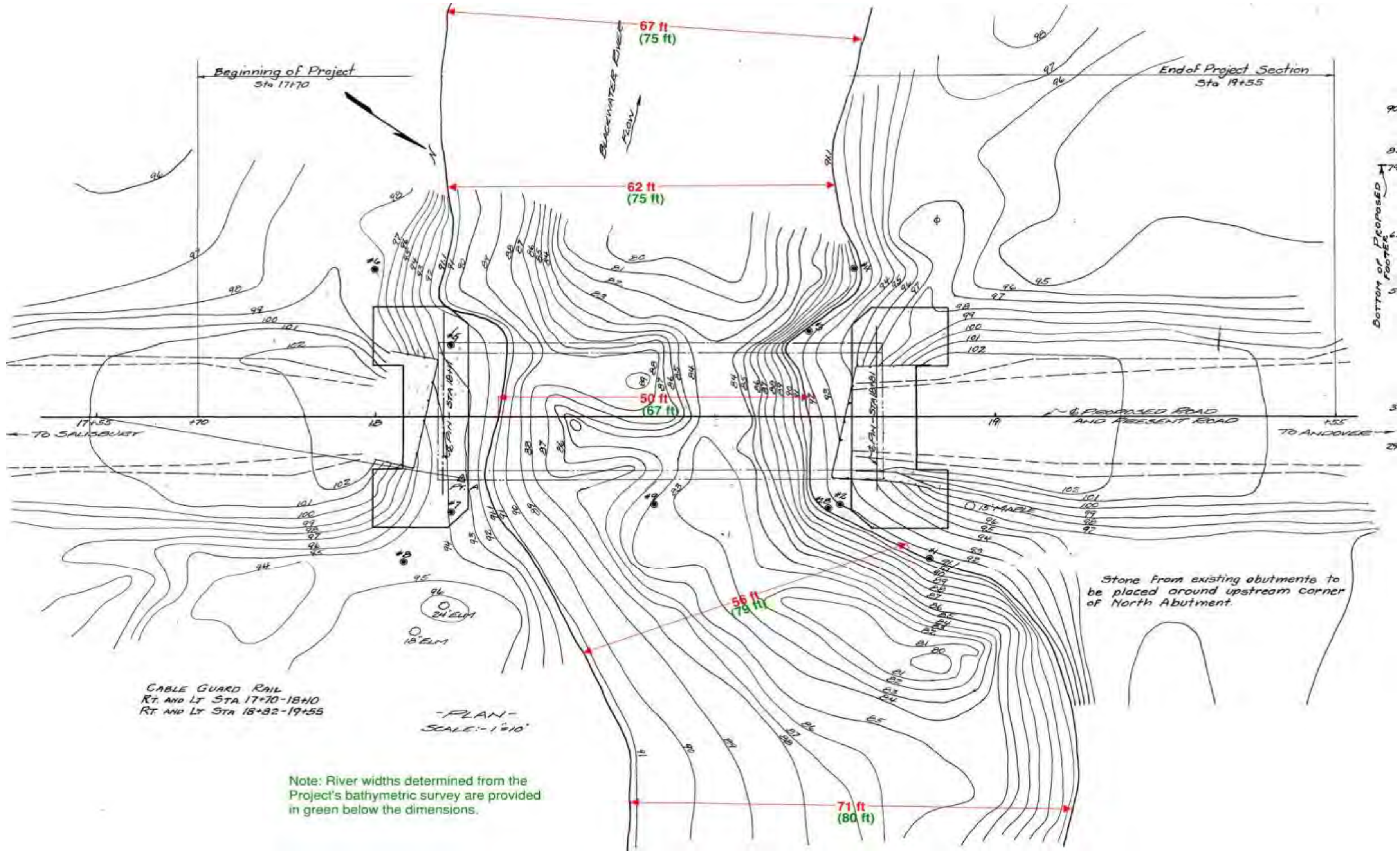
STEP 4: LATERAL STABILITY

• Google Earth Image from 4/11/1998:

• Google Earth Image from 4/27/2016:

STEP 4: LATERAL STABILITY

• Existing Plan View from State of New Hampshire State Highway Department, N.R.S. Project No. 253, dated October 1933, Sheet 1 of 5 (Bridge B and Approaches)



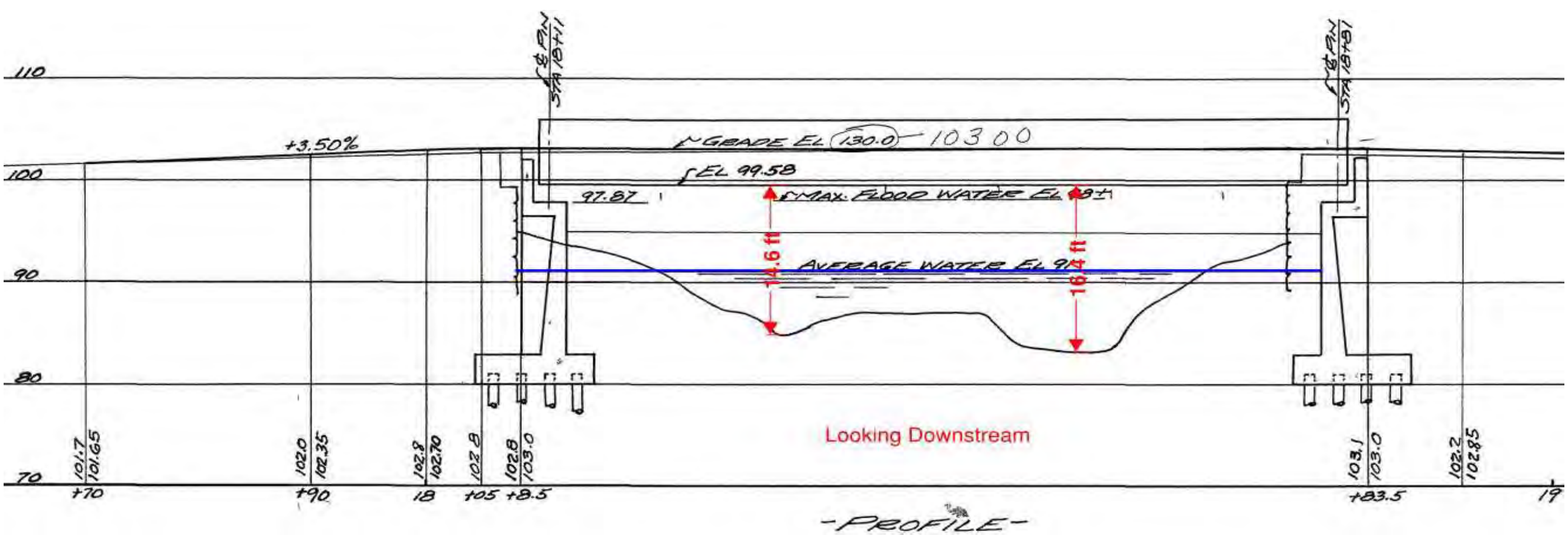
STEP 5: VERTICAL STABILITY

NOTES

- According to the last bridge inspection report dated 11/20/2019, the Bridge Scour Critical Status is rated an 8 for stable above footings.

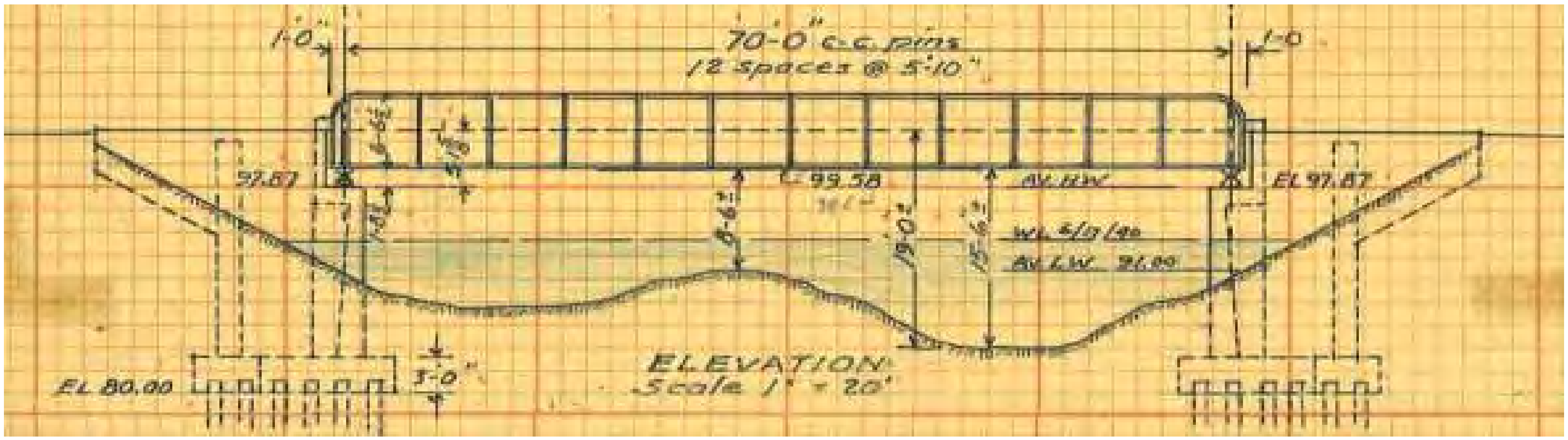
- The only known previous bathymetry of the river at the bridge is from the existing plans (see below) and the bridge Flat Card dated 6/17/1940 (see next sheet).
- These can be compared to the current bathymetry obtained by the survey for this project (see cross-section and photos on following sheets).
- By comparing the streambed from 1933 to the streambed from 2020 (an 87 year difference), there is evidence of vertical changes in the streambed.
    - Per the project plan Profile, the streambed was higher than the average water level at the abutments. However, it is unknow if this was the as-built condition or if the streambed grades in front of the abutments were adjusted. Per the 1940 flat card and the bathymetry and the existing photos (see attached), the water extends to the face of the abutments.
    - Per the project plan Profile, the two lowest points of the streambed were about 14.5' and 16.5' below the low chord elevation. Per the flat card, the low point was 15.5' below the low chord. And per the bathymetry, the two lowest points are 14.5' and 15.5' below the low chord elevation.
    - Therefore, although there has potentially been degradation of the streambed near the abutments, the overall low points of the stream have not varied greatly and possibly show aggradation in the center of the river.

- Profile View from State of New Hampshire State Highway Department, N.R.S. Project No. 253, dated October 1933, Sheet 1 of 5 (Bridge B and Approaches)



STEP 5: VERTICAL STABILITY

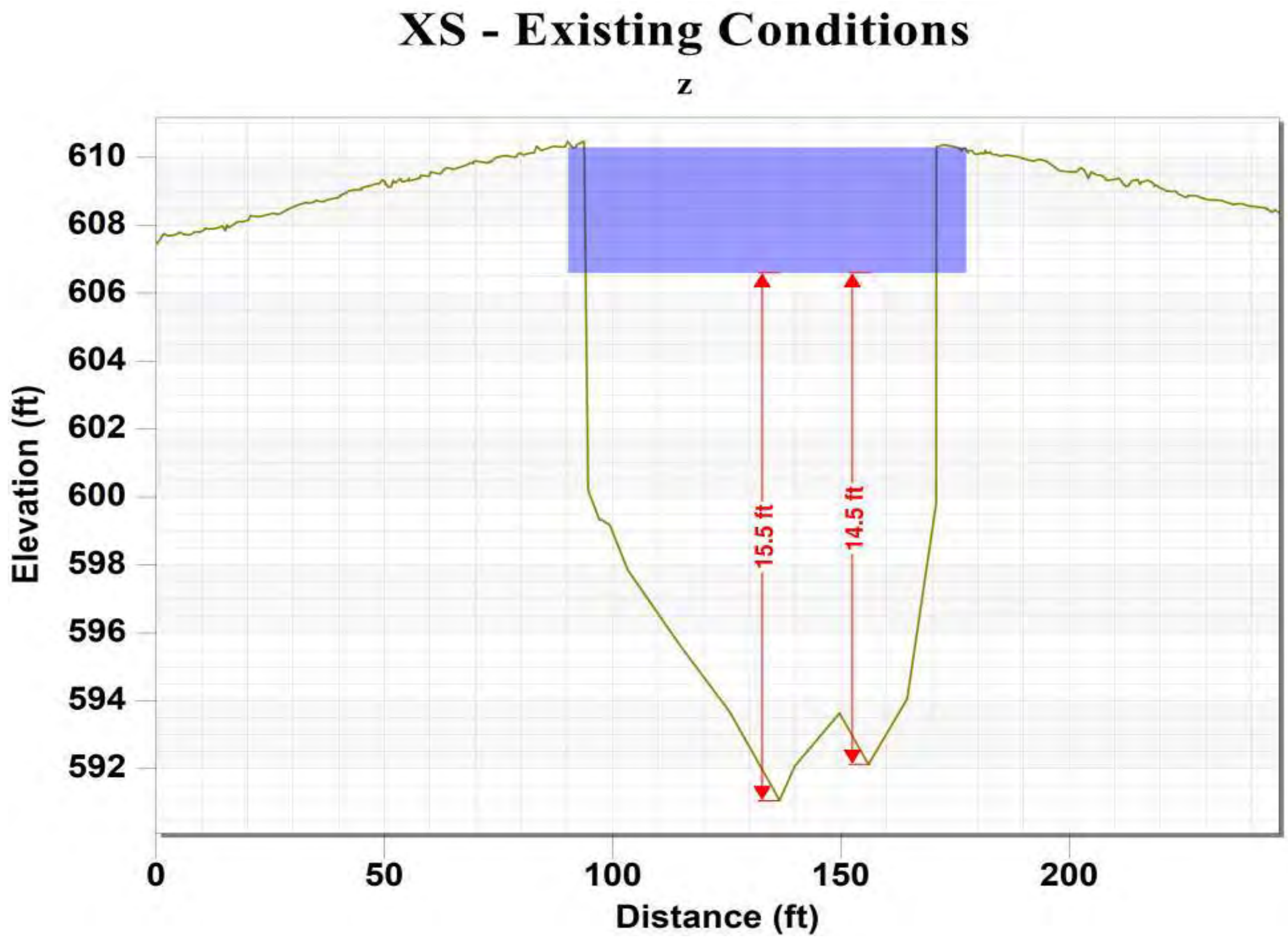
• Profile View from State of New Hampshire State Highway Department Flat Card for Route 4 over Blackwater River, Andover, NH (Bridge No. 143/077)



• Upstream photograph from State of New Hampshire State Highway Department Flat Card for Route 4 over Blackwater River, Andover, NH (Bridge No. 143/077)

STEP 5: VERTICAL STABILITY

- River cross-section per bathymetry survey obtained for the project.



STEP 5: VERTICAL STABILITY

• Photo from 10/09/2018 Looking Downstream

• Photo from 10/09/2018 Looking Upstream

STEP 6: STREAM RESPONSE

NOTES

- Lane (1955) developed relationships based on channel bed slope and mean annual discharge to distinguish between braided streams, meandering streams, and streams transitioning between these for sand-bed streams. This is shown in HEC-20 Figure 5.16 (below).
  - The mean annual discharge is unknown at this crossing; however, the value is estimated to be about 200 cfs based on the data from the downstream gage (see next page). Although this stream gage cannot be used to determine peak flows because of the Blackwater dam, the mean annual discharge would be similar to the project site values.
  - The slope is about 0.0005 ft/ft based on the hydraulic analysis.
  - The Blackwater River is considered "Transitional" based on Lane's relationship.

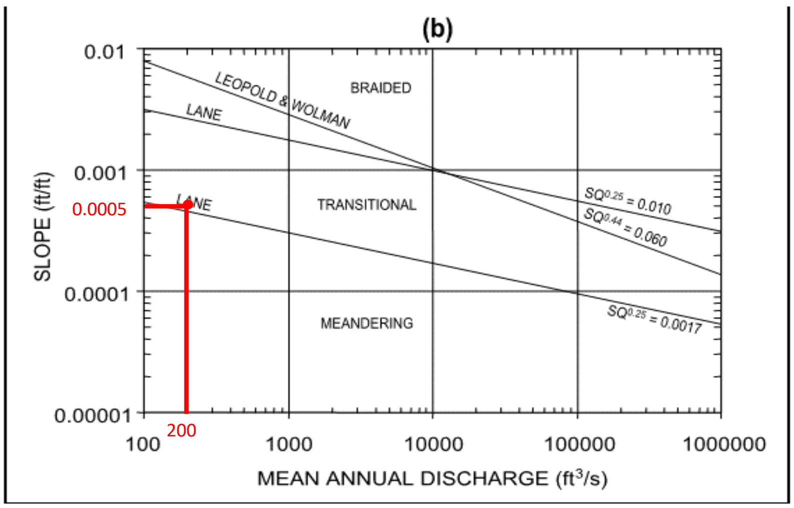


Figure 5.16a, b. Slope-discharge relationship for braiding or meandering in sand-bed streams (after Lane 1955). a = SI Units b = English Units

Where:
S = channel bed slope, ft/ft (m/m)
Q = mean annual discharge, ft^3/s (m^3/s)

- Per HEC-20, "Lane (1955) studied the changes in stream morphology caused by modifications of water and sediment discharges and developed simple qualitative relationships among the most important variables indicating stream behavior. Similar but more comprehensive treatments of channel response to changing conditions in streams have been presented by Leopold and Maddock (USGS 1953), Schumm (1971), and Santos-Cayado (1972). All research results support the relationship originally proposed by Lane:

$QS \propto Q_s D_{50}$ where:

Q = Discharge of water
S = Energy slope
Q_s = Sediment discharge
D_{50} = Median sediment size

- Based on this relationship, if bank erosion increases and increases sediment discharge, one of the other parameters will have to adjust to maintain equilibrium. For example, this could be accomplished by the energy slope increasing. However, if the discharge increases, the energy slope could stay the same, or it could decrease or increase. These changes can be represented using the relationship as follows:

  - Increase in sediment discharge may result in increase in energy slope

$$QS^+ \propto Q_s^+ D_{50}$$

  - Increase in sediment discharge and increase in discharge may result in increase or decrease in energy slope

$$Q^+ S^{\pm} \propto Q_s^+ D_{50}$$

Note: When neither + or - appears as a superscript in the Lane relationship, conditions remain unchanged.

STEP 6: STREAM RESPONSE

• USGS Stream Gage Data from: https://streamstatsags.cr.usgs.gov/gagepages/html/01087000.htm

USGS
science for a changing world

StreamStats Data-Collection Station Report

USGS Station Number **01087000**
Station Name **BLACKWATER RIVER NEAR WEBSTER, NH**

Streamflow Statistics

Statistic Name	Value	Units	Citation Number	Preferred?	Years of Record	Standard Error, percent	Variance log-10	Lower 95% Confidence Interval	Upper 95% Confidence Interval	Start Date	End Date	Remarks
Annual Flow Statistics												
Mean_Annual_Flow	215	cubic feet per second	325	Y	64					10/1/1918	9/30/1989	
Stand_Dev_of_Mean_Annual_Flow	54	cubic feet per second	325	Y	64					10/1/1918	9/30/1989	
Maximum_Annual_Mean_Flow	330	cubic feet per second	325	Y	64					10/1/1918	9/30/1989	
Minimum_Annual_Mean_Flow	84	cubic feet per second	325	Y	64					10/1/1918	9/30/1989	

Citations

Citation Number	*Citation Name and URL*
30	Imported from NWIS file
41	Wolock, D.M., 2003, Flow characteristics at U.S. Geological Survey streamgages in the conterminous United States: U.S. Geological Survey Open-File Report 03-146, digital data set
42	Wolock, D.M., 2003, Base-flow index grid for the conterminous United States: U.S. Geological Survey Open-File Report 03-263, digital data set
325	Granato G.E., Ries, K.G., III, and Steeves, P.A., 2017, Compilation of streamflow statistics calculated from daily mean streamflow data collected during water years 1901�2015 for selected U.S. Geological Survey streamgages: U.S. Geological Survey Open-File Report 2017-1108, 17 p.

CONCLUSION

NOTES

- Considering all of the steps for the Level 1 analysis, this portion of the Blackwater River has elements indicating both stability and instability.
- The proposed structure will span beyond the existing bankfull width, so it will most likely not constrict the flow if the banks continue to erode.
- Additionally, there is no evidence of scour at the existing footings.
- Therefore, a full Level 2 Scour Analysis is not warranted (see flow chart below). However, the total scour depth is calculated for use in the foundation design (one of the steps that would be performed as part of the Level 2 Analyses).

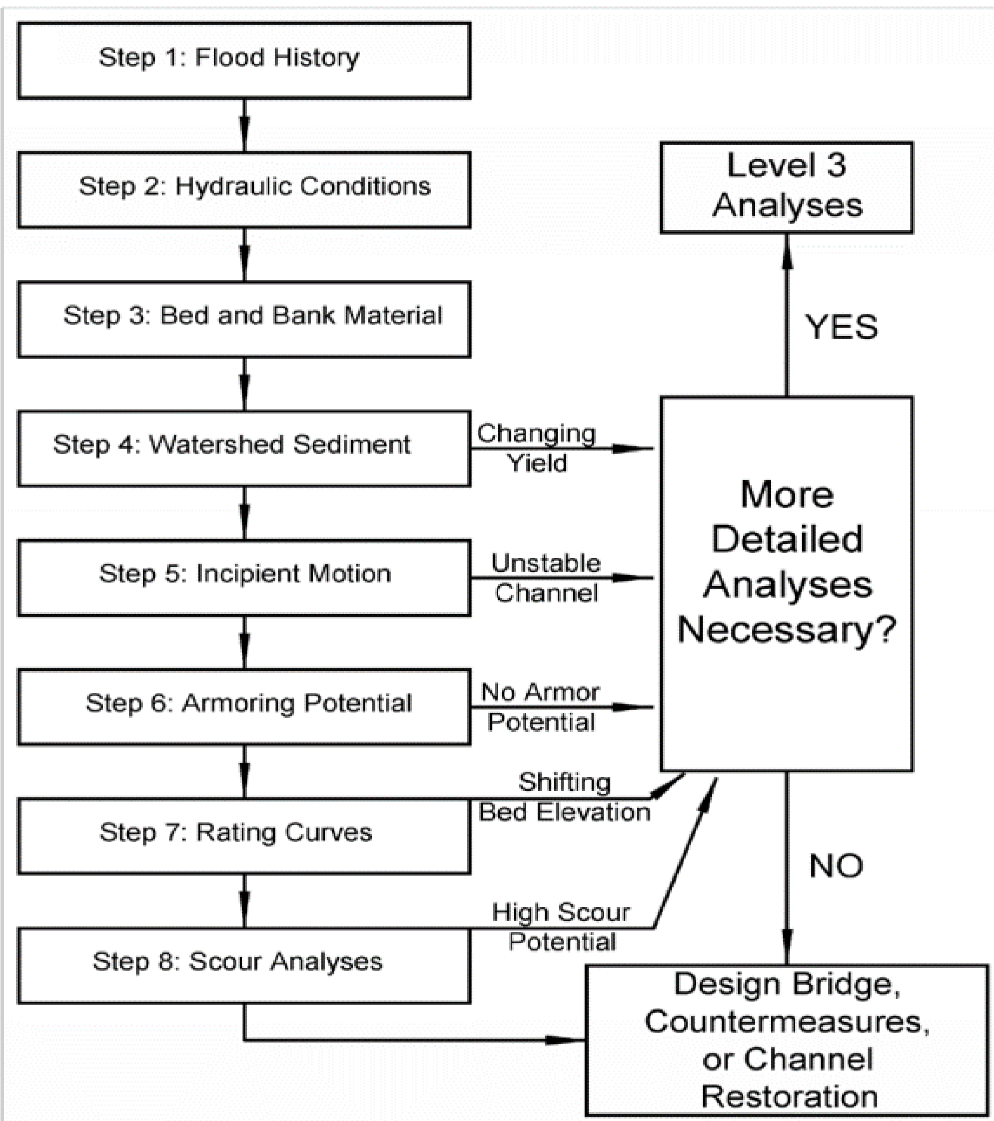


Figure 4.4. Flow chart for Level 2: Basic Engineering Analyses.

APPENDIX G

Hydraulic Model Development

Hoyle, Tanner & Associates, Inc.

Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 Over Blackwater River
NHDOT Bridge No. 143/077
2D Hydraulic Analyses

Modeler: KMH
Reviewer: AML
Date: 7/2020

2-D Hydraulic Model Review Checklist - SRH-2D/SMS

Project: Route 4, Andover, NH
River: Blackwater River
Project Purpose: Bridge Replacement
Project File Name: Rte4_BlackwaterRiver_Andover.sms

Modeler: KMH
Reviewer: AML
Date: 7/16/2020 & 7/17/20

2-D Hydraulic Model Review Checklist - SRH-2D/SMS - EXISTING & PROPOSED MODELS

Item	Input Comment	Check Comment	Action Needed (blank=none)	Response to Comment/Resolution	Screen Shot	Link
Model Background Data						
Version of SMS/SRH-2D documented?	SMS 13.0.14	Analysis results based on V. 13.0.13 (software upgraded after COB on 7/15/20); no computational changes in software operation			☐	
Project vertical datum?	NAVD88 (U.S. Survey Feet)				☐	
Project horizontal datum?	State Plane Coord. System, Zone 2800; NAD83				☐	
Documentation of techniques and procedures?	This document & report				☐	
Meta data included in model files?	Yes				☐	
Topography						
Source/Date	LiDAR & Bathymetry received from GM2 on 5/28/2020	Reviewed on 6/26/20, prior to starting hydraulic analysis			☐	
Stated Accuracy	None noted				☐	
Datums verified	GM2 elevations matched LiDAR elevations from GRANIT				☐	
Data type (Scatter set or 3D Raster image)	XML file of survey & LiDAR				☐	
Number of points / average spacing	Not reviewed	Visually reviewed; density of points appears appropriate for intended use of topo			☐	
Bathymetry						
Source/Date	GM2 received 5/28/2020				☐	
Datums verified	GM2 elevations matched LiDAR elevations from GRANIT				☐	
Check Stamp Arcs - XS geometry? Slope? Location?	OK	Reviewed on 6/26/20, prior to starting hydraulic analysis			☑	Topographic Data'!A6
Additional Survey						
Source/Date	NHDOT Survey of Roadway reportedly incorporated into survey file received from GM2				☐	
Datums verified	Not a lot of points evident of this area; seem to be OK w/ LiDAR data				☐	
Bridge/Culvert/Structure Data						
Source/Date	Existing Plans Dated 1933				☐	
Datums verified	Appears that arbitrary datum used				☐	
Topographic Data review						
Were multiple data sources merged to create a terrain map? If so, which sources?	Yes; LIDAR, bathymetry, stamped channels				☐	
Data consistency - Are the transitions between data sets smooth?	Yes	Confirmed via visual review of 3D model			☐	
Does final surface accurately represent site (are hydraulic controls represented)?	Yes	Confirmed via visual review of 3D model			☐	
Confirm breaklines used where necessary	OK				☐	

Item	Input Comment	Check Comment	Action Needed (blank=none)	Response to Comment/Resolution	Screen Shot	Link
2D Mesh						
How many mesh elements?	~63,000	Expanded from ~51,000 elements to encompass expanded eastern portion of site			☐	
Are the number and size of mesh elements appropriate?	Yes	Visual review: finer mesh within channel, coarser elements at perimeter of model - OK			☐	
Bridge Mesh OK? (7-10 quadrilateral (patch) mesh across width)	OK; 7 used	7 transverse elements confirmed			☐	
Road Mesh near Crossing OK? (quadrilateral mesh, similar to bridge)	OK				☐	
River Mesh OK? (5-7 quadrilateral (patch) mesh across width; more for mountainous streams)	OK, 8 to 9 used for blackwater river, 4 for tributaries (OK)				☐	
What is the range of element sizes and is it appropriate for this project application?	Fairly small range, but seems reasonable for floodplain area				☐	
What is the length of the modeled reach?	8280				☐	Mesh!A3
What are the approximate floodplain widths (upstream/downstream)?	1500				☐	
Is the upstream mesh limit sufficient?	OK				☐	Mesh!A8
Is the downstream mesh limit sufficient?	OK				☐	Mesh!A9
Are the lateral extents sufficient?	Yes				☐	
Are key project features correctly represented?	Yes				☐	
Are all slope features (channel banks, embankments, etc.) represented by at least 2 or more elements?	Yes				☐	
Is mesh quality acceptable?	Yes				☐	
Min Interior Angles OK?	OK				☐	
Max Interior Angles OK?	OK				☐	
Concave Quadrilaterals OK?	OK				☐	
Element Area Change OK?	Acceptable				☐	
Connecting Elements OK?	Acceptable				☐	
Boundary Conditions						
Are unsteady or steady simulations performed?	Steady				☐	
Do boundary conditions have descriptive names?	Yes	BC = Boundary condition; Ex = Existing; Prop = Proposed; Q = storm; descriptor at end			☐	
What is the source for the inflow data?	StreamStats				☐	
Upstream Boundary - Verify correct inflow(s) amount, type, and location	OK	Document/explain that inflow into upstream confluence already included in SS flow but will be conservatively left in	Include narrative in hydrology calculations	Done	☐	
How were downstream tailwater boundaries computed (normal depth, critical depth, known water surface, other?)	Normal Depth with WSEL computed using composite n of 0.06 and slope of 0.0005	Include notes/documentation in calcs on how these values were determined	Add notes to hydrology calcs	Done	☐	
Downstream Boundary - Verify correct stage, type, and location	OK				☑	Boundary Conditions'!A4
Internal Sink - Verify correct type, flow, & location	Used for low flow only for DS tributary				☐	
Are boundary conditions applied (mapped) to mesh correctly?	Yes				☐	
Are monitoring lines used?	Yes; 4 of them	U/S & D/S Blackwater River boundary conditions + 2 at bridge			☐	

Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 Over Blackwater River
NHDOT Bridge No. 143/077
2D Hydraulic Analyses

Modeler: KMH
Reviewer: AML
Date: 7/2020

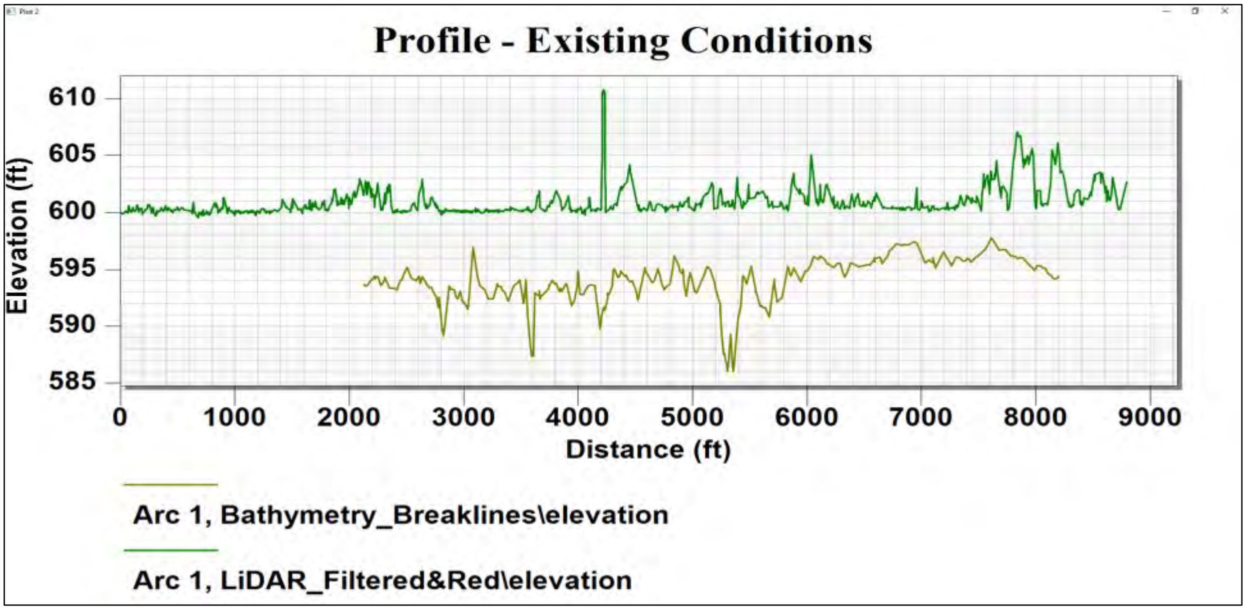
Item	Input Comment	Check Comment	Action Needed (blank=none)	Response to Comment/Resolution	Screen Shot	Link
Material Roughness						
How many materials types are used?	8				☐	
What is the source of material coverage and values?	Aerial Image				☐	
Do the materials definition extend to the limits (or beyond) the mesh domain limits?	Yes				☐	
Are material types correctly assigned?	Yes				☑	Materials!A3
Are the appropriate Manning's n-values used?	Yes	Yes; see USGS document of verified roughness values on actual rivers	Include 'Materials' tab plot in report Appendix	Done	☑	Materials!A3
Hydraulic Structures						
How many structures are represented? What types?	1 Bridge				☐	
Bridge						
Is the geometry beneath the bridge represented correctly?	Yes	Grading matches proposed info from GM2; SW quadrant may require add'l regrading to better tie-in proposed bridge - has been discussed with GM2			☐	
For detailed hydraulics, piers should be represented as holes in the mesh. The dimensions of the hole should represent the average dimensions that are obstructing the flow.	N/A	No piers, but abutments modeled as 'Unassigned Elements' to prevent flow rather than using holes in mesh - OK			☐	
Pressure BC arcs should be parallel and form rectangular zone between them.	OK				☐	
The ceiling elevation should represent the average low chord elevation of the bridge, or the span represented.	OK	Manning roughness coefficient may require revision to reflect girder superstructure vs. plane surface (like arch soffit)	Perform brief sensitivity analysis; try n=.05 as extreme value to start	Completed; the results did not change, so keep n=0.012	☐	
If the upstream WSEL exceeds the deck elevation, the overtopping option should be selected and parameters defined.	WSEL lower than top of deck	No roadway overtopping at the bridge observed in any model/flow scenario (roadway approaches are overtopped)			☐	
If the deck is overtopping, the Internal#.dat file should be reviewed for stable WSEL and flow	N/A				☐	
Culvert						
The mesh elements should generally align with the culvert and have element faces that are located close to the culvert inverts	N/A	2 small culverts in DS confluence streams, US of the confluences, were not modeled - no info available for these structures and their performance will not change model results in area of interest			☐	
Culvert BC arcs should be placed at the culvert invert locations and should generally represent the width of the culvert(s)	N/A				☐	
Is the culvert modeled in the 2D mesh or as a HY-8 culvert?	N/A				☐	
HY-8 Culvert BC arcs should be located at the culvert invert locations and the HY-8 elevations should be consistent with the mesh elevations at the invert locations.	N/A				☐	
Is culvert correctly represented	N/A				☐	
Obstructions						
Are obstructions used in the model?	No	No piers, and abutments are modeled as unassigned elements (not obstructions)			☐	
The elevation of the obstruction arc should be set to the bottom elevation of the obstruction.	N/A				☐	
The obstruction arc should align with the centerline of the obstruction, with the appropriate dimensions and coefficients entered in the obstructions dialog.	N/A				☐	
Other Structures						
What other structures are represented?	None				☐	
Is structure correctly represented?	N/A				☐	

Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 Over Blackwater River
NHDOT Bridge No. 143/077
2D Hydraulic Analyses

Modeler: KMH
Reviewer: AML
Date: 7/2020
Rev: 1/2021

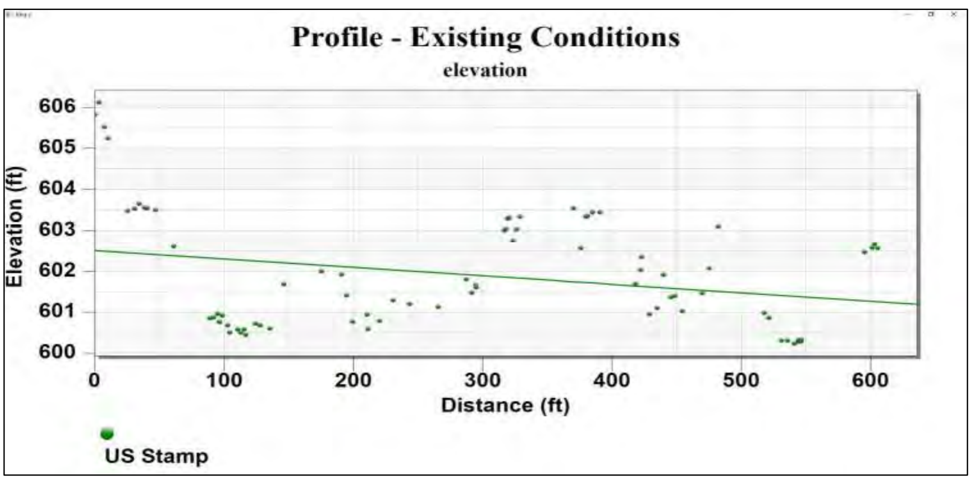
Item	Input Comment	Check Comment	Action Needed (blank=none)	Response to Comment/Resolution	Screen Shot	Link
Model Controls and Simulations						
How simulations are included?	Multiple	Multiple recurrence interval flows considered for multiple modeling scenarios including existing, proposed, and sensitivity analysis runs			☐	
Are they labeled appropriately and do they include the correct components.	Yes				☐	
Review time step used for each simulation	OK	Visual review - OK			☐	
Review simulation times	OK	Visual review - OK			☐	
Turbulence model should be set to the Parabolic Method with a coefficient of 0.7	OK	Visual review - OK			☐	
Model Results						
Are monitoring points used?	Yes, 5				☐	
Confirm model stability at monitoring points	OK	Reviewed .txt files for select models and observed convergence in values at end of time step			☐	
Confirm continuity at monitoring lines	OK				☐	
Confirm stable results through the domain	OK	Visual review - OK			☐	
Froude Number - Are results reasonable?	OK	AML performed visual review at various times during model development & analysis			☐	
Shear Stress	OK	AML performed visual review at various times during model development & analysis			☐	
Water Elevations	OK	AML performed visual review at various times during model development & analysis			☐	
Velocity	OK	AML performed visual review at various times during model development & analysis			☐	
Water Depth	OK	AML performed visual review at various times during model development & analysis			☐	
Freeboard >= 1' for Q100	Minimum Low Chord is 608.9' for 1' freeboard; this would require road to be raised	This low chord will be presented in draft Hydraulics Report and revised as necessary per GM2/NHDOT comments			☑	Model Results'!I4
Model Calibration						
Was calibration performed? If so, does the model data match the calibration data?	Have photo from May 16, 2006 from extreme flooding, but no flow data available.	No WSE data available either; road floods, bridge does not appear overtopped for 2006 event - model results align well			☐	
If no calibration, were any sensitivity analyses performed?	Yes, for both material roughness variations and DS BC's				☑	Model Sensitivity &
General Comments						
Other					☐	
					☐	

Topographic Data

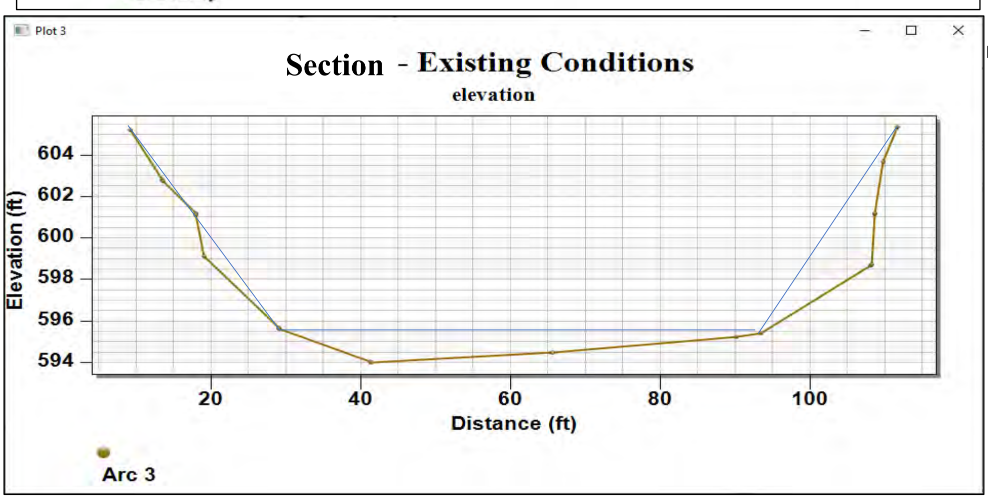


The bathymetry data is approximately 5' lower than LiDAR data.

US Stamp



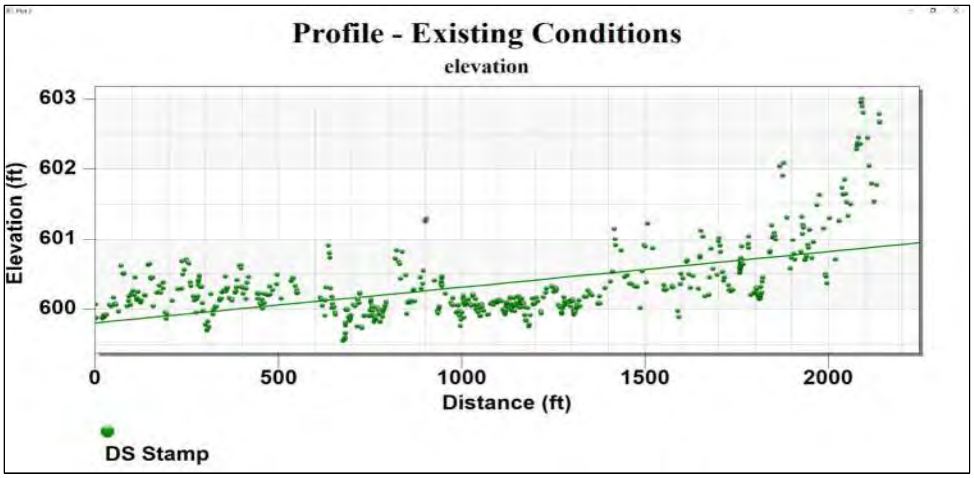
US LiDAR shows an adverse slope
Use horizontal stream bottom for stamp



First US XS from Bathymetry:
- Roughly trapezoidal
- 65' bottom width
- 20' wide sizes
- 10' deep

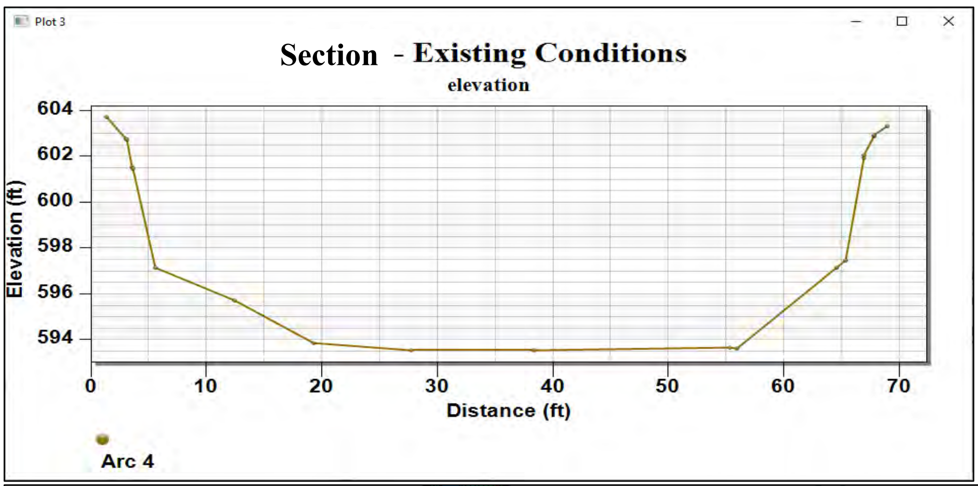
Topographic Data

DS Stamp



	X	Y
Point 1	1400	600.5
Point 2	400	600

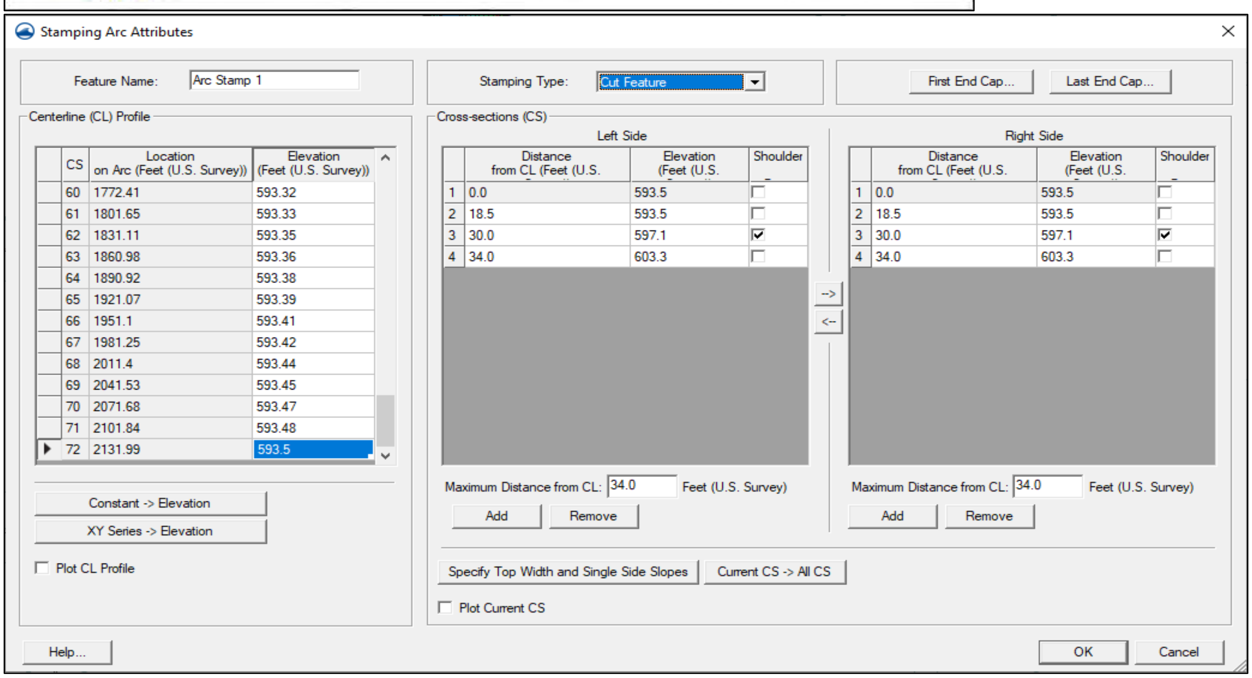
Slope = 0.0005



Last DS XS from Bathymetry:
Roughly trapezoidal
Dims from Lt to Rt (1/2 section)

Heights	Widths
6.2	4
3.6	11.5
0	18.5

See Stamp XS data below



CS	Location on Arc (Feet (U.S. Survey))	Elevation (Feet (U.S. Survey))
60	1772.41	593.32
61	1801.65	593.33
62	1831.11	593.35
63	1860.98	593.36
64	1890.92	593.38
65	1921.07	593.39
66	1951.1	593.41
67	1981.25	593.42
68	2011.4	593.44
69	2041.53	593.45
70	2071.68	593.47
71	2101.84	593.48
72	2131.99	593.5

Left Side

	Distance from CL (Feet (U.S.	Elevation (Feet (U.S.	Shoulder
1	0.0	593.5	☐
2	18.5	593.5	☐
3	30.0	597.1	☑
4	34.0	603.3	☐

Right Side

	Distance from CL (Feet (U.S.	Elevation (Feet (U.S.	Shoulder
1	0.0	593.5	☐
2	18.5	593.5	☐
3	30.0	597.1	☑
4	34.0	603.3	☐

Topographic Data

DS Stamp Cont.

	CS	Location	Elevation	CS	Location	Elevation
DS	1	0	592.43	37	1081.4	592.97
	2	30.15	592.45	38	1111.41	592.99
	3	60.3	592.46	39	1140.64	593.00
	4	90.27	592.48	40	1170.79	593.02
	5	120.33	592.49	41	1200.69	593.03
	6	150.49	592.51	42	1230.84	593.05
	7	180.64	592.52	43	1260.68	593.06
	8	210.79	592.54	44	1290.83	593.08
	9	240.94	592.55	45	1320.98	593.09
	10	271.07	592.57	46	1351.13	593.11
	11	301.22	592.58	47	1380.69	593.12
	12	331.34	592.60	48	1410.84	593.14
	13	361.5	592.61	49	1440.99	593.15
	14	391.65	592.63	50	1471.07	593.17
	15	420.83	592.64	51	1501.22	593.18
	16	450.6	592.66	52	1531.37	593.20
	17	480.51	592.67	53	1561.52	593.21
	18	510.66	592.69	54	1591.67	593.23
	19	540.79	592.70	55	1621.82	593.24
	20	570.89	592.72	56	1651.94	593.26
	21	601.04	592.73	57	1682.1	593.28
	22	631.12	592.75	58	1712.25	593.29
	23	661.25	592.76	59	1742.4	593.31
	24	691.41	592.78	60	1772.41	593.32
	25	721.52	592.79	61	1801.65	593.33
	26	751.67	592.81	62	1831.11	593.35
	27	781.56	592.82	63	1860.98	593.36
	28	811.29	592.84	64	1890.92	593.38
	29	840.93	592.85	65	1921.07	593.39
	30	870.89	592.87	66	1951.1	593.41
	31	901.05	592.88	67	1981.25	593.42
	32	931.15	592.90	68	2011.4	593.44
	33	960.82	592.91	69	2041.53	593.45
	34	990.97	592.93	70	2071.68	593.47
	35	1021.12	592.94	71	2101.84	593.48
	36	1051.24	592.96	72	2131.99	593.5

Mesh Development

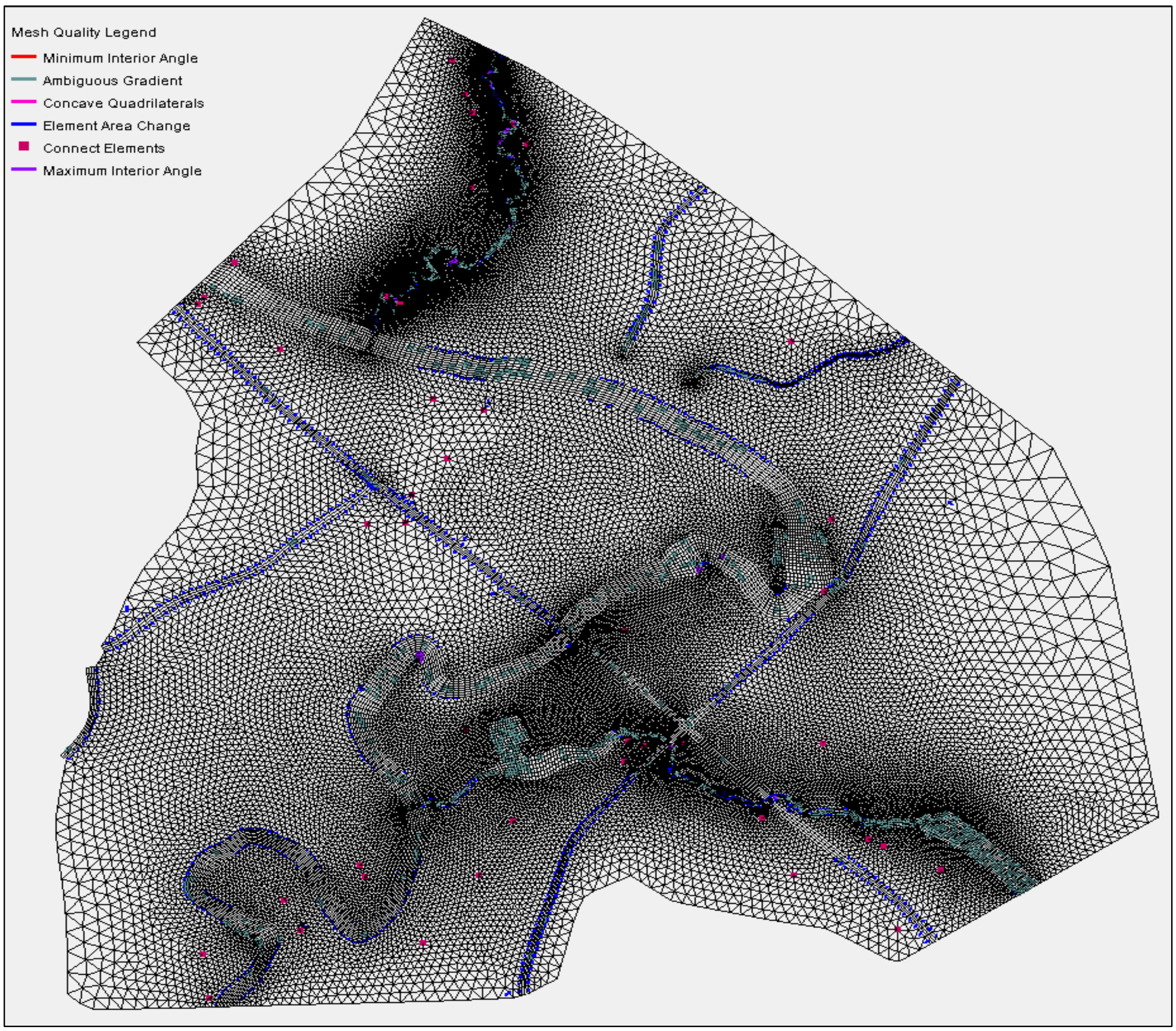
Measured Lengths in Model:	4200 ft US	4050 ft DS	30 ft bridge	8280 ft total

Guidelines from FHWA NHI 2D Modeling Course:

Floodplain Width =	1500 ft +/-	Floodplain is actual width of water for event				Check
US BC 2-3 times floodplain width from crossing		2 x FP W=	3000	3 x FP W=	4500	OK
DS BC 1-2 times floodplain width from crossing		1 x FP W=	1500	2 x FP W=	3000	OK
Overall length typically 3-5 times floodplain width		3 x FP W=	4500	5 x FP W=	7500	OK

Mesh Quality

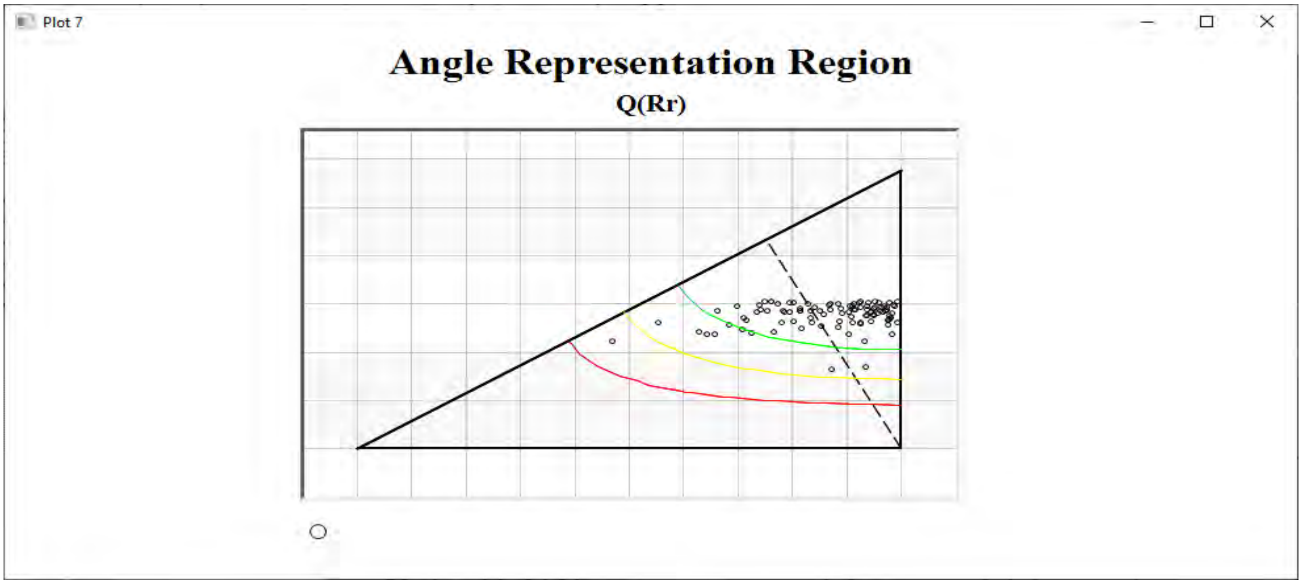
Existing mesh shown, proposed mesh similar



Mesh Development

Mesh Quality Summary https://www.xmswiki.com/wiki/SMS:ARR_Mesh_Quality_Assessment_Plot

Green = best
Yellow = acceptable
Red = possible problem areas



Boundary Conditions

US BC - Input Flow Values

Storm Event	Blackwater River*	US Tributary	DS Tributary	Total
Q2	2450	63.6	51.5	2565
Q5	3670	108	87.4	3865
Q10	4630	145	118	4893
Q25	5840	199	161	6200
Q50	6800	243	197	7240
Q100	7930	298	240	8468
Q100_Plu	14500	557	447	15504
Q500	10500	434	348	11282

DS BC - Parameters Used to Determine Water Surface Elevation

Composite Manning's n: 0.06
Streambed n = 0.04 & overbanks between 0.06 & 0.10; estimate composite n of 0.06

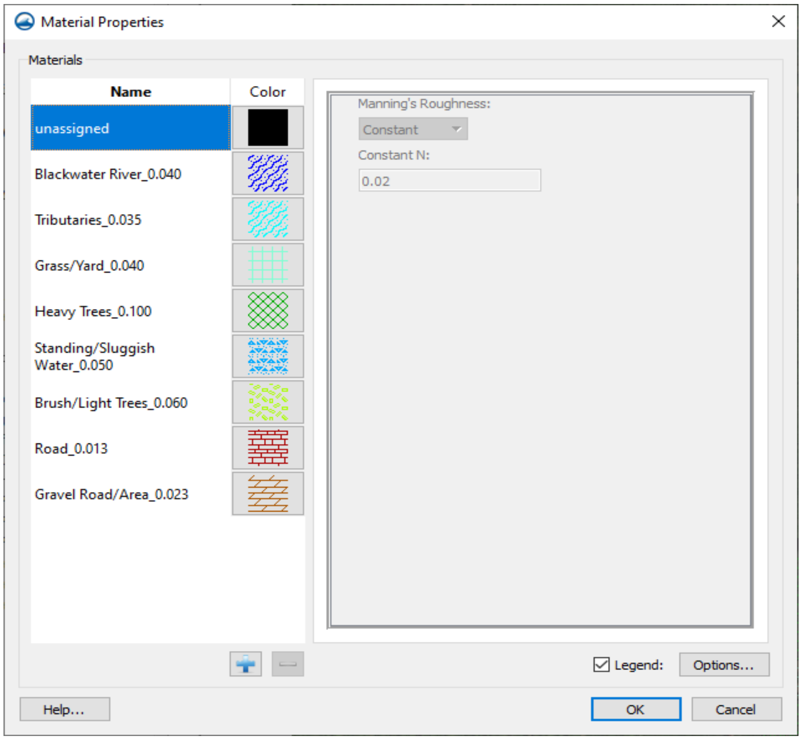
Slope: 0.0005
See Topographic Data for DS Stamp Slope Info

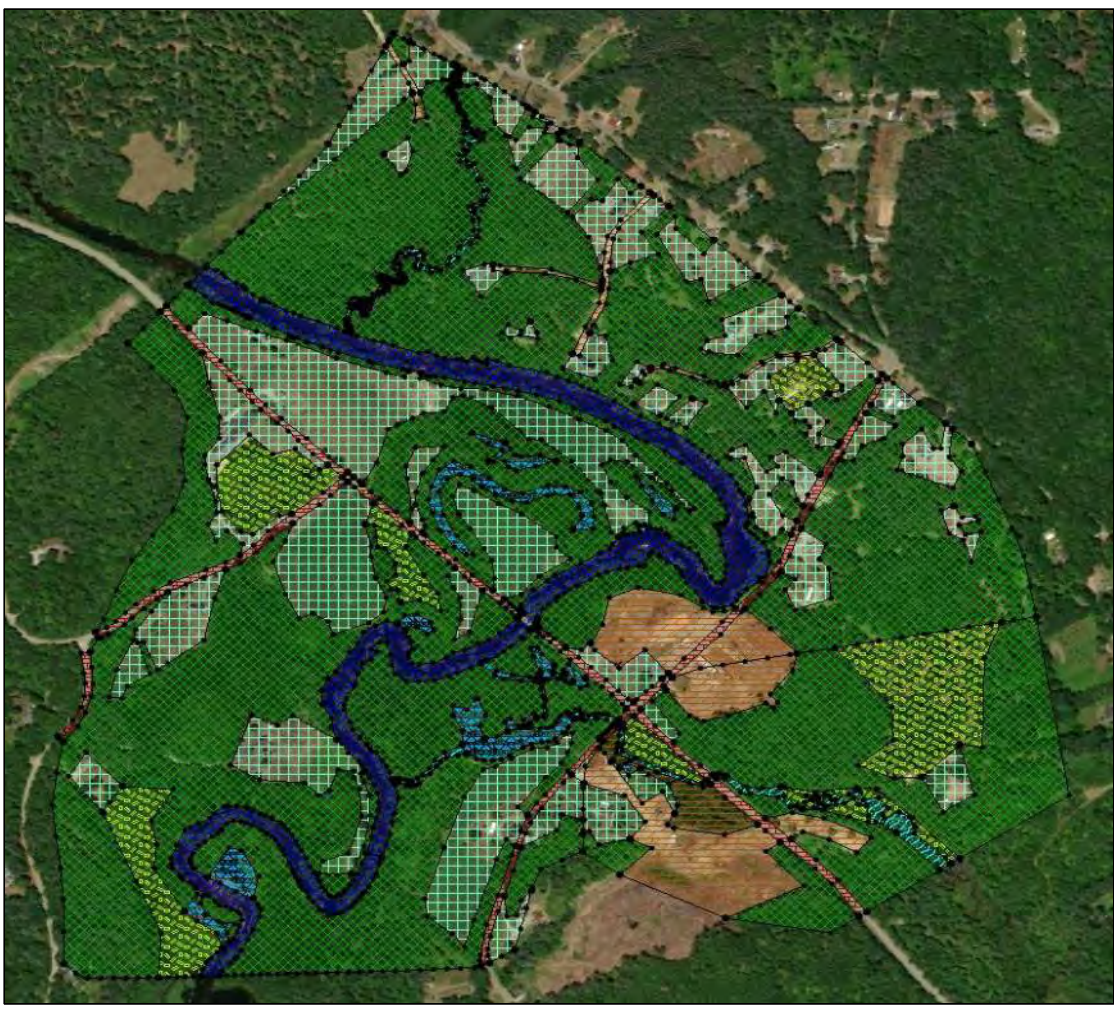
Existing Bridge - Pressure BC

Roadway Elevation from LiDAR:	610.1 ft
Estimated Pavement Thickness:	0.25 ft
Deck Thickness:	0.67 ft
Ht to Bot of Girder:	2.55 ft
Bottom Cover PL:	0.04 ft
Approx. Low Chord:	606.6 ft

BC Locations on Mesh Boundary:

Materials Coverage





Monitor Lines & Points

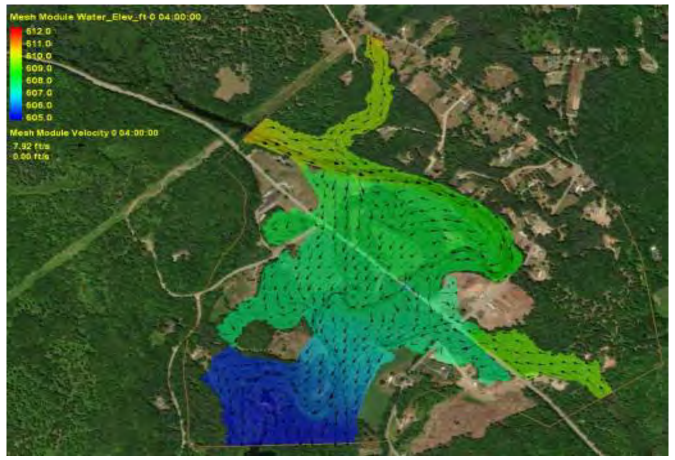
4 Monitor Lines & 5 Monitoring Points are used in the model:

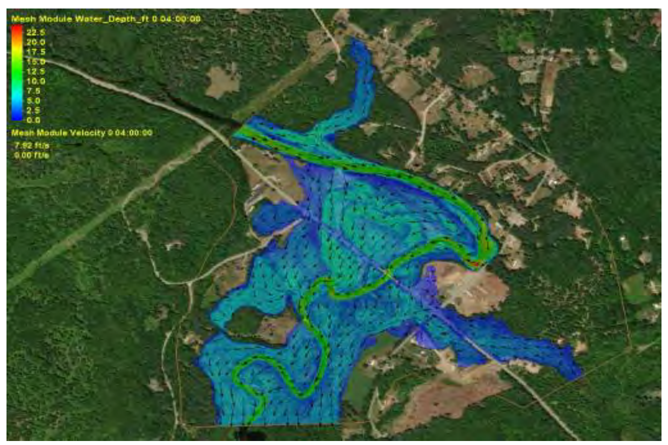
Model Sensitivity & Testing

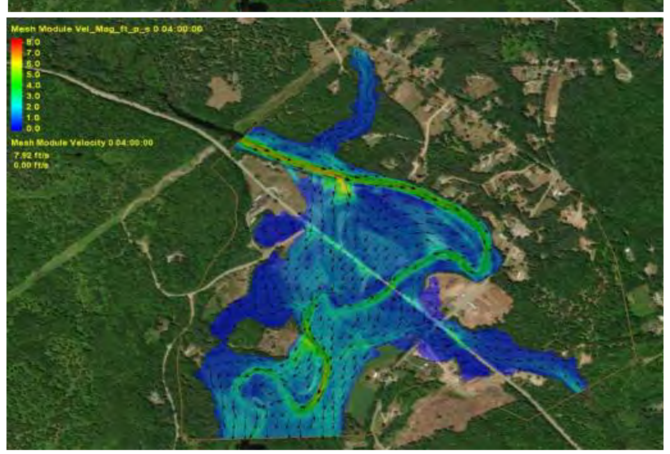
1. Test Refinement of Mesh

Q100E

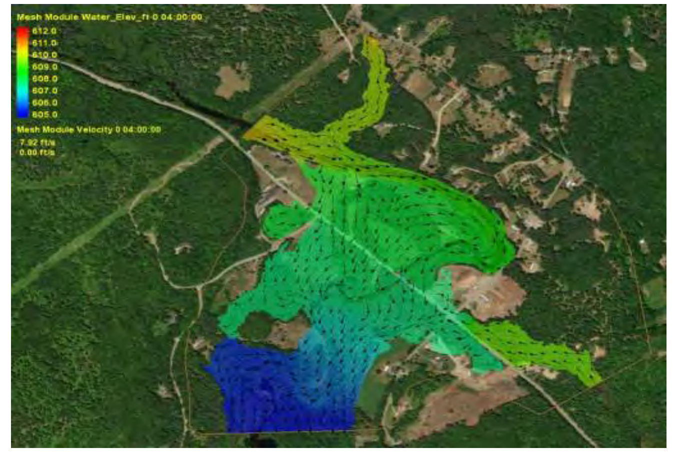
Original existing mesh (including east area of DS tributary)

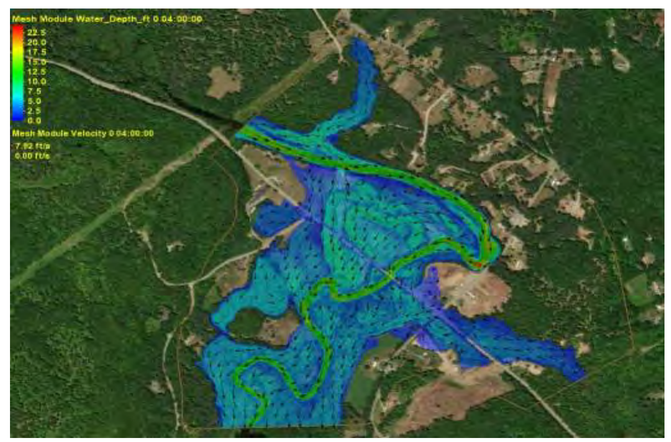


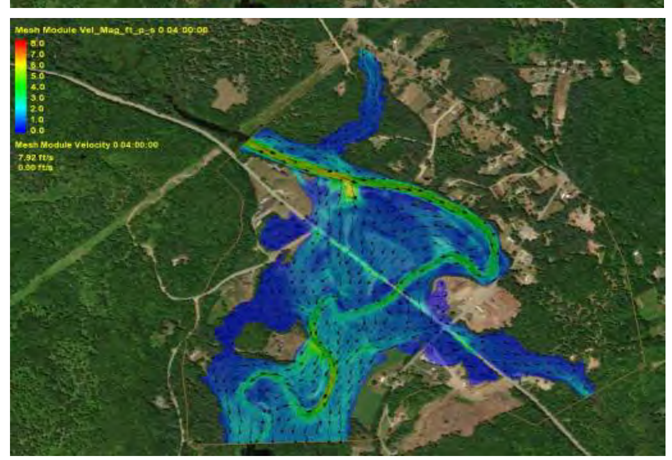




Refined existing mesh (including east area of DS tributary)

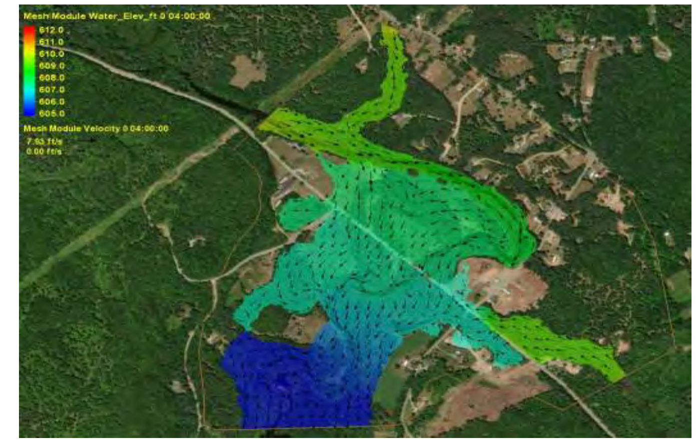


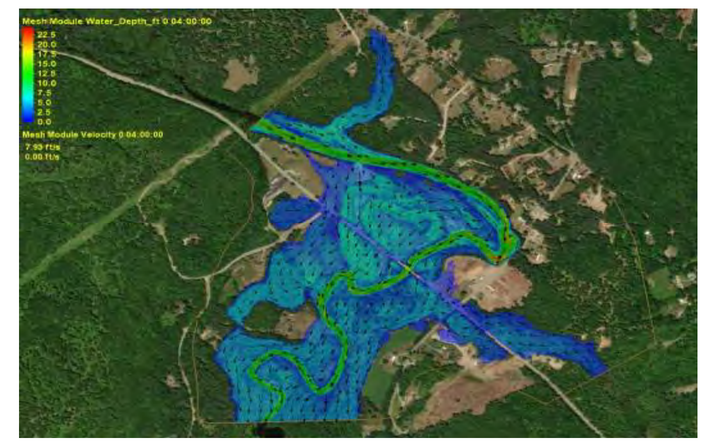


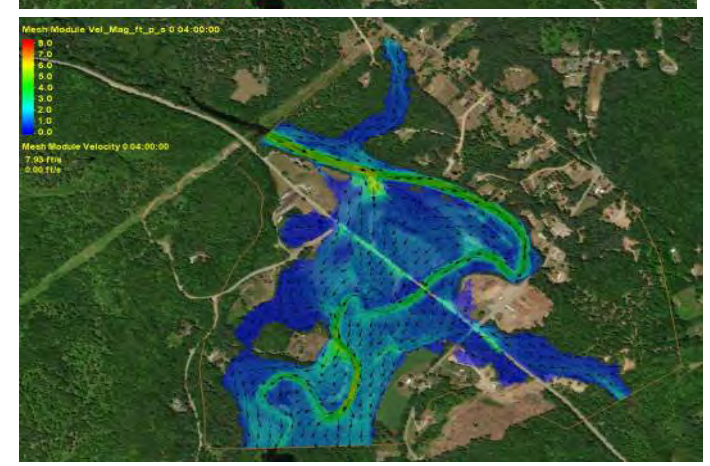


Q50E

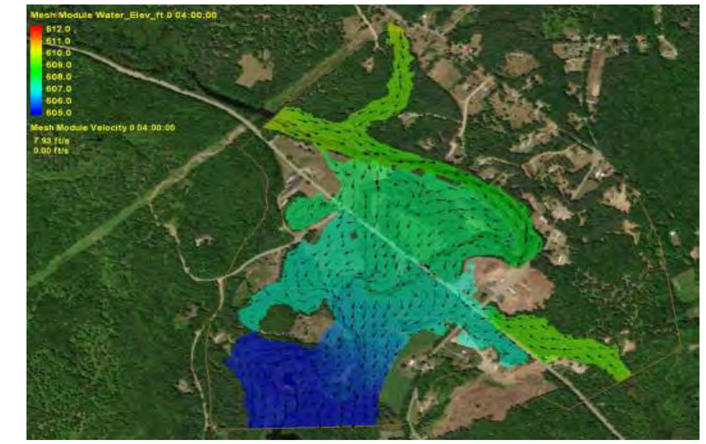
Original existing mesh (including east area of DS tributary)

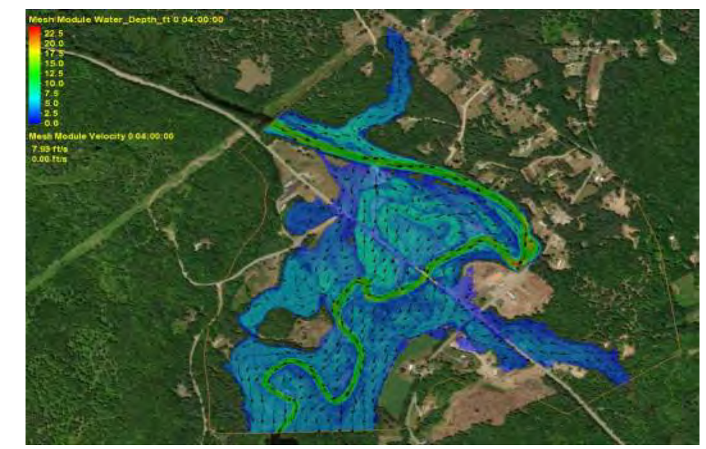


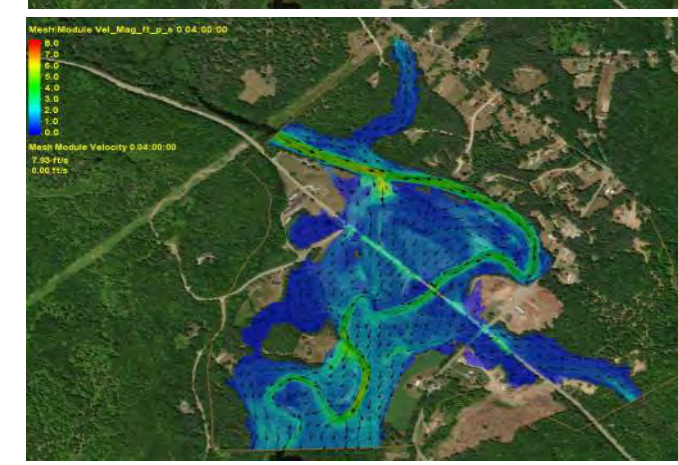




Refined existing mesh (including east area of DS tributary)







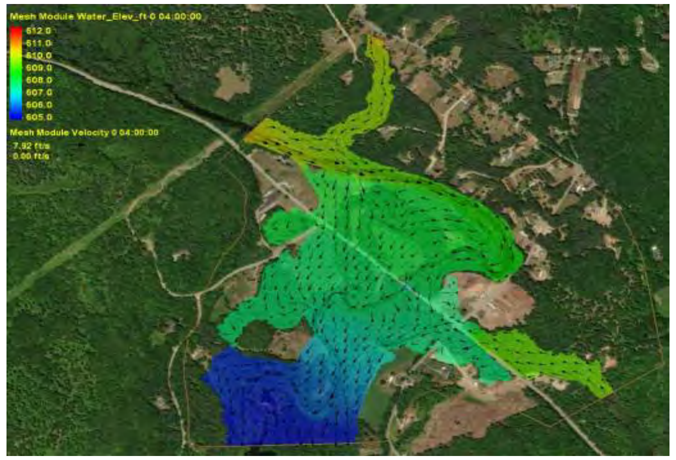
Conclusion: Essentially same results, so use original mesh

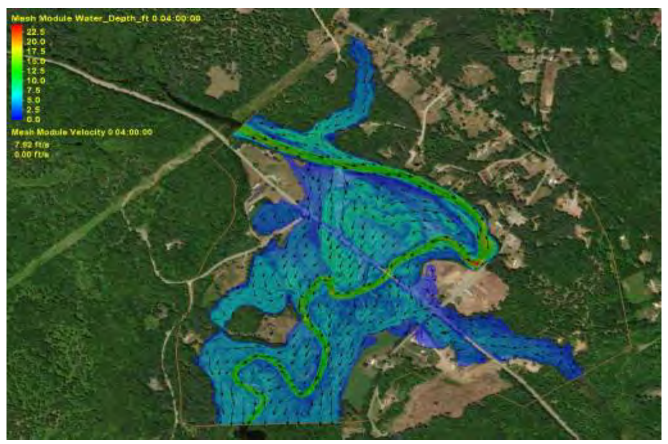
Model Sensitivity & Testing

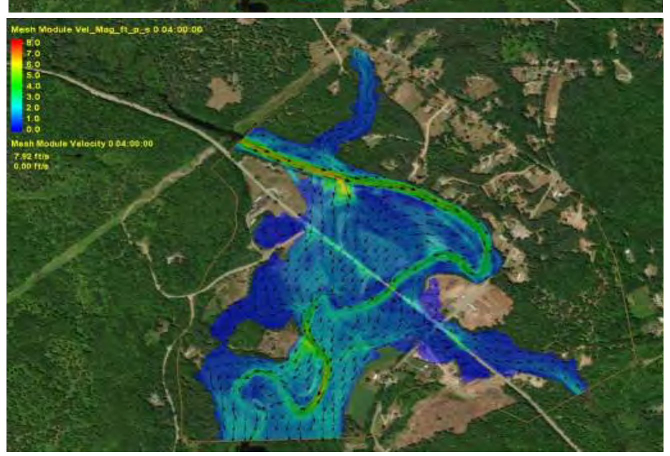
2. Test Material Roughness

Q100E

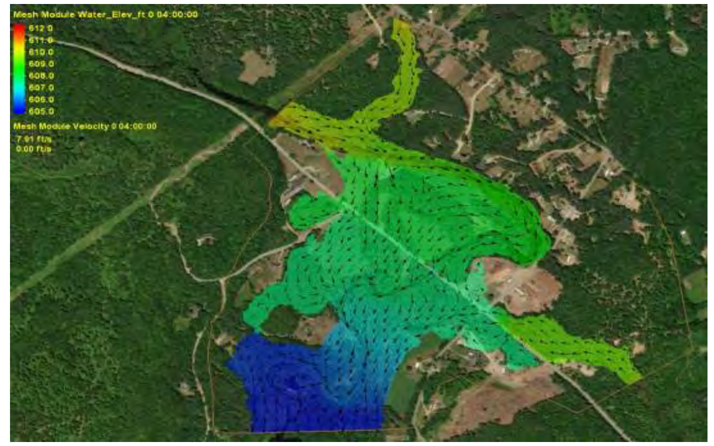
Original existing mesh used 0.04 for all grass/crop areas

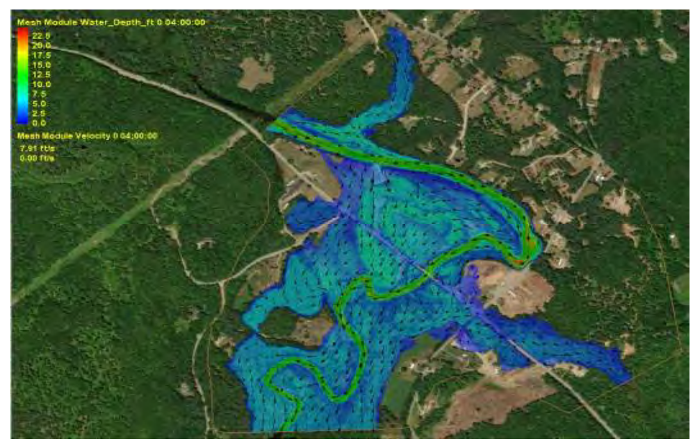


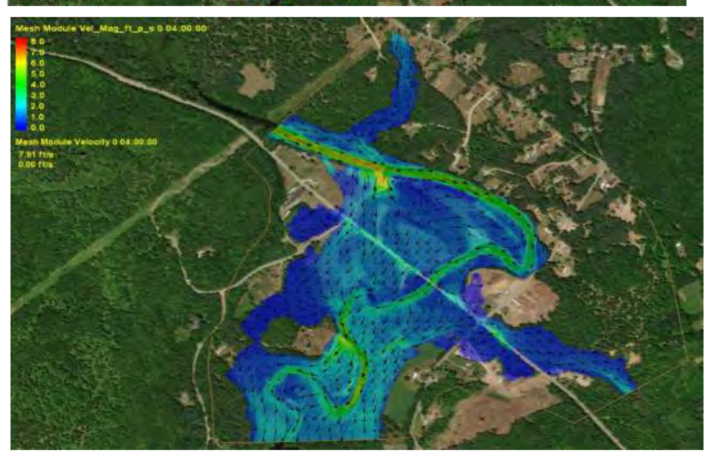




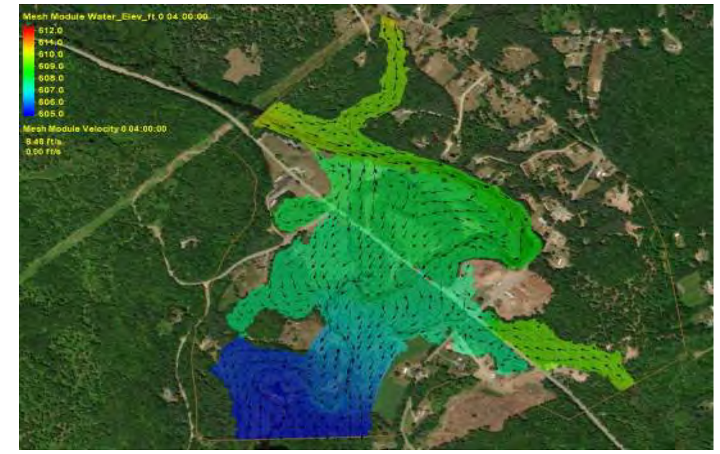
Break out grass vs crop and drop grass down to 0.03 (keep crops at 0.04)

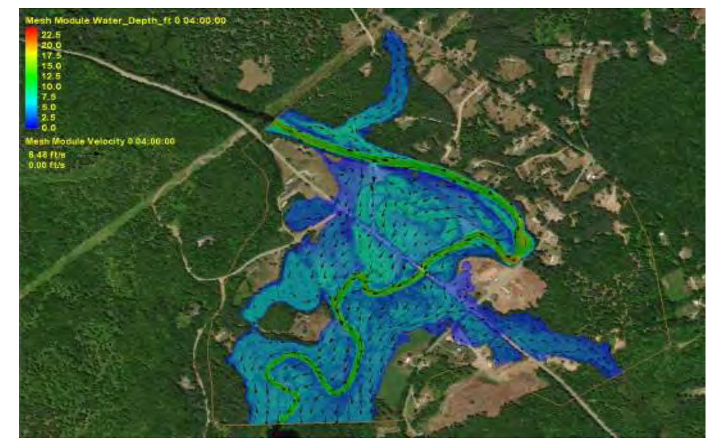


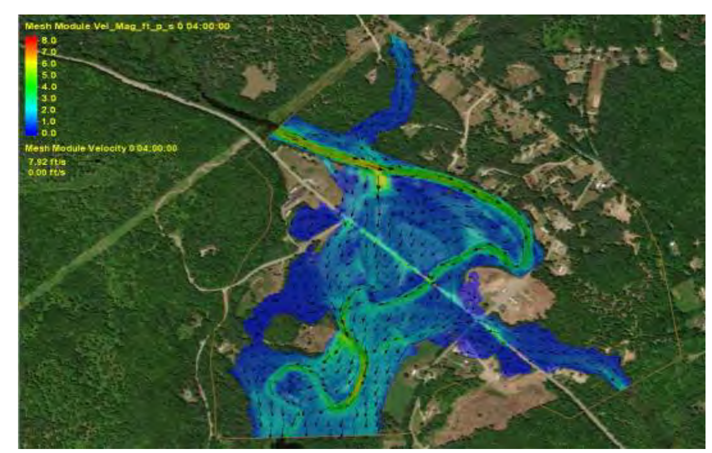




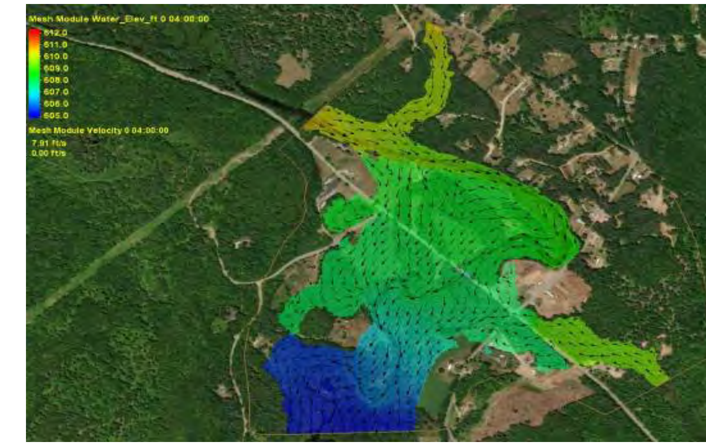
Break out grass vs crop and drop grass down to 0.03 (keep crops at 0.04), & reduce Blackwater River to 0.033

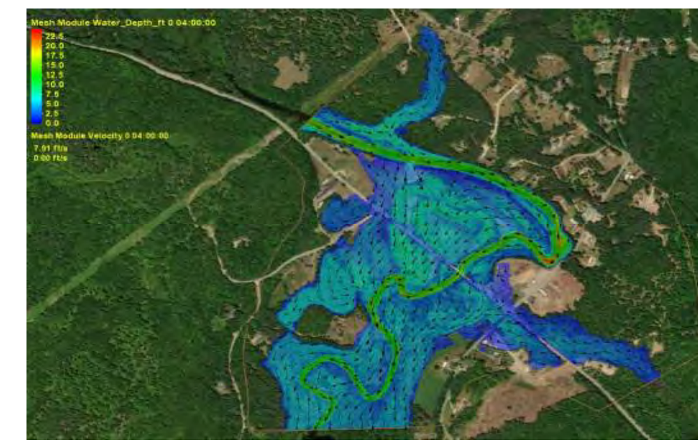


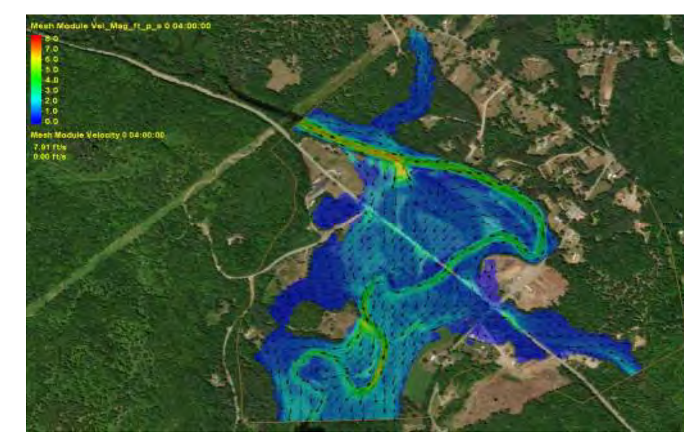




Break out grass vs crop and drop grass down to 0.03 (keep crops at 0.04), & increase dense trees to 0.12 (keep Blackwater River at 0.04)





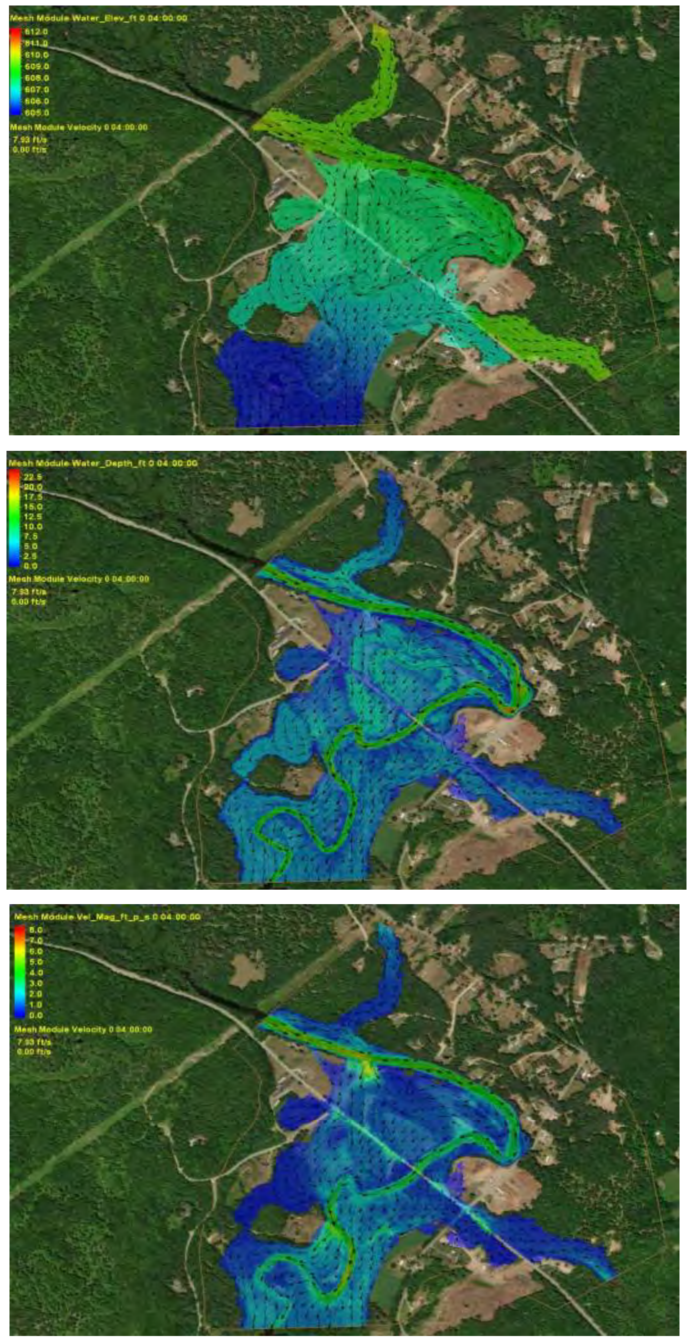


Model Sensitivity & Testing

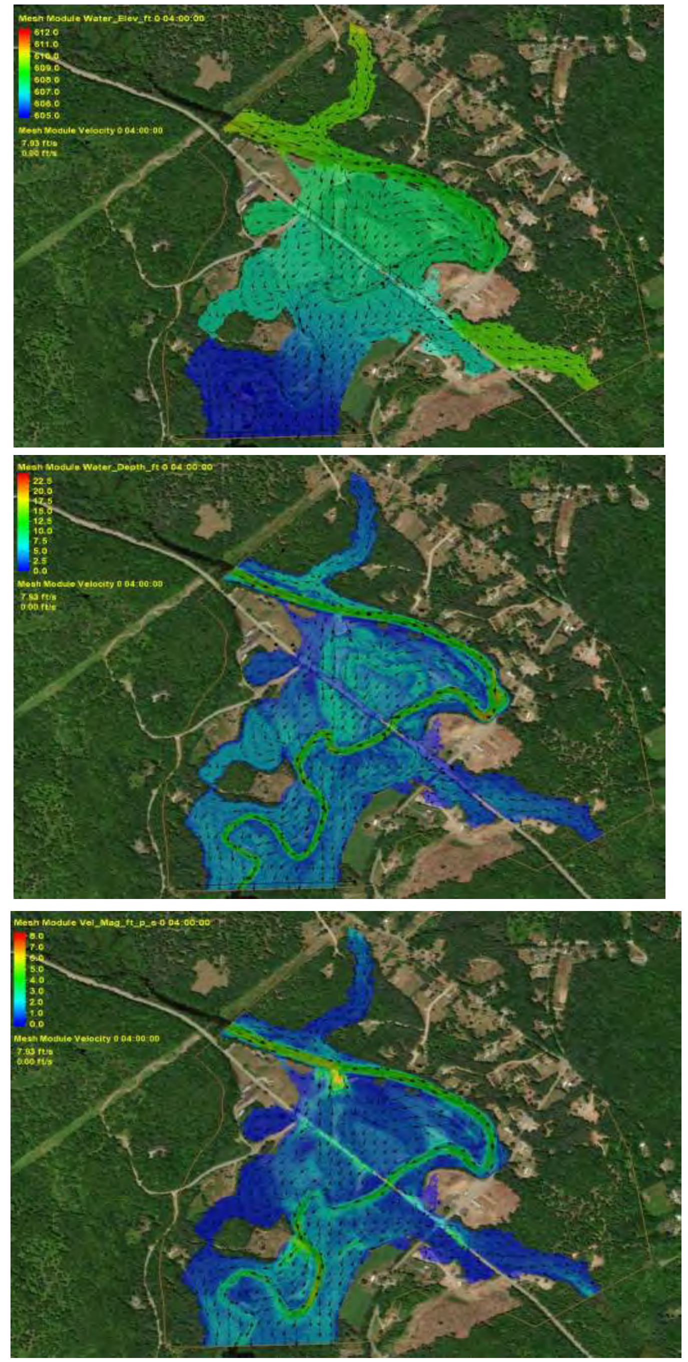
2. Test Material Roughness (Cont.)

Q50E

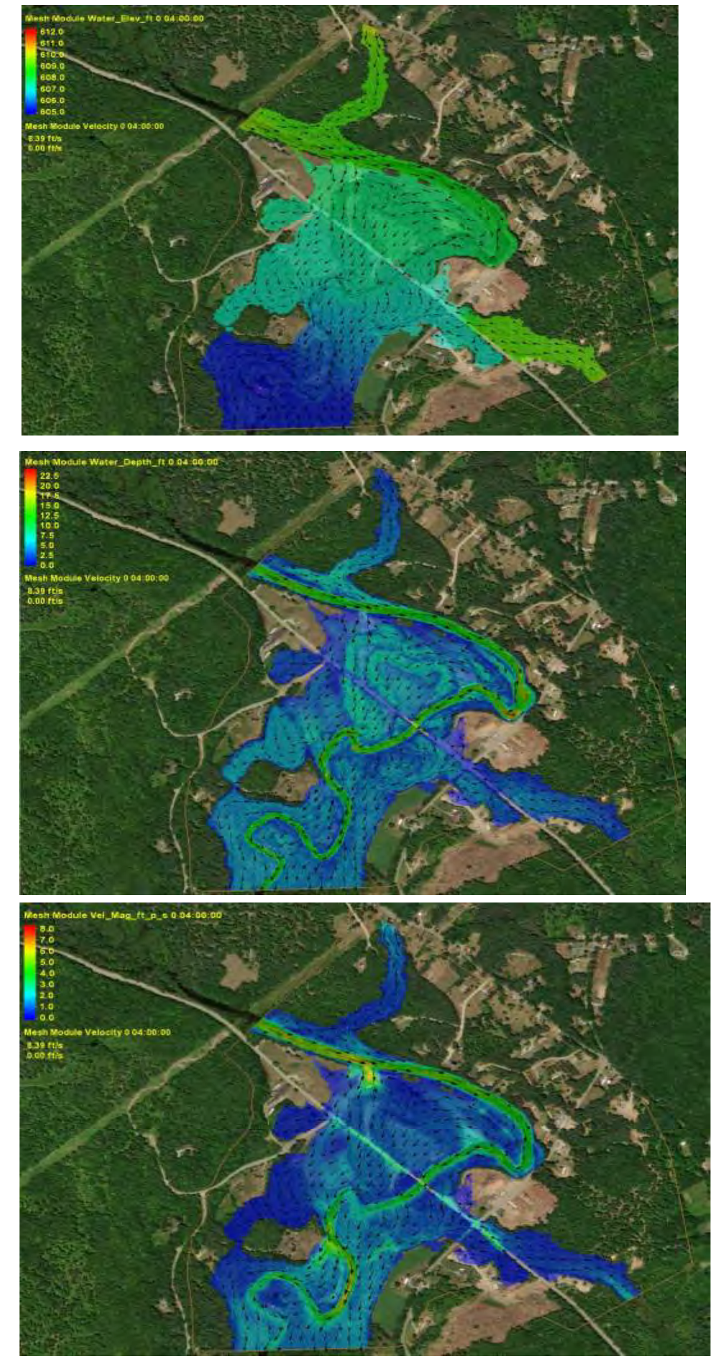
Original existing mesh used 0.04 for all grass/crop areas



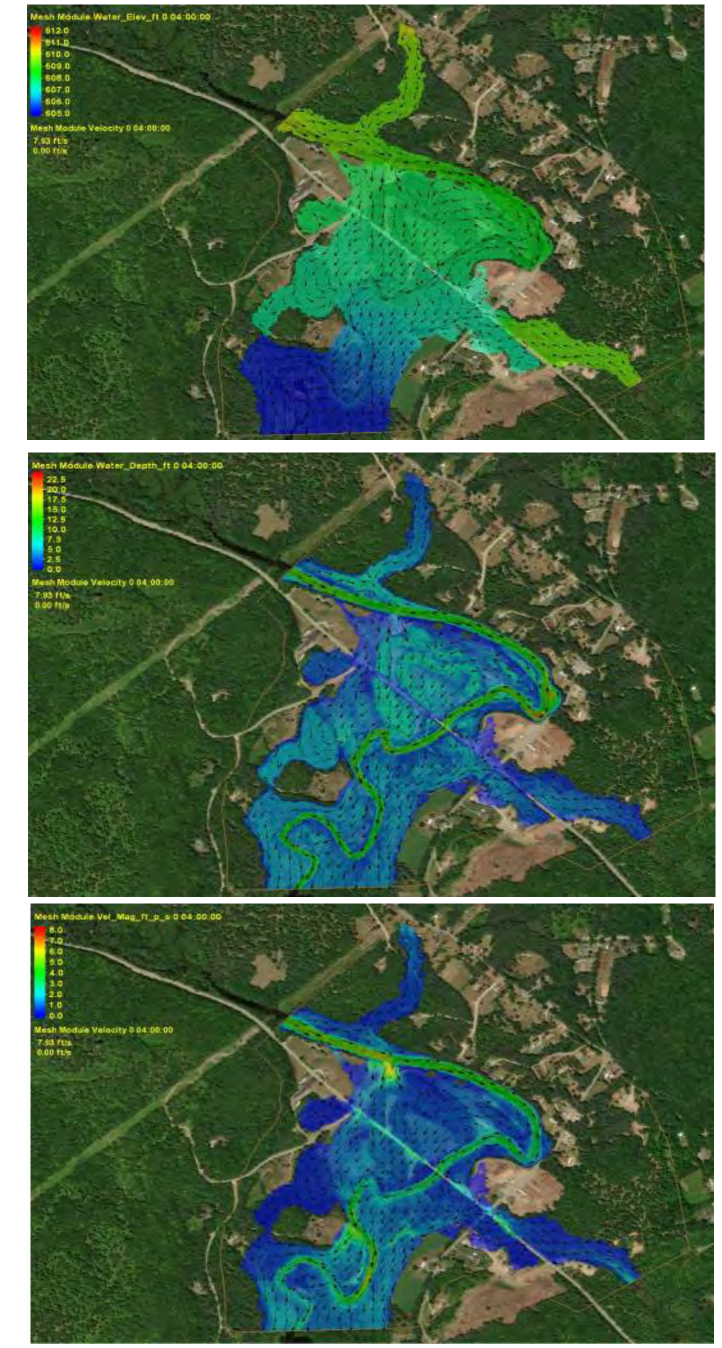
Break out grass vs crop and drop grass down to 0.03 (keep crops at 0.04)



Break out grass vs crop and drop grass down to 0.03 (keep crops at 0.04), & reduce Blackwater River to 0.033



Break out grass vs crop and drop grass down to 0.03 (keep crops at 0.04), & increase dense trees to 0.12 (keep Blackwater River at 0.04)



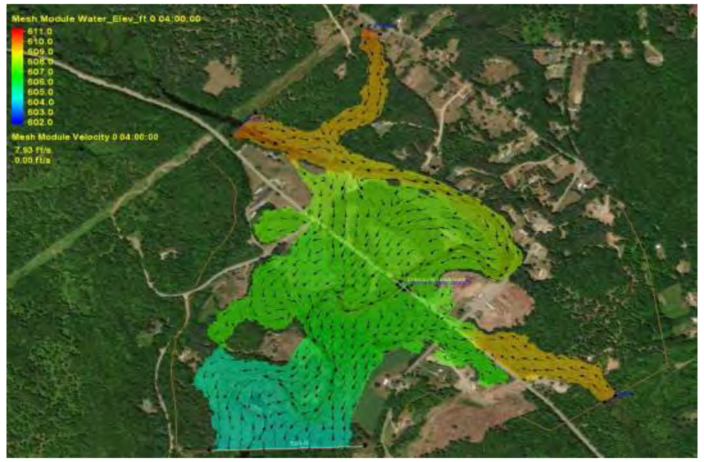
Conclusion: Essentially same results, so use original materials

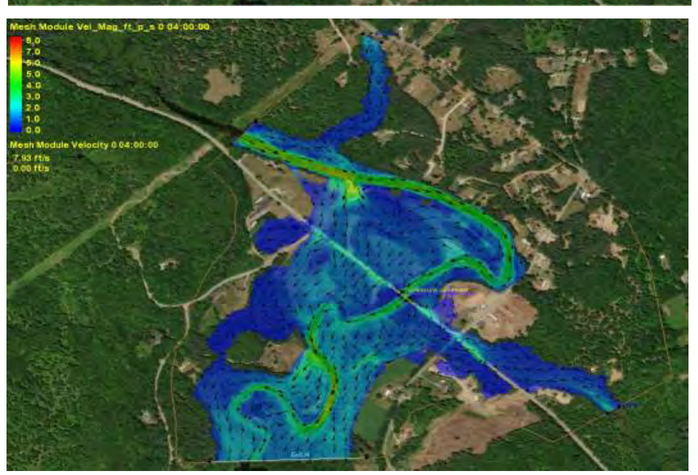
Model Sensitivity & Testing

3. Test DS Boundary Condition

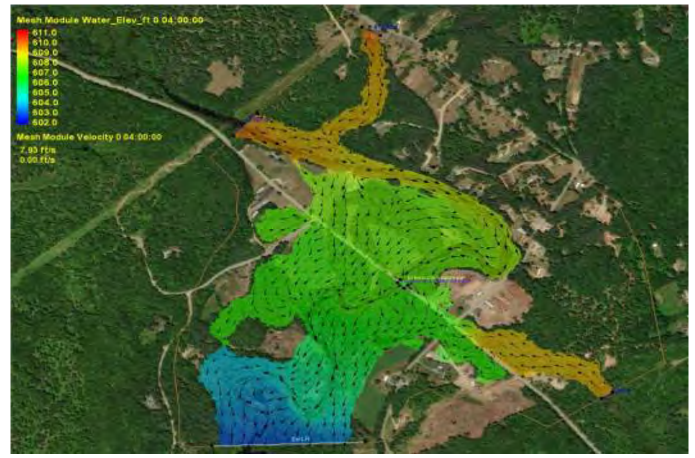
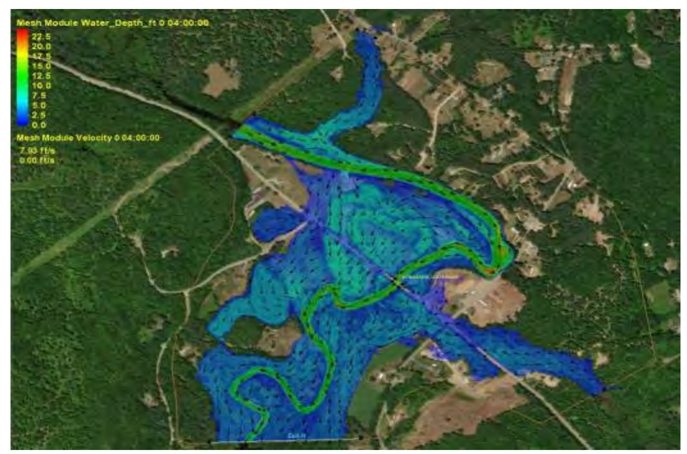
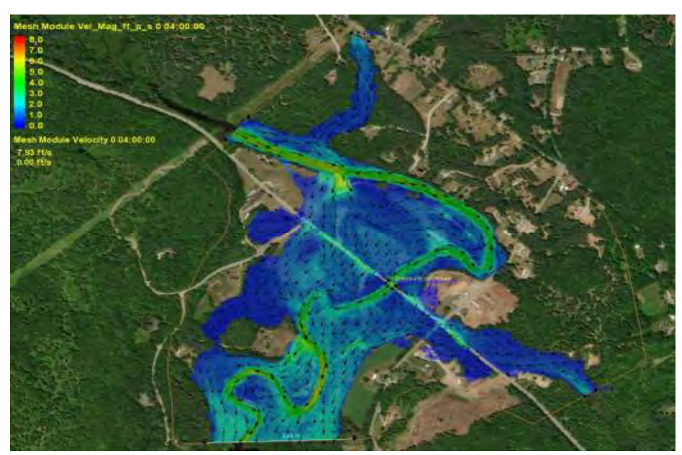
Q50E

For Composite n of 0.06 & slope 0.0005, WSEL = 604.41'

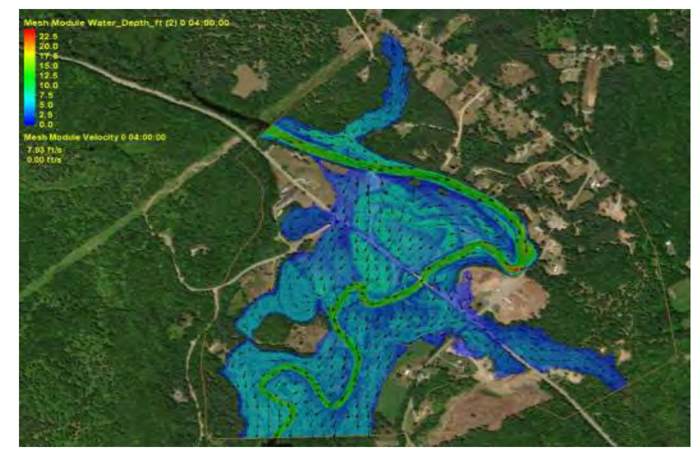
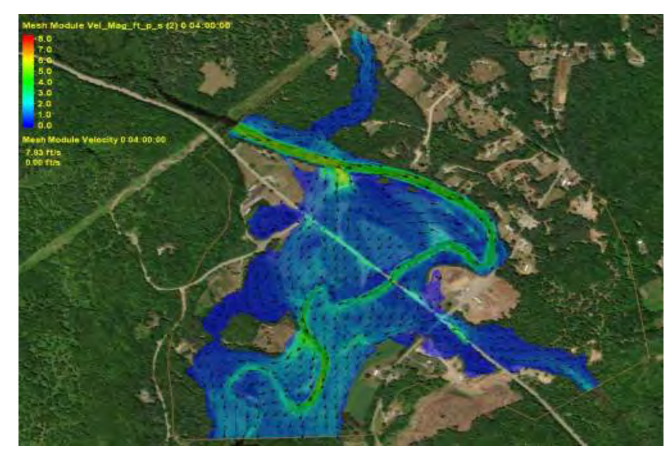




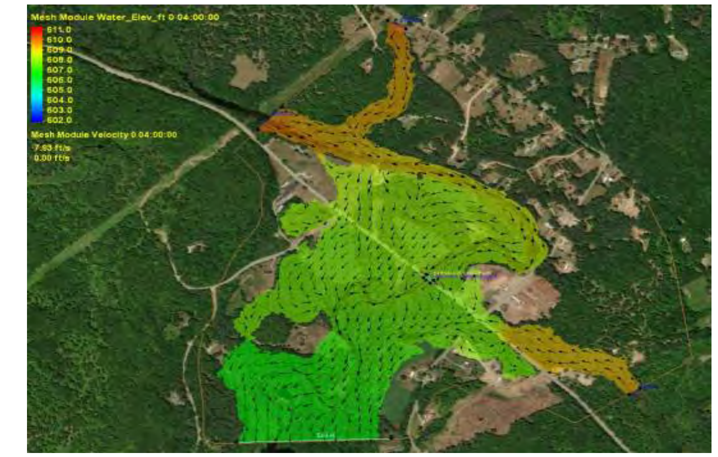
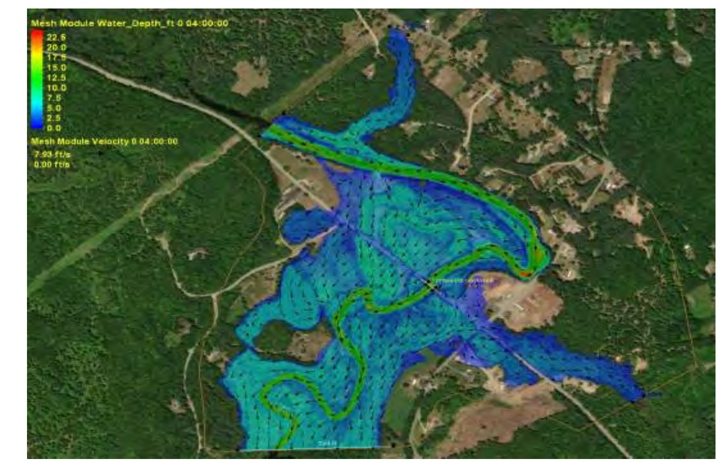
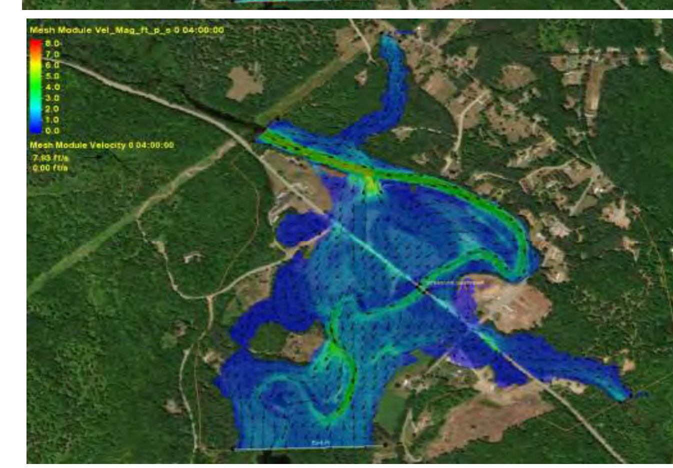
Lower Elevation by 2 ft, WSEL = 602.41' (about same as Q2 DS BC WSEL = 602.46')

Riase Elevation by 1 ft, 605.41' (> Q100 DS BC WSEL = 604.82')

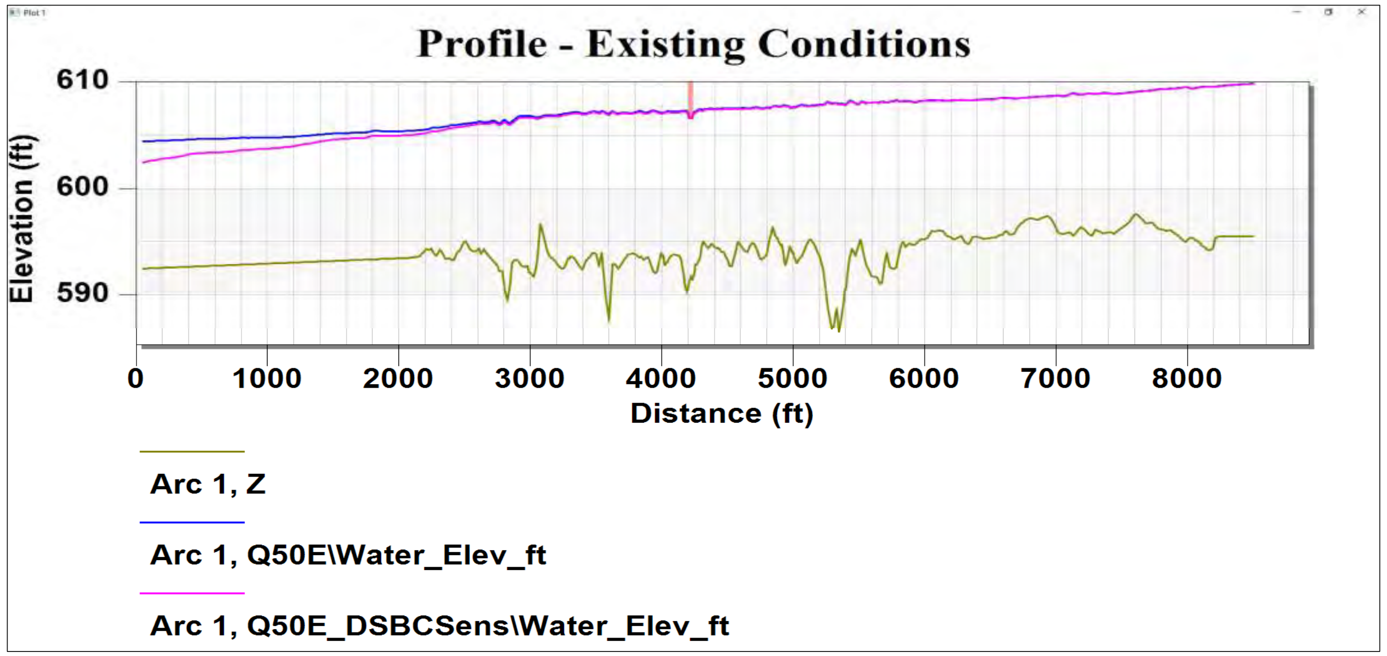
Riase Elevation by 2 ft, 606.41' (>> Q100 DS BC WSEL = 604.82', so may be too high to converge at bridge)

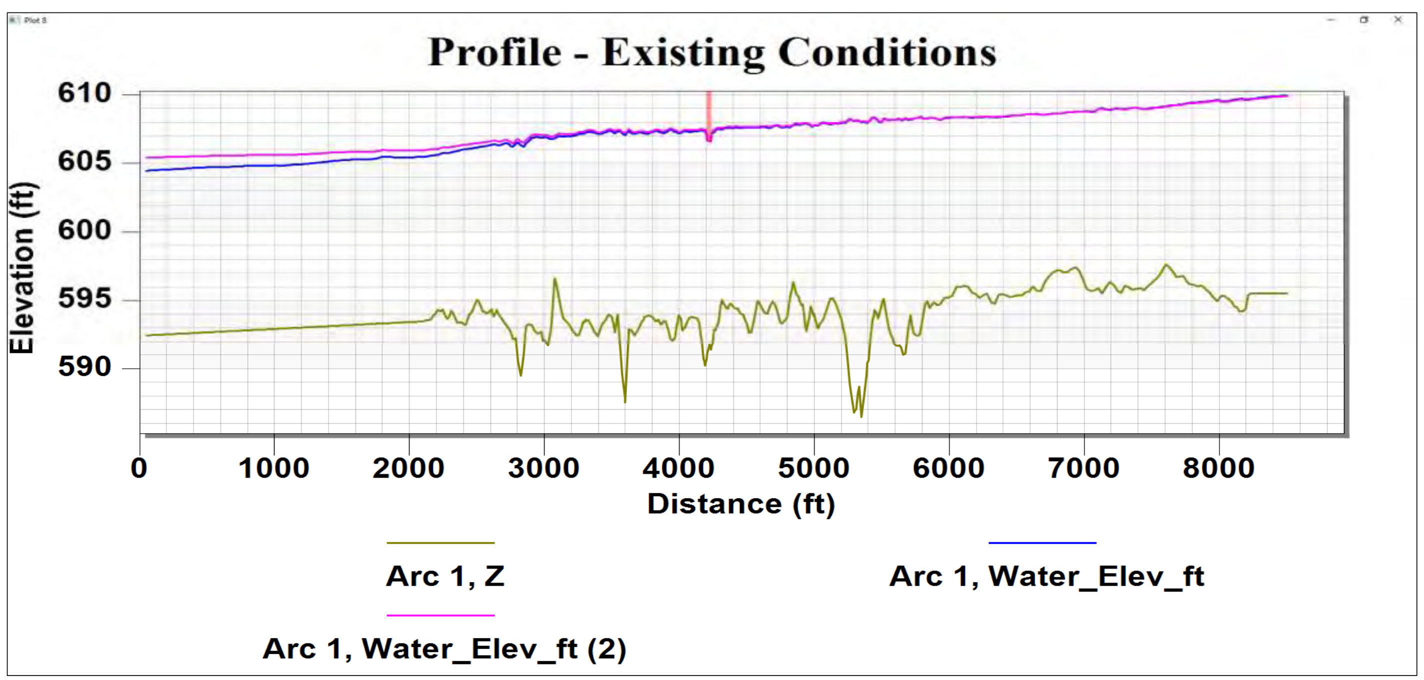
Model Sensitivity & Testing

3. Test DS Boundary Condition (Cont.)

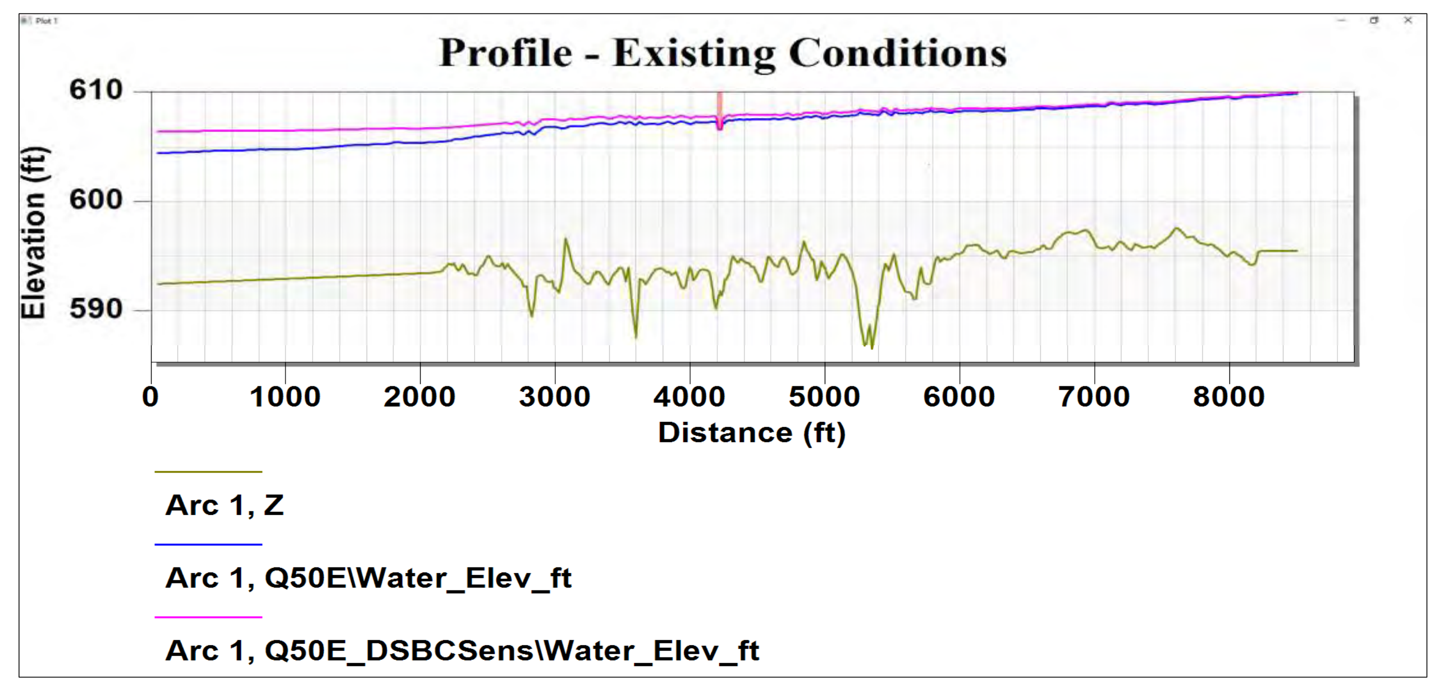
Lower Elevation by 2 ft, WSEL = 602.41' (about same as Q2 DS BC WSEL = 602.46')



Riase Elevation by 1 ft, 605.41' (> Q100 DS BC WSEL = 604.82')



Riase Elevation by 2 ft, 606.41' (>> Q100 DS BC WSEL = 604.82', so may be too high to converge at bridge)



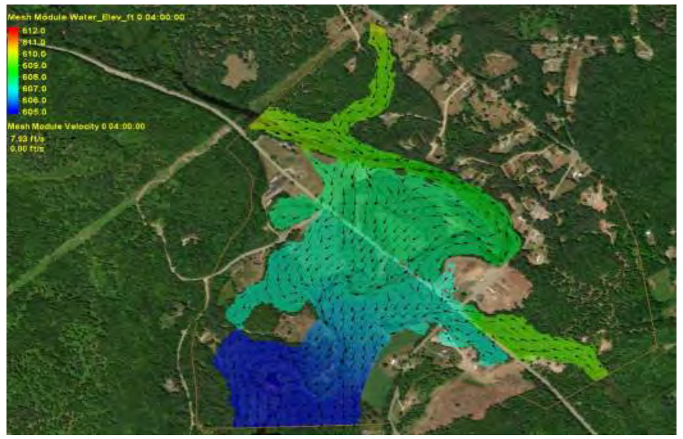
Conclusion: Model converges at bridge when lower WSEL by 2' and raise WSEL by 1'; there is 0.4' difference when WSEL raised 2'. Original BC results are reasonable.

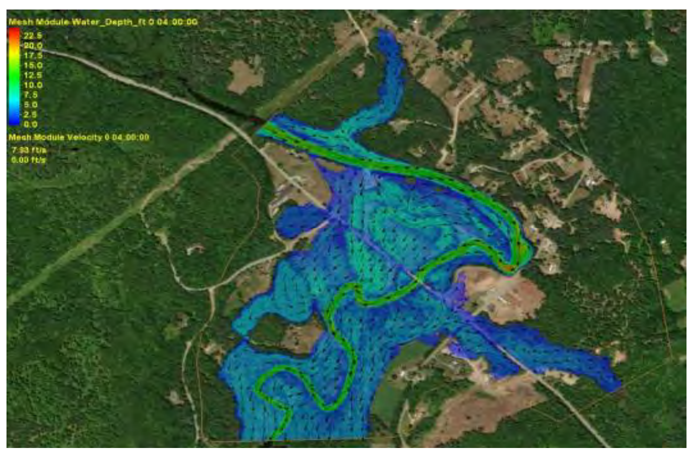
Model Sensitivity & Testing

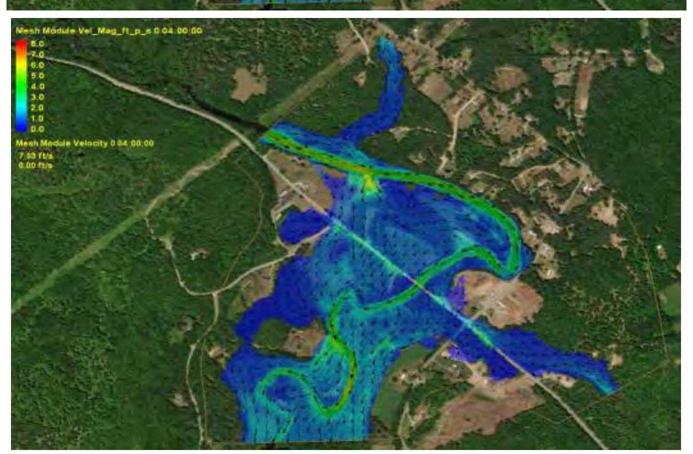
4. Test Bridge Manning's n

Q50E

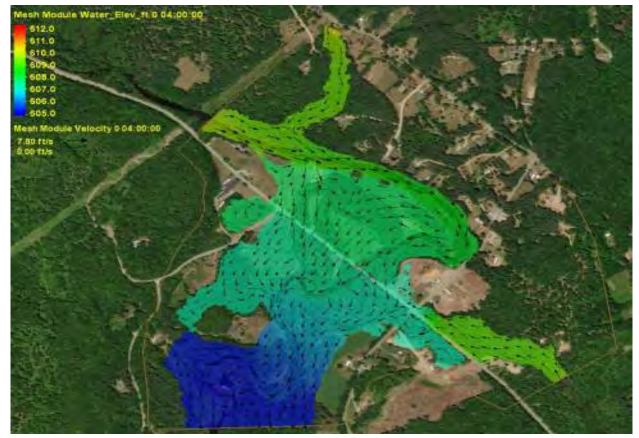
Original n = 0.012

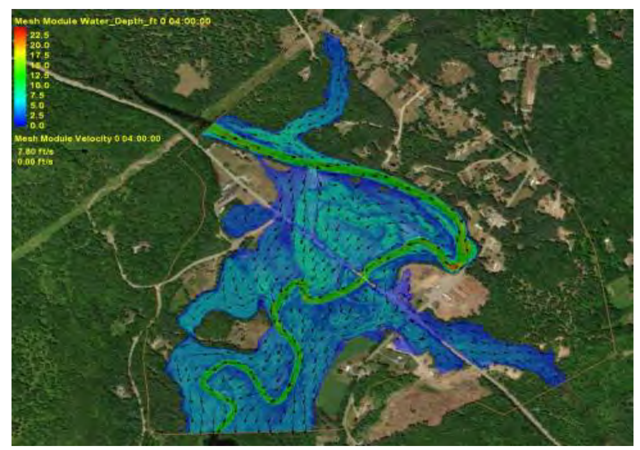


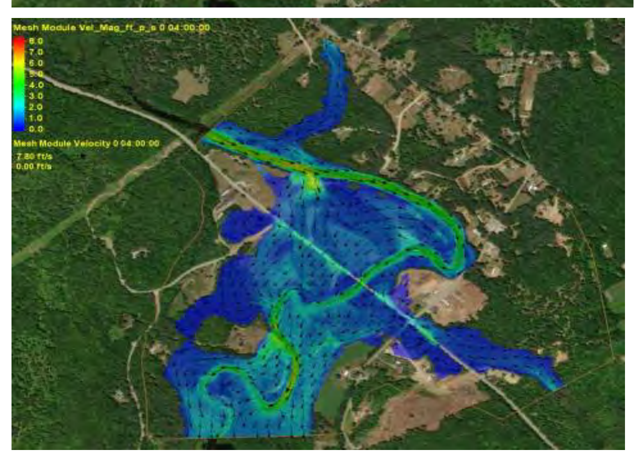


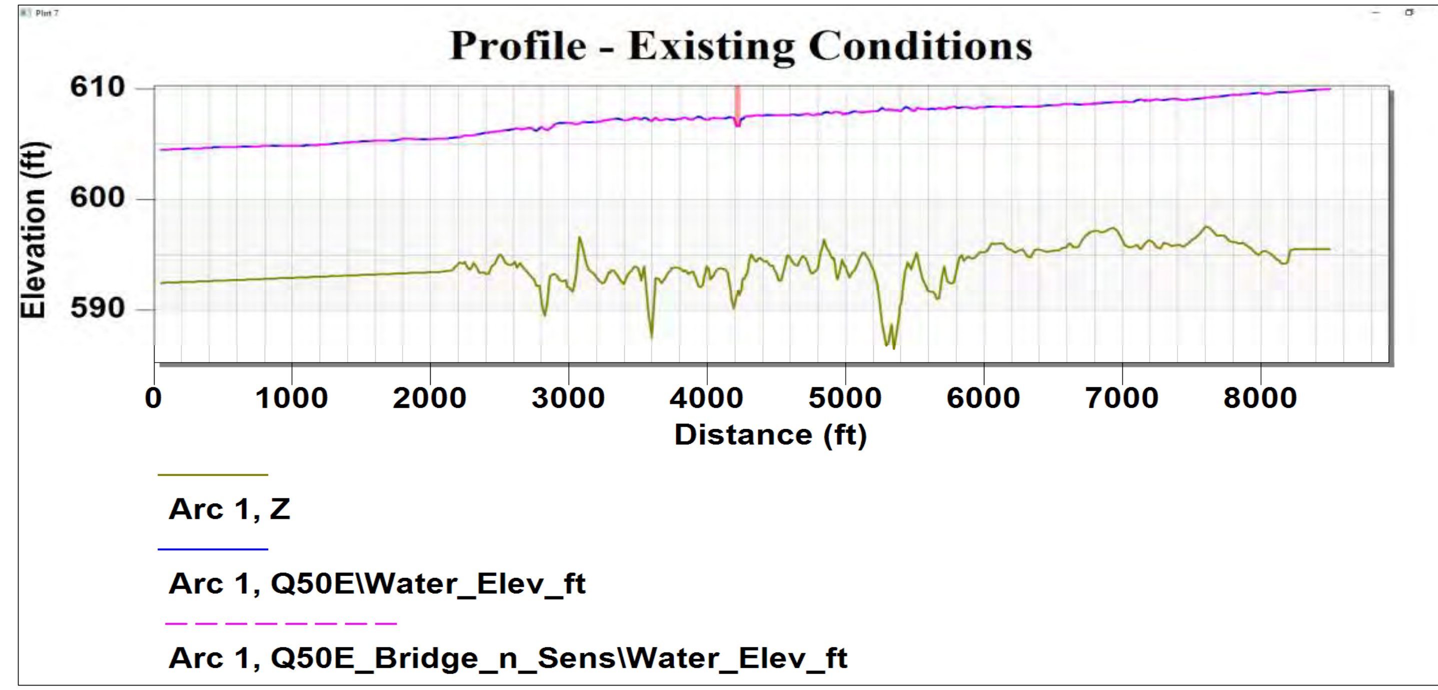


Sensitivity analysis with n = 0.05:









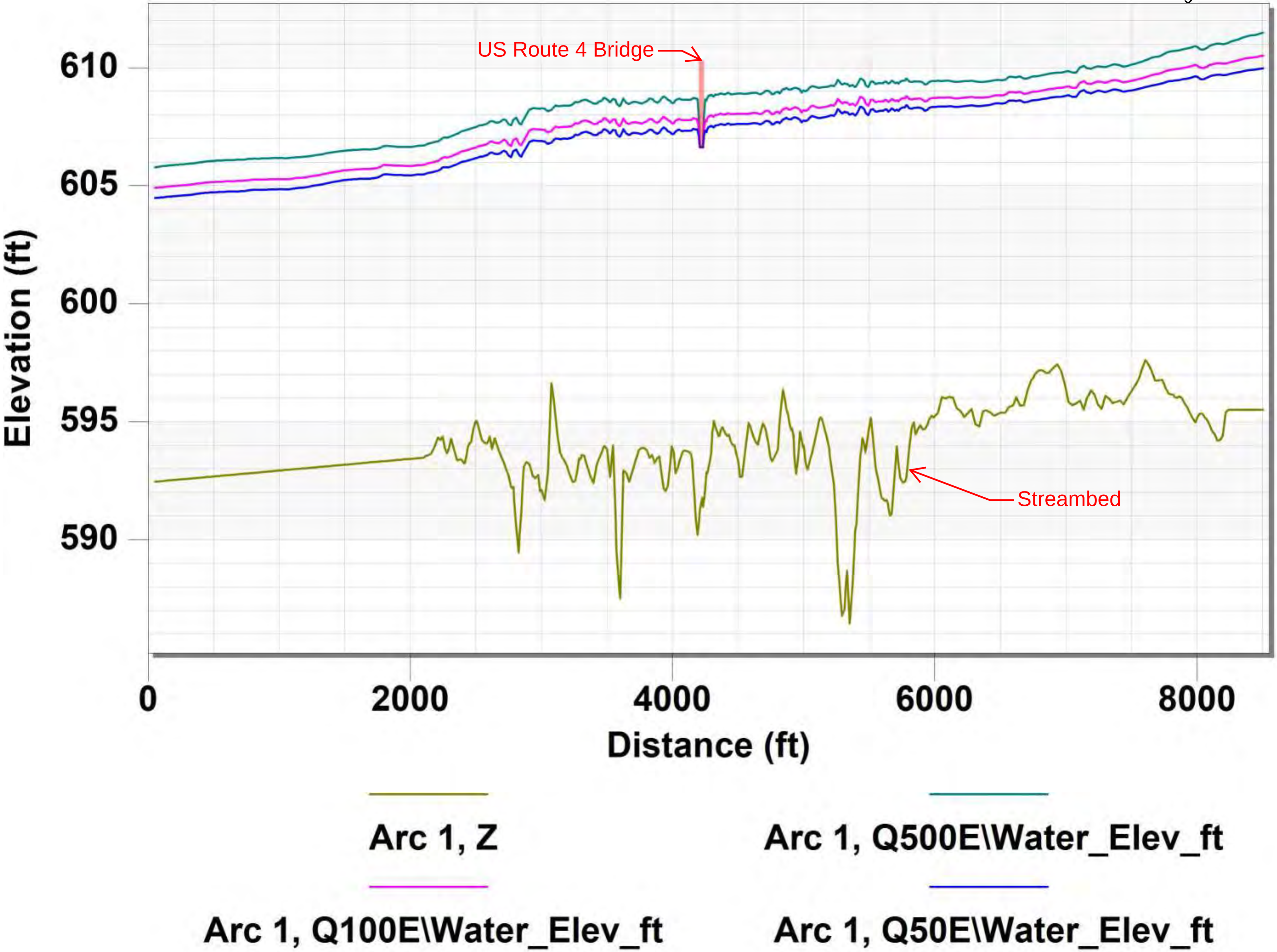
Conclusion: Essentially same results, so use original roughness coefficient

APPENDIX H

Hydraulic Analysis – Existing Bridge

Profile - Existing Conditions

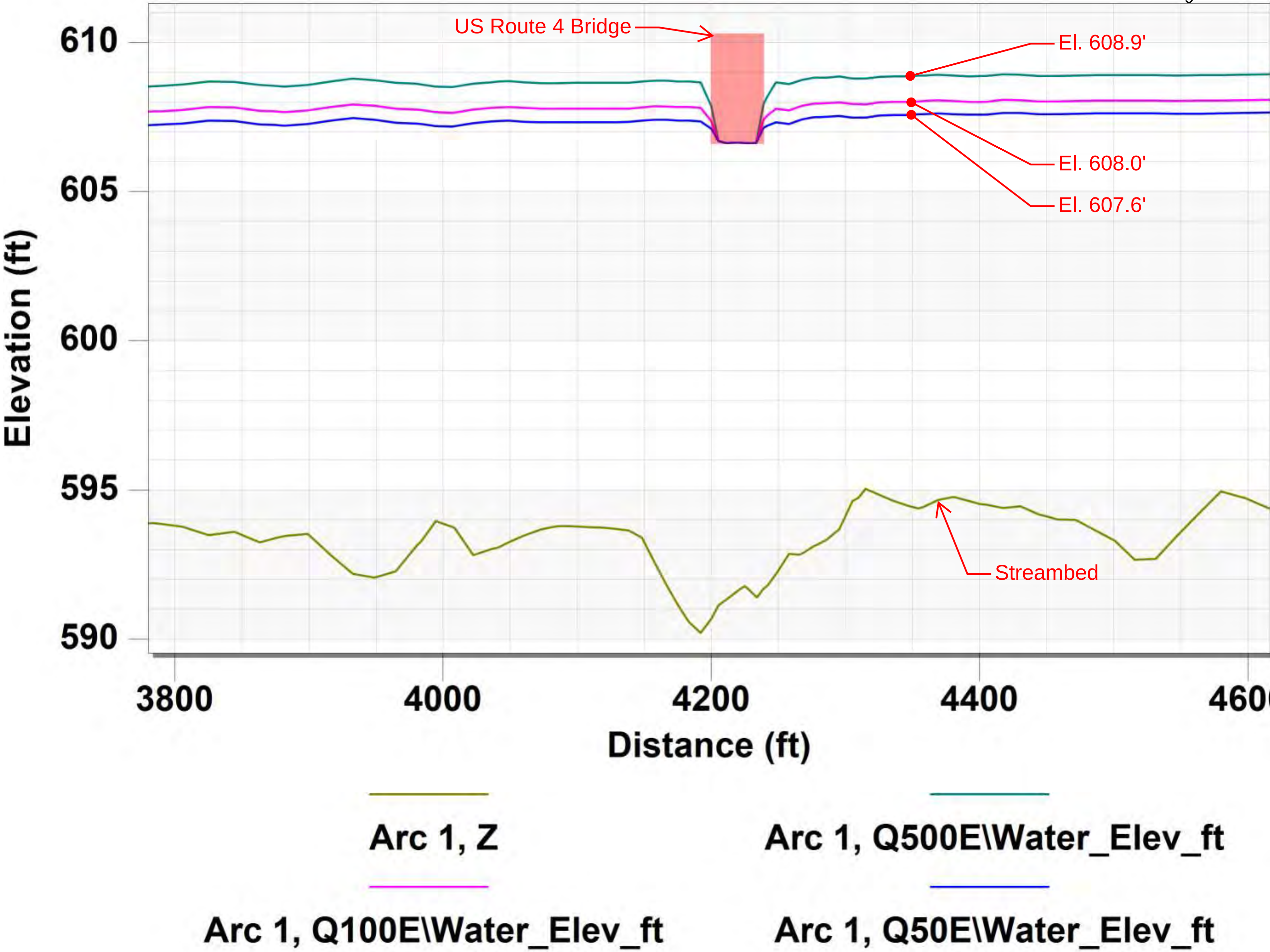
Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077



Hoyle, Tanner & Associates, Inc.

Profile - Existing Conditions

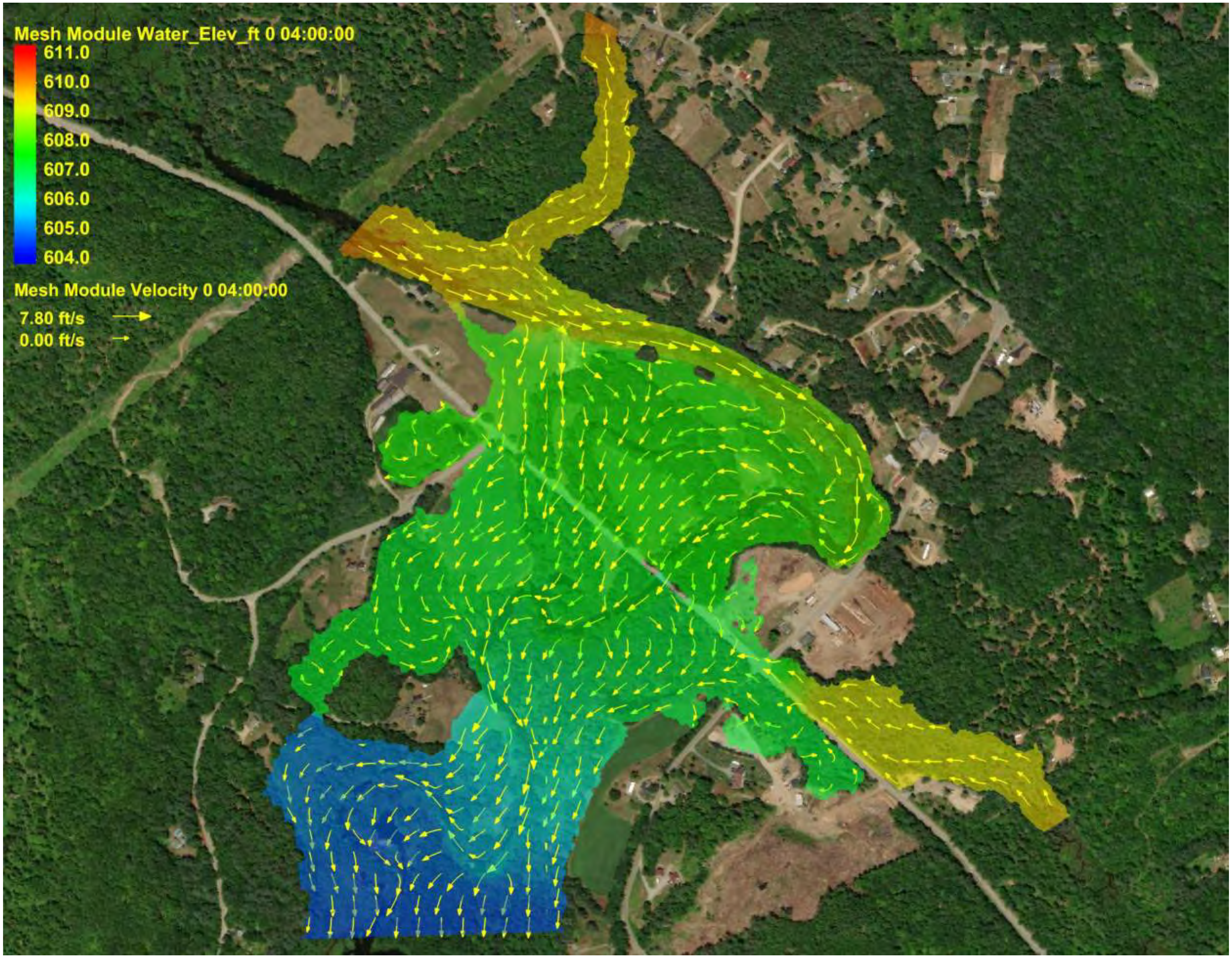
Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077



Hoyle, Tanner & Associates, Inc.

Existing Conditions Hydraulic Model

Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077

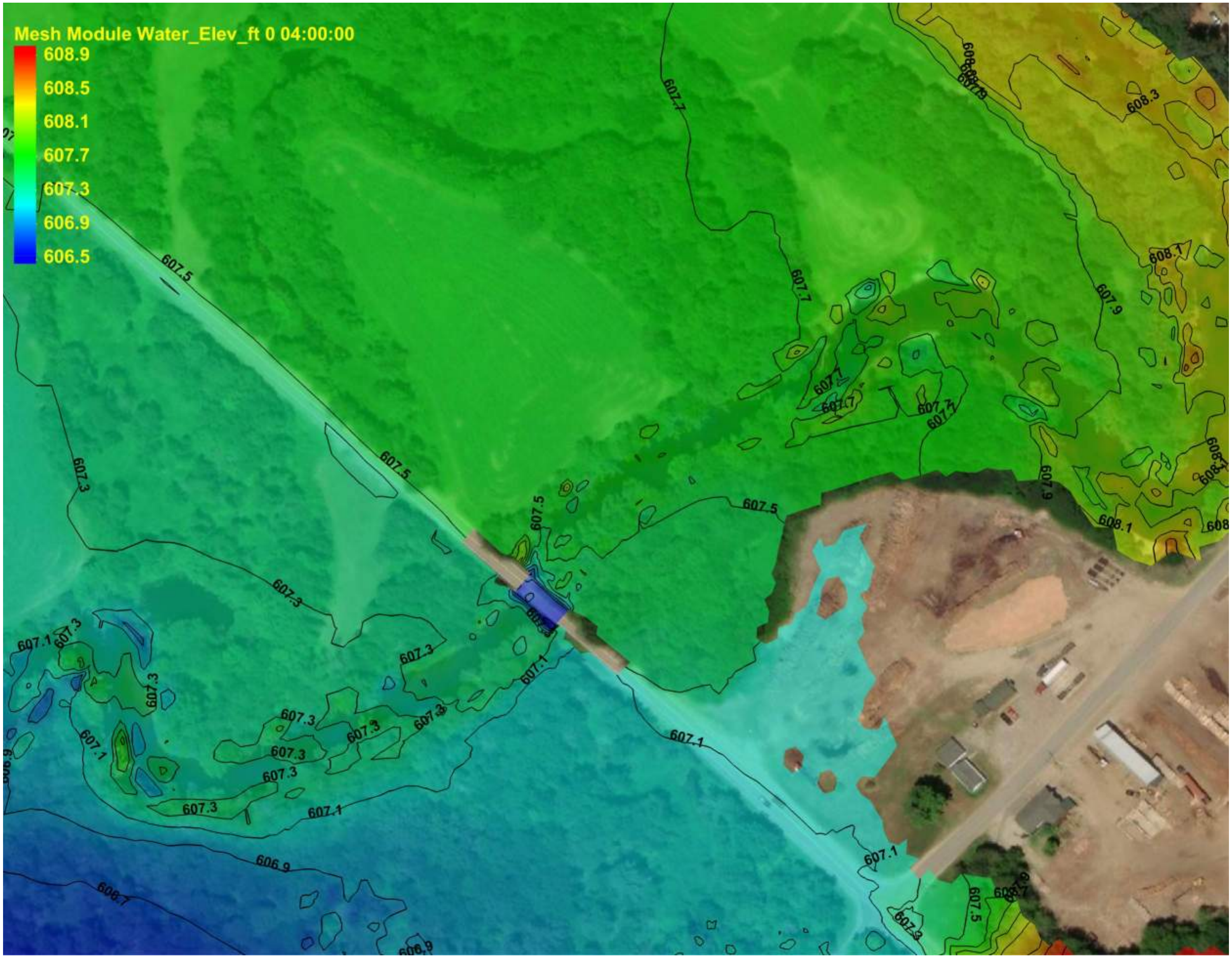


50-year Storm Event - Water Surface Elevation (ft) with Flow Vectors

Hoyle, Tanner & Associates, Inc.

Existing Conditions Hydraulic Model

Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077

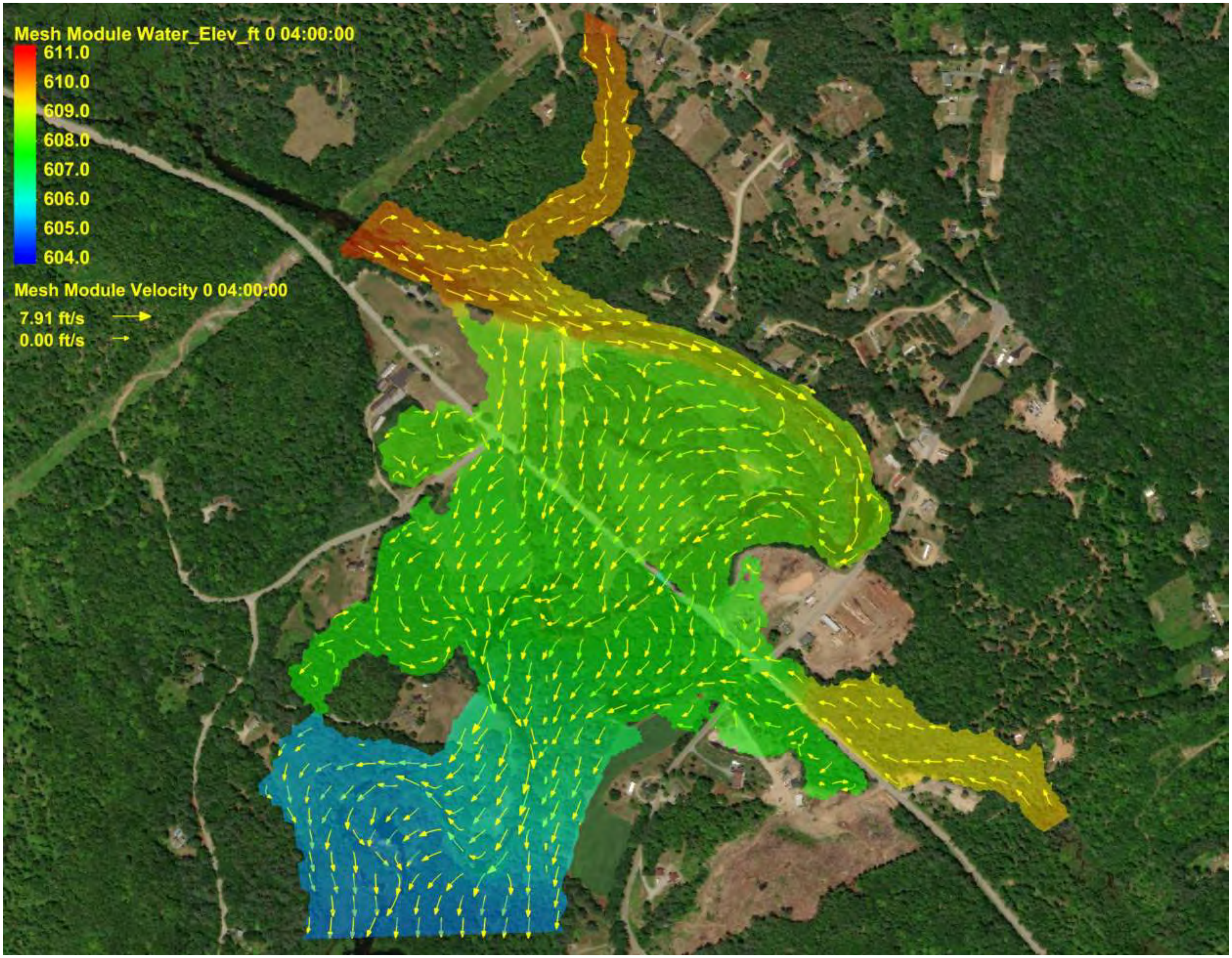


50-year Storm Event - Water Surface Elevation (ft)

Hoyle, Tanner & Associates, Inc.

Existing Conditions Hydraulic Model

Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077

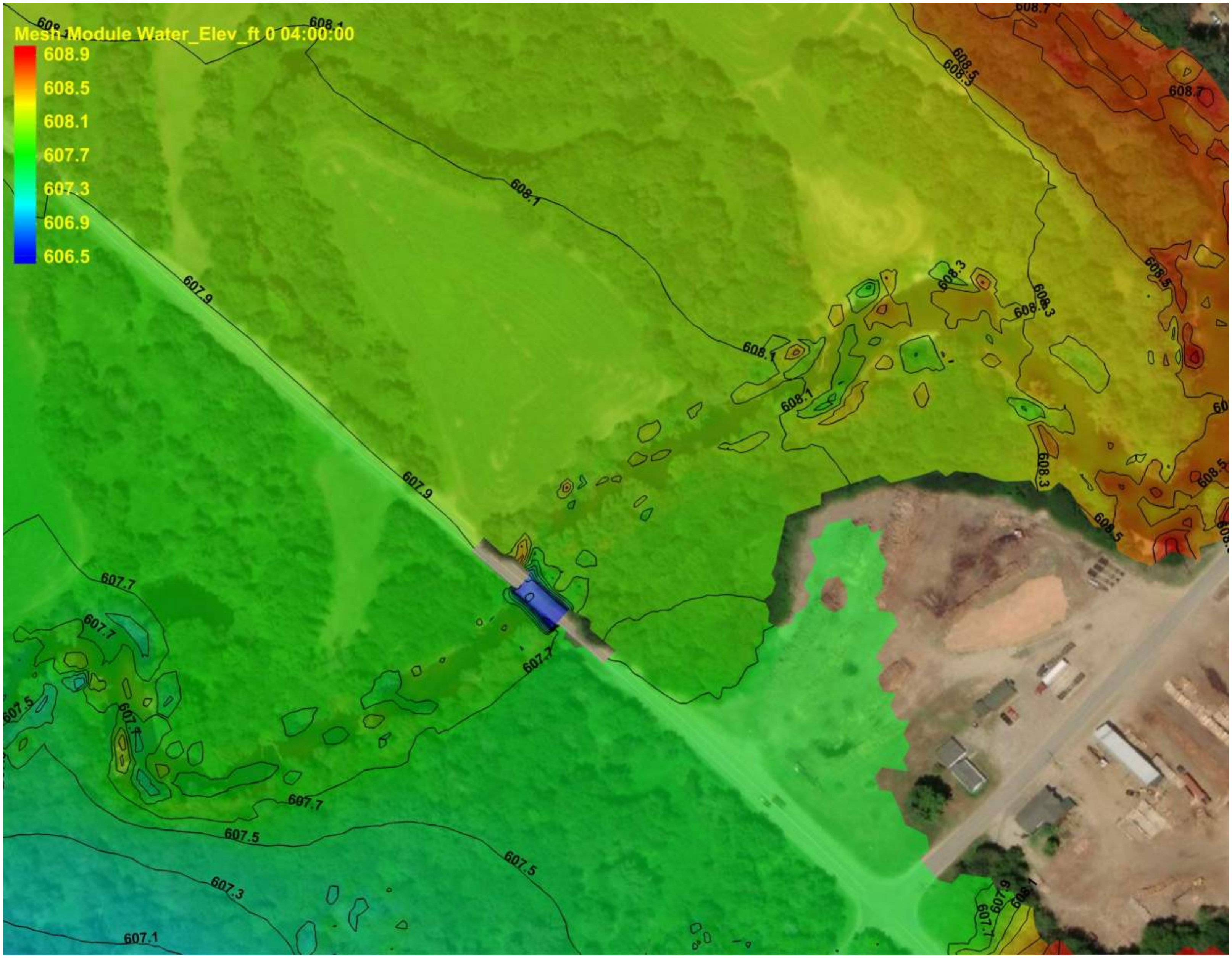


100-year Storm Event - Water Surface Elevation (ft) with Flow Vectors

Hoyle, Tanner & Associates, Inc.

Existing Conditions Hydraulic Model

Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077

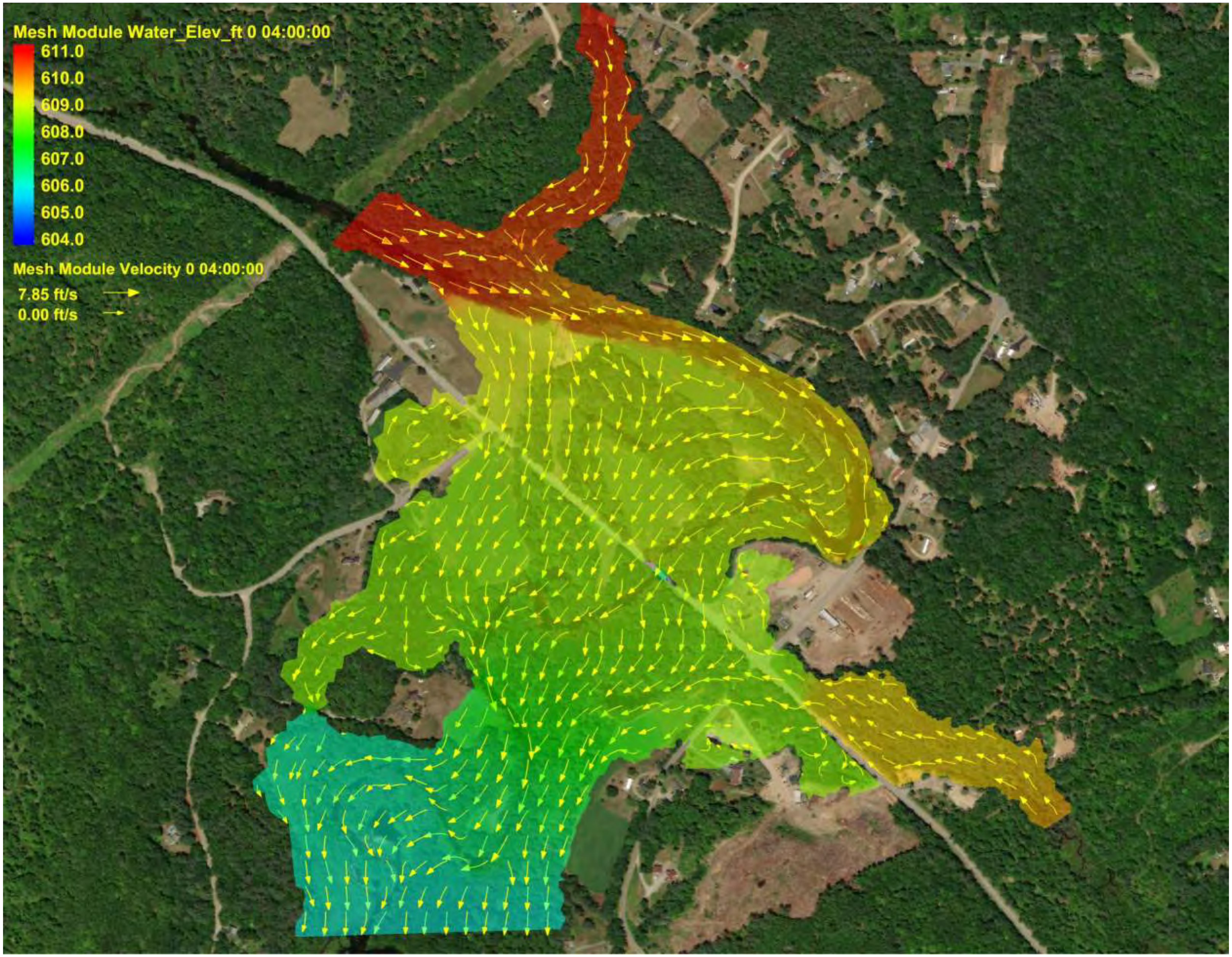


100-year Storm Event - Water Surface Elevation (ft)

Hoyle, Tanner & Associates, Inc.

Existing Conditions Hydraulic Model

Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077

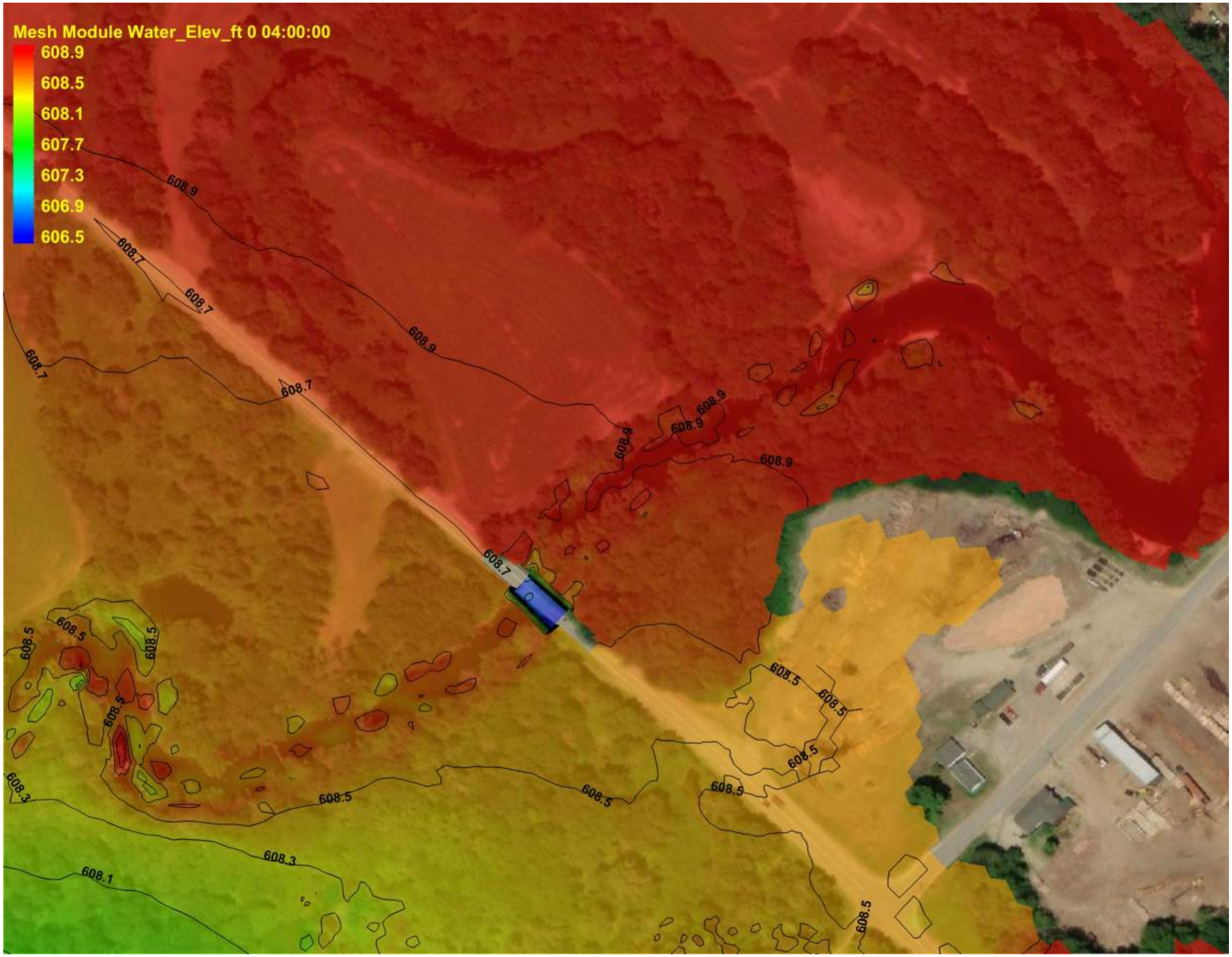


500-year Storm Event - Water Surface Elevation (ft) with Flow Vectors

Hoyle, Tanner & Associates, Inc.

Existing Conditions Hydraulic Model

Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077

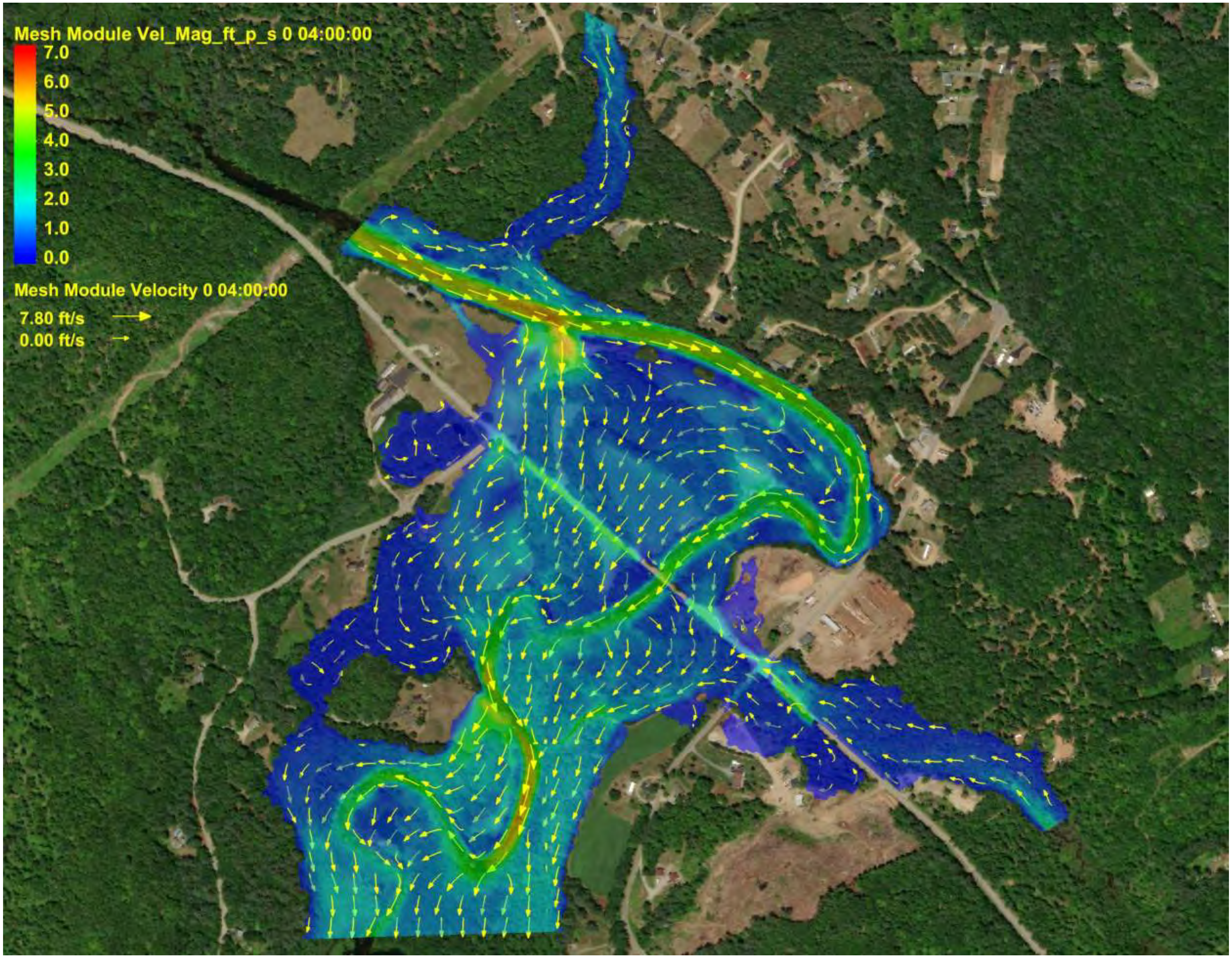


500-year Storm Event - Water Surface Elevation (ft)

Hoyle, Tanner & Associates, Inc.

Existing Conditions Hydraulic Model

Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077

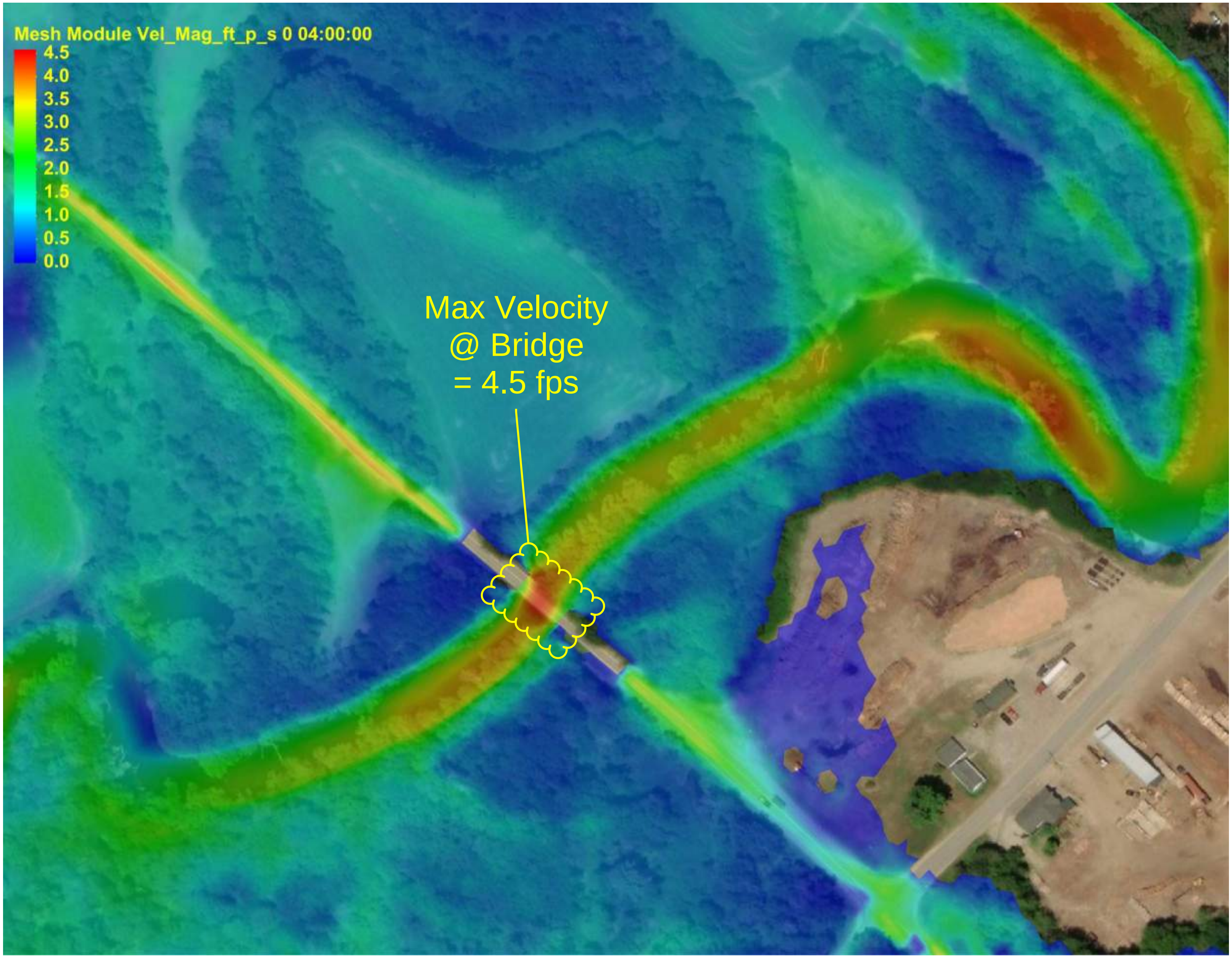


50-year Storm Event - Velocity (ft/sec) with Flow Vectors

Hoyle, Tanner & Associates, Inc.

Existing Conditions Hydraulic Model

Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077

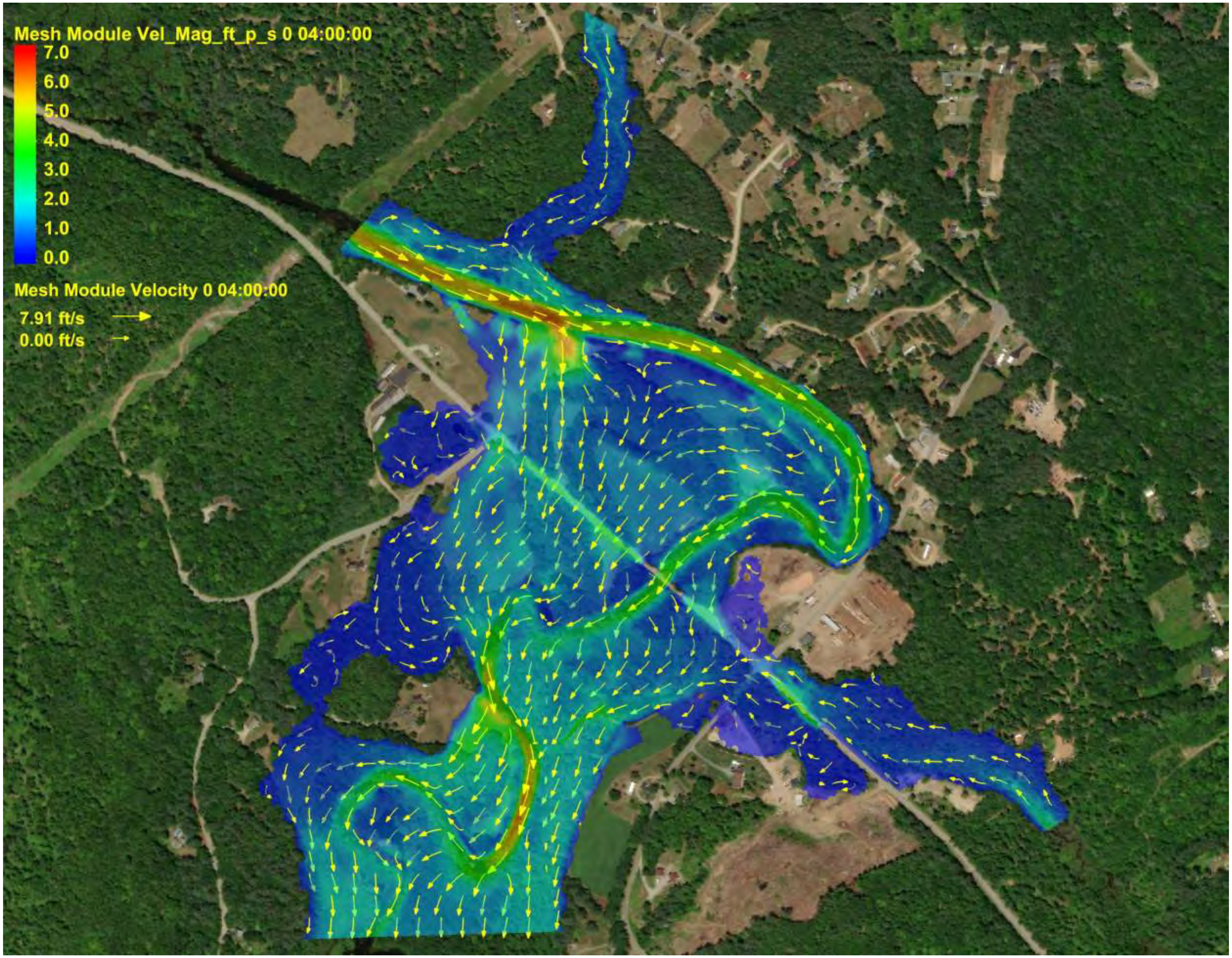


50-year Storm Event - Velocity (ft/sec)

Hoyle, Tanner & Associates, Inc.

Existing Conditions
Hydraulic Model

Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077



100-year Storm Event - Velocity (ft/sec) with Flow Vectors

Hoyle, Tanner & Associates, Inc.

Existing Conditions Hydraulic Model

Hoyle, Tanner Project No. 928100
Town of Andover
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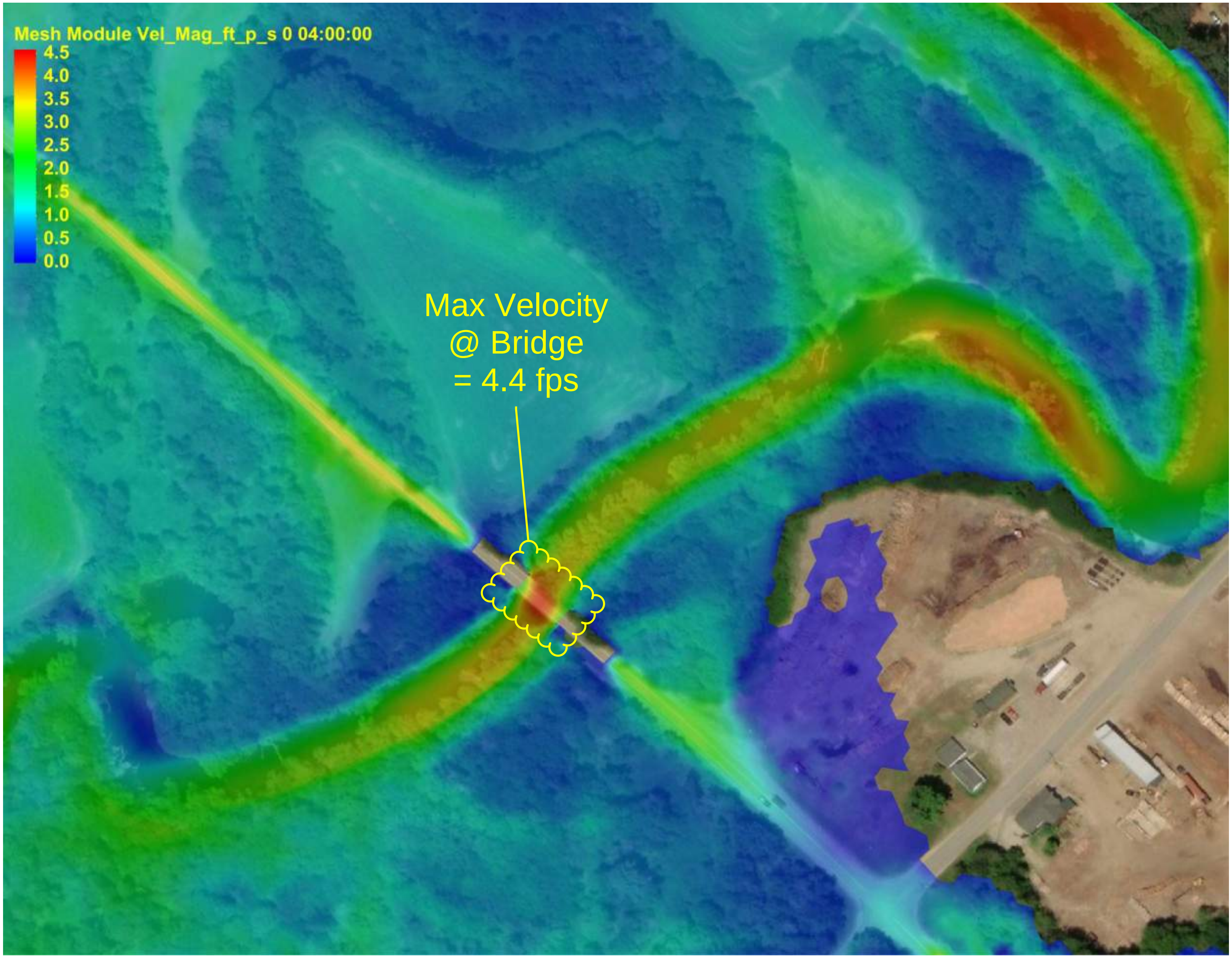
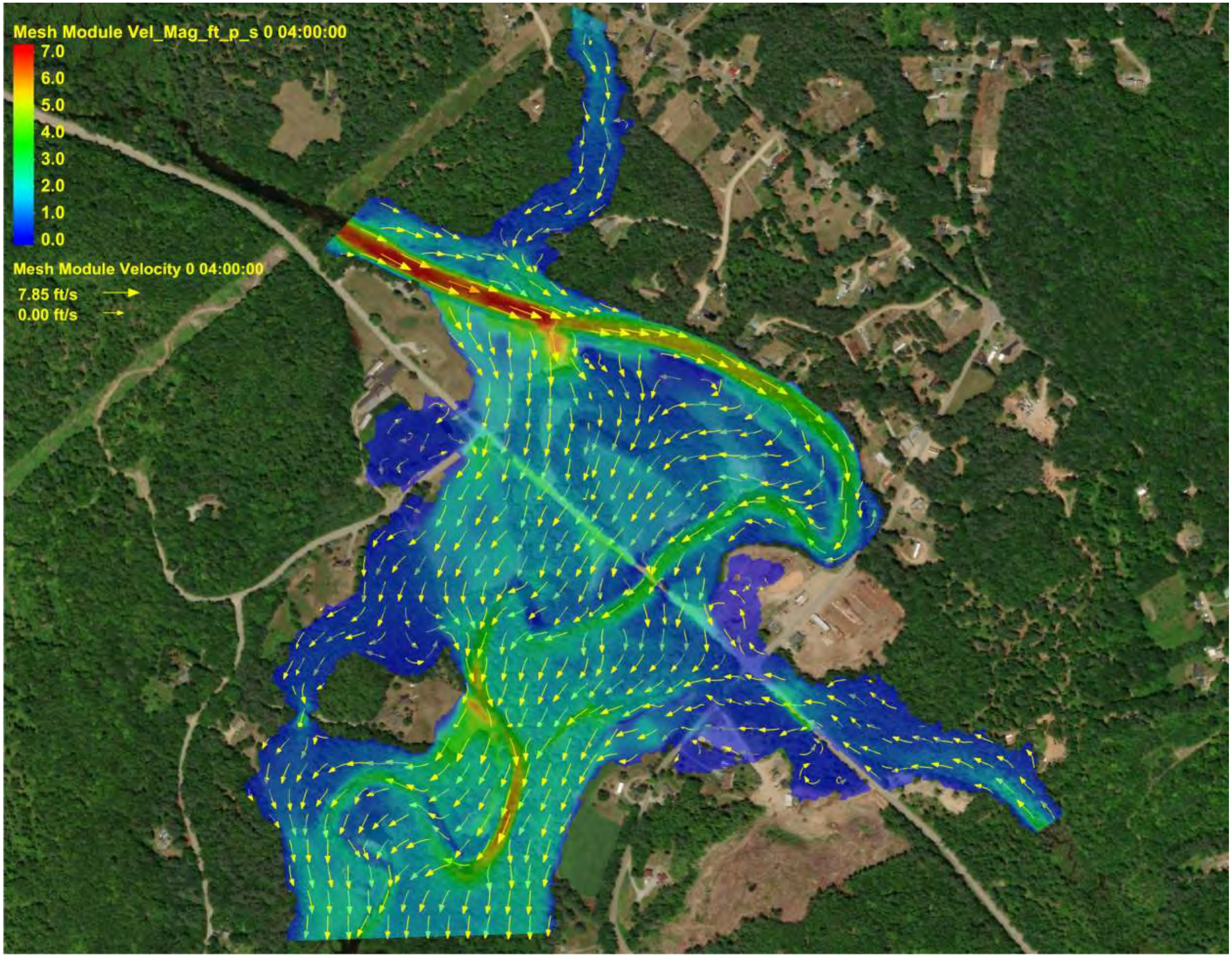


100-year Storm Event - Velocity (ft/sec)

Hoyle, Tanner & Associates, Inc.

Existing Conditions Hydraulic Model

Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077



500-year Storm Event - Velocity (ft/sec) with Flow Vectors

Hoyle, Tanner & Associates, Inc.

Existing Conditions Hydraulic Model

Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
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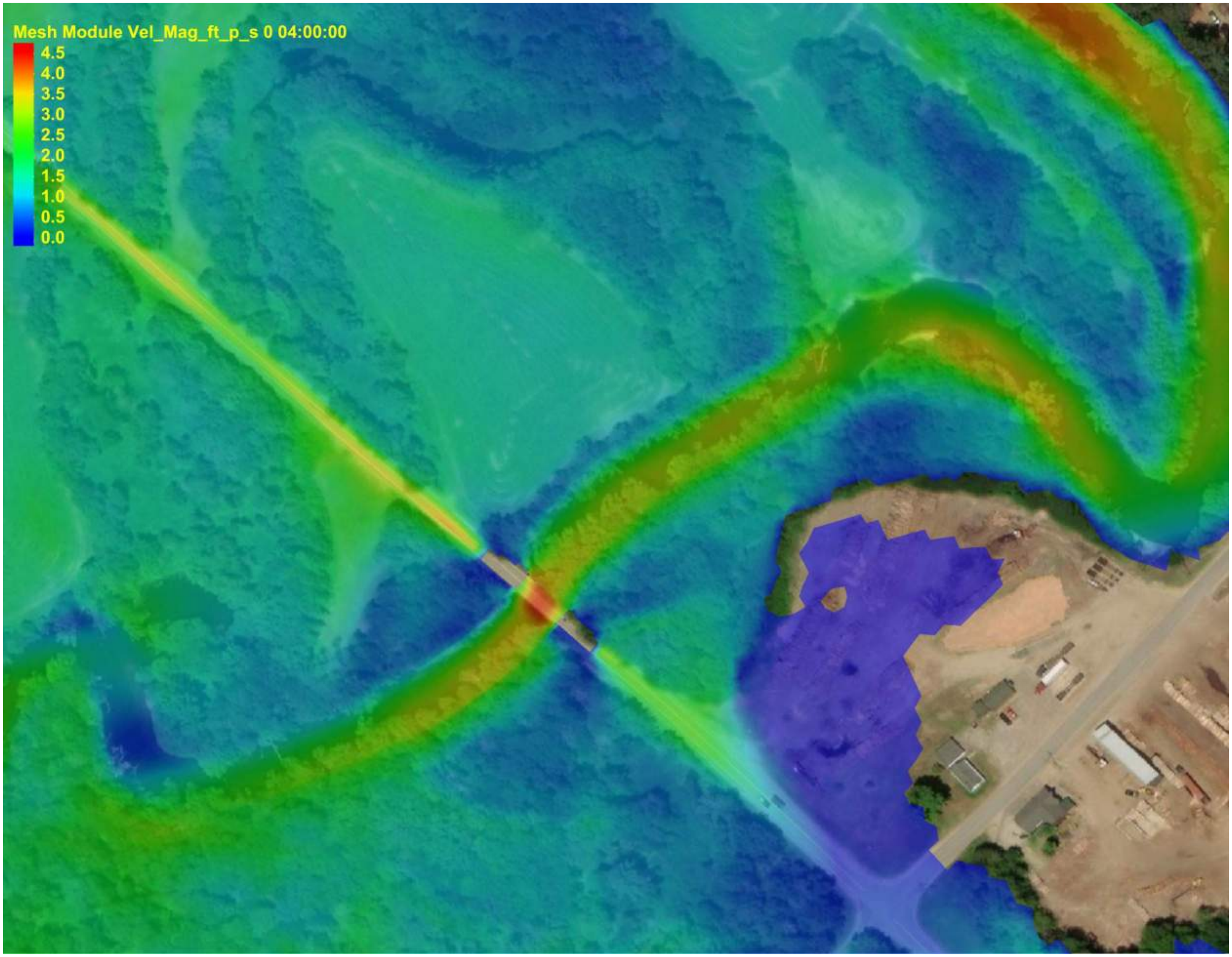
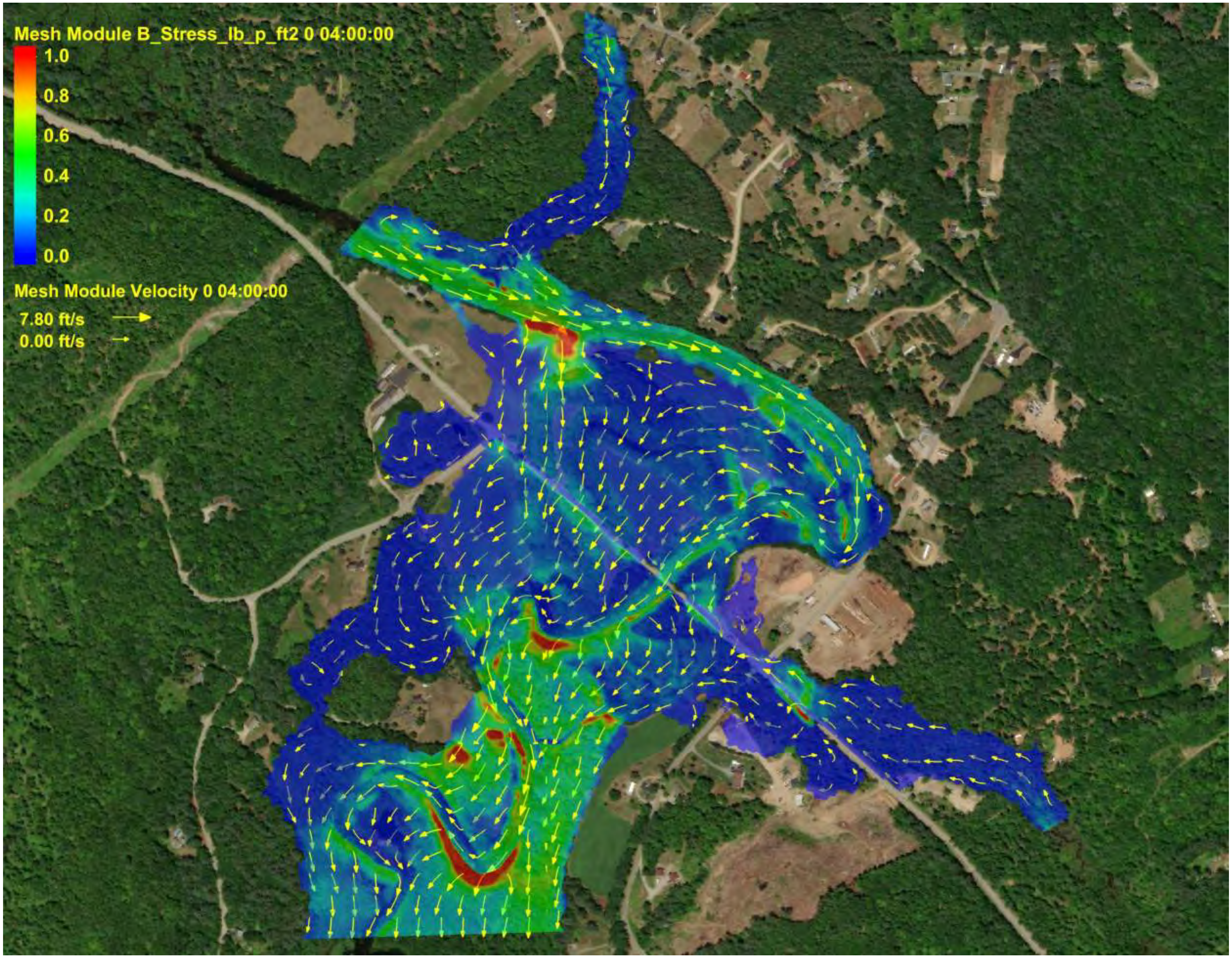


500-year Storm Event - Velocity (ft/sec)

Existing Conditions Hydraulic Model

Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077

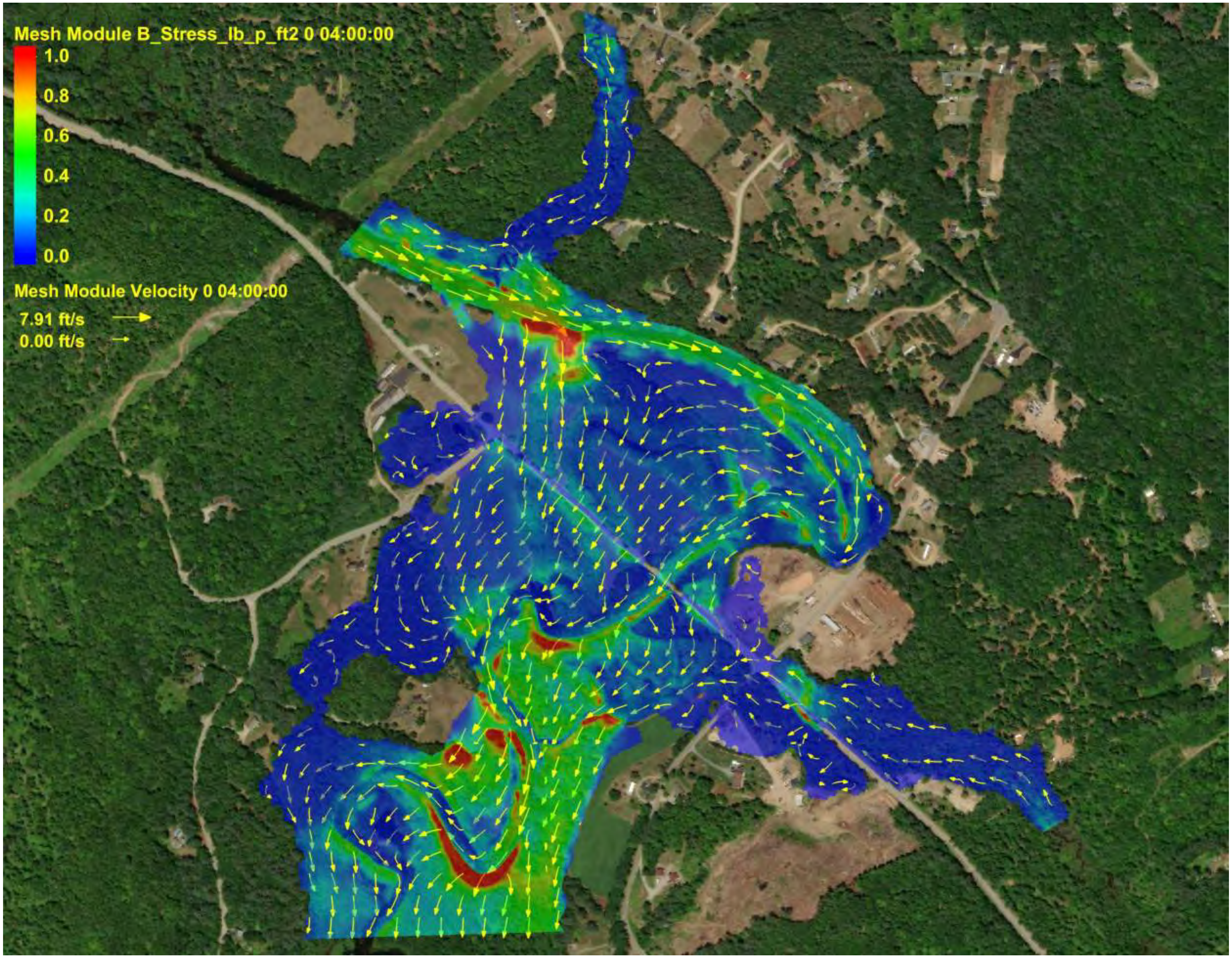


50-year Storm Event - Shear Stress (lb/ft^2) with Flow Vectors

Hoyle, Tanner & Associates, Inc.

Existing Conditions Hydraulic Model

Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077

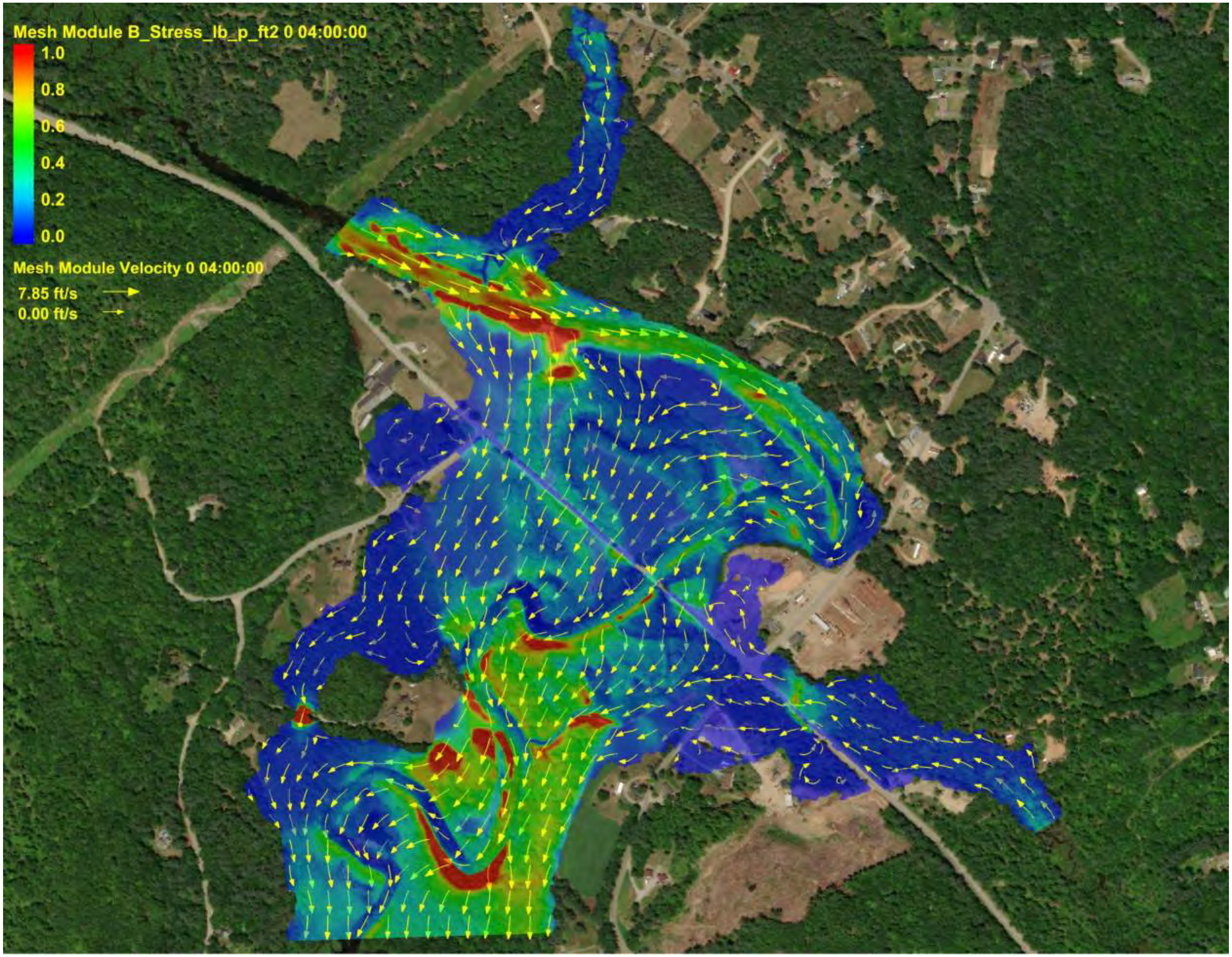


100-year Storm Event - Shear Stress (lb/ft^2) with Flow Vectors

Hoyle, Tanner & Associates, Inc.

Existing Conditions Hydraulic Model

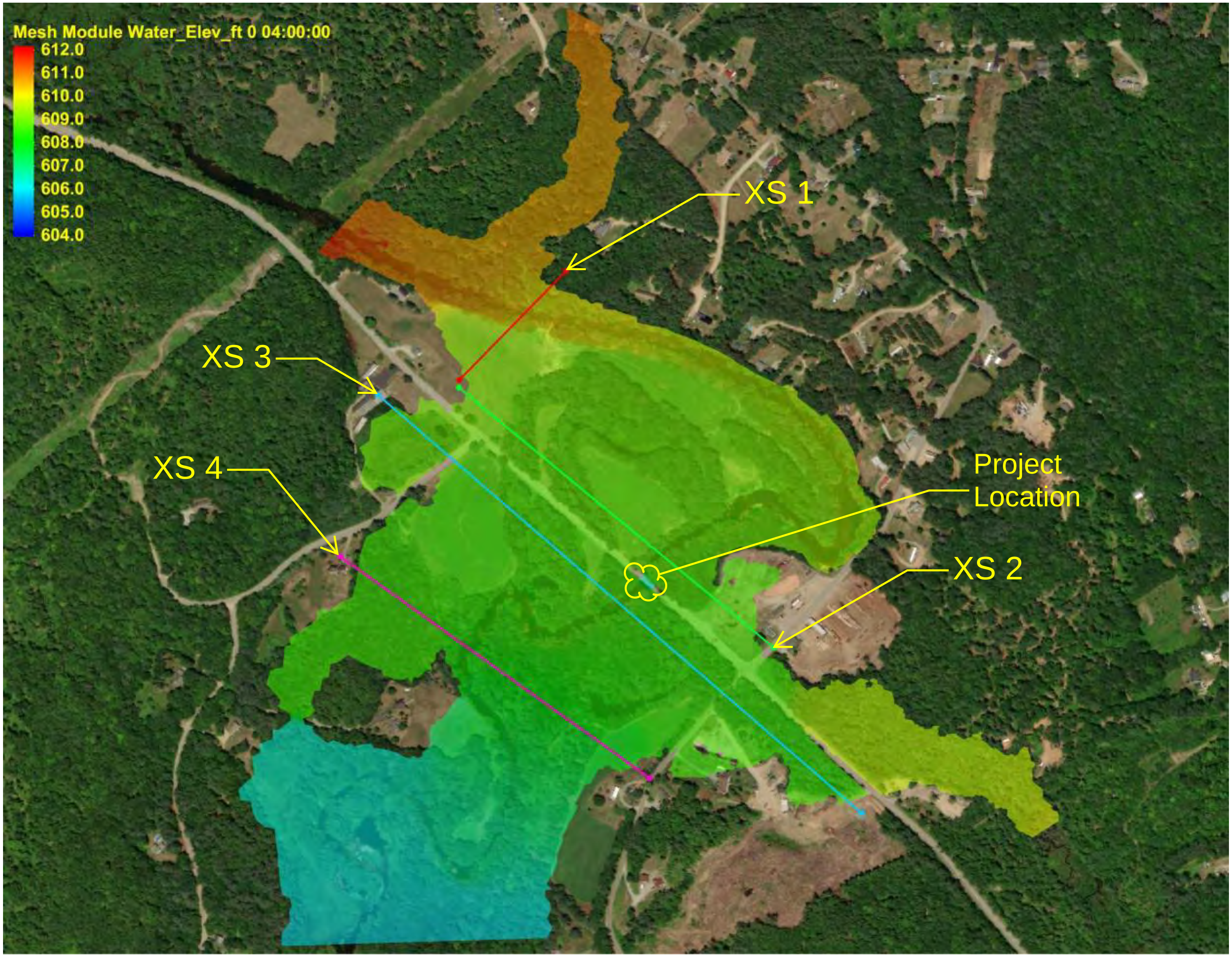
Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077



500-year Storm Event - Shear Stress (lb/ft^2) with Flow Vectors

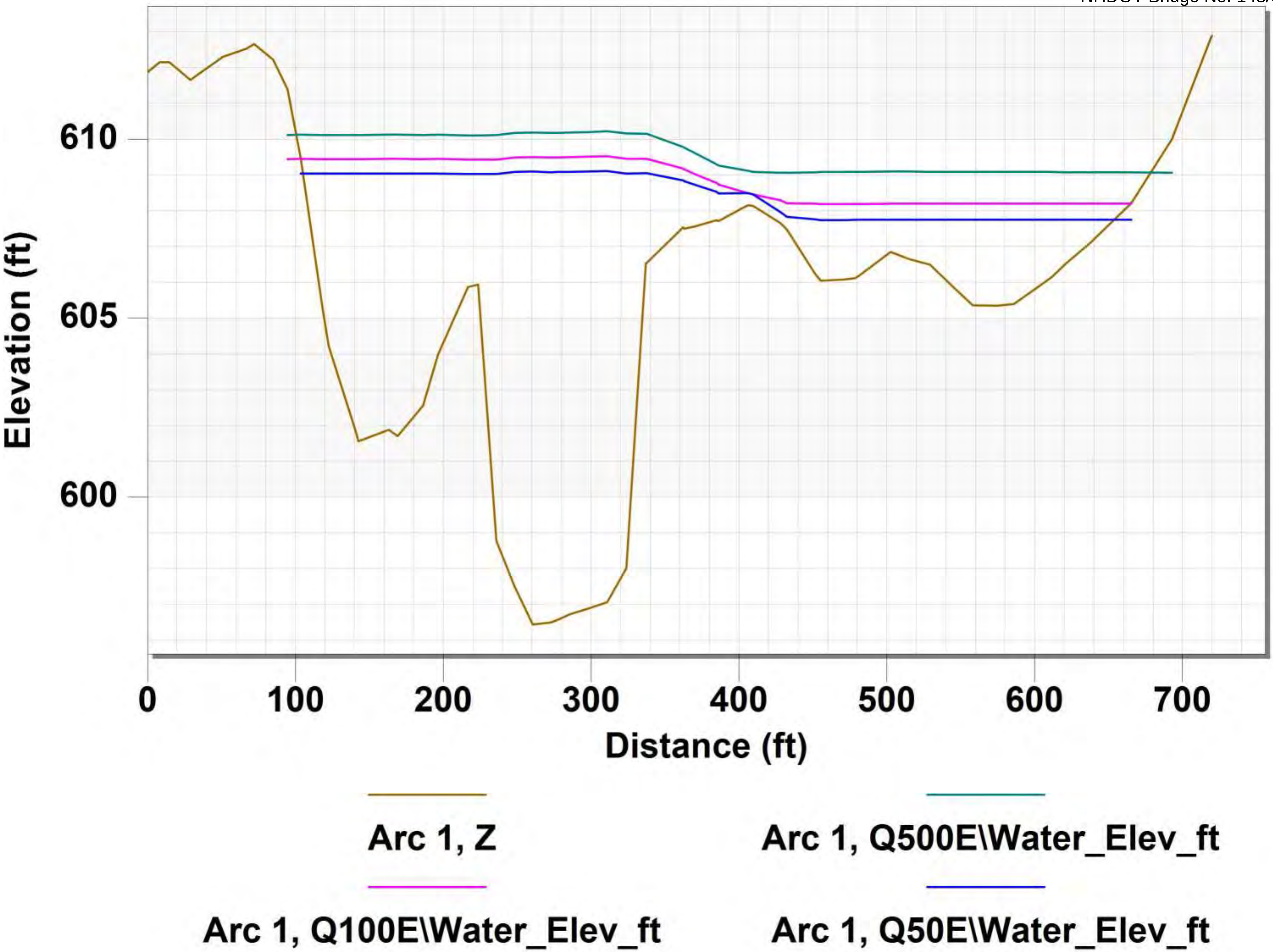
Existing Conditions
Hydraulic Model

Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077



500-year Storm Event - Water Surface Elevation (ft)

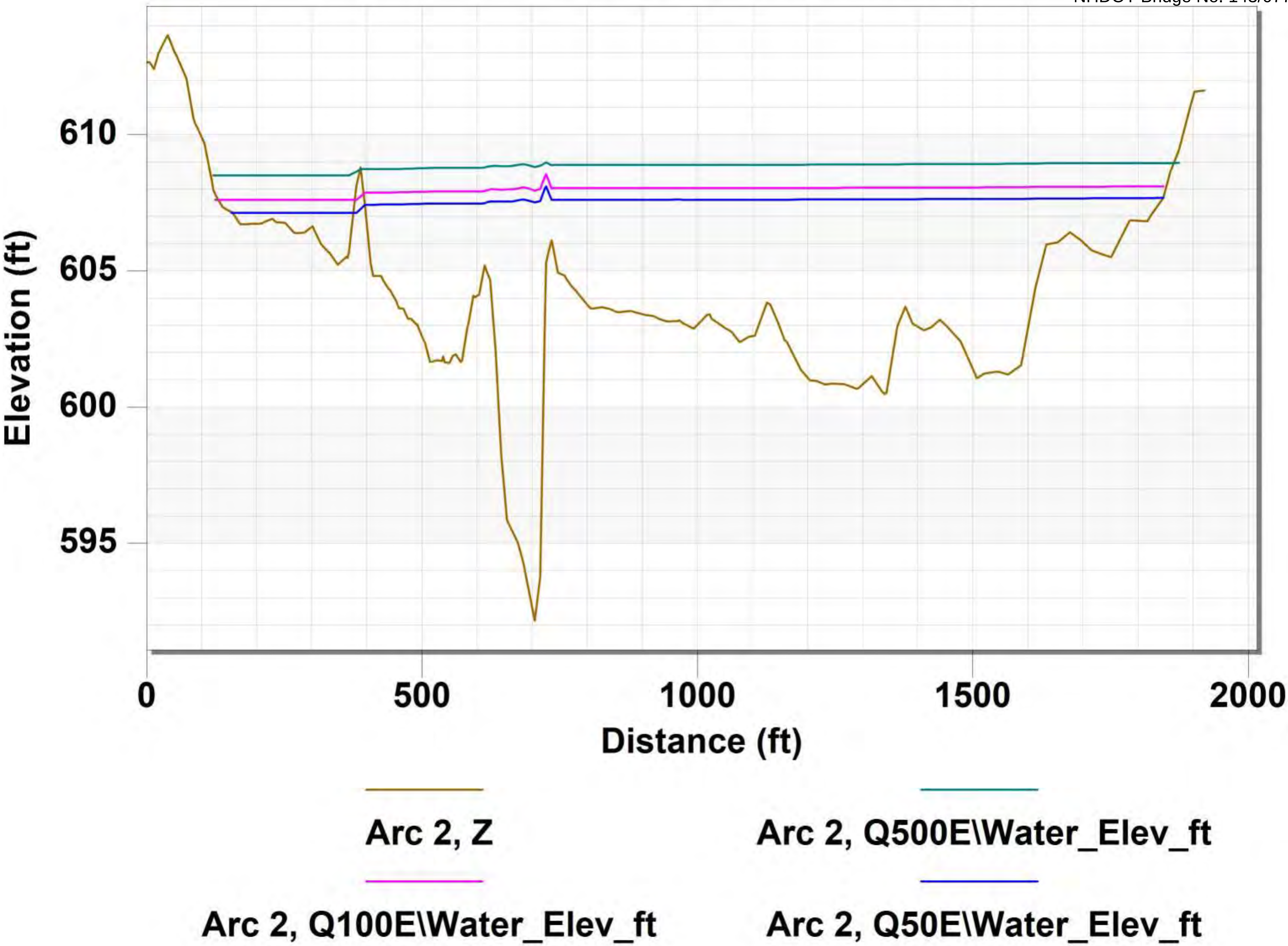
XS 1 - Existing Conditions



Hoyle, Tanner & Associates, Inc.

XS 2 - Existing Conditions

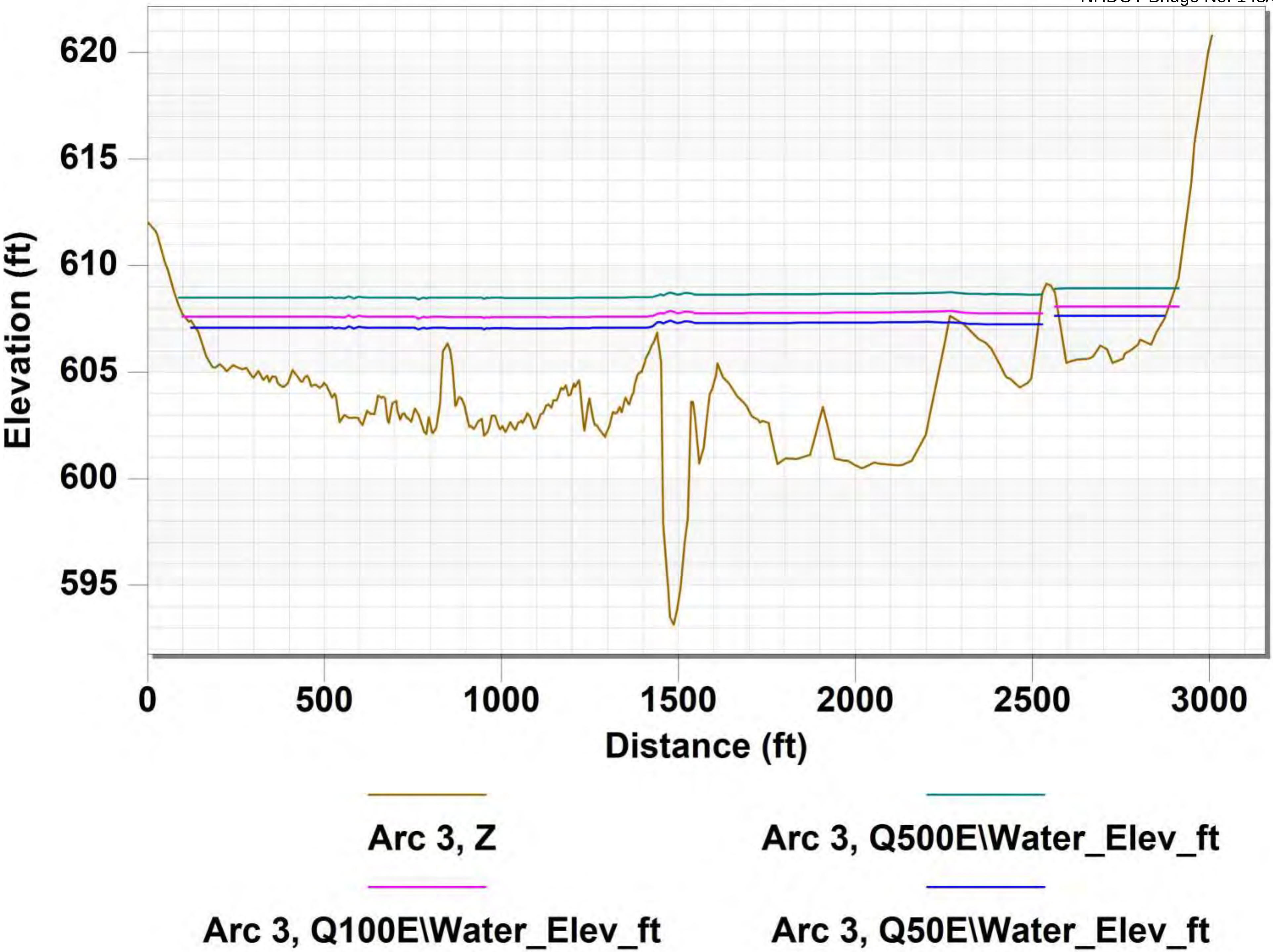
Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077



XS 3 - Existing Conditions

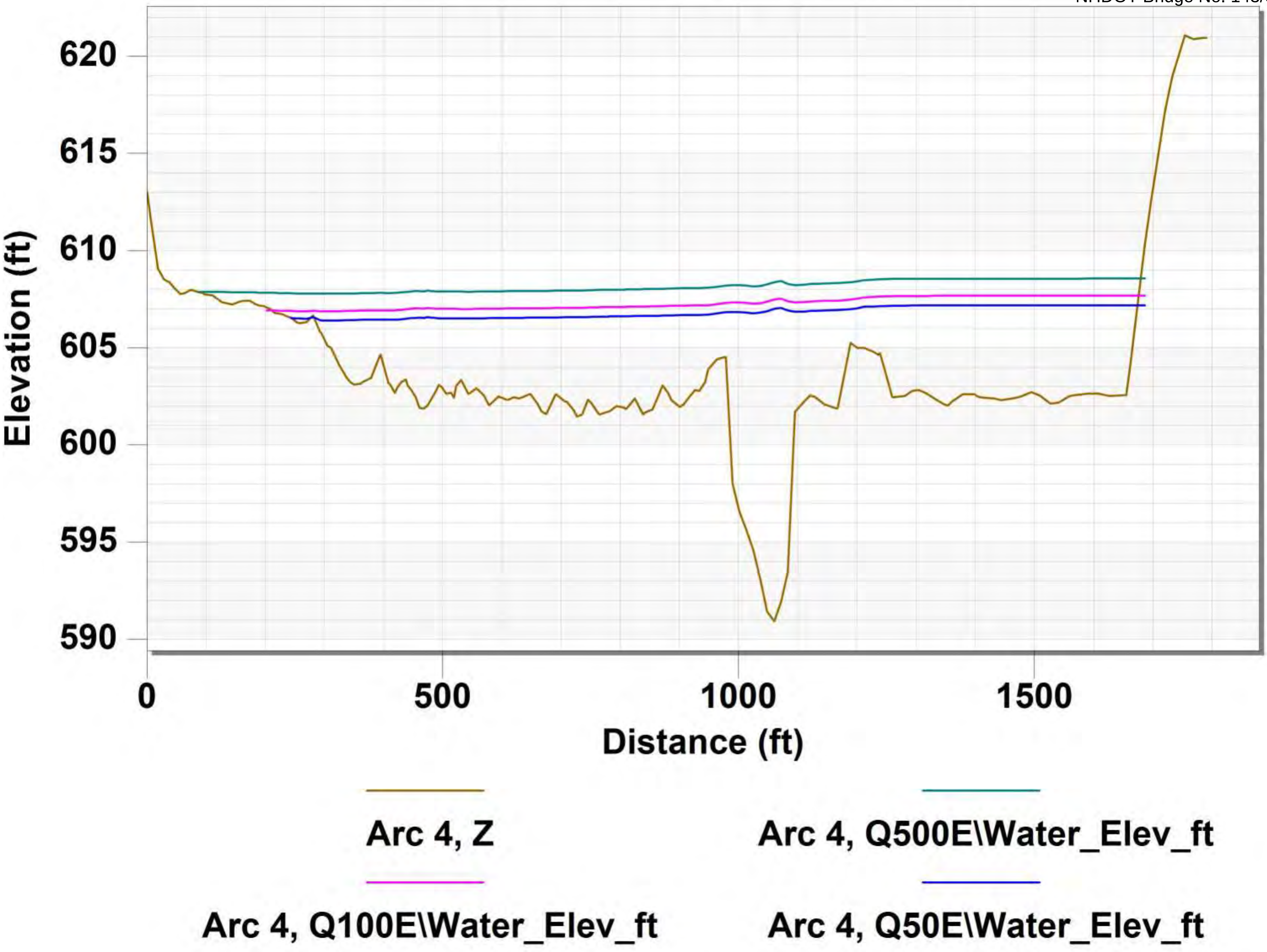
Hoyle, Tanner & Associates, Inc.

Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077



XS 4 - Existing Conditions

Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077



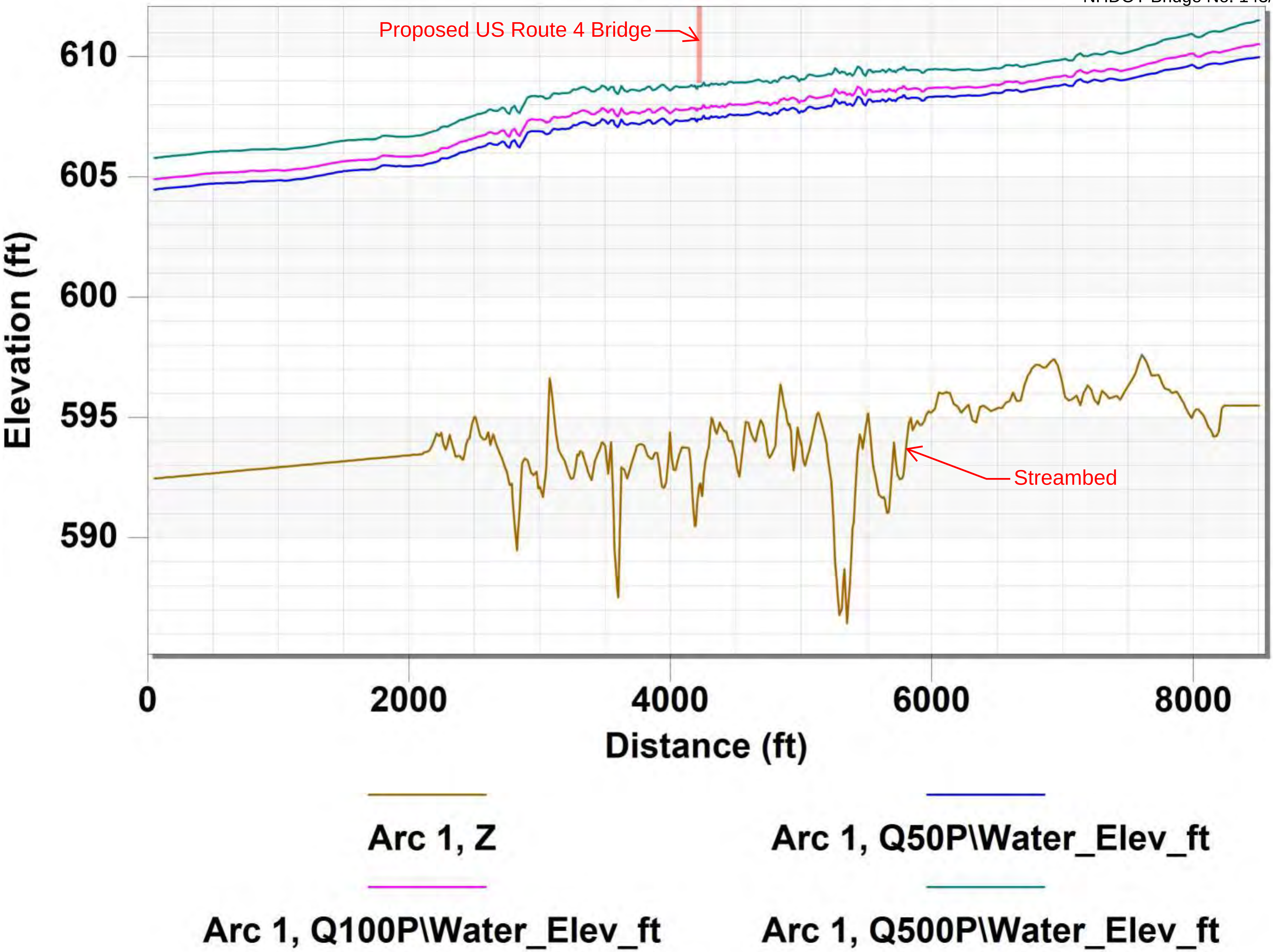
APPENDIX I

Hydraulic Analysis – Proposed Bridge

Hoyle, Tanner & Associates, Inc.

Profile - Proposed Conditions

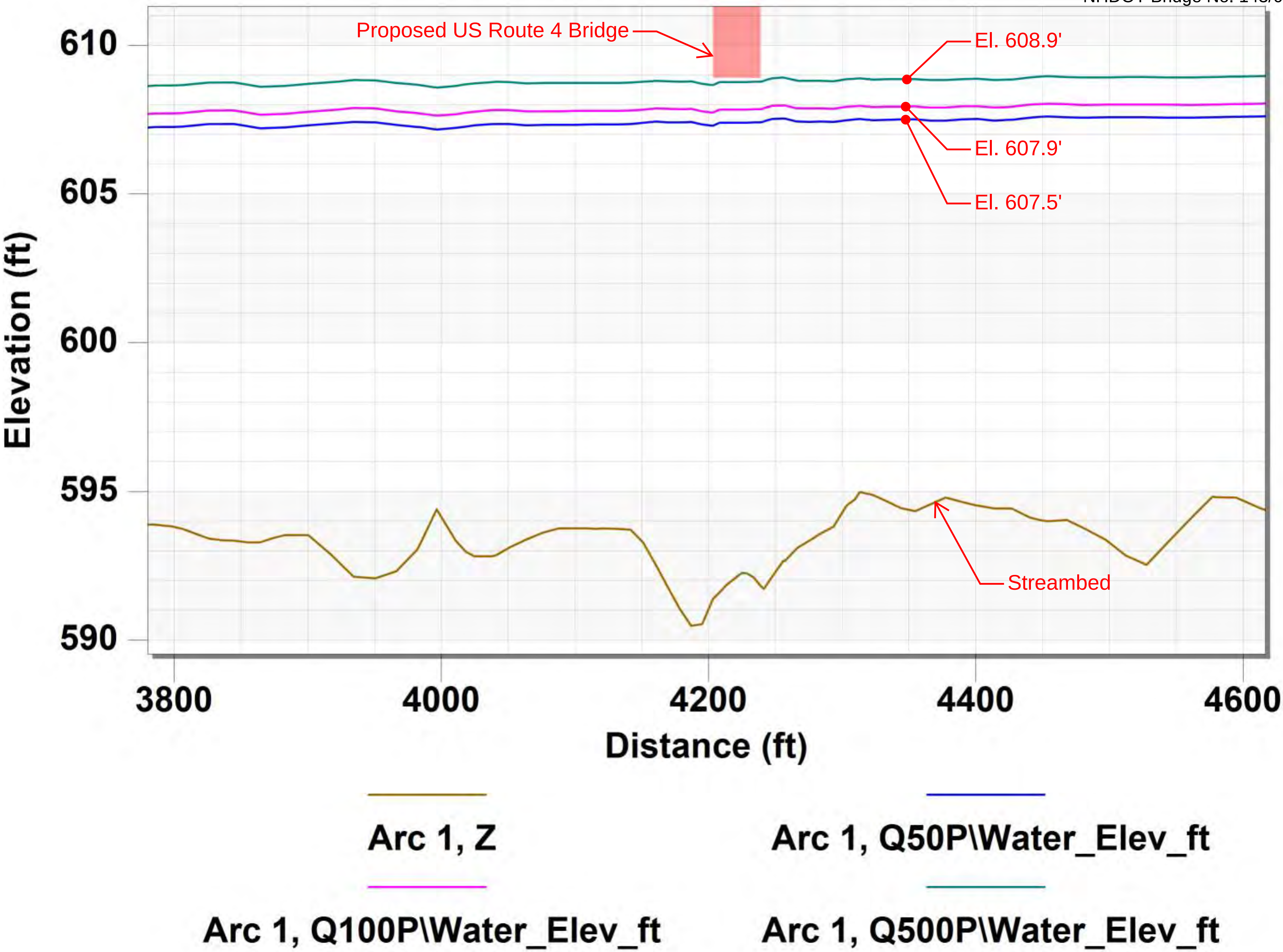
Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077



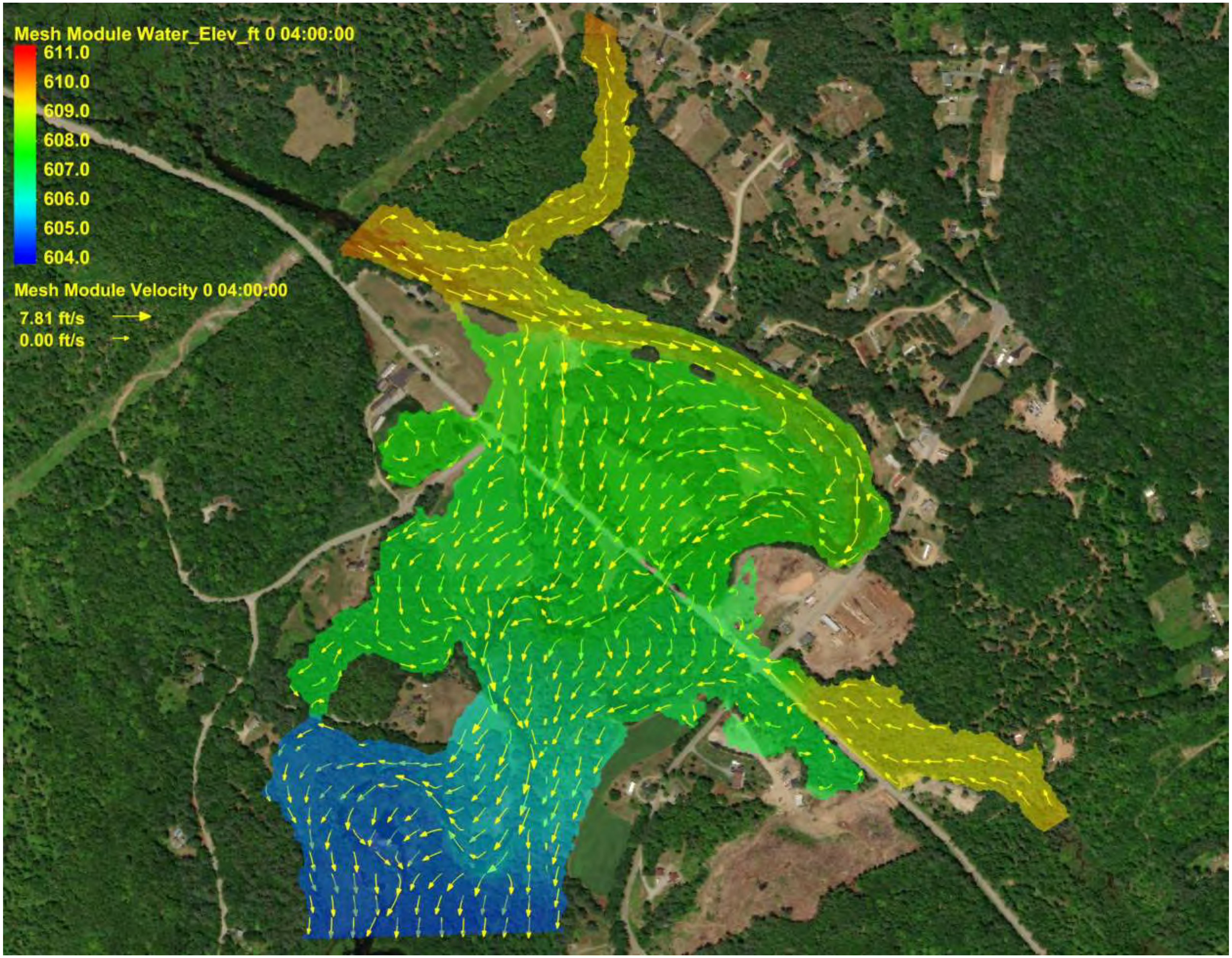
Hoyle, Tanner & Associates, Inc.

Profile - Proposed Conditions

Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077



Proposed Conditions
Hydraulic Model

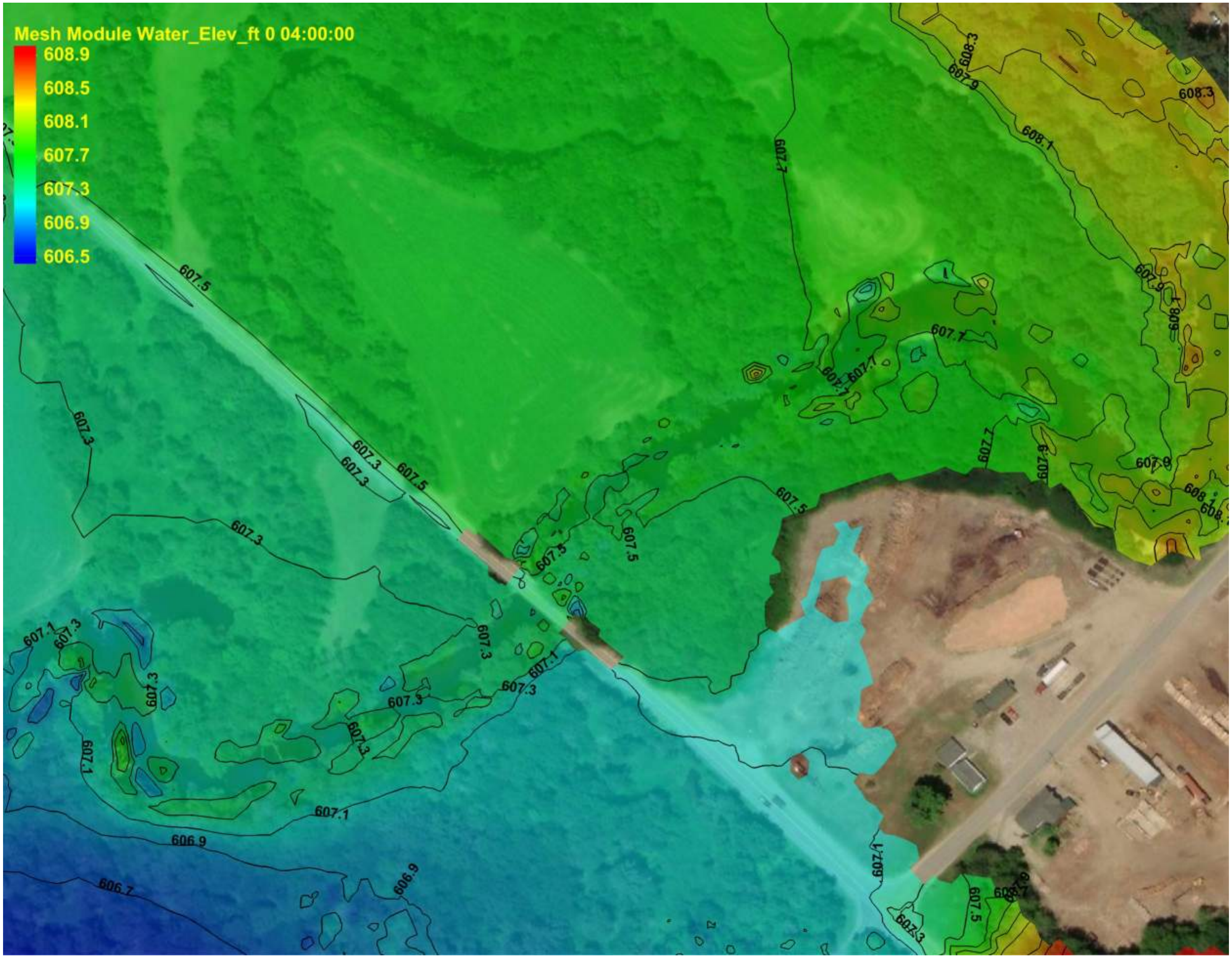


50-year Storm Event - Water Surface Elevation (ft) with Flow Vectors

Hoyle, Tanner & Associates, Inc.

Proposed Conditions
Hydraulic Model

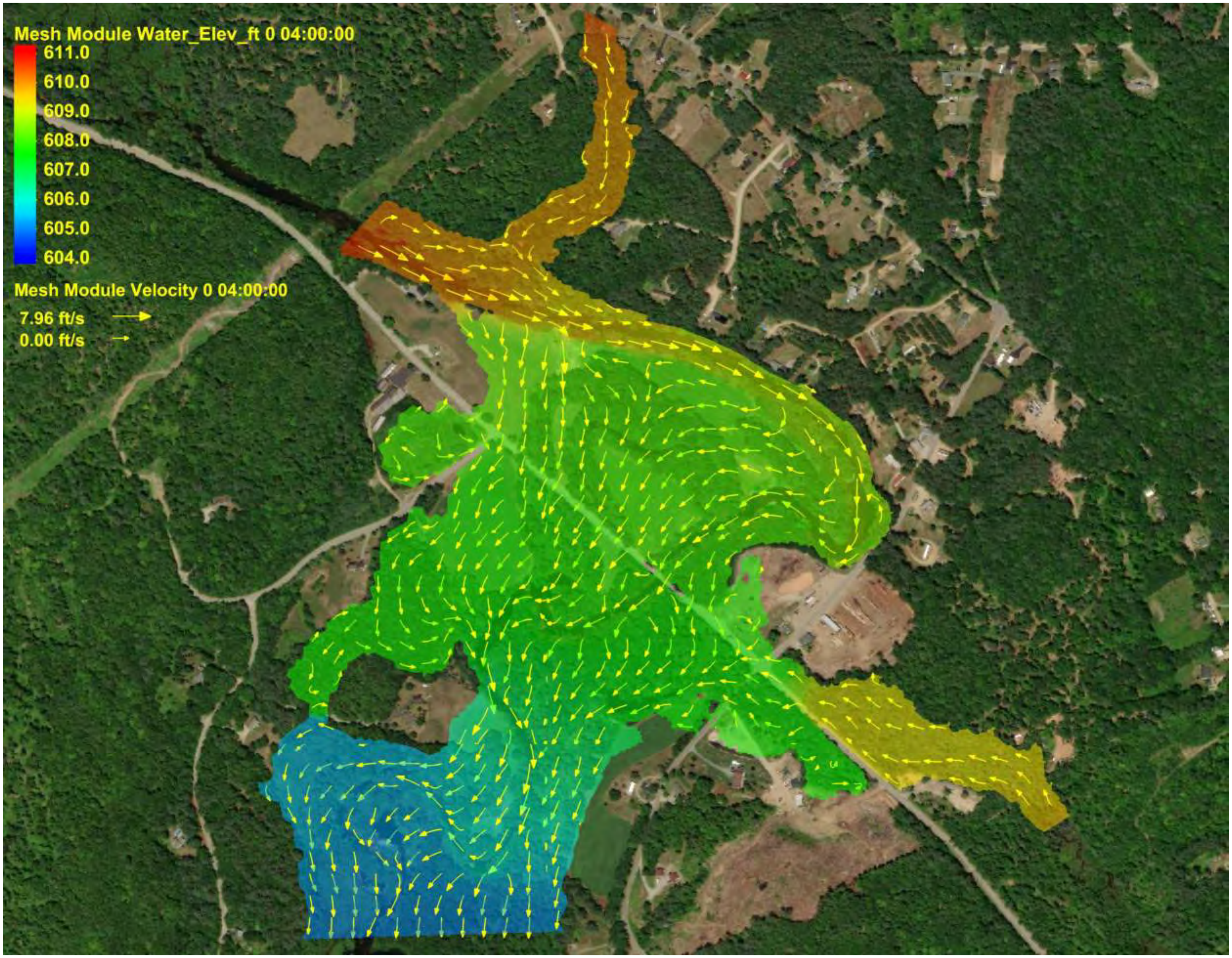
Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077



50-year Storm Event - Water Surface Elevation (ft)

Proposed Conditions Hydraulic Model

Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077

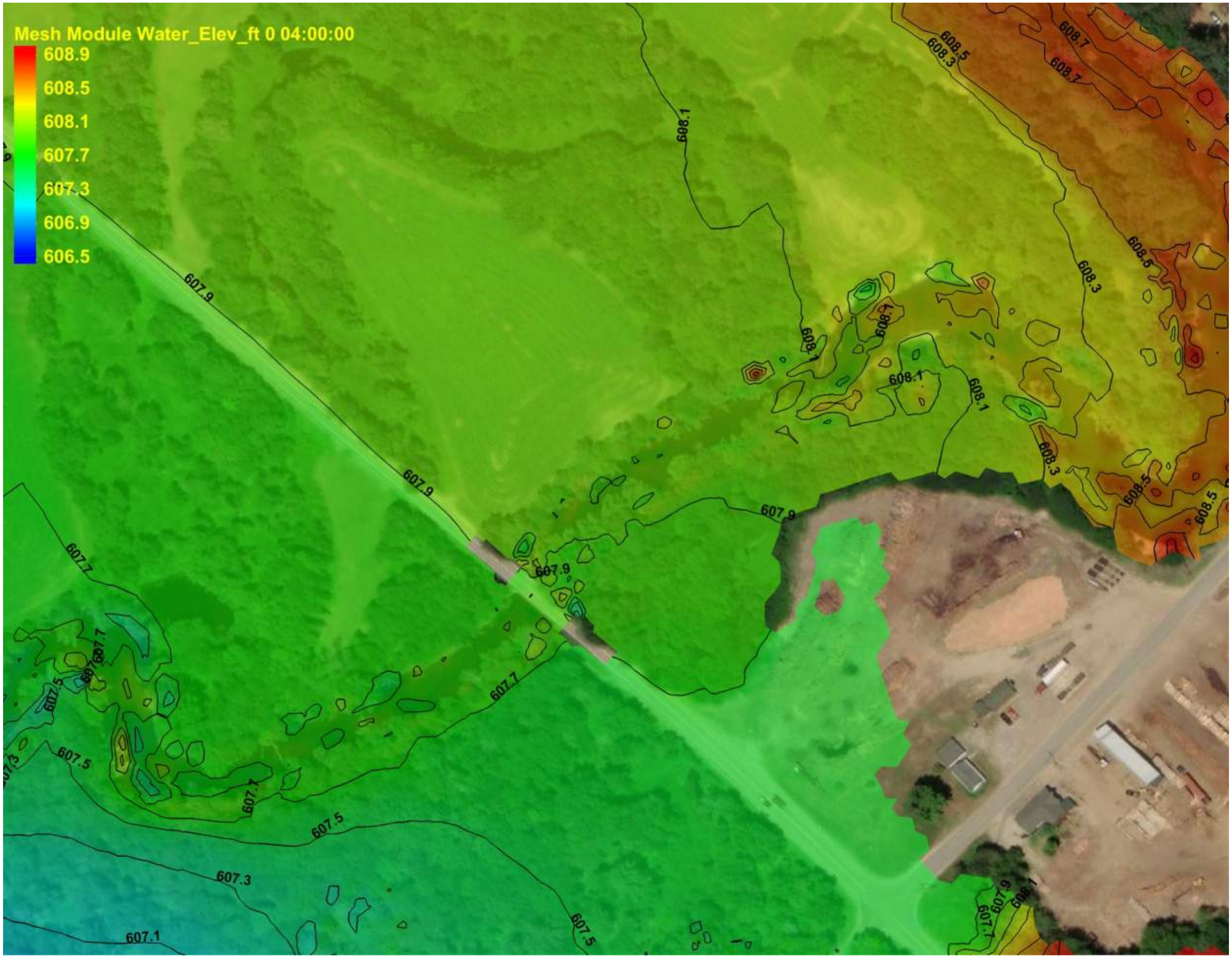


100-year Storm Event - Water Surface Elevation (ft) with Flow Vectors

Hoyle, Tanner & Associates, Inc.

Proposed Conditions Hydraulic Model

Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077

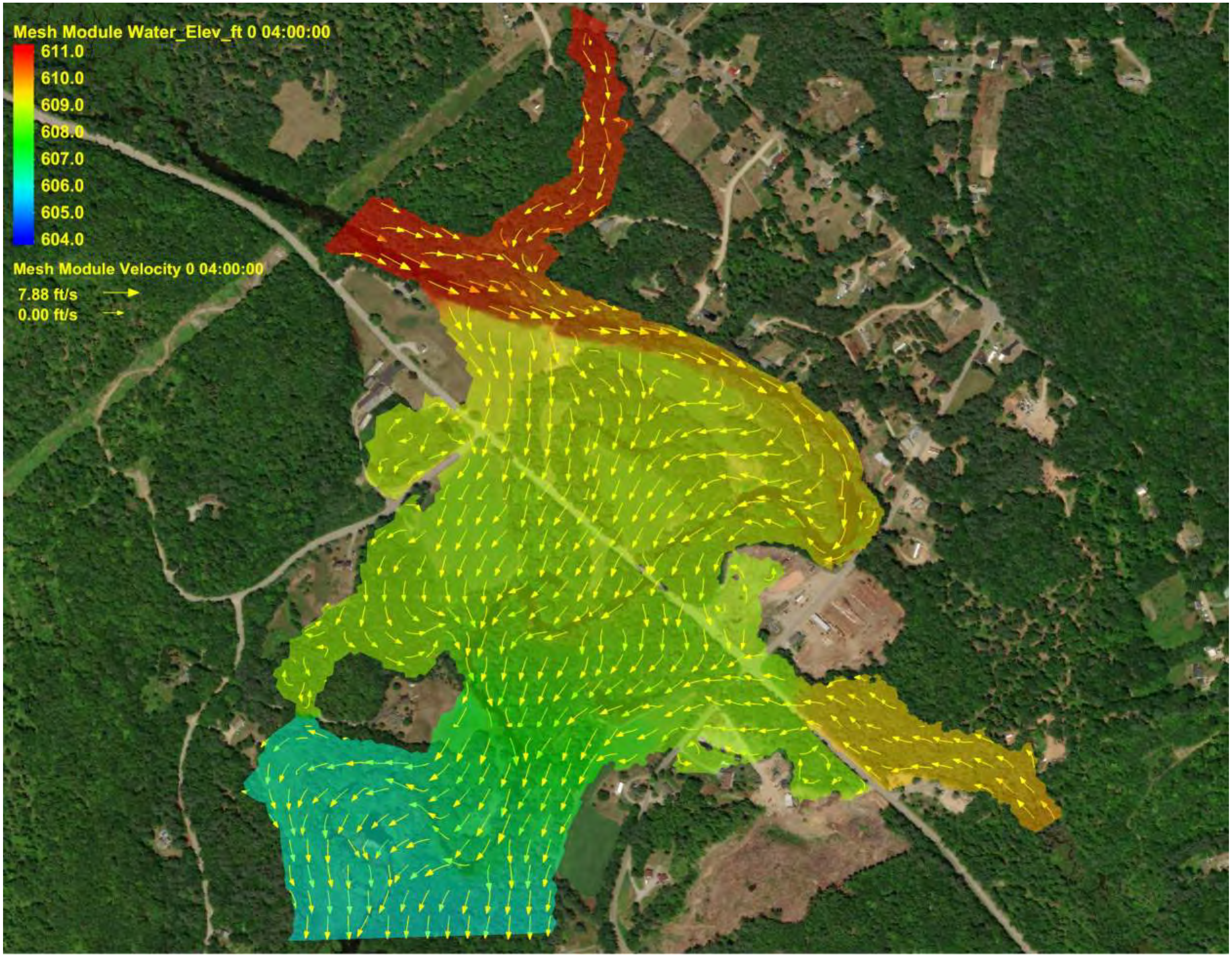


100-year Storm Event - Water Surface Elevation (ft)

Hoyle, Tanner & Associates, Inc.

Proposed Conditions Hydraulic Model

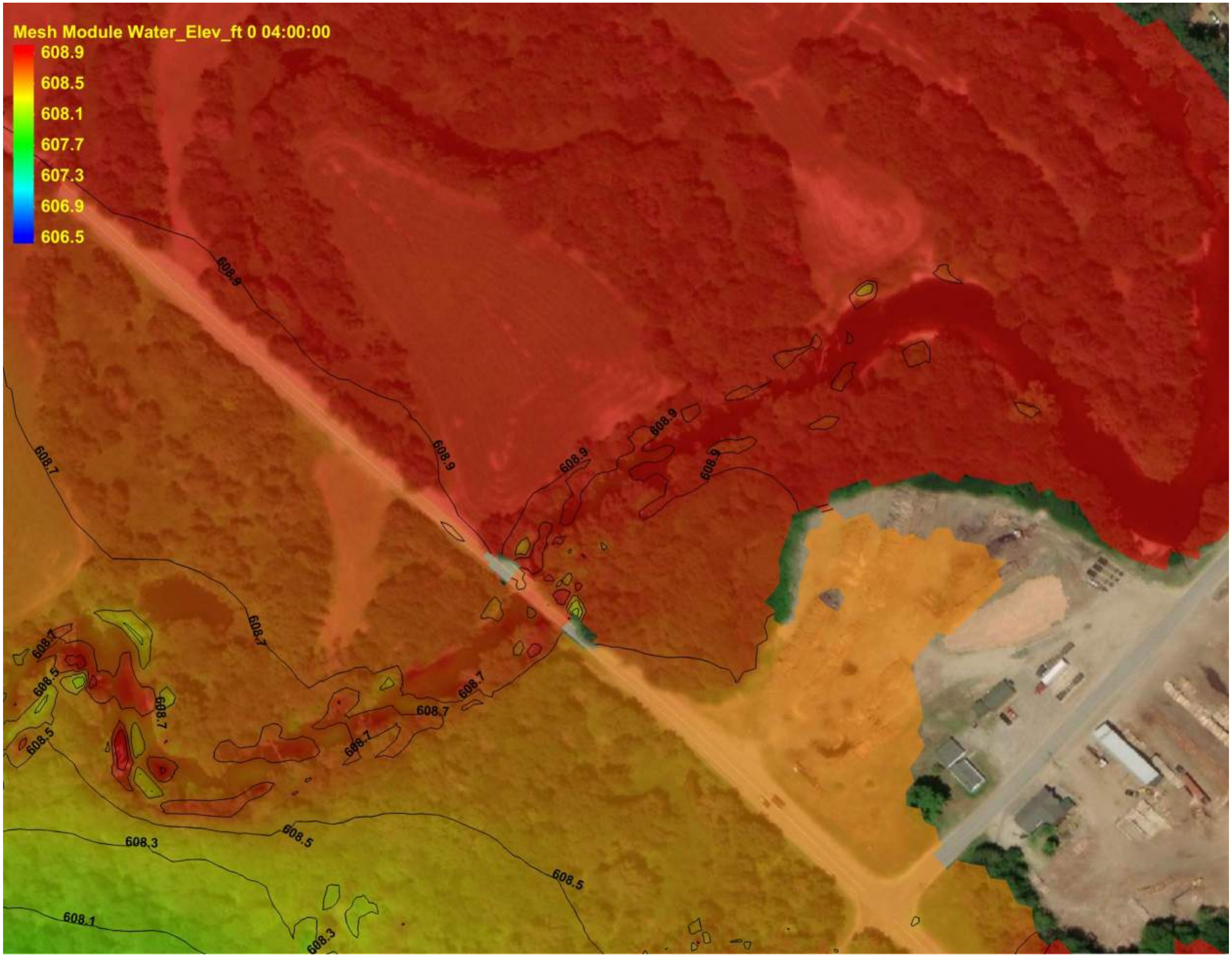
Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077



500-year Storm Event - Water Surface Elevation (ft) with Flow Vectors

Proposed Conditions
Hydraulic Model

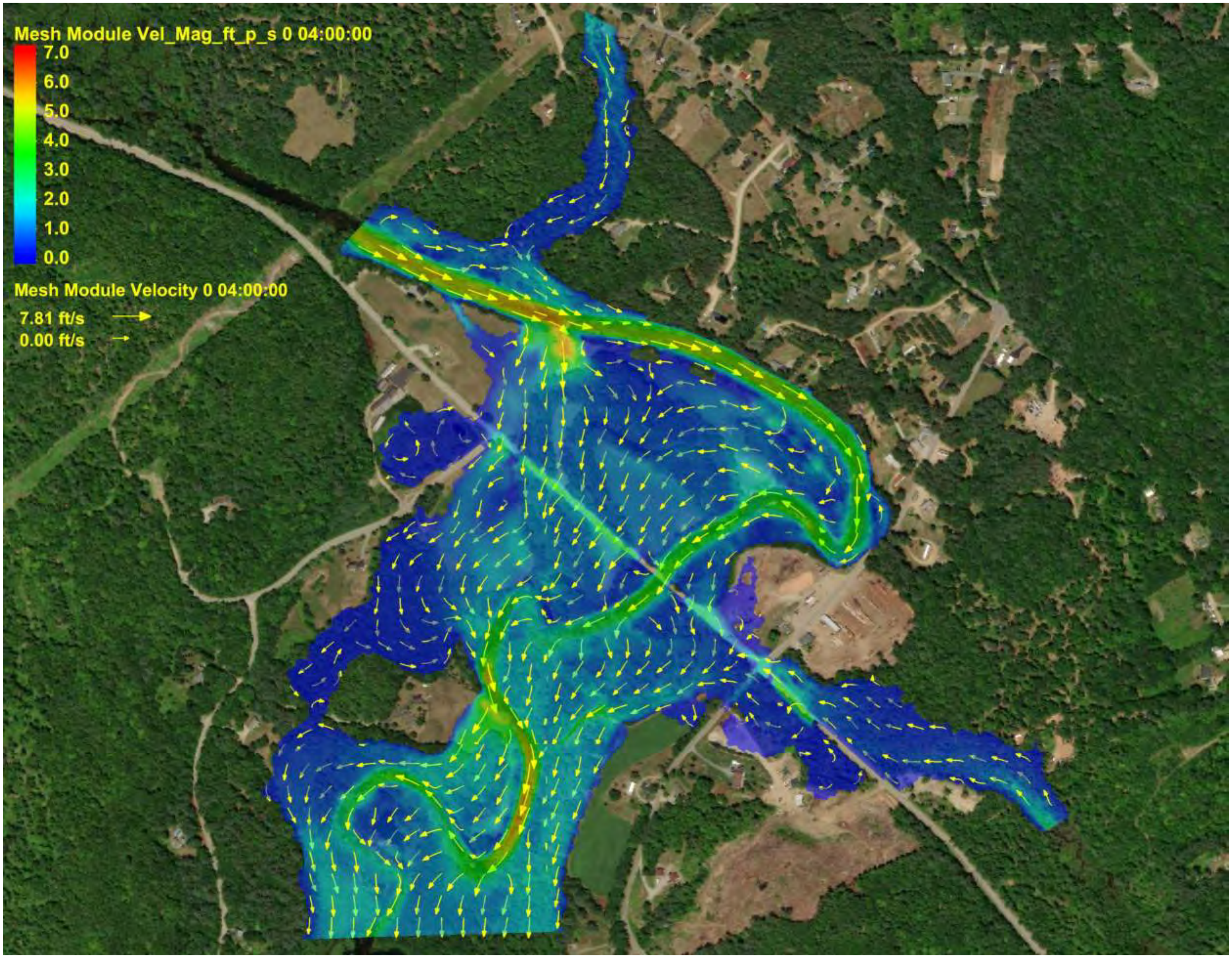
Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077



500-year Storm Event - Water Surface Elevation (ft)

Proposed Conditions
Hydraulic Model

Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077

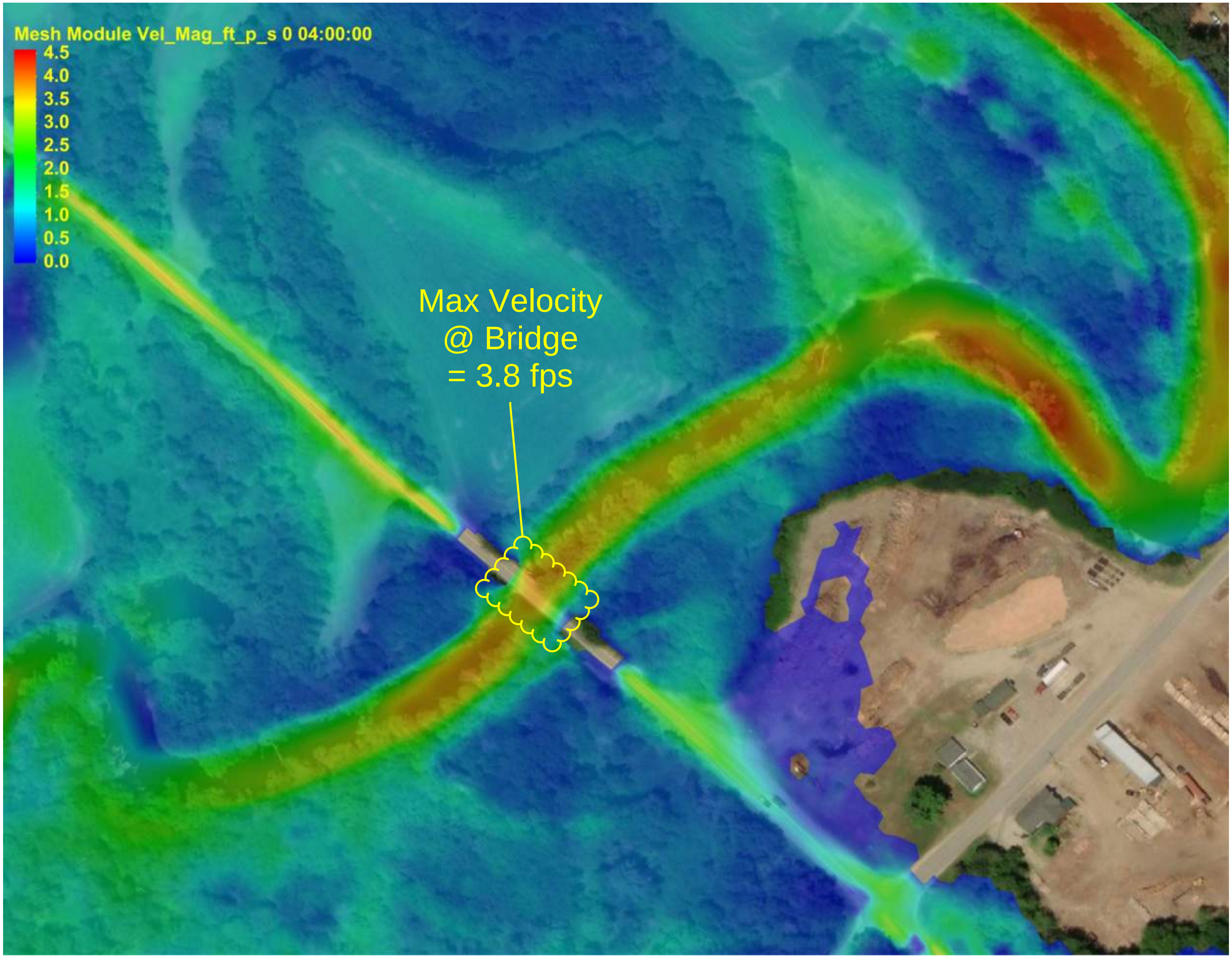


50-year Storm Event - Velocity (ft/sec) with Flow Vectors

Hoyle, Tanner & Associates, Inc.

Proposed Conditions Hydraulic Model

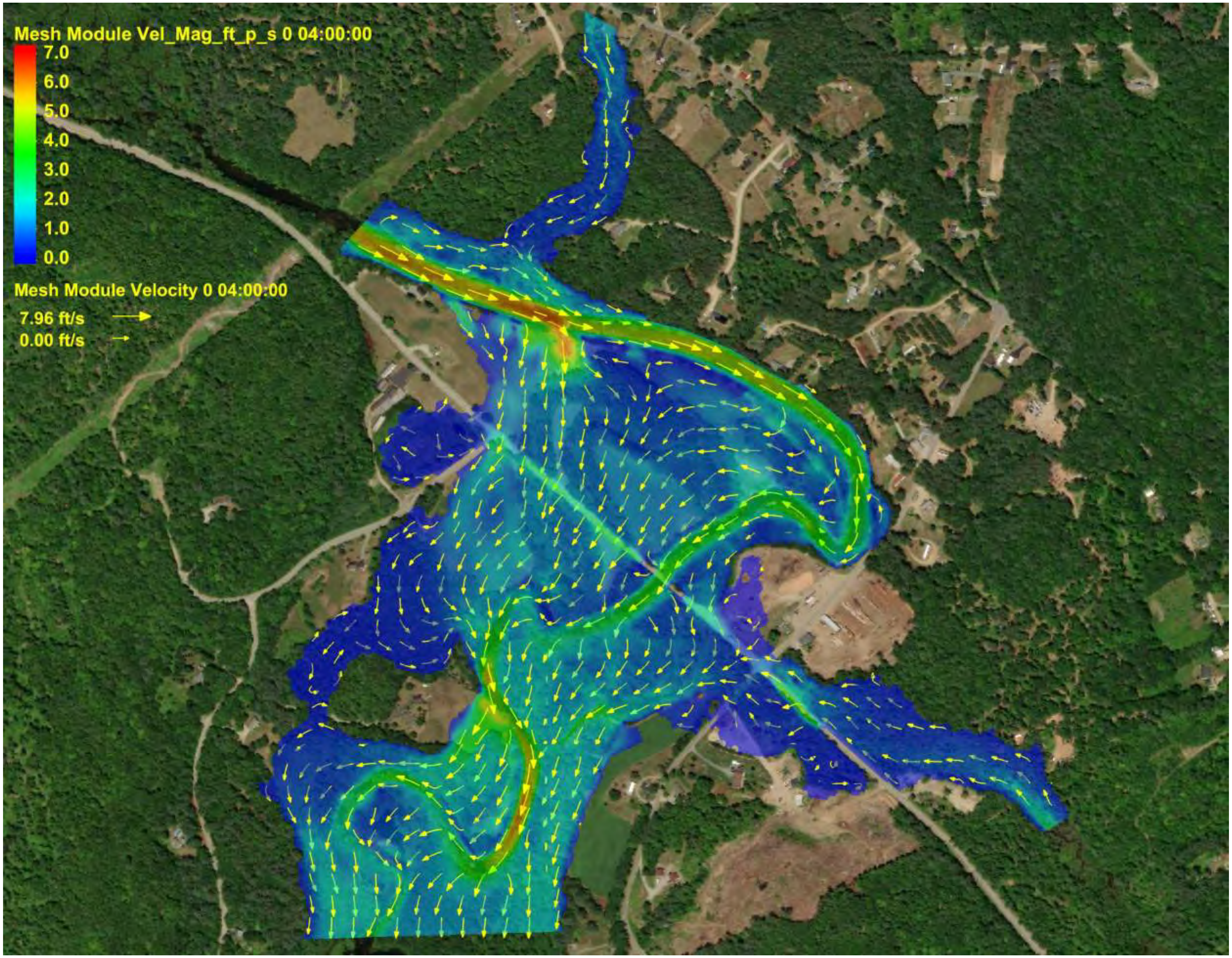
Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077



50-year Storm Event - Velocity (ft/sec)

Proposed Conditions Hydraulic Model

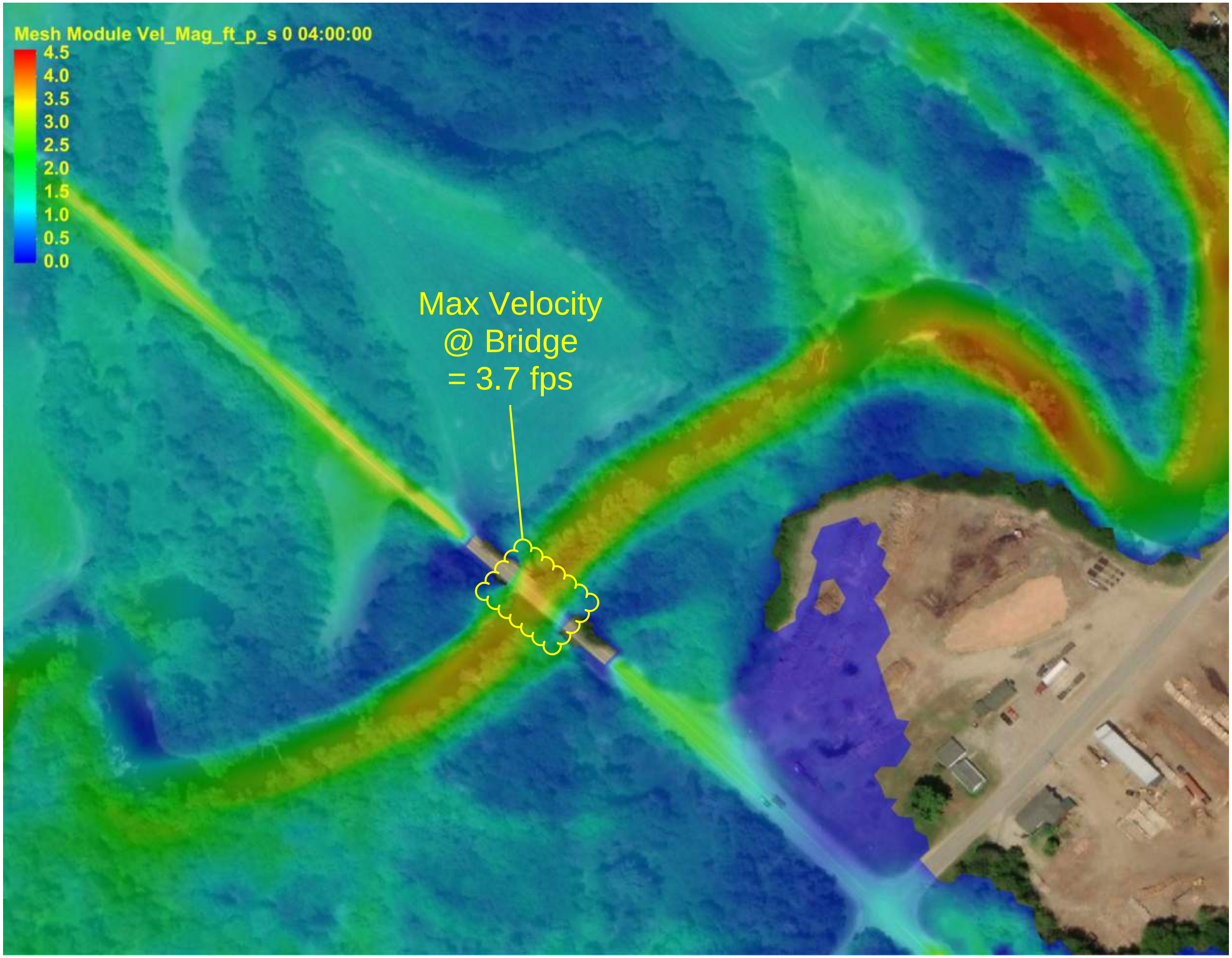
Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077



100-year Storm Event - Velocity (ft/sec) with Flow Vectors

Proposed Conditions
Hydraulic Model

Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077

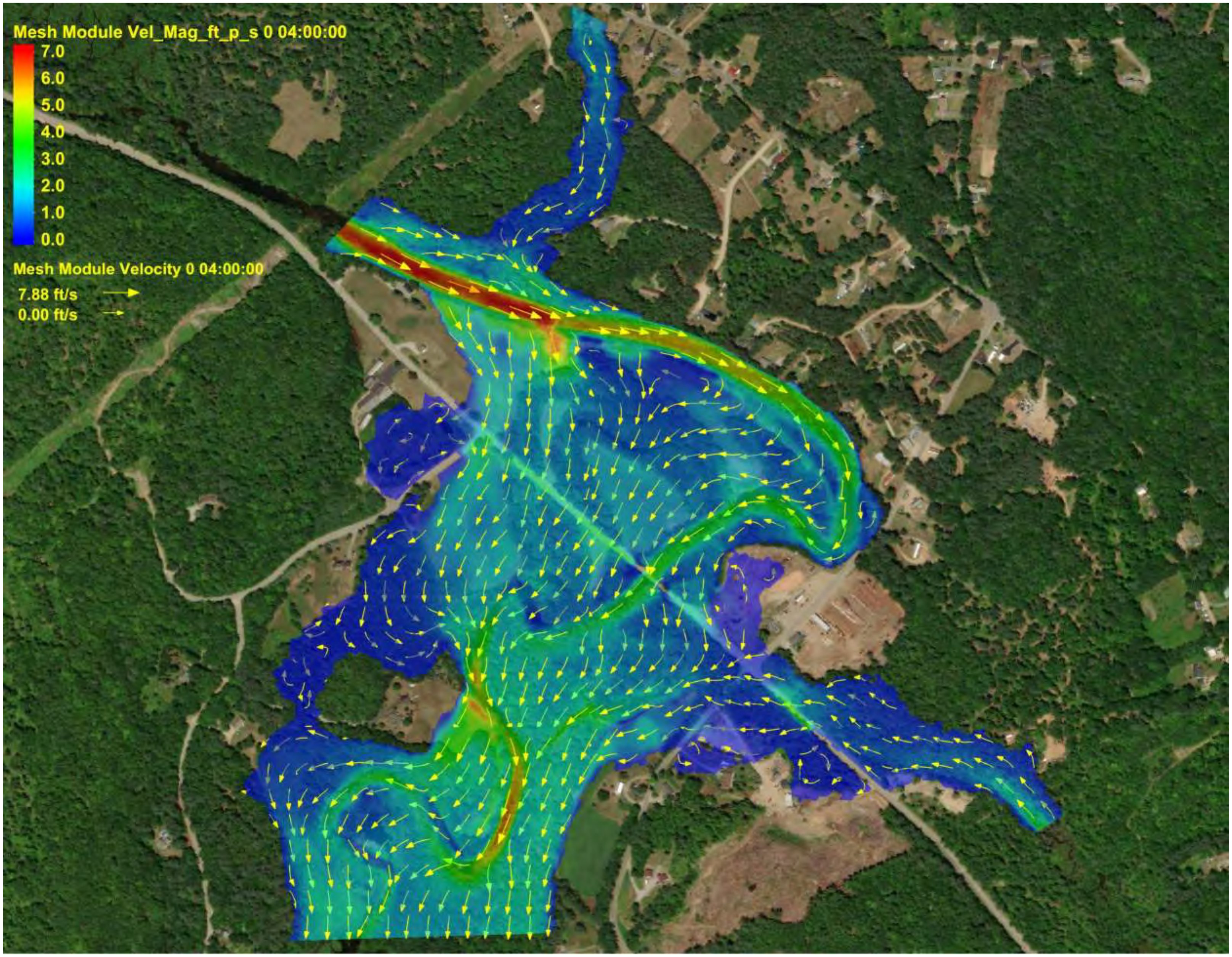


100-year Storm Event - Velocity (ft/sec)

Hoyle, Tanner & Associates, Inc.

Proposed Conditions Hydraulic Model

Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077

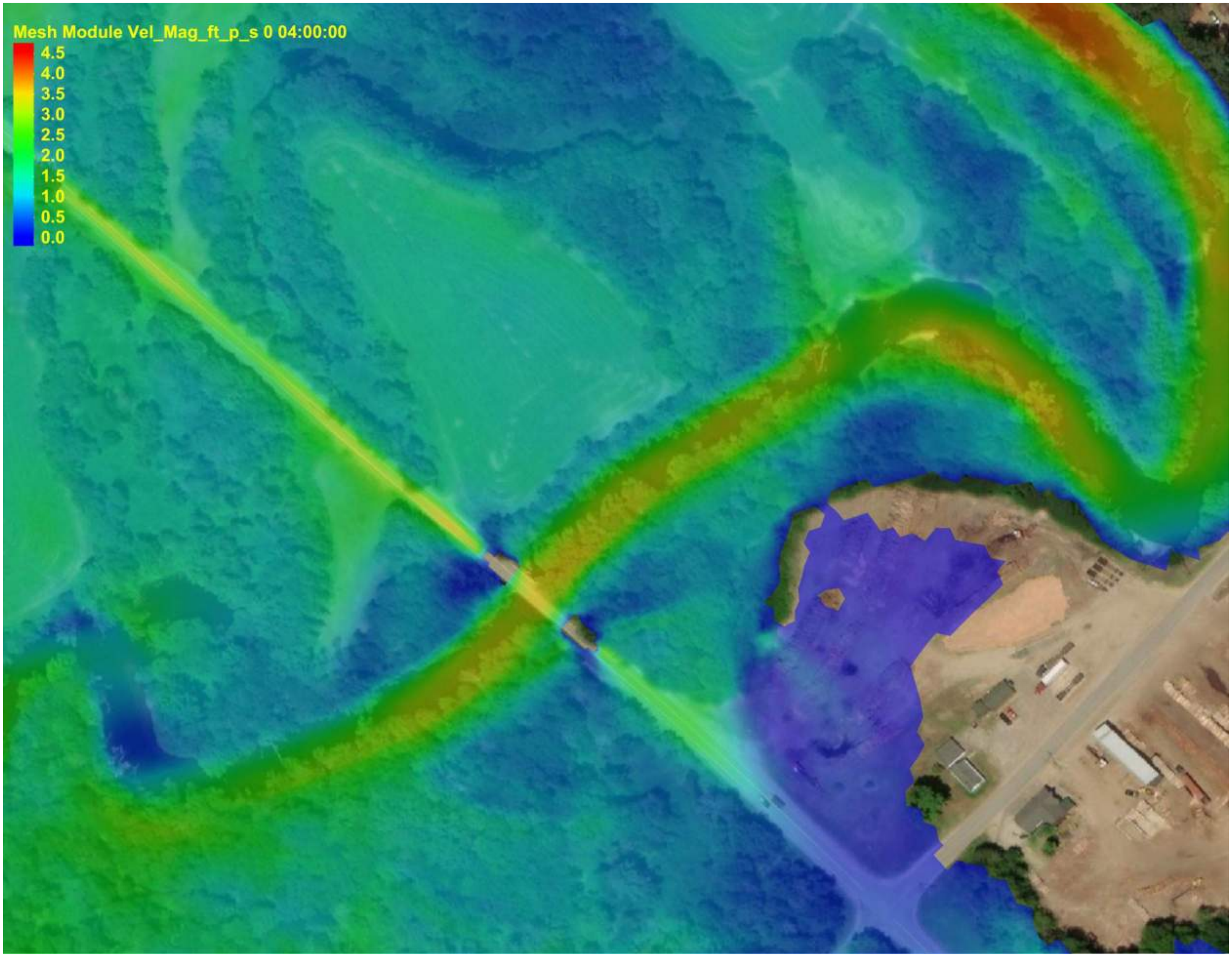


500-year Storm Event - Velocity (ft/sec) with Flow Vectors

Hoyle, Tanner & Associates, Inc.

Proposed Conditions Hydraulic Model

Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077

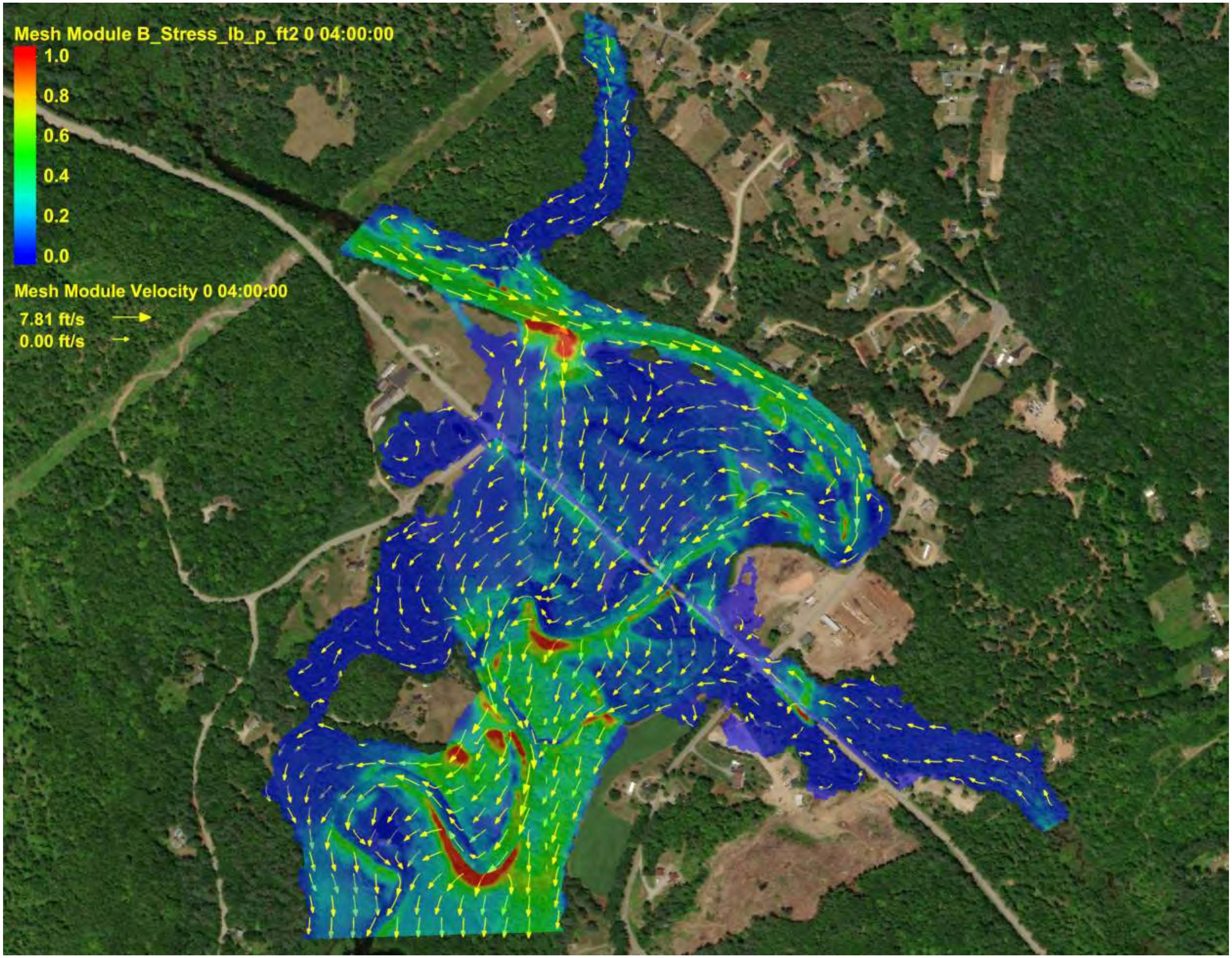


500-year Storm Event - Velocity (ft/sec)

Hoyle, Tanner & Associates, Inc.

Proposed Conditions Hydraulic Model

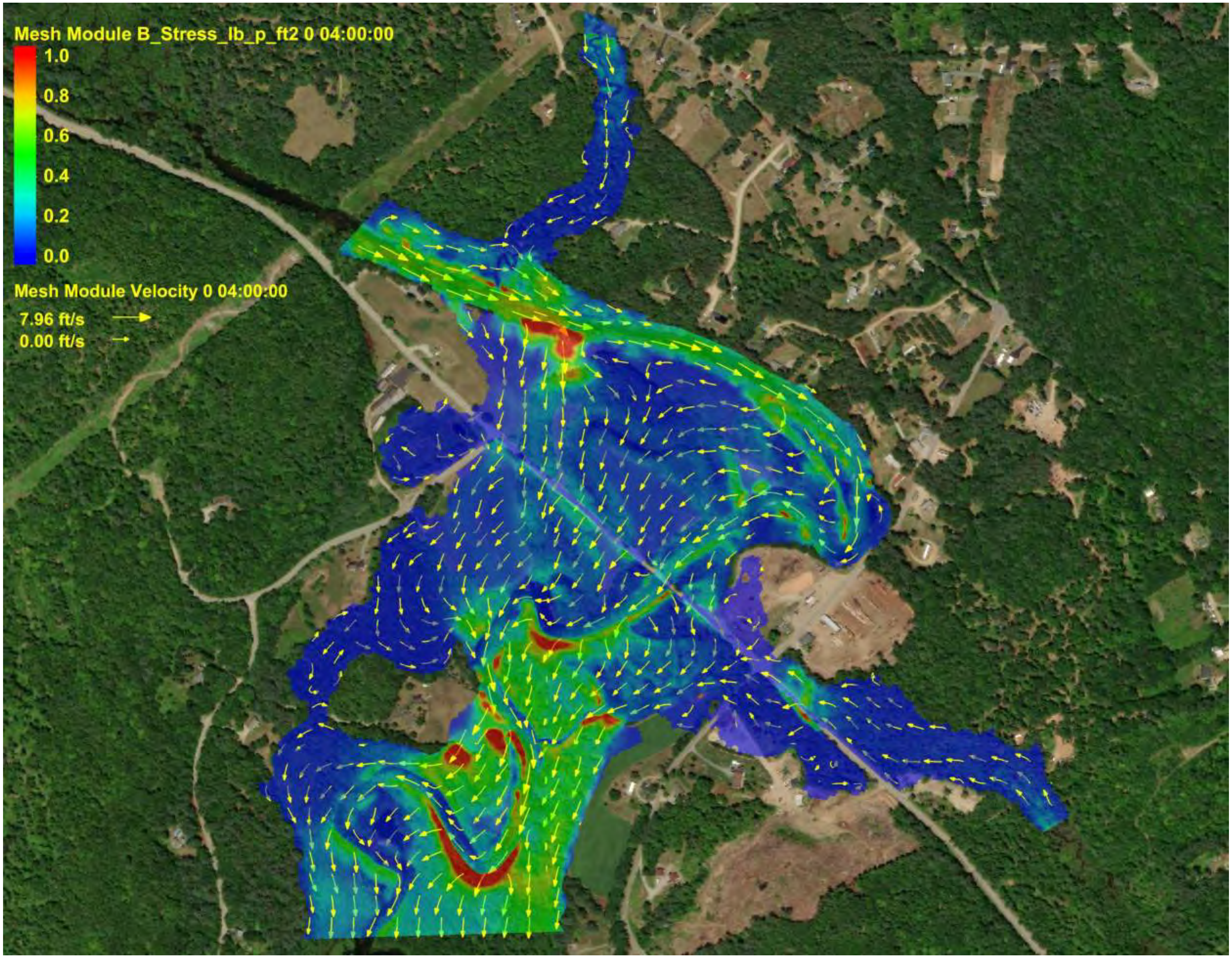
Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077



50-year Storm Event - Shear Stress (lb/ft^2) with Flow Vectors

Proposed Conditions
Hydraulic Model

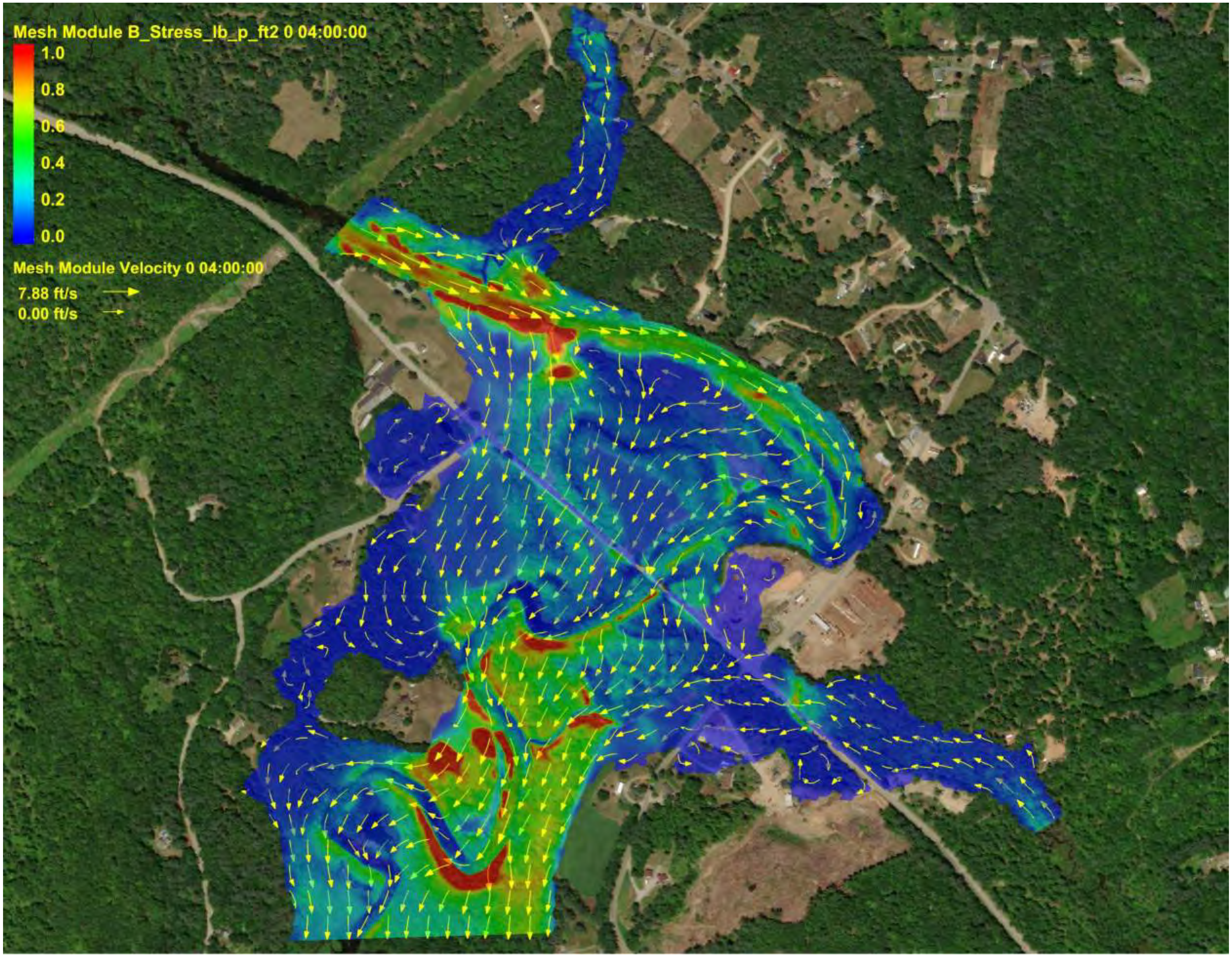
Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077



100-year Storm Event - Shear Stress (lb/ft^2) with Flow Vectors

Proposed Conditions Hydraulic Model

Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077

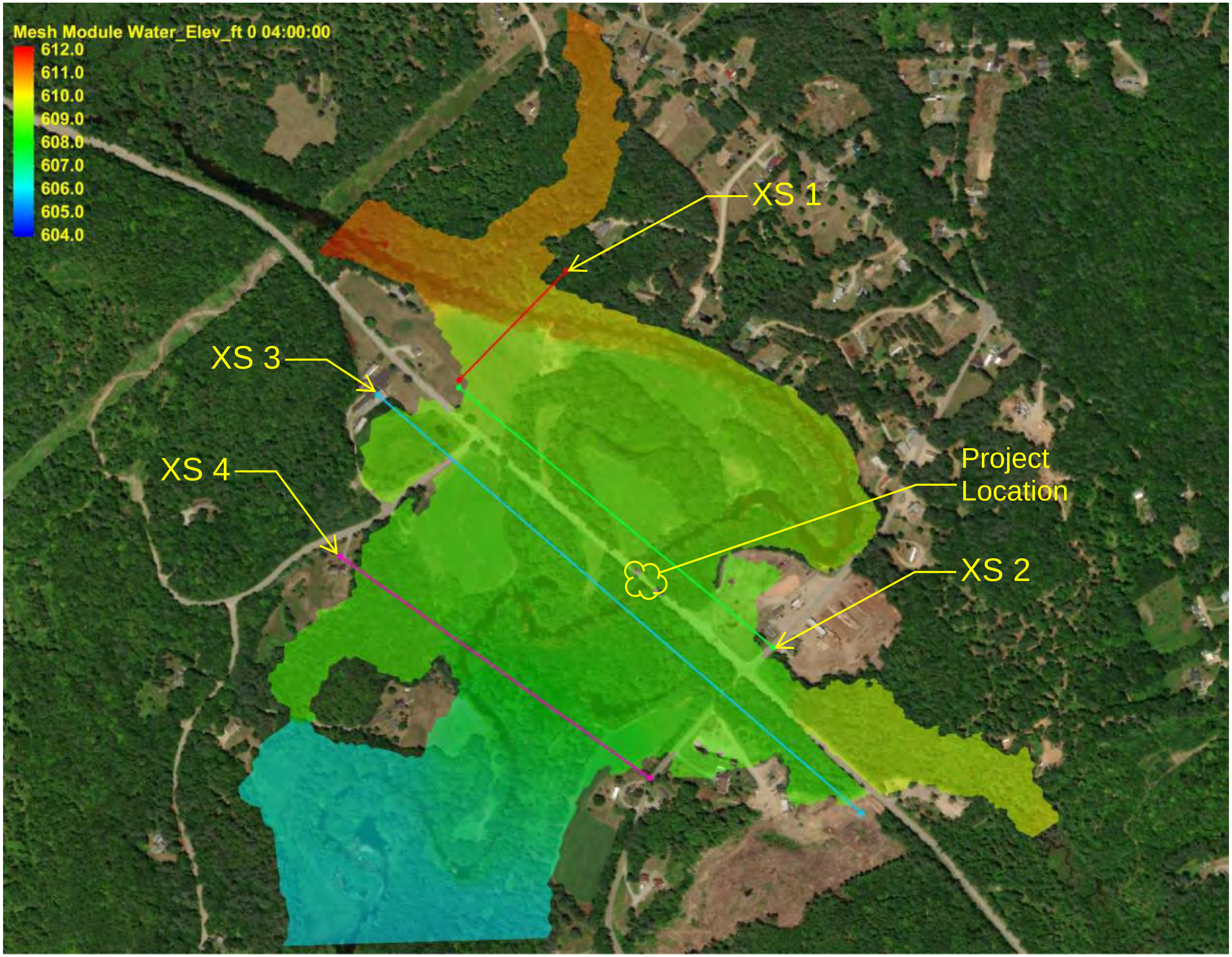


500-year Storm Event - Shear Stress (lb/ft^2) with Flow Vectors

Hoyle, Tanner & Associates, Inc.

Proposed Conditions Hydraulic Model

Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077

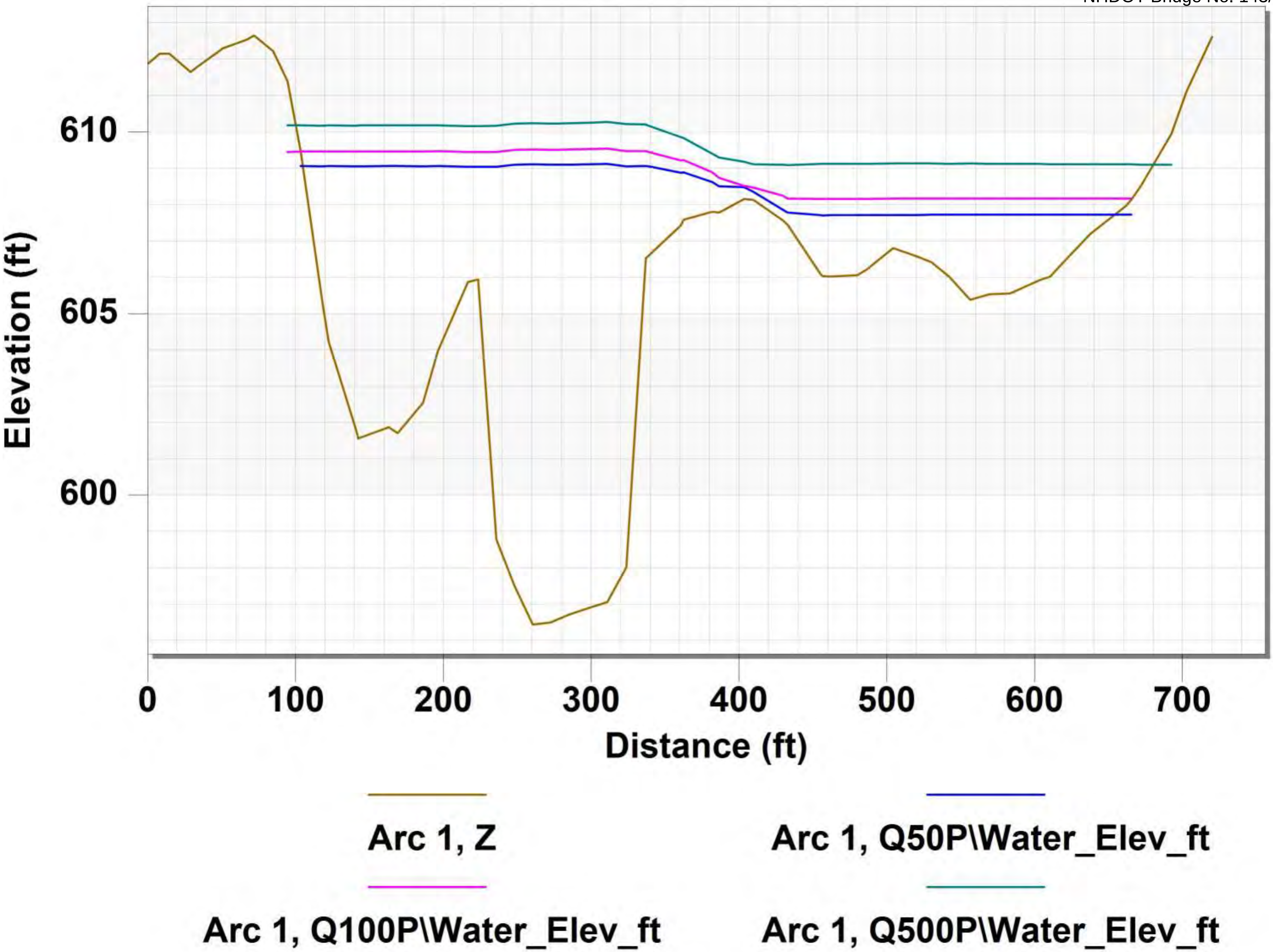


500-year Storm Event - Water Surface Elevation (ft)

Hoyle, Tanner & Associates, Inc.

XS 1 - Proposed Conditions

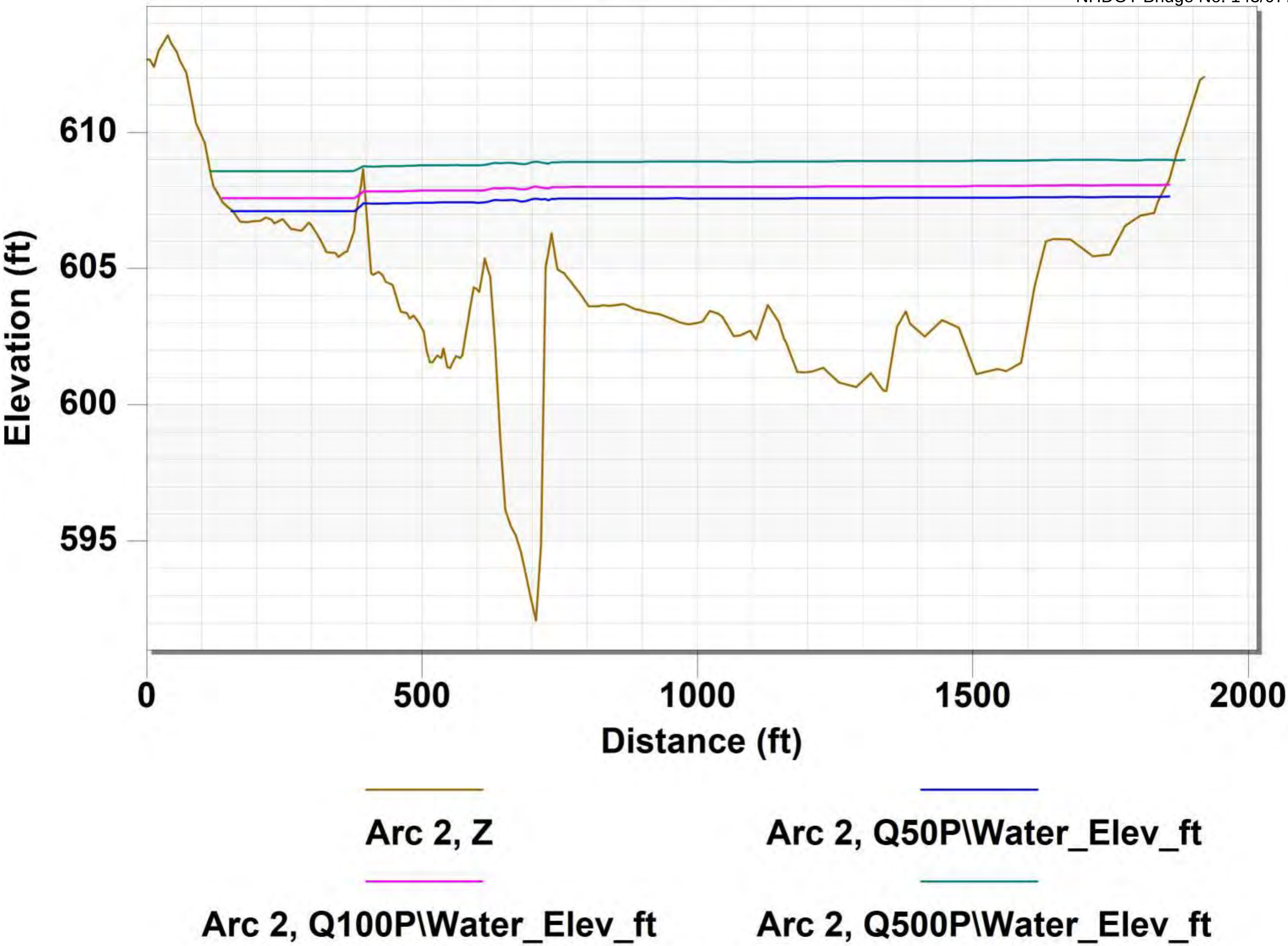
Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077



XS 2 - Proposed Conditions

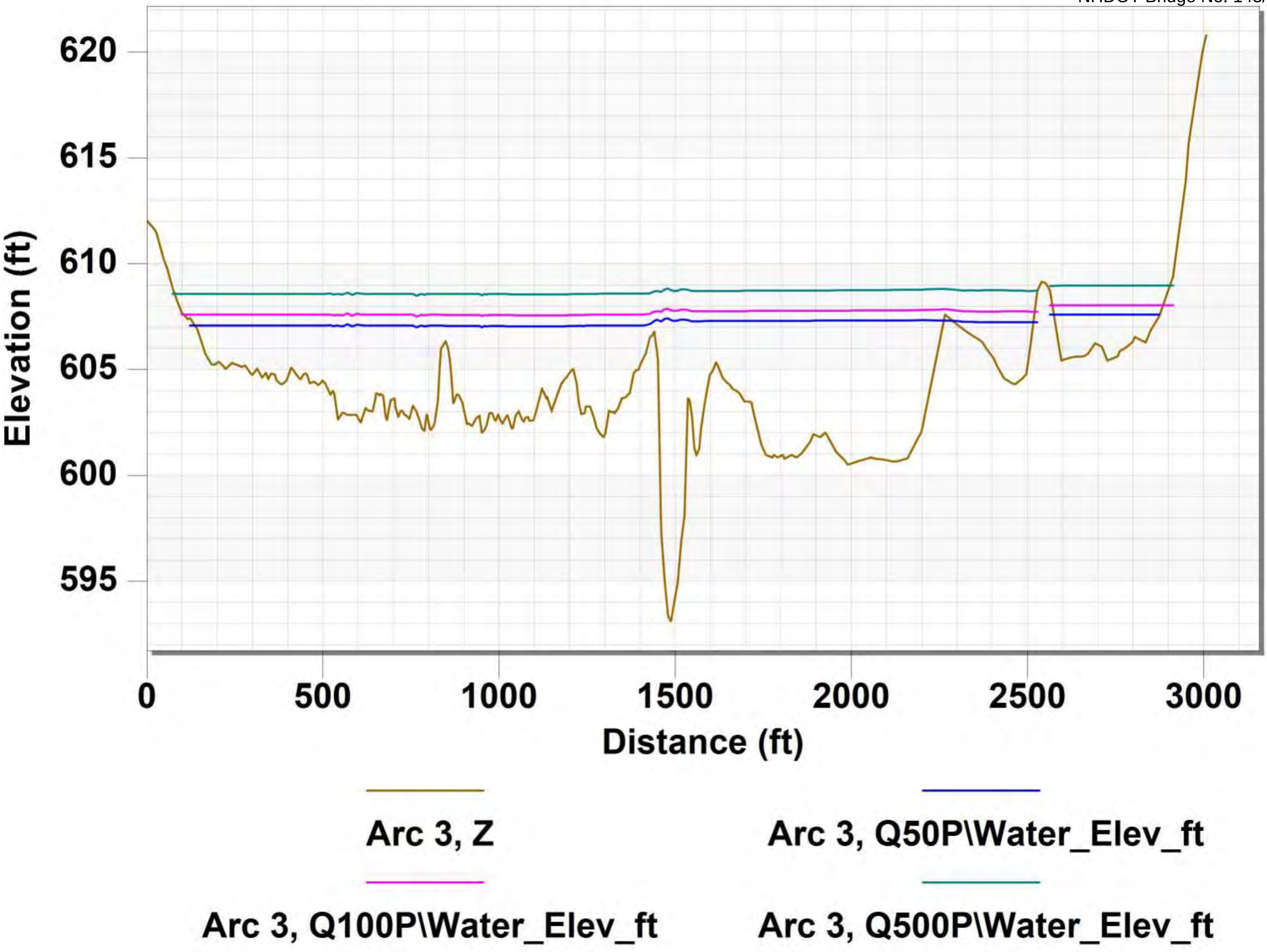
Hoyle, Tanner & Associates, Inc.

Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077



XS 3 - Proposed Conditions

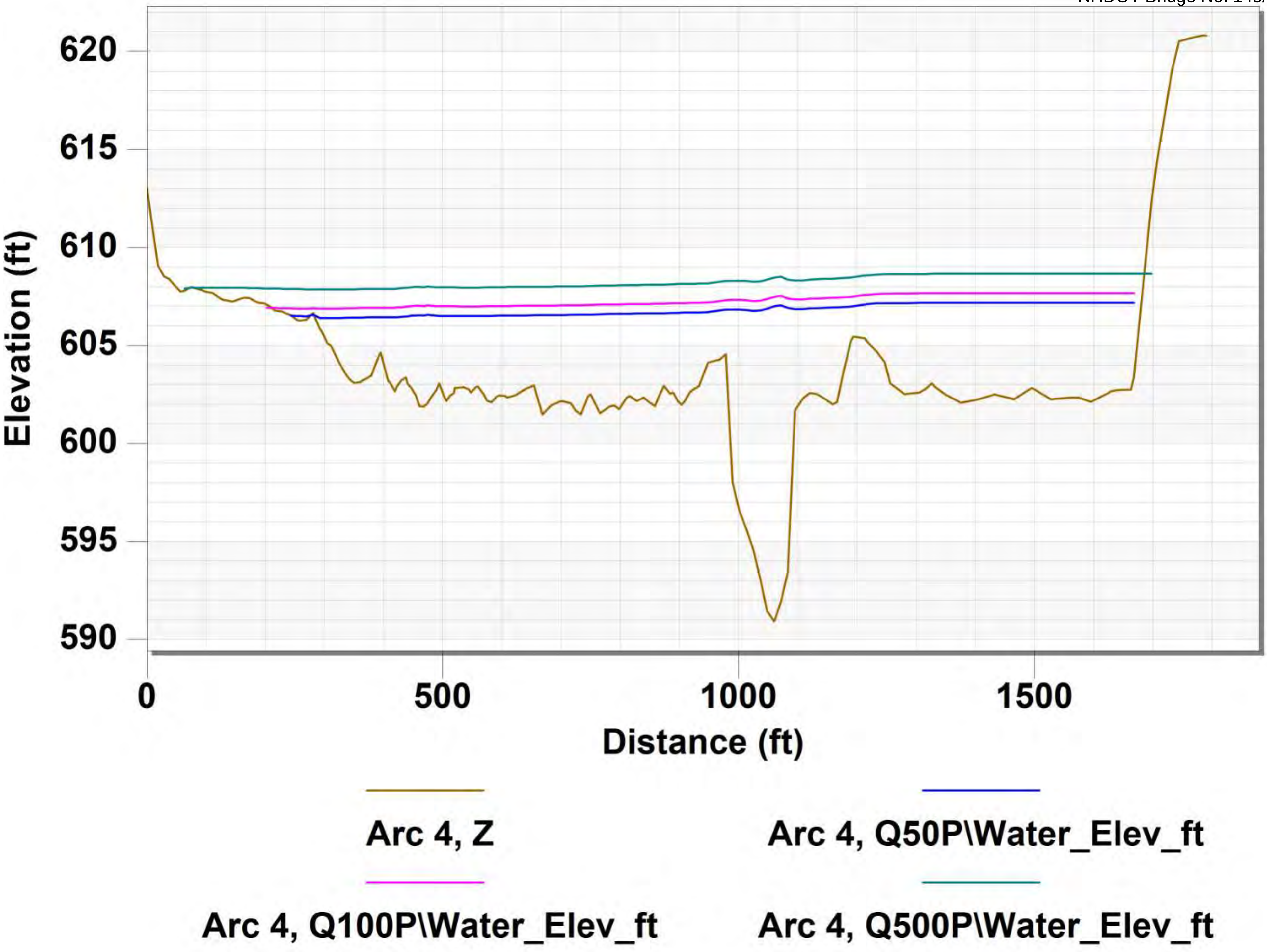
Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077



XS 4 - Proposed Conditions

Hoyle, Tanner & Associates, Inc.

Hoyle, Tanner Project No. 928100
Town of Andover
Route 4 over Blackwater River
NHDOT Bridge No. 143/077



APPENDIX J

Scour Analyses
& Countermeasure Design

NOTES AND ASSUMPTIONS

References:

1. FHWA HEC 18, 5th Edition, Publication No. FHWA-HIF-12-003
2. NHDOT Bridge Design Manual, 2nd Edition, January 2015
3. NHDOT Standard Specifications for Road and Bridge Construction, 2016
4. Report of Gradation by NHDOT dated 6/23/2020 of Blackwater River streambed samples

- Scour is to be analyzed per FHWA Hydraulic Engineering Circular (HEC) 18.
- Proposed hydraulic data including flood velocity and elevations are taken from Proposed 2D Hydraulic Model. Data from SMS was extracted using summary tables for 1D Hydraulic Cross-Sections at the locations of interest. Copies of Tables and Cross-sections used are included.
- Per the NHDOT Bridge Design Manual Chapter 2 Section 2.7.7.A, the structure shall be designed to resist scour from a 100-year storm and be checked against a 500-year storm.
- Matrices will be used for the calculations to evaluate the scour for the 100-year and 500-year storm events. The top values correspond to the 100-year flow and the bottom value correspond to the 500-year flow.

SMS TABLES

- Extract data from proposed hydraulic model for the 100-year and 500-year storm events for the apprach cross-section and bridge cross-section.

Q100													
					Vel_Mag_ft_p_s			Water_Depth_ft			Water_Elev_ft		
Name	Reach	Station	Flow	Width	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max
BR Main	River_CL	4307.01	3561.69	97.44	0.28	2.78	3.7	4.55	12.45	16.12	607.73	607.81	607.86
US Main	River_CL	3993.23	3250.78	88.64	1.18	2.86	3.32	3	12.23	15.27	607.98	608.01	608.03
US LOB	Bank_Left	633.092	358.61	117.8	0.12	1.02	2.19	0.15	3.1	4.87	607.89	607.92	607.99
US ROB	Bank_Right	341.568	4686.27	1200.55	0.37	1	1.45	0.4	4.22	7.02	608	608.04	608.1

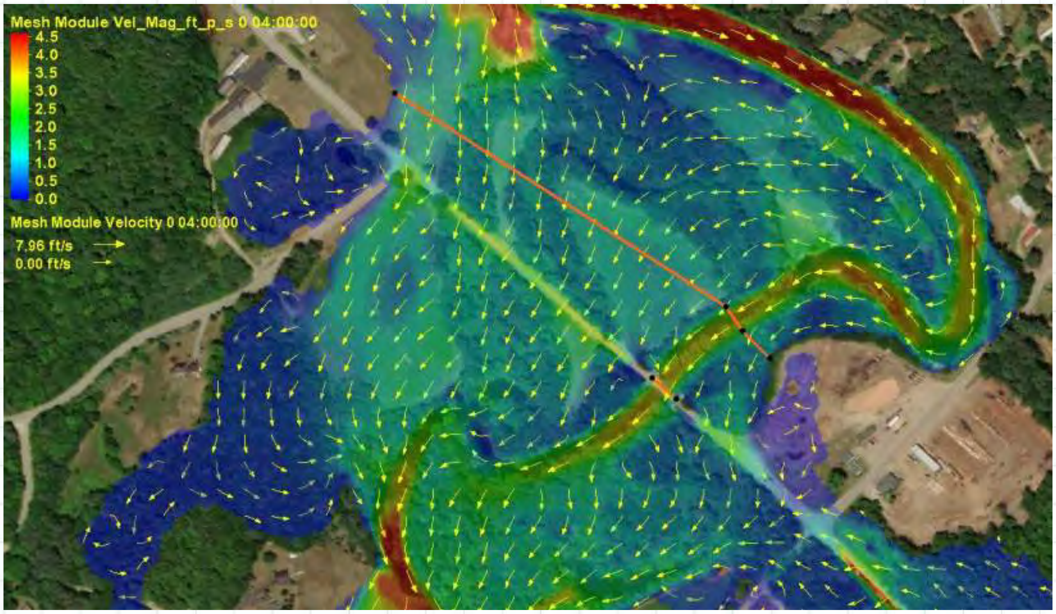
Q500													
					Vel_Mag_ft_p_s			Water_Depth_ft			Water_Elev_ft		
Name	Reach	Station	Flow	Width	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max
BR Main	River_CL	4307.01	3716.57	97.44	0.46	2.76	3.57	5.32	13.15	16.81	608.44	608.5	608.56
US Main	River_CL	3993.23	3284.7	88.64	1.22	2.71	3.15	3.92	13.16	16.19	608.9	608.93	608.96
US LOB	Bank_Left	633.092	564.19	117.8	0.3	1.22	2.29	1.07	4.03	5.8	608.82	608.85	608.91
US ROB	Bank_Right	341.568	7128.85	1200.55	0.91	1.27	1.92	1.31	5.15	7.95	608.92	608.97	609.02

			Unit_Discharge_q_ft2_p_s	
			Q100P	Q500P
Name	Reach	Station	Ave	Ave
BR Main	River_CL	4307.01	37.26	38.83
US Main	River_CL	3993.23	36.74	37.12
US LOB	Bank_Left	633.092	3.23	5
US ROB	Bank_Right	341.568	4.13	6.32

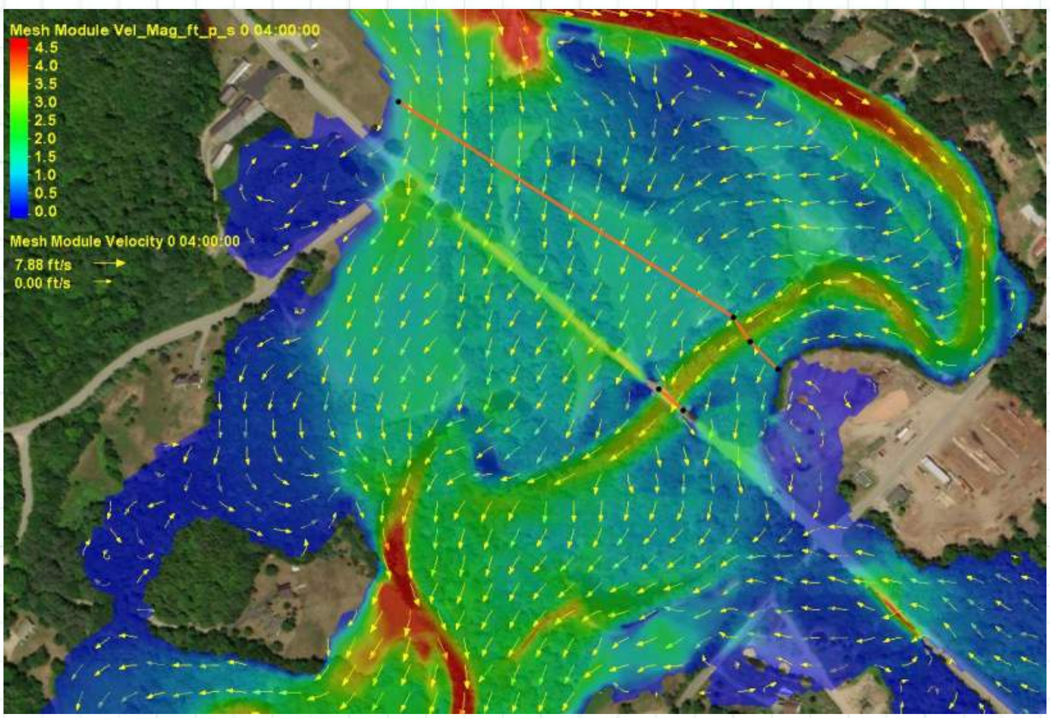
SMS VECTOR & VELOCITY PLOT

- Note: approach cross-section & bridge cross-section are highlighted orange

100-year Storm:



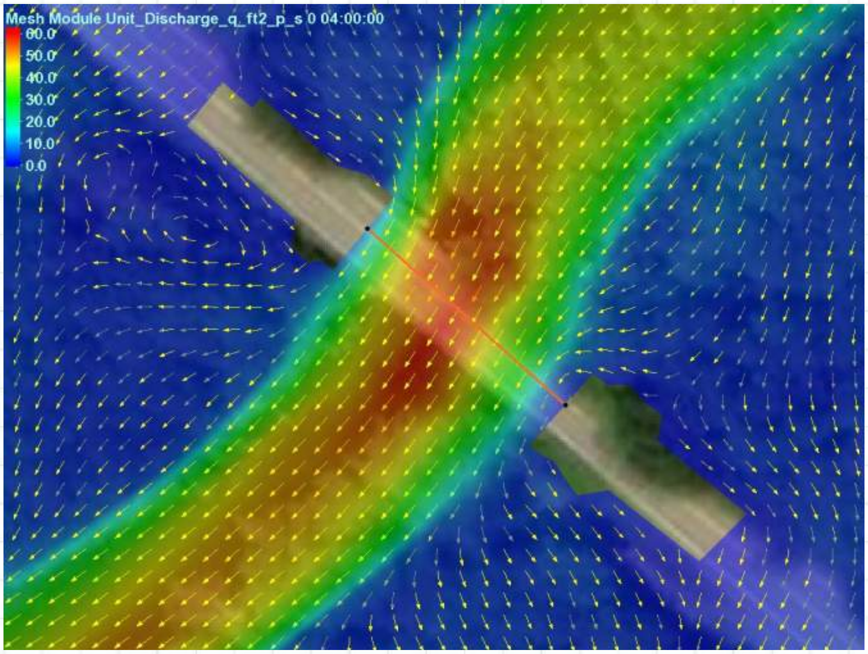
500-year Storm:



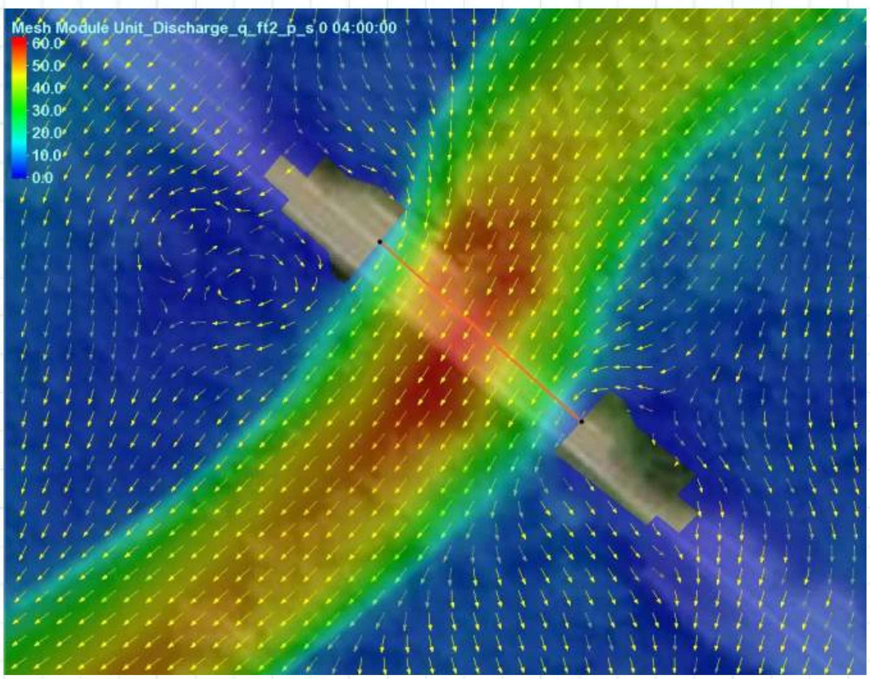
BRIDGE UNIT DISCHARGE PLOT

- Unit discharge = velocity * depth

100-year Storm:



500-year Storm:



HYDRAULIC DATA

Bridge Contraction Scour Variables

Max Depth in Contracted Section before Scour: $y_{BR.Main.Max} := \begin{bmatrix} 16.12 \\ 16.81 \end{bmatrix} ft$ SMS Tables

Average Depth in Contracted Section before Scour: $y_{BR.Main} := \begin{bmatrix} 12.45 \\ 13.15 \end{bmatrix} ft$ SMS Tables

Average Depth in Upstream Main Channel: $y_{US.Main} := \begin{bmatrix} 12.23 \\ 13.16 \end{bmatrix} ft$ SMS Tables

Top Width of Upstream Main Channel: $TW_{US.Main} := 88.64\ ft$ SMS Tables

Top Width of Contracted Section Main Channel: (Note: slightly larger than clear span due to how arc is drawn in SMS) $TW_{BR.Main} := 97.44\ ft$ SMS Tables

Flow in Upstream Main Channel Transporting Sediment: $Q_{US.Main} := \begin{bmatrix} 3250.78 \\ 3284.7 \end{bmatrix} \frac{ft^3}{s}$ SMS Tables

Flow in Contracted Channel: $Q_{BR.Main} := \begin{bmatrix} 3561.69 \\ 3716.57 \end{bmatrix} \frac{ft^3}{s}$ SMS Tables

Average Velocity in Upstream (Main) Channel Transporting Sediment: $V_{US.Main} := \begin{bmatrix} 2.86 \\ 2.71 \end{bmatrix} \frac{ft}{s}$ SMS Tables

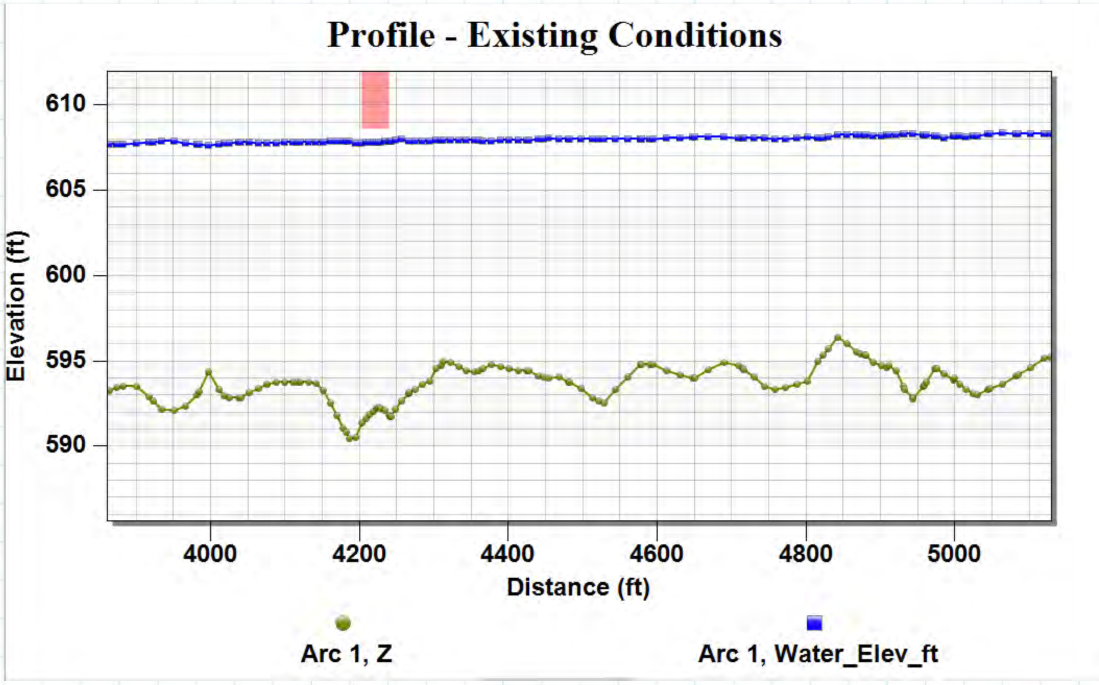
Mathcad Matrix Definition: $i := 1..2$

Average unit discharge within Approach Section (Live Bed Scour): $q_{1.live_i} := V_{US.Main_i} \cdot y_{US.Main_i} = \begin{bmatrix} 34.978 \\ 35.664 \end{bmatrix} \frac{ft^2}{s}$

Average unit discharge within Contracted Section (Live Bed Scour): $q_{2.live_i} := \frac{Q_{BR.Main_i}}{TW_{BR.Main}} = \begin{bmatrix} 36.553 \\ 38.142 \end{bmatrix} \frac{ft^2}{s}$

HYDRAULIC DATA (CONT.)

Upstream Energy Grade Line Slope: $S_{1.US} := \frac{608.10\ ft - 607.83\ ft}{4801.58\ ft - 4303.20\ ft} = 0.0005\ \frac{ft}{ft}$



Gravitational Acceleration: $g = 32.174\ \frac{ft}{s^2}$

Shear Velocity in Upstream Channel: $V'_{Main} := \sqrt{g \cdot y_{US.Main} \cdot S_{1.US}} = \begin{bmatrix} 0.462 \\ 0.479 \end{bmatrix} \frac{ft}{s}$

CRITICAL VELOCITY

Median Diameter of Bed Material: $D_{50} := 0.24\ mm$ Per NHDOT Report of Hand Auger Soil Sample (~avg)

(Note: This median size is found in the east bank. Assume that this size material is found at west bank as well.)

Diameter of the Smallest Nontransportable Particle: $D_{m.Main} := 1.25 \cdot D_{50} = 0.300\ mm$

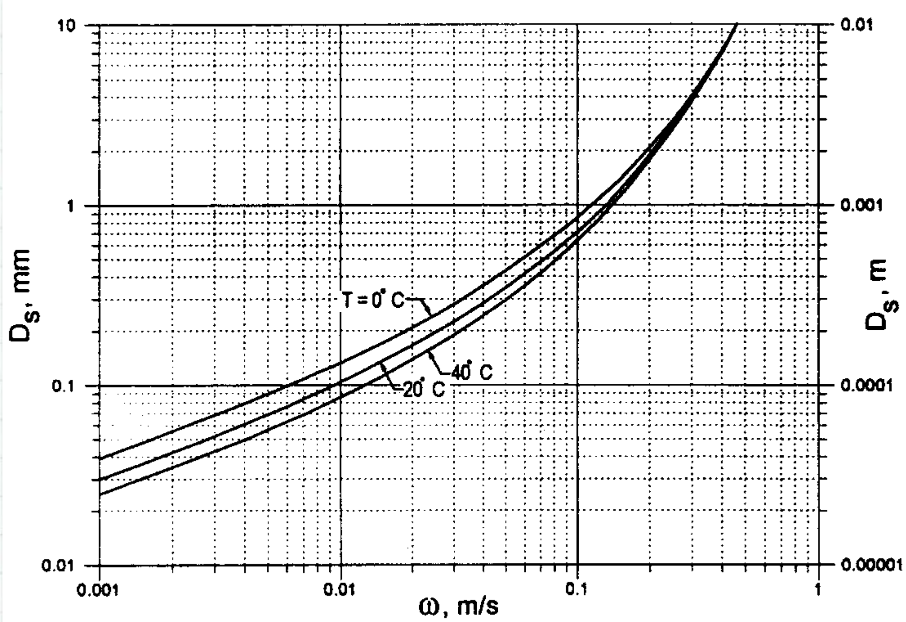
Note: If D50< 0.2mm, use 0.2mm for clear-water scour

Specific Gravity of Bed Material: $S_s := 2.65$

Water Unit Weight: $\gamma_w := 62.4\ \frac{lb}{ft^3}$

Particle Unit Weight: $\gamma_s := S_s \cdot \gamma_w = 165.360\ \frac{lb}{ft^3}$

D50 Fall Velocity @ 20C: $\omega_{Main} := 0.035\ \frac{m}{s}$ Ref. 1, Fig. 6.8 (as seen below)



CRITICAL VELOCITY (CONT.)

English Unit Constant for Critical Velocity Eq.: $K_u := 11.17$

Critical Velocity that Bed Material of Size D50 and smaller will be transported:

$$V_{c.Main} := K_u \cdot y_{US.Main}^{\frac{1}{6}} \cdot \left(D_{50}\right)^{\frac{1}{3}} \cdot \frac{ft^{\left(\frac{1}{2}\right)}}{sec}$$

$$V_{c.Main} = \begin{bmatrix} 1.566 \\ 1.585 \end{bmatrix} \frac{ft}{s}$$ Ref. 1, Eq. 6.1

Note: Most Likely, Live Bed Scour will occur V>Vc

CONTRACTION SCOUR

Main Channel

English Unit Constant for Clear-Water Scour:

$K_{u\_clear} := 0.0077$

Check if Live-Bed or Clear-Water Scour is Present:

$check\_cont\_scour_i :=$ if $V_{c.Main_i} > V_{US.Main_i}$
  "Clear−Water Scour "
else if $V_{US.Main_i} > V_{c.Main_i}$
  "Live−Bed Scour"

$check\_cont\_scour = \begin{bmatrix} \text{"Live−Bed Scour"} \\ \text{"Live−Bed Scour"} \end{bmatrix}$

Exponent determined for Live-Bed Contraction Scour:

V*/T	k1	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	Mostly suspended bed material discharge

$k_{1_i} :=$ if $\frac{V'_{Main_i}}{\omega_{Main}} < 0.50$
  0.59
else if $0.50 \le \frac{V'_{Main_i}}{\omega_{Main}} \le 2.0$
  0.64
else if $\frac{V'_{Main_i}}{\omega_{Main}} > 2.0$
  0.69

$= \begin{bmatrix} 0.690 \\ 0.690 \end{bmatrix}$

Ref. 1, Art. 6.3

CONTRACTION SCOUR (CONT.)

Main Channel (Cont.)

Average Equilibrium Depth in Contracted Section:

$$y_{2\_main_i} := \text{if } V_{c.Main_i} > V_{US.Main_i}$$

$$\left\| \left(\frac{K_{u\_clear} \cdot Q_{BR.Main_i}^{\ 2}}{\left(\max\left(D_{m.Main}, 0.2\ mm\right)\right)^{\frac{2}{3}} \cdot TW_{BR.Main}^{\ 2}} \cdot \frac{sec^2}{ft} \right)^{\frac{3}{7}} \right.$$

$$\text{else if } V_{US.Main_i} > V_{c.Main_i}$$

$$\left\| y_{US.Main_i} \cdot \left(\left(\frac{Q_{BR.Main_i}}{Q_{US.Main_i}} \right)^{\frac{6}{7}} \cdot \left(\frac{TW_{US.Main}}{TW_{BR.Main}} \right)^{k_{1_i}} \right) \right.$$

Ref. 1, Eq. 6.2 & 6.4

$$y_{2\_main} = \begin{bmatrix} 12.390 \\ 13.705 \end{bmatrix} ft$$

Contraction Scour Depth:

$$y_{s.main} := y_{2\_main} - y_{BR.Main}$$

Ref. 1, Eq. 6.3 & 6.5

$$y_{s.main} = \begin{bmatrix} -0.060 \\ 0.555 \end{bmatrix} ft$$

(negative value indicates aggredation)

TOTAL SCOUR

NCHRP 24-20 Abutment Scour Approach

Abutment Live-Bed Scour:

Unit Discharge Ratio: $\frac{q_{2.live}}{q_{1.live}} = \begin{bmatrix} 1.045 \\ 1.069 \end{bmatrix}$

Flow Depth Including Live-Bed Scour: $y_{c_i} := y_{US.Main_i} \cdot \left(\frac{q_{2.live_i}}{q_{1.live_i}} \right)^{\frac{6}{7}} = \begin{bmatrix} 12.700 \\ 13.940 \end{bmatrix} ft$ Ref. 1, Eq. 8.5

Scour Amplification Factor for Live-Bed Conditions: $\alpha_{A.live} := \begin{bmatrix} 1.47 \\ 1.55 \end{bmatrix}$ Ref. 1, Fig. 8.10 (As seen Below)

Maximum Flow Depth Resulting from Abutment Scour: $y_{max.live_i} := \alpha_{A.live_i} \cdot y_{c_i}$ Ref. 1, Eq. 8.3

$y_{max.live} = \begin{bmatrix} 18.670 \\ 21.607 \end{bmatrix} ft$

Abutment Scour Depth: $y_{s.NCHRP.live} := y_{max.live} - y_{BR.Main.Max}$ Ref. 1, Eq. 8.4

$y_{s.NCHRP.live} = \begin{bmatrix} 2.550 \\ 4.797 \end{bmatrix} ft$

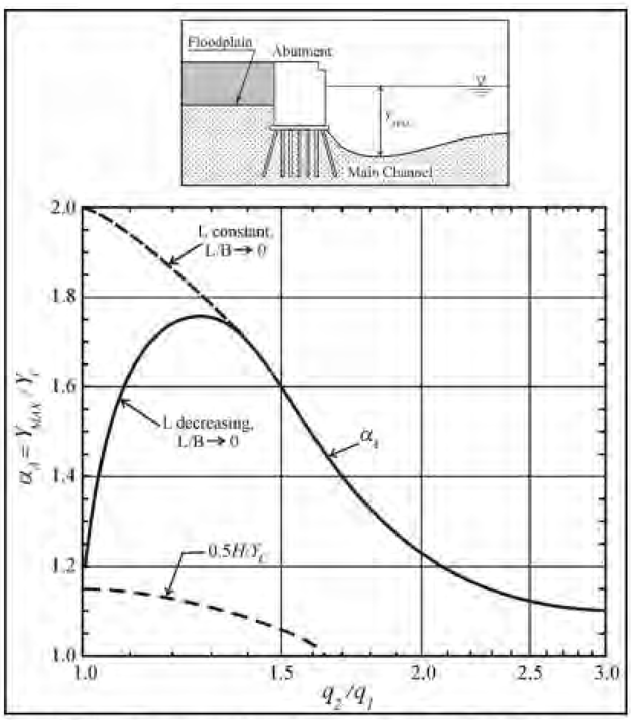


Figure 8.10. Scour amplification factor for wingwall abutments and live-bed conditions (NCHRP 2010b).

SUMMARY

Main Channel

Check if Live-Bed or Clear-Water Scour is Present:

$$check\_cont\_scour = \begin{bmatrix} \text{“Live–Bed Scour”} \\ \text{“Live–Bed Scour”} \end{bmatrix}$$

Contraction Scour:

$$y_{s.main} = \begin{bmatrix} -0.060 \\ 0.555 \end{bmatrix} ft$$

Live Bed Total Scour

Local Scour:

$$y_{s.NCHRP.live} = \begin{bmatrix} 2.550 \\ 4.797 \end{bmatrix} ft$$

Scour Depth Elevation

Channel Elevation:

$$El_{Thawleg} := 590.4\ ft$$

Total Scour Depth:

$$Y_{SC_i} := \max\left(y_{s.main_i}, y_{s.NCHRP.live_i}\right)$$

$$Y_{SC} = \begin{bmatrix} 2.550 \\ 4.797 \end{bmatrix} ft$$

Scour Elevation:

$$Scour_{el} := El_{Thawleg} - Y_{SC}$$

$$Scour_{el} = \begin{bmatrix} 587.850 \\ 585.603 \end{bmatrix} ft$$

HAND AUGER REPORT

STATE OF NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION
MATERIALS & RESEARCH BUREAU - GEOTECHNICAL SECTION

New Hampshire DOT

PROJECT ANDOVER 40392
DESCRIPTION US Route 4 over Blackwater River (Br. No. 143/077)

HOLE NO.	HA-4
SHEET NO.	1 OF 1
STATION	103+25
OFFSET	RT 19
BASELINE	US Route 4 CL
ELEVATION (ft)	601.0
DATE	6/23/2020
CLASSIFIER	Kyle Ashe

COORDINATES	GROUNDWATER		
EAST/NORTH 954996/335947	TIME		
	DEPTH (ft)	1.5	
	NOT ENCOUNTERED (if marked)		

DEPTH (ft)	STRATA CHANGE (ft)	ELEV. (ft)	STRATA SYMBOL	DESCRIPTION OF MATERIALS AND REMARKS
				Dark Brown, silty FINE SAND
	0.8	600.2		
1.0				Dark Brown, silty FINE SAND
	1.5	599.5	▼	
				Tan, FINE SAND, wet
2.0	2.0	599.0		
				Tan, FINE SAND, wet
				Refusal — Bottom of Exploration @ 2.7 ft (EL. 598.3 ft)
3.0				
4.0				(S1; 0' - 0.8') FINE SAND, trace to little silt, trace f-gravel, trace c-sand, trace m-sand; with organics and wood fragments USCS Classification: Poorly Graded Sand with Silt (SP-SM)
5.0				(S2; 0.8' - 1.5') FINE SAND, some m-sand, trace f-gravel, trace c-sand, trace silt; with organics USCS Classification: Poorly Graded Sand with Silt (SP-SM)
6.0				(S3; 1.5' - 2.0') FINE SAND, some m-sand, trace f-gravel, trace c-sand, trace silt USCS Classification: Poorly Graded Sand (SP)
7.0				(S4; 2.0' - 2.7') FINE SAND, some m-sand, trace f-gravel, trace c-sand, trace silt USCS Classification: Poorly Graded Sand (SP)
8.0				
9.0				

AUGER DIGGING TOOL Sand Bit

ENGLISH

HAND AUGER REPORT

STATE OF NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION
MATERIALS & RESEARCH BUREAU - GEOTECHNICAL SECTION

PROJECT **ANDOVER 40392**
DESCRIPTION US Route 4 over Blackwater River (Br. No. 143/077)

HOLE NO. **HA-5**
SHEET NO. 1 OF 1
STATION 103+18
OFFSET RT 02
BASELINE US Route 4 CL
ELEVATION (ft) 599.0
DATE 6/24/2020
CLASSIFIER Doug Rogers

COORDINATES	GROUNDWATER		
EAST/NORTH 955001/335965	TIME	12.20 pm	
	DEPTH (ft)	0.2	
	NOT ENCOUNTERED (if marked)		_______

DEPTH (ft)	STRATA CHANGE (ft)	ELEV. (ft)	STRATA SYMBOL	DESCRIPTION OF MATERIALS AND REMARKS
				Very dark greyish brown, fibrous to silty MUCK -ORGANIC (Riverbed) DEPOSIT-
	0.6	598.4		
1.0				Dark greyish brown and dark grey, FINE SAND, trace silt, slight trace organic
	1.5	597.5		
2.0				
3.0				Dark brown-very dark greyish brown, SILT, little organic, trace fine gravel, trace coarse-fine sand -ALLUVIUM-
4.0				
5.0	5.1	593.9		Advanced into "gravelly" material; soil being washed from auger flights (GLACIAL FLUVIAL)
				Refusal Bottom of Exploration @ 5.3 ft (EL. 593.7 ft)
6.0				(S1; 0' - 0.6') FINE SAND, trace m-sand, trace silt; with organics, leaves, and wood fragments USCS Classification: Poorly Graded Sand with Silt (SP-SM)
7.0				(S2; 0.6' - 1.5') FINE SAND, trace c-sand, trace m-sand, trace silt; with organics and wood fragments USCS Classification: Poorly Graded Sand with Silt (SP-SM)
8.0				(S3; 1.5' - 5.1') FINE SAND, little m-sand, trace-little silt, trace f-gravel, trace c-sand; with organics and wood fragments USCS Classification: Poorly Graded Sand with Silt (SP-SM)
9.0				

AUGER DIGGING TOOL Screw Bit **ENGLISH**

HAND AUGER REPORT

STATE OF NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION
MATERIALS & RESEARCH BUREAU - GEOTECHNICAL SECTION

PROJECT: **ANDOVER 40392**
DESCRIPTION: US Route 4 over Blackwater River (Br. No. 143/077)

HOLE NO.	**HA-6**
SHEET NO.	1 OF 1
STATION	103+18
OFFSET	LT 21
BASELINE	US Route 4 CL
ELEVATION (ft)	601.0
DATE	6/23/2020
CLASSIFIER	Kyle Ashe

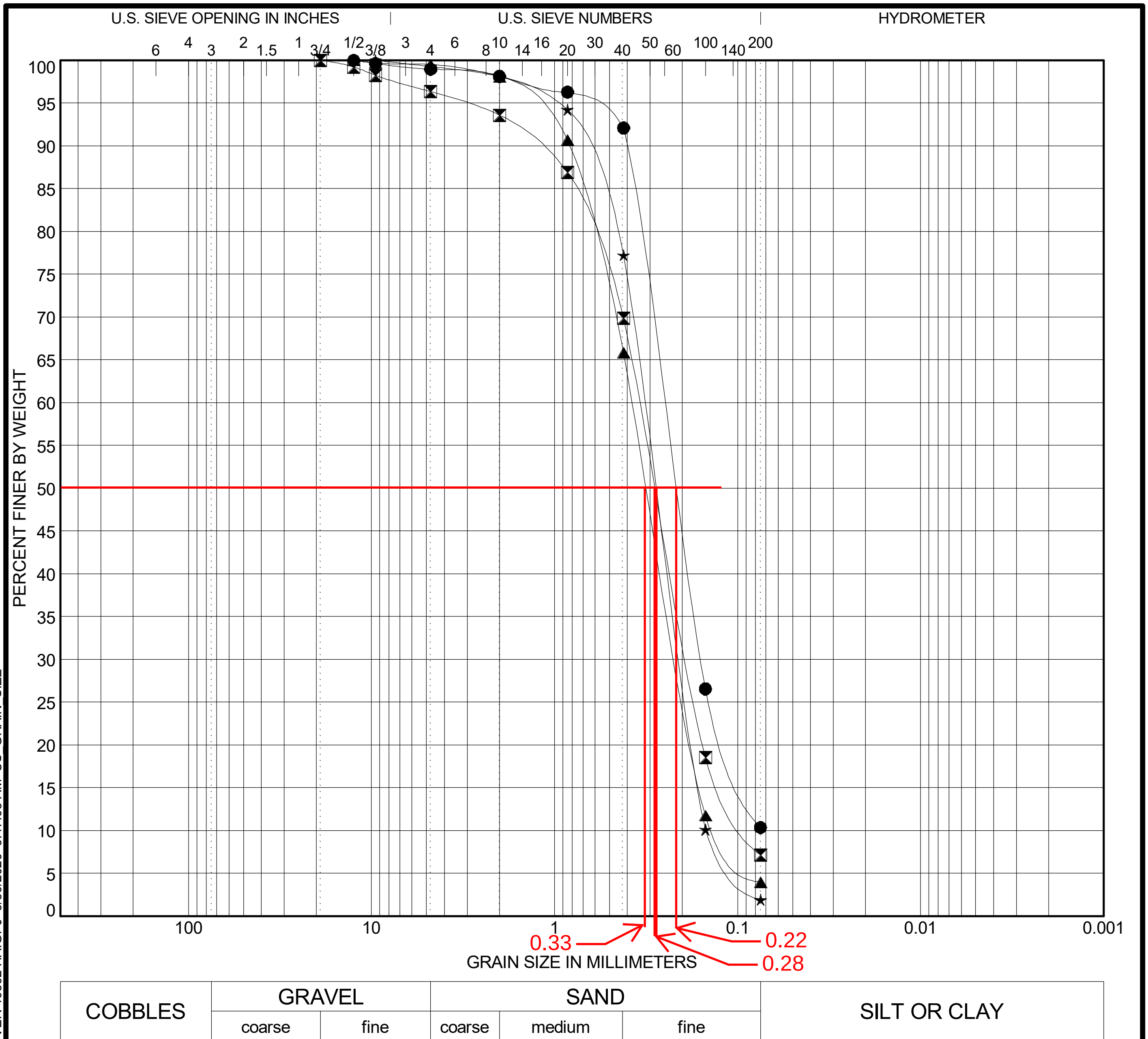
COORDINATES: EAST/NORTH 955016/335982

GROUNDWATER		
TIME		
DEPTH (ft)	1.6	
NOT ENCOUNTERED (if marked)		

DEPTH (ft)	STRATA CHANGE (ft)	ELEV. (ft)	STRATA SYMBOL	DESCRIPTION OF MATERIALS AND REMARKS
				Dark Brown, silty FINE SAND
1.0	1.0	600.0		Dark Brown with orange streaking, silty FINE SAND
	1.6	599.4	▼	Tan, FINE SAND, wet
2.0				Refusal — Bottom of Exploration @ 2.0 ft (EL. 599.0 ft)
3.0				(S1; 0' - 1.0') FINE SAND, some m-sand, little silt, trace c-f gravel, trace c-sand; with organics and wood fragments USCS Classification: Silty Sand (SM)
4.0				(S2; 1.0' - 1.6') FINE SAND, some m-sand, little to some silt, trace f-gravel, trace c-sand; with organics and wood fragments USCS Classification: Silty Sand (SM)
5.0				(S3; 1.6' - 2.0') FINE SAND, some m-sand, little f-gravel, little silt, trace c-sand; with organics USCS Classification: Poorly Graded Sand with Silt and Gravel (SP-SM)
6.0				
7.0				
8.0				
9.0				

AUGER DIGGING TOOL: Sand Bit

ENGLISH



	Specimen Identification		USCS Classification	LL	PL	PI	Cc	Cu
●	**HA-4, S1**	**0.4**	**Poorly Graded SAND with Silt (SP-SM)**				**1.34**	**3.43**
⧗	**HA-4, S2**	**1.2**	**Poorly Graded SAND with Silt (SP-SM)**				**1.16**	**3.86**
▲	**HA-4, S3**	**1.8**	**Poorly Graded SAND (SP)**				**0.94**	**2.93**
★	**HA-4, S4**	**2.4**	**Poorly Graded SAND (SP)**				**0.87**	**2.17**

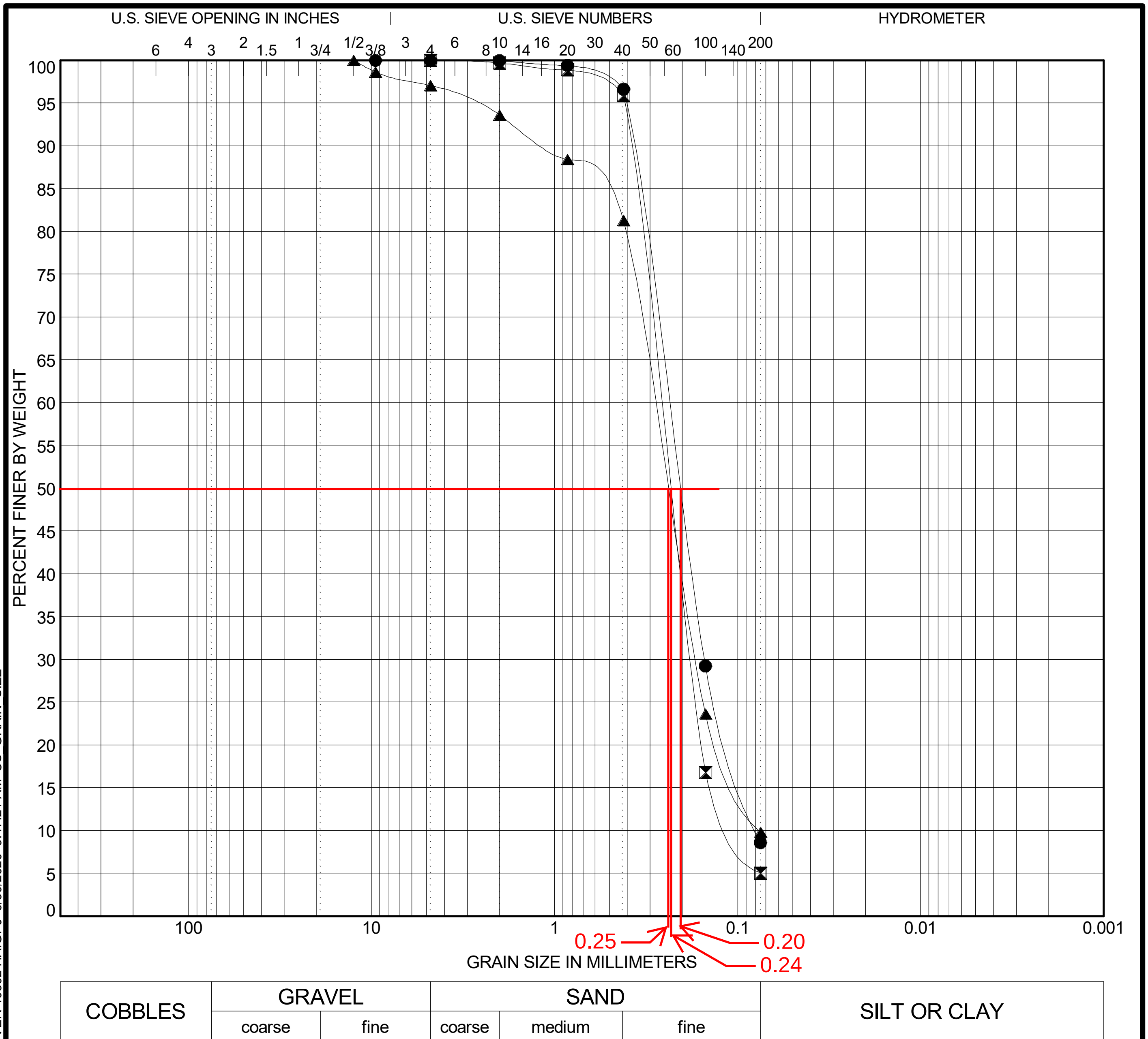
	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**HA-4, S1**	**0.4**	**12.5**	**0.254**	**0.158**		**1.0**	**88.6**	**10.4**	
⧗	**HA-4, S2**	**1.2**	**19**	**0.345**	**0.189**	**0.089**	**3.6**	**89.2**	**7.1**	
▲	**HA-4, S3**	**1.8**	**12.5**	**0.376**	**0.212**	**0.128**	**0.5**	**95.5**	**4.0**	
★	**HA-4, S4**	**2.4**	**9.5**	**0.322**	**0.203**	**0.148**	**0.7**	**97.3**	**1.9**	

State of New Hampshire
Department of Transportation
Bureau of Materials & Research

Project: Andover
Location: US Route 4 over Blackwater River (Br. No. 143/077)
Number: 40392

GRAIN SIZE DISTRIBUTION

AASHTO T27/T11 - Sieve Analysis of Fine and Coarse Aggregates/Materials Finer Than No. 200 Sieve in Mineral Aggregates by Washing



	Specimen Identification		USCS Classification	LL	PL	PI	Cc	Cu
●	**HA-5, S1**	**0.3**	**Poorly Graded SAND with Silt (SP-SM)**				**1.22**	**3.05**
⧗	**HA-5, S2**	**1.1**	**Poorly Graded SAND with Silt (SP-SM)**				**1.20**	**2.62**
▲	**HA-5, S3**	**3.3**	**Poorly Graded SAND with Silt (SP-SM)**				**1.30**	**3.79**

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**HA-5, S1**	**0.3**	**9.5**	**0.24**	**0.152**	**0.079**	**0.0**	**91.4**	**8.6**	
⧗	**HA-5, S2**	**1.1**	**4.75**	**0.263**	**0.178**	**0.1**	**0.0**	**95.0**	**5.0**	
▲	**HA-5, S3**	**3.3**	**12.5**	**0.287**	**0.168**	**0.076**	**2.9**	**87.2**	**9.8**	

State of New Hampshire
Department of Transportation
Bureau of Materials & Research

Project: Andover
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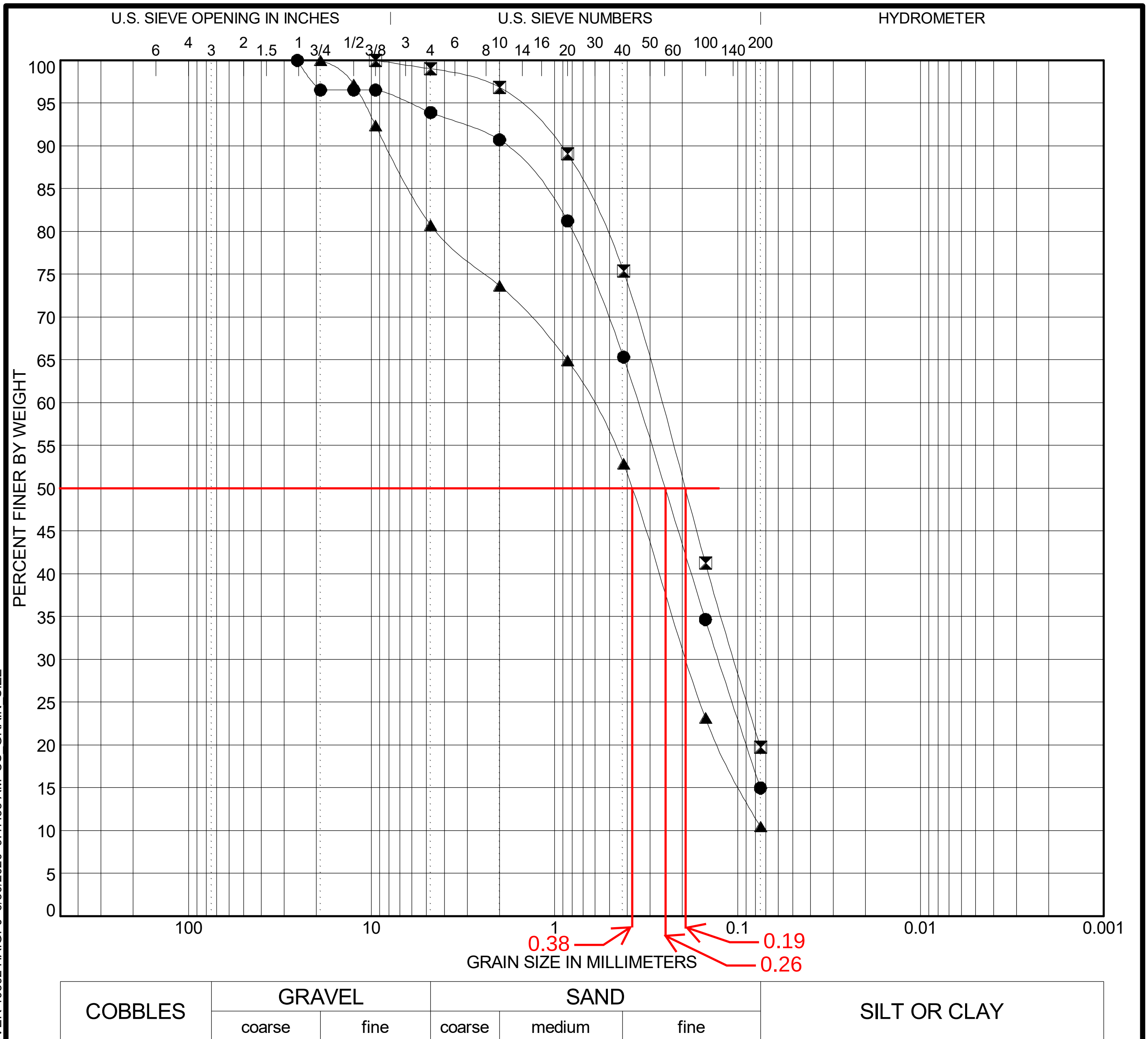
GRAIN SIZE DISTRIBUTION

AASHTO T27/T11 - Sieve Analysis of Fine and Coarse Aggregates/Materials Finer Than No. 200 Sieve in Mineral Aggregates by Washing



US GRAIN SIZE S:\MATERIALS-RESEARCH\GINTW\PROJECTS\ANDOVER\40392\ANDOVER 40392 HA.GPJ 6/30/2020 9:47:35 AM US GRAIN SIZE

	Specimen Identification		USCS Classification	LL	PL	PI	Cc	Cu
●	**HA-6, S1**	**0.5**	**Silty SAND (SM)**					
⧗	**HA-6, S2**	**1.3**	**Silty SAND (SM)**					
▲	**HA-6, S3**	**1.8**	**Poorly Graded SAND with Silt and Gravel (SP-SM)**				**0.78**	**8.71**

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**HA-6, S1**	**0.5**	**25.4**	**0.351**	**0.127**		**6.1**	**78.9**	**15.0**	
⧗	**HA-6, S2**	**1.3**	**9.5**	**0.264**	**0.104**		**1.0**	**79.3**	**19.7**	
▲	**HA-6, S3**	**1.8**	**19**	**0.636**	**0.19**		**19.2**	**70.3**	**10.5**	

State of New Hampshire
Department of Transportation
Bureau of Materials & Research

Project: Andover
Location: US Route 4 over Blackwater River (Br. No. 143/077)
Number: 40392

GRAIN SIZE DISTRIBUTION

AASHTO T27/T11 - Sieve Analysis of Fine and Coarse Aggregates/Materials Finer Than No. 200 Sieve in Mineral Aggregates by Washing

EROSION CONTROL FOR EMBANKMENTS

NOTES AND ASSUMPTIONS

- The erosion control will be based on the NHDOT Manual on Drainage Design for Highways, 2015 Draft.
- The results of the proposed hydraulic model analyses will be used to determine the required erosion control.

EROSION CONTROL DETERMINATION

- The erosion control is based on permissible shear stress as provided in Section 4.1.3, Design Criteria for Open Channels and Ditches.

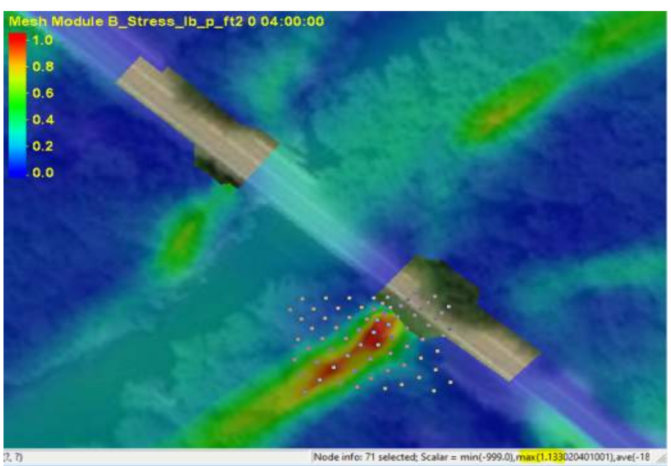
Table 4.1.3a Permissible Shear Stress (λ_p) by Land Cover and Description

Protective Cover	Description	Permissible Shear Stress (λ_p)
Class B, native grass	dense growth uncut > 12”	2.10 lb/ft^2
Class C, native grass	good stand, mowed, 6”- 12”	1.00
Class D, native grass	good stand, 3” - 6”	0.60
Class E, “Bermuda” grass	good stand cut to 1.5”	0.35
Gravel	D_{50} = 2”	0.80
Stone	D_{50} = 6”	2.40
Stone	D_{50} = 12”	4.80

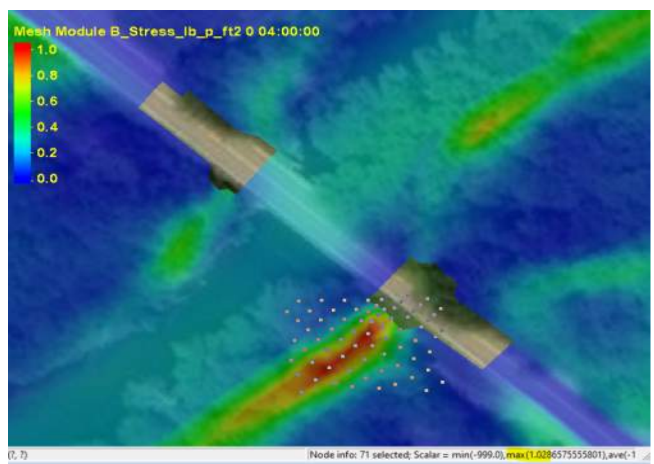
*See HEC 15 for additional permissible shear stress values in cohesive & non-cohesive soils.

- The maximum shear stress of the overbanks near the bridge is 1.1 lb/ft2 for the 50-year storm and 1.0 lb/ft2 for the 100-year storm.

50-year Storm Shear Stress:



100-year Storm Shear Stress:



- Based on Table 4.1.3a, stone with a median diameter (D50) of 6" would be adequate.

- Therefore, provide Class I Riprap (NHDOT Item 583.1) on the channel banks.

Table 583-1 (From NHDOT Standard Specifications 2016)

Riprap Classes and Sizes			Percentage Distribution of Particle Sizes by Volume (cubic feet)			
Class	Nominal Size (in)	Maximum Size (in)	< 15%	15% – 85%	> 85%	Maximum
I	6	12	0.05	0.14	0.31	1.0
III	12	24	0.4	1.0	2.5	6.5
V	18	36	1.3	3.5	8.5	22
VII	24	48	3	8	19	53
IX	36	72	10	27	65	179

Note: Nominal Size and Maximum Size are based on the Width dimension of the stone. The riprap classes conform to the standard classes described in the FHWA HEC-23 publication.

NOTES AND ASSUMPTIONS

References

1. FHWA HEC 18, 5th Edition, Publication No. FHWA-HIF-12-003
2. FHWA HEC 23 Vol. 1, 3rd Edition, Publication No. FHWA-NHI-09-111
3. FHWA HEC 23 Vol. 2, 3rd Edition, Publication No. FHWA-NHI-09-112
4. FHWA Tech Brief, Publication No. FHWA-HIF-19-007
5. NHDOT Bridge Design Manual, 2nd Edition, January 2015
6. NHDOT Standard Specifications for Road and Bridge Construction, 2016

- Rock riprap revetment shall be designed to resist scour and protect the abutments per "Design Guideline 14" in the FHWA HEC 23.
- Rock riprap sizes shall meet those as detailed in Section 583 of the NHDOT Standard Specifications.
- Hydraulic data including flood velocity and elevations are taken from the 2D hydraulic model.
- The proposed bridge is on a Tier 2 highway. Per the NHDOT Bridge Design Manual Table 2.7.5-1, the design flood for scour is the 100-year event and the check flood for scour is the 500-year event. The Riprap Revetment is to be designed for the 100 Year Flood Frequency. It shall be assumed that the riprap is not there for Extreme Limit State, which the Q500 check flood is used for.

MATERIAL AND CONSTANTS

Specific Gravity of Riprap: $S_s := 2.65$ Typical value per FHWA and conservative vs using 2.69 per BDM Section 2.7.7.C

Gravitational Acceleration: $g = 32.174\ \frac{ft}{s^2}$

Vertical Wall or Spill-through Abutment? $abut := \text{"Vertical"}$

- Enter "Vertical" if Vertical Wall or "Spill" if Spill-through

NHDOT Riprap Sizes

- The following are taken from NHDOT Standard Specifications Section 583.

	Median size	Maximum size
Class I Riprap:	$D_{50\_I} := 6\ in$	$D_{100\_I} := 12\ in$
Class III Riprap:	$D_{50\_III} := 12\ in$	$D_{100\_III} := 24\ in$
Class V Riprap:	$D_{50\_V} := 18\ in$	$D_{100\_V} := 36\ in$
Class VII Riprap:	$D_{50\_VII} := 24\ in$	$D_{100\_VII} := 48\ in$
Class IX Riprap:	$D_{50\_IX} := 36\ in$	$D_{100\_IX} := 72\ in$

HYDRAULIC ANALYSIS & RIPRAP DESIGN

Compute Required Riprap Size

- Follow HEC-23.
- Use SMS output for the flow depth and velocity (see following pages).

Max Water Depth: $y_{BR.Main} := 16.7\ ft$ $\quad y_{BR.Main} \cdot 2 = 33.400\ ft$

Max Velocity: $V_{BR.Main} := 3.7\ \frac{ft}{s}$ within 2 flow depths

Froude Number: $F_{r.main} := \frac{V_{BR.Main}}{\left(g \cdot y_{BR.Main}\right)^{0.5}} = 0.160$

Velocity Multiplier:

$$k := \begin{cases} \text{if } abut = \text{“Vertical”} \wedge F_{r.main} \le 0.8 \\ \quad 1.02 \\ \text{else if } abut = \text{“Spill”} \wedge F_{r.main} \le 0.8 \\ \quad 0.89 \\ \text{else if } abut = \text{“Vertical”} \wedge F_{r.main} > 0.8 \\ \quad 0.69 \\ \text{else if } abut = \text{“Spill”} \wedge F_{r.main} > 0.8 \\ \quad 0.61 \end{cases} = 1.020$$

Determine Equation:

$$Equation := \begin{cases} \text{if } F_{r.main} \le 0.80 \\ \quad \text{“HEC 23 Eq. 14.1”} \\ \text{else} \\ \quad \text{“HEC 23 Eq. 14.2”} \end{cases} = \text{“HEC 23 Eq. 14.1”}$$

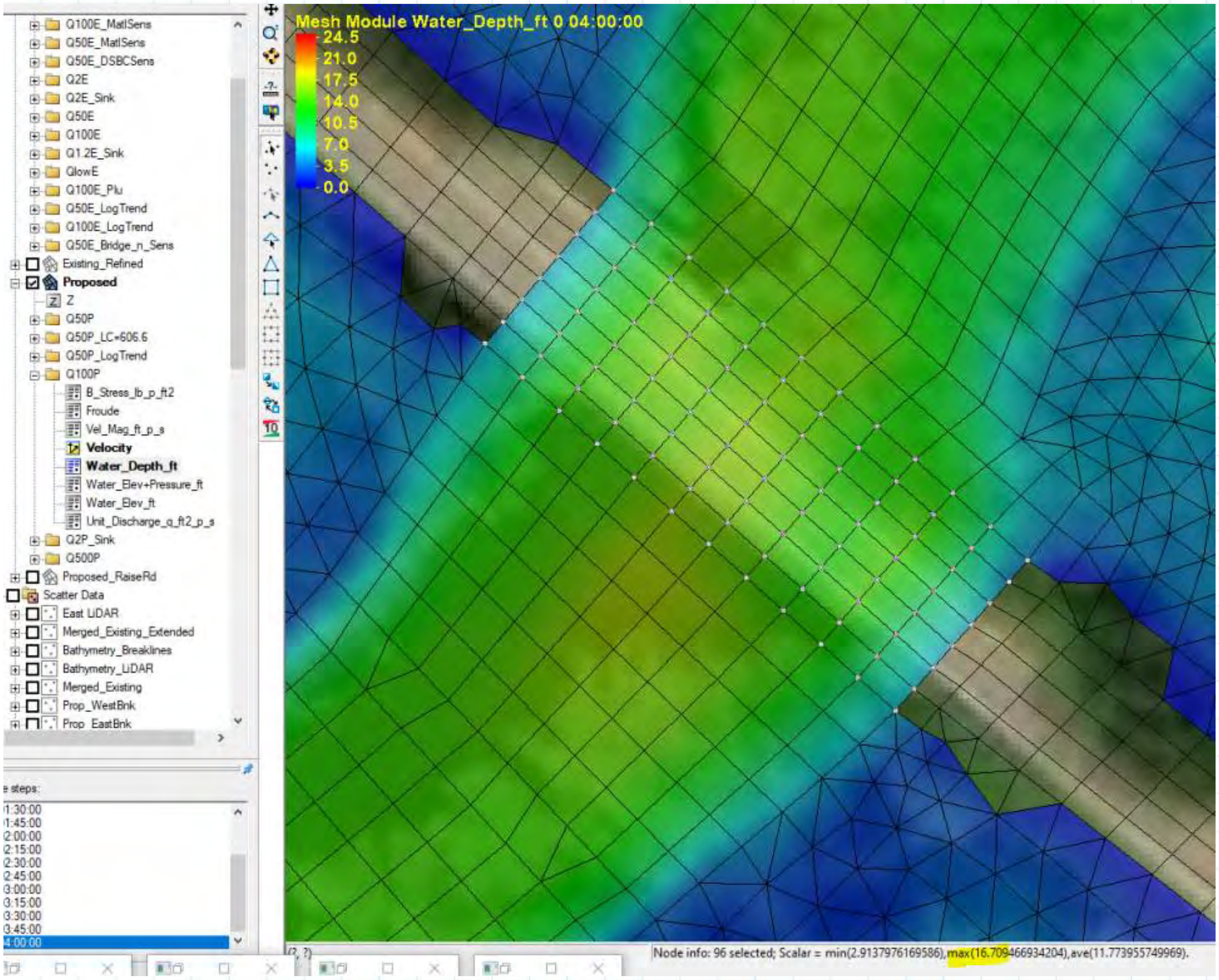
Required D_{50}:

$$D_{50} := \begin{cases} \text{if } F_{r.main} \le 0.80 \\ \quad y_{BR.Main} \cdot \left(\frac{k}{\left(S_s - 1\right)} \cdot \frac{V_{BR.Main}^{\ 2}}{g \cdot y_{BR.Main}}\right) \\ \text{else} \\ \quad \left(y_{BR.Main} \cdot \left(\frac{k}{\left(S_s - 1\right)} \cdot \left(\frac{V_{BR.Main}^{\ 2}}{g \cdot y_{BR.Main}}\right)^{0.14}\right)\right) \end{cases} = 0.263\ ft$$

HYDRAULIC ANALYSIS & RIPRAP DESIGN (CONT.)

Compute Required Riprap Size (Cont.)

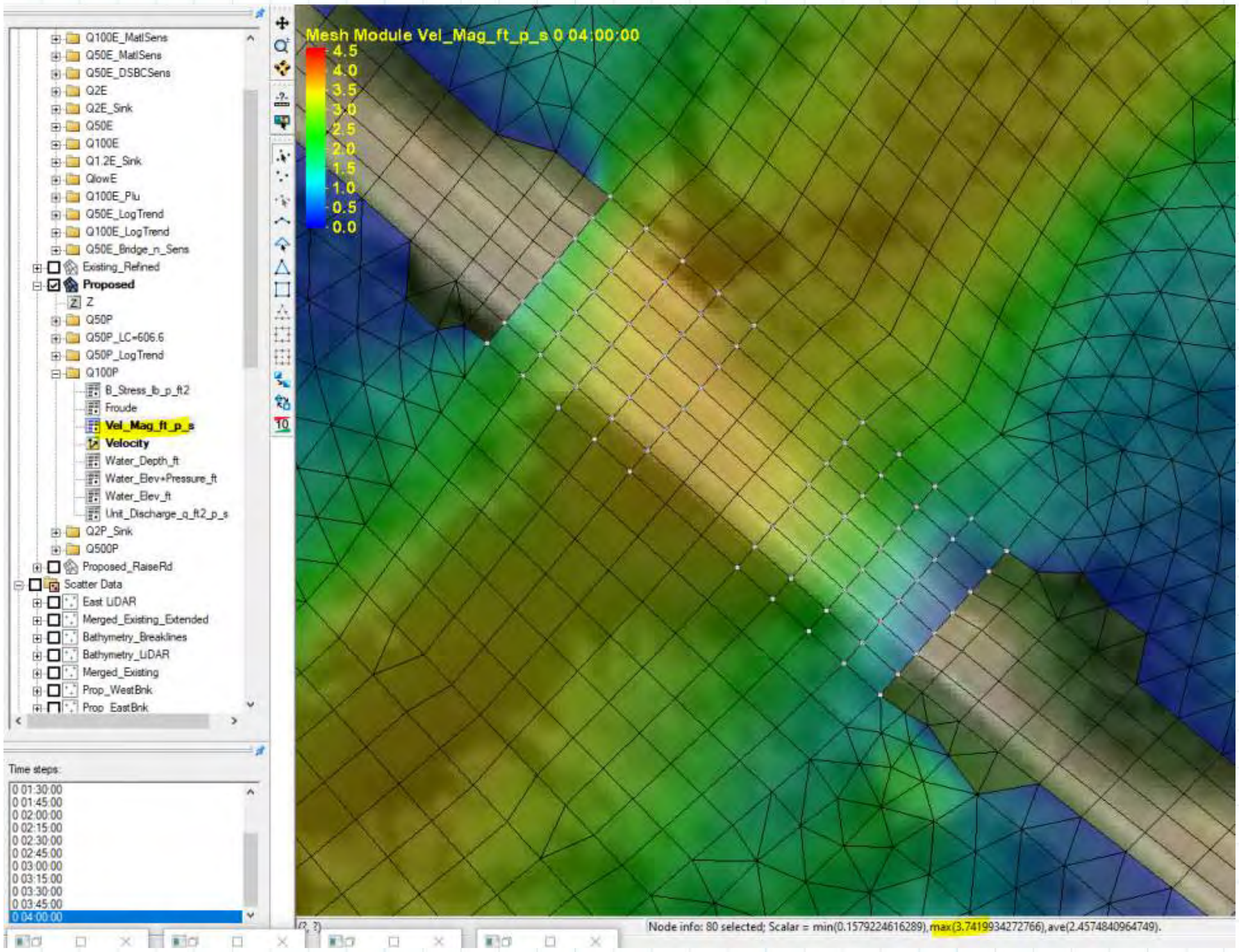
Water Depth



HYDRAULIC ANALYSIS & RIPRAP DESIGN (CONT.)

Compute Required Riprap Size (Cont.)

Velocity



HYDRAULIC ANALYSIS & RIPRAP DESIGN (CONT.)

Compute Required Riprap Size (Cont.)

Minimum HEC 23 Riprap Class to specify:

$$HEC23\_Riprap := \begin{cases} \text{"Class I Riprap, D50 = 6in"} & \text{if } D_{50} \le D_{50\_I} \\ \text{"Class III Riprap, D50 = 12in"} & \text{else if } D_{50\_I} < D_{50} \le D_{50\_III} \\ \text{"Class V Riprap, D50 = 18in"} & \text{else if } D_{50\_III} < D_{50} \le D_{50\_V} \\ \text{"Class VII Riprap, D50 = 24in"} & \text{else if } D_{50\_V} < D_{50} \le D_{50\_VII} \\ \text{"Class IX Riprap, D50 = 36in"} & \text{else} \end{cases} = \text{"Class I Riprap, D50 = 6in"}$$

Proposed Median Diameter:

$$D_{50} := \begin{cases} D_{50\_I} & \text{if } D_{50} \le D_{50\_I} \\ D_{50\_III} & \text{else if } D_{50\_I} < D_{50} \le D_{50\_III} \\ D_{50\_V} & \text{else if } D_{50\_III} < D_{50} \le D_{50\_V} \\ D_{50\_VII} & \text{else if } D_{50\_V} < D_{50} \le D_{50\_VII} \\ D_{50\_IX} & \text{else} \end{cases}$$

$$D_{50} = 6.000\ in$$

Proposed Maximum Diameter:

$$D_{100} := \begin{cases} D_{100\_I} & \text{if } D_{50} \le D_{50\_I} \\ D_{100\_III} & \text{else if } D_{50\_I} < D_{50} \le D_{50\_III} \\ D_{100\_V} & \text{else if } D_{50\_III} < D_{50} \le D_{50\_V} \\ D_{100\_VII} & \text{else if } D_{50\_V} < D_{50} \le D_{50\_VII} \\ D_{100\_IX} & \text{else} \end{cases}$$

$$D_{100} = 12.000\ in$$

Minimum Riprap Thickness: $t_{riprap} := \max\left(1.5 \cdot D_{50}, D_{100}\right) = 1.000\ ft$

- A **1' thick** layer of Class I Riprap (**D50 = 6in, D100 = 12in**) would be needed to design for the 100-year flood for riprap placed in-the-dry.

HYDRAULIC ANALYSIS & RIPRAP DESIGN

Compute Required Riprap Size (Cont.)

- Check the stone size required for the 500-year storm event.

Max Water Depth: $y_{BR.Main\_Q500} := 17.6\ ft$ $\quad y_{BR.Main\_Q500} \cdot 2 = 35.200\ ft$

Max Velocity: $V_{BR.Main\_Q500} := 3.6\ \frac{ft}{s}$ within 2 flow depths

Froude Number: $F_{r.main\_Q500} := \frac{V_{BR.Main\_Q500}}{\left(g \cdot y_{BR.Main\_Q500}\right)^{0.5}} = 0.151$

Velocity Multiplier:

$$k_{500} := \begin{cases} \text{if } abut = \text{"Vertical"} \wedge F_{r.main\_Q500} \le 0.8 \\ \quad 1.02 \\ \text{else if } abut = \text{"Spill"} \wedge F_{r.main\_Q500} \le 0.8 \\ \quad 0.89 \\ \text{else if } abut = \text{"Vertical"} \wedge F_{r.main\_Q500} > 0.8 \\ \quad 0.69 \\ \text{else if } abut = \text{"Spill"} \wedge F_{r.main\_Q500} > 0.8 \\ \quad 0.61 \end{cases} = 1.020$$

Determine Equation:

$$Equation_{Q500} := \begin{cases} \text{if } F_{r.main\_Q500} \le 0.80 \\ \quad \text{"HEC 23 Eq. 14.1"} \\ \text{else} \\ \quad \text{"HEC 23 Eq. 14.2"} \end{cases} = \text{"HEC 23 Eq. 14.1"}$$

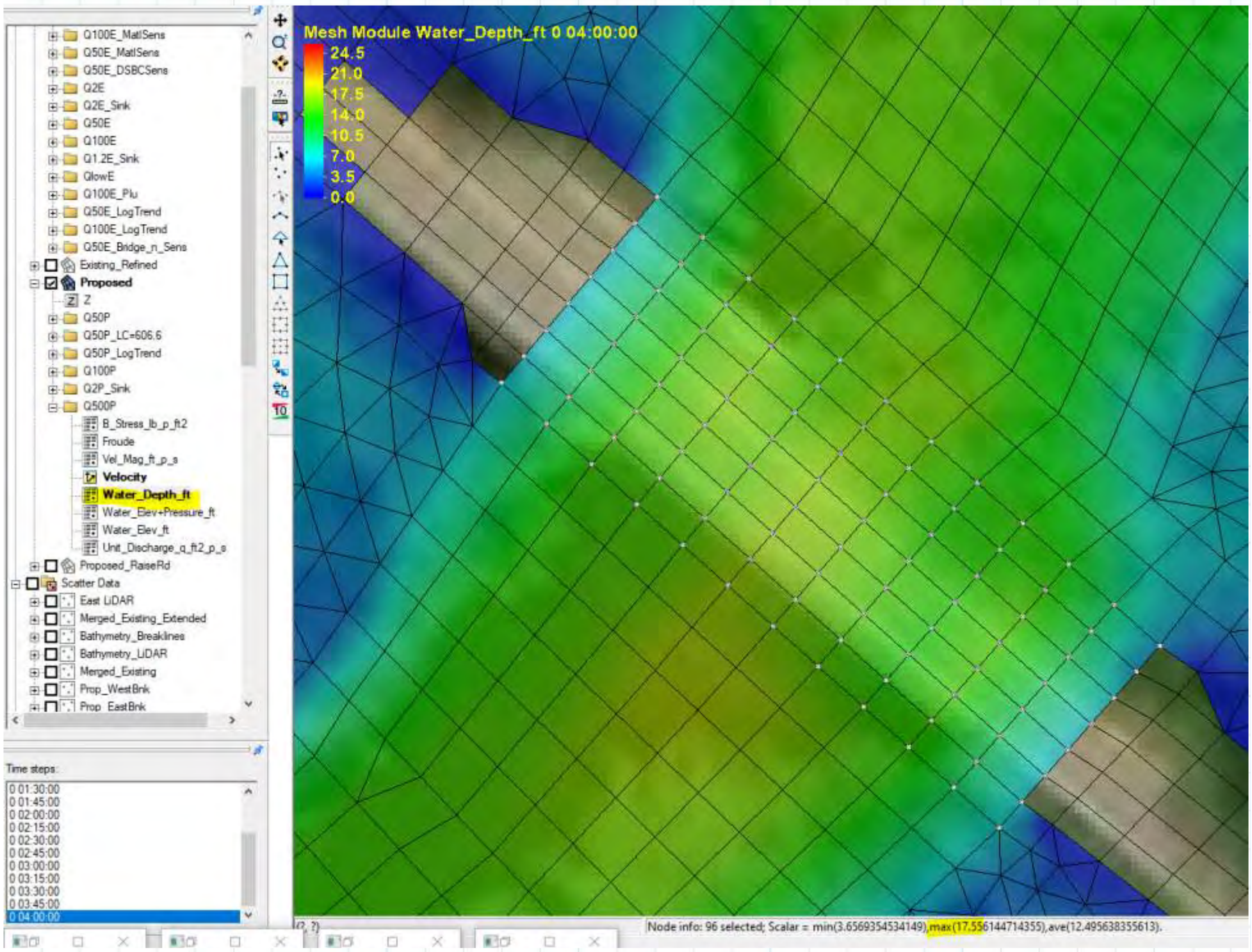
Required D_{50}:

$$D_{50\_Q500} := \begin{cases} \text{if } F_{r.main\_Q500} \le 0.80 \\ \quad y_{BR.Main\_Q500} \cdot \left(\frac{k_{500}}{(S_s - 1)} \cdot \frac{{V_{BR.Main\_Q500}}^2}{g \cdot y_{BR.Main\_Q500}} \right) \\ \text{else} \\ \quad \left(y_{BR.Main\_Q500} \cdot \left(\frac{k_{500}}{(S_s - 1)} \cdot \left(\frac{{V_{BR.Main\_Q500}}^2}{g \cdot y_{BR.Main\_Q500}} \right)^{0.14} \right) \right) \end{cases} = 0.249\ ft$$

HYDRAULIC ANALYSIS & RIPRAP DESIGN (CONT.)

Compute Required Riprap Size (Cont.)

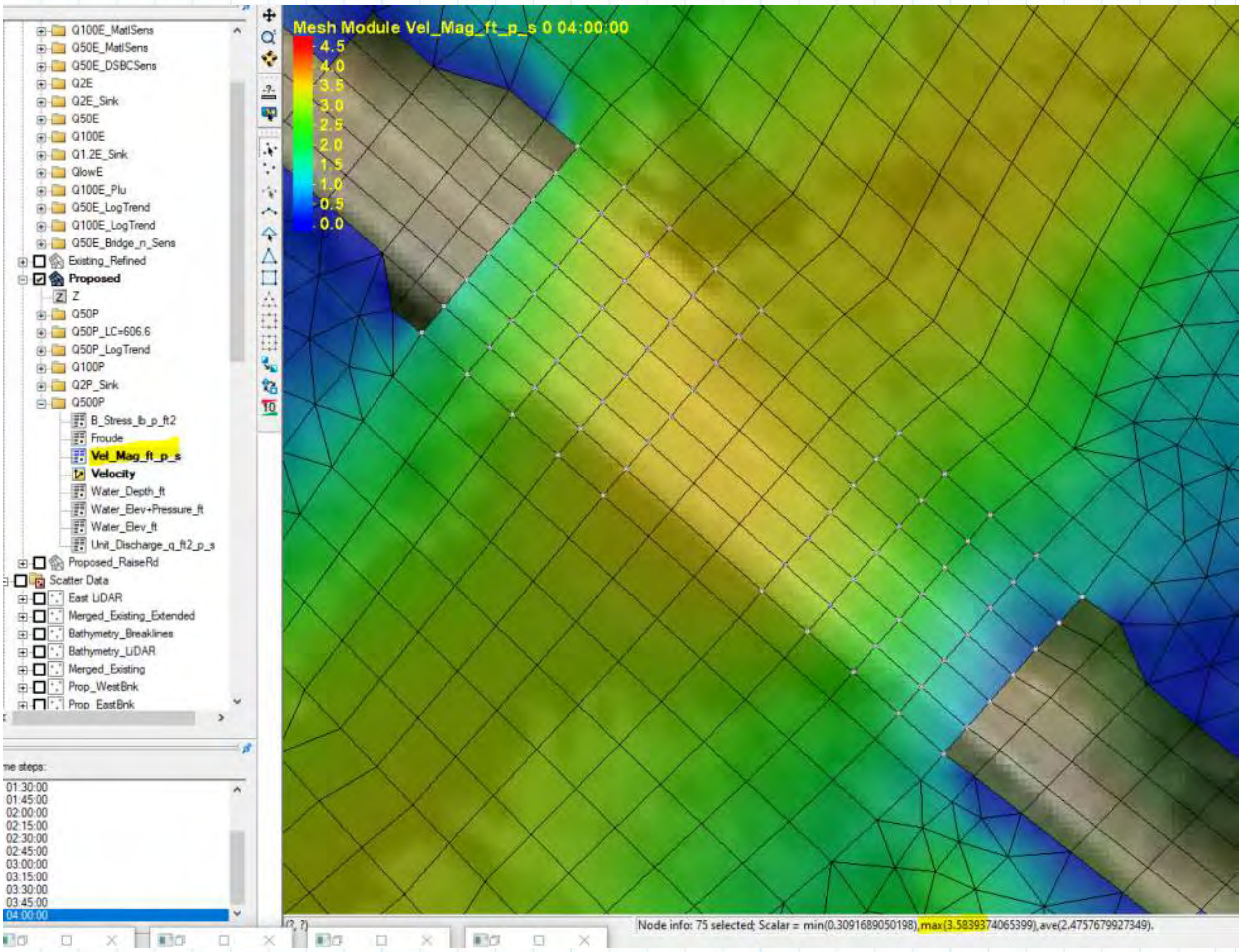
Water Depth - Q500



HYDRAULIC ANALYSIS & RIPRAP DESIGN (CONT.)

Compute Required Riprap Size (Cont.)

Velocity - Q500



HYDRAULIC ANALYSIS & RIPRAP DESIGN (CONT.)

Compute Required Riprap Size (Cont.)

Minimum HEC 23 Riprap Class to specify:

$$HEC23\_Riprap_{Q500} := \begin{array}{l} \text{if } D_{50\_Q500} \le D_{50\_I} \\ \quad \text{"Class I Riprap, D50 = 6in"} \\ \text{else if } D_{50\_I} < D_{50\_Q500} \le D_{50\_III} \\ \quad \text{"Class III Riprap, D50 = 12in"} \\ \text{else if } D_{50\_III} < D_{50\_Q500} \le D_{50\_V} \\ \quad \text{"Class V Riprap, D50 = 18in"} \\ \text{else if } D_{50\_V} < D_{50\_Q500} \le D_{50\_VII} \\ \quad \text{"Class VII Riprap, D50 = 24in"} \\ \text{else} \\ \quad \text{"Class IX Riprap, D50 = 36in"} \end{array} = \text{"Class I Riprap, D50 = 6in"}$$

Proposed Median Diameter:

$$D_{50\_Q500} := \begin{array}{l} \text{if } D_{50\_Q500} \le D_{50\_I} \\ \quad D_{50\_I} \\ \text{else if } D_{50\_I} < D_{50\_Q500} \le D_{50\_III} \\ \quad D_{50\_III} \\ \text{else if } D_{50\_III} < D_{50\_Q500} \le D_{50\_V} \\ \quad D_{50\_V} \\ \text{else if } D_{50\_V} < D_{50\_Q500} \le D_{50\_VII} \\ \quad D_{50\_VII} \\ \text{else} \\ \quad D_{50\_IX} \end{array}$$

$$D_{50} = 6.000\ in$$

Proposed Maximum Diameter:

$$D_{100\_Q500} := \begin{array}{l} \text{if } D_{50\_Q500} \le D_{50\_I} \\ \quad D_{100\_I} \\ \text{else if } D_{50\_I} < D_{50\_Q500} \le D_{50\_III} \\ \quad D_{100\_III} \\ \text{else if } D_{50\_III} < D_{50\_Q500} \le D_{50\_V} \\ \quad D_{100\_V} \\ \text{else if } D_{50\_V} < D_{50\_Q500} \le D_{50\_VII} \\ \quad D_{100\_VII} \\ \text{else} \\ \quad D_{100\_IX} \end{array}$$

$$D_{100} = 12.000\ in$$

Minimum Riprap Thickness: $t_{riprap\_Q500} := \max\left(1.5 \cdot D_{50}, D_{100}\right) = 1.000\ ft$

- A **1' thick** layer of Class I Riprap (**D50 = 6in, D100 = 12in**) would be needed to design for the 500-year flood for riprap placed in-the-dry.

HYDRAULIC ANALYSIS & RIPRAP DESIGN (CONT.)

Determine Extent of Riprap

- The proposed replacement structure is an integral abutment bridge; however conservatively use shallow foundation considerations to determine the initial extent of riprap per the FHWA TechBrief.
- This bridge is a Scour Condition A where the abutments are in the main channel.
- It should be noted that the TechBrief indicates that the riprap should be buried below the scour depth (see Figures included on the next two sheets), however, the NHDOT Bridge Design Manual Figure 2.7.7-1 (see sheet 14) has not been updated to reflect this.
- These calculations evaluated the TechBrief recommended limits as well as NHDOT limits. Ultimately, it is the responsibility of the bridge design consultant to coordinate the required extents, and the riprap shall be installed per the project Contract Drawings.

Bridge Opening Width: $W_2 := 97\ ft$

Flow Depth in Bridge Opening: $y_0 := y_{BR.Main} = 16.700\ ft$ Hydraulic Model (max value for Q100)

Width to Depth Ratio: $\frac{W_2}{y_0} = 5.808$

Opening Classification: $Opening := \text{if } \frac{W_2}{y_0} > 6.2 \;\; \| \text{"Wide"} \;\; \text{else} \;\; \| \text{"Narrow"}$ $= \text{"Narrow"}$

- Based on the abutment location and opening classification, Figure 9 of the TechBrief would be used to design the apron if a shallow foundation was proposed. However, since a deep foundation designed for scour is proposed, Figure 7 of the TechBrief is used for initial riprap limits. Figures 9 and 7 are included on the following pages.

Minimum Width of Riprap in Front of Abutments: $W_{riprap\_abut} := 2 \cdot y_0 = 33.400\ ft$ Say 33'

Minimum Width of Riprap Horizontal Apron in Front of Abutments: $W_{riprap\_abut\_horz\_apron} := 1 \cdot y_0 = 16.700\ ft$ Say 17'

Length of Riprap Beyond Wingwalls: $L_{riprap\_beyond} := 2 \cdot y_0 = 33.400\ ft$ Say 33'

Width of Riprap Behind Abutments along Wingwalls: (measured from face of abutment) $W_{riprap\_WW} := \max\left(2 \cdot y_0, 25\ ft\right) = 33.400\ ft$ Say 33'

HYDRAULIC ANALYSIS & RIPRAP DESIGN (CONT.)

Determine Extent of Riprap (Cont.)

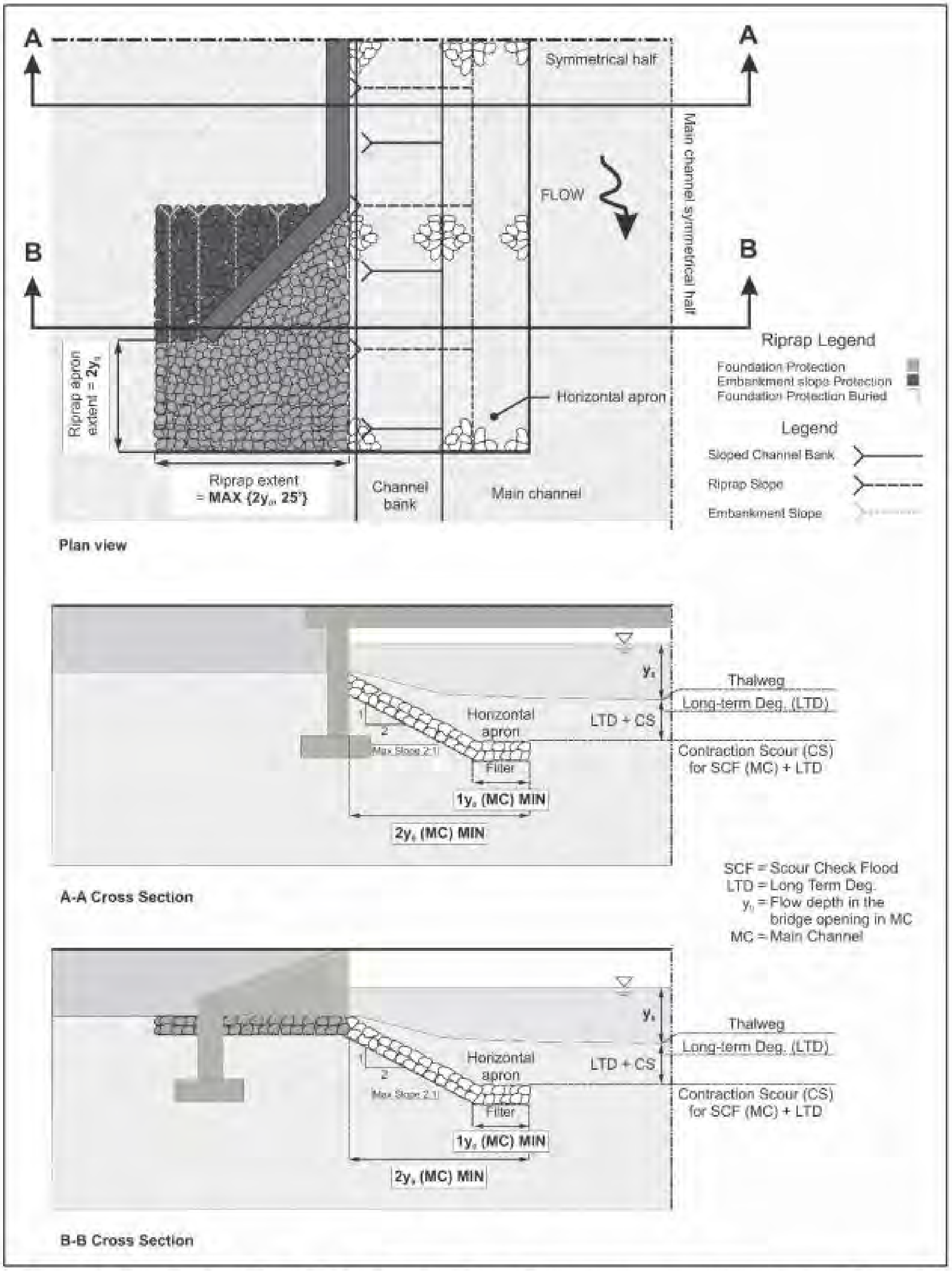


Figure 7. Free-Surface Flow, Wide-Opening Scour Countermeasure, Abutment near Channel Bank – Scour Condition (A) and sloping riprap extends into main channel (Option 2a).

HYDRAULIC ANALYSIS & RIPRAP DESIGN (CONT.)

Determine Extent of Riprap (Cont.)

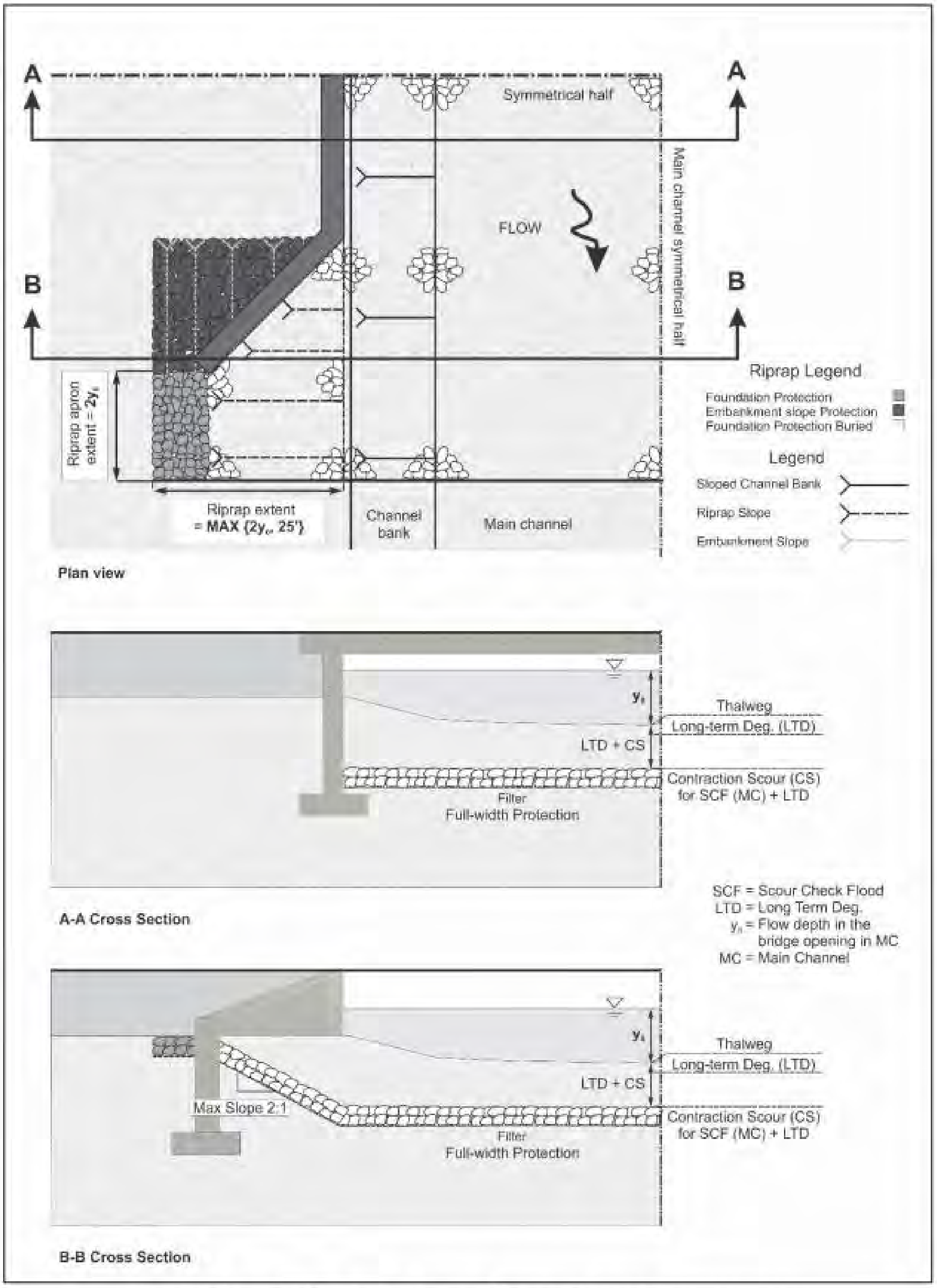
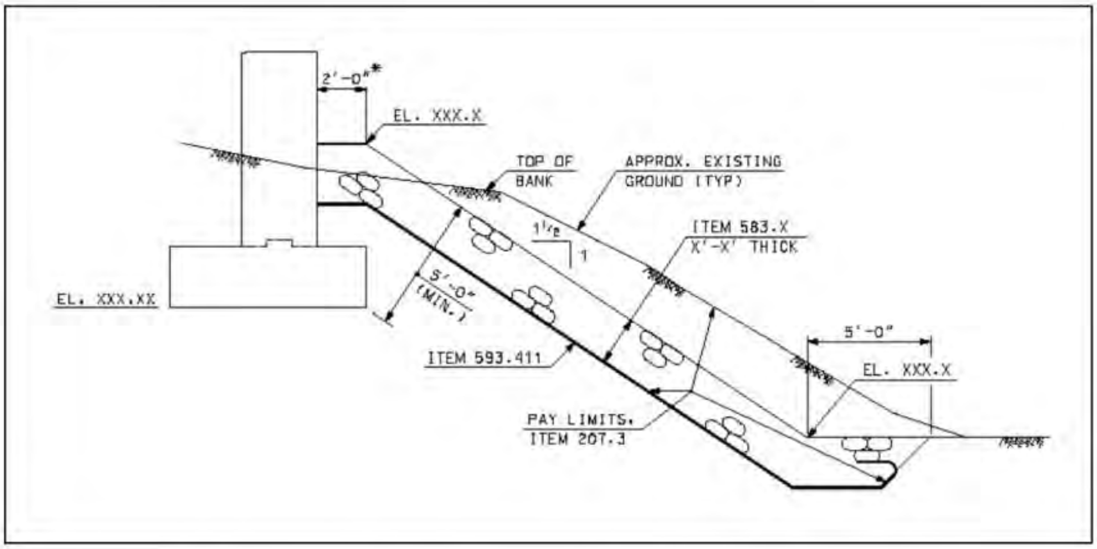


Figure 9: Free-Surface Flow, Narrow-Opening Scour Countermeasure.

HYDRAULIC ANALYSIS & RIPRAP DESIGN (CONT.)

Determine Extent of Riprap (Cont.)

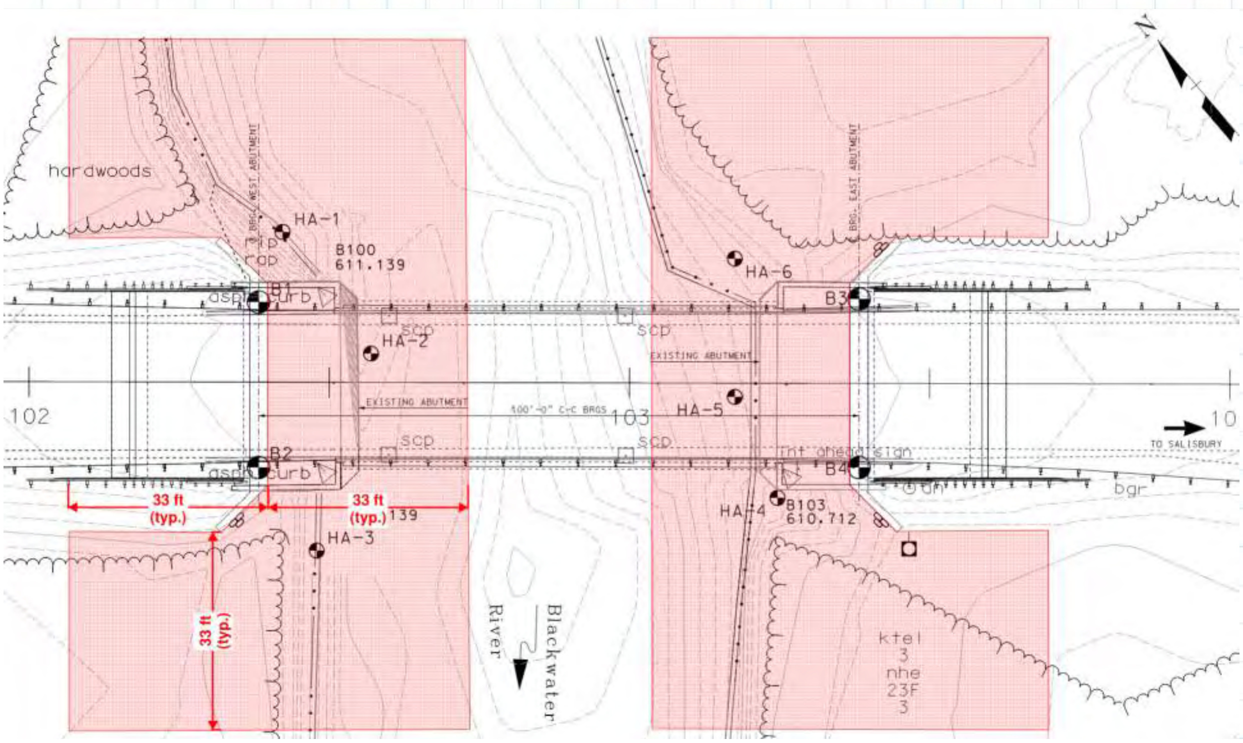


Typical NHDOT Channel Protection Section

Figure 2.7.7-1

* Use 2-ft. (0.6-m) minimum top shelf width unless directed otherwise by the Design Chief, to provide provisions for inspection access.

Riprap limits per TechBrief Fig. 9:



HYDRAULIC ANALYSIS & RIPRAP DESIGN - CONCLUSION & RECOMMENDATIONS

100-year Flood Design

Proposed Median Diameter: $D_{50} = 6.000\ in$

Proposed Maximum Diameter: $D_{100} = 12.000\ in$

Minimum Riprap Thickness: $t_{riprap} = 1.000\ ft$
(assuming placement in the dry)

500-year Flood Design

Proposed Median Diameter: $D_{50\_Q500} = 6.000\ in$

Proposed Maximum Diameter: $D_{100\_Q500} = 12.000\ in$

Minimum Riprap Thickness: $t_{riprap\_Q500} = 1.000\ ft$
(assuming placement in the dry

Countermeasure Design

- The extent of riprap based on Figure 9 of the TechBrief seems excessive for a deep foundation. It is recommended to use the BDM Figure 2.7.7-1 and install riprap on the slope in front of the abutments and toe it in as shown. The width of riprap in front of the abutment can be used for the riprap extents beyond the wingwalls and behind the face of the abutment.
- The required riprap for the 100-year flood is the same as the 500-year flood:
    - D50 = 6" (Class I)
    - D100 = 12"
    - t_{min} = 12"
- It should be noted that riprap thickness should be increased by 50% when placement must occur under water (HEC-23, Vol. 2). Coordinate with the project design drawings and anticipated construction methods to determine final thickness of riprap.
- Additionally, this riprap design is based on scour conditions; other considerations, such as ice, m ay warrant either larger stone size or blanket thickness.

Hoyle, Tanner & Associates, Inc.

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Manchester, NH 03101

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Yarmouth, ME 04096

125 College Street, 4th Floor
Burlington, VT 05401

95 E. Mitchell Hammock Road, Suite 200
Oviedo, FL 32765

New Hampshire Natural Heritage Bureau
NHB DataCheck Results Letter

To: New Hampshire DOT
7 Hazen Dr
Concord, NH 03302

From: NH Natural Heritage Bureau

Date: 12/27/2023 (This letter is valid through 12/27/2024)

Re: Review by NH Natural Heritage Bureau of request dated 12/27/2023

Permit Types: Shoreland Standard Permit
Wetland Standard Dredge & Fill - Major
Federal: NEPA Review

NHB ID: NHB23-3680

Applicant: New Hampshire DOT

Location: Andover
Tax Map: N/A, Tax Lot: N/A
Address: US Route 4 over the Blackwater River

Proj. Description: The project involves the replacement of the existing bridge that carries US Route 4 over the Blackwater River in Andover (NHDOT Project 40392). Proposed work includes replacement of the existing bridge structure, construction of new abutments behind the existing abutments, and roadway approach work extending from approximately 500 feet on each end of the bridge. The existing bridge abutments will be cut at ground level and stone riprap will be placed at the edge of the river channel for scour protection. The bridge will be closed to traffic during construction and construction of a temporary detour bridge is not proposed. Previous NHB numbers: NHB18-3627, NHB20-3503, and NHB22-0947.

The NH Natural Heritage database has been checked for records of rare species and exemplary natural communities near the area mapped below. The species considered include those listed as Threatened or Endangered by either the state of New Hampshire or the federal government. We currently have no recorded occurrences for sensitive species near this project area.

A negative result (no record in our database) does not mean that a sensitive species is not present. Our data can only tell you of known occurrences, based on information gathered by qualified biologists and reported to our office. However, many areas have never been surveyed, or have only been surveyed for certain species. An on-site survey would provide better information on what species and communities are indeed present.

Based on the information submitted, no further consultation with the NH Fish and Game Department pursuant to Fis 1004 is required.

MAP OF PROJECT BOUNDARIES FOR: NHB23-3680

Jennifer Riordan

From: Dube, Melilotus <Melilotus.M.Dube@dot.nh.gov>
Sent: Wednesday, January 25, 2023 8:30 AM
To: Jennifer Riordan
Cc: Tremblay, Jason
Subject: FW: [WARNING-EXT] Re: NHDOT Project - Andover 40392

Hi Jenn,
Please see Kaitlyn Shaw's response to the EFH assessment below.
Meli

From: Kaitlyn Shaw - NOAA Federal <kaitlyn.shaw@noaa.gov>
Sent: Tuesday, January 24, 2023 3:43 PM
To: Dube, Melilotus <Melilotus.M.Dube@dot.nh.gov>
Subject: Re: [WARNING-EXT] Re: NHDOT Project - Andover 40392

EXTERNAL: Do not open attachments or click on links unless you recognize and trust the sender.

Hi Meli,
I've reviewed the project plans and worksheet. The specific measures identified in the project materials to avoid and minimize adverse effects to EFH, such as work in the dry and maintaining river flow throughout the project should effectively minimize adverse effects to EFH as well as diadromous species in the project vicinity. Further EFH consultation should be reinitiated if new information becomes available, or if the project is revised in such a manner that affects the basis for the EFH determination.
Best,

Kaitlyn Shaw
Marine Habitat Resource Specialist
Habitat and Ecosystem Services Division
NOAA/ National Marine Fisheries Service
Gloucester, MA
Office: 978-282-8457
Pronouns: she/her
kaitlyn.shaw@noaa.gov
www.nmfs.noaa.gov

On Fri, Jan 20, 2023 at 11:16 AM Dube, Melilotus <Melilotus.M.Dube@dot.nh.gov> wrote:

> Hi Kaitlyn,
>
> Thanks for the quick response! Plans are still preliminary, I've attached the highway plans. I hope you find something usable in the package, but if not, let me know and we'll see what we can do.
>
> Meli

From: Kaitlyn Shaw - NOAA Federal <kaitlyn.shaw@noaa.gov>
Sent: Friday, January 20, 2023 9:29 AM
To: Dube, Melilotus <Melilotus.M.Dube@dot.nh.gov>
Subject: Re: [WARNING-EXT] Re: NHDOT Project - Andover 40392

EXTERNAL: Do not open attachments or click on links unless you recognize and trust the sender.

Hi Meli,

Yes I saw that this river is on the omnibus habitat amendment. Should be a quick turnaround but is there a plan set associated with the project for me to review?

Best,

Kaitlyn Shaw

Marine Habitat Resource Specialist

Habitat and Ecosystem Services Division

NOAA/ National Marine Fisheries Service

Gloucester, MA

Office: 978-282-8457

Pronouns: she/her

kaitlyn.shaw@noaa.gov

www.nmfs.noaa.gov

On Thu, Jan 19, 2023 at 10:18 AM Dube, Melilotus <Melilotus.M.Dube@dot.nh.gov> wrote:

> Hi Kaitlyn,
>
> Please see the attached EFH form for the Andover 40392 project. When I checked the mapper, it did not show the Blackwater River as EFH for salmon or any other species, but I did check the textual list and found it on there. I also checked DES and our own GIS layers and could not find any indication that it is a cold water fishery. Unfortunately, I searched but could not find any temp data for the Blackwater River in this area. Please let me know when you have had a chance to review and if there are any recommendations from NOAA for this project.
>
> Thank you!

Meli

From: Jennifer Riordan <JRiordan@GM2INC.COM>
Sent: Tuesday, December 20, 2022 2:44 PM
To: Dube, Melilotus <Melilotus.M.Dube@dot.nh.gov>
Subject: FW: [WARNING-EXT] Re: NHDOT Project - Andover 40392

Meli,

I heard you will be doing the EFH assessment for Andover. Here's the email I received from NMFS with the EFH Worksheet.

Jenn

JENNIFER RIORDAN, CWS, CPESC

P 603.856.7854 | **C** 603.724.4950
GM2

From: Kaitlyn Shaw - NOAA Federal <kaitlyn.shaw@noaa.gov>
Sent: Monday, December 19, 2022 9:56 AM
To: Jennifer Riordan <JRiordan@GM2INC.COM>
Subject: [WARNING-EXT] Re: NHDOT Project - Andover 40392

Hi Jennifer,

Please complete the attached worksheet, including attachments with required information indicated on page ii of the worksheet, and CC the federal action agency when you respond. Our consultation procedures are between NOAA and the action agency, so it is important that they are included in consultation correspondence.

Hope you have a wonderful holiday season!

Best,

Kaitlyn Shaw

Marine Habitat Resource Specialist

Habitat and Ecosystem Services Division

NOAA/ National Marine Fisheries Service

Gloucester, MA

Office: 978-282-8457

Pronouns: she/her

kaitlyn.shaw@noaa.gov

www.nmfs.noaa.gov

On Wed, Dec 14, 2022 at 9:59 PM Jennifer Riordan <JRiordan@gm2inc.com> wrote:

Hi Kaitlyn,

The NH Department of Transportation (NHDOT) is proposing to replace Bridge No. 143/077 that carries US Route 4 over the Blackwater River in the Town of Andover (refer to attached site location map). The existing bridge was constructed in 1933 and is on the State's Red List. The project was originally to include rehabilitation of the existing bridge, but it was determined that the bridge has deteriorated to a point that repair or rehabilitation is not a feasible option. The project scope now includes bridge replacement.

Work will include replacement of the existing bridge structure, constructing new abutments behind the existing abutments, and roadway approach work (approximately 500 feet on each end of the bridge). The existing bridge abutments will be cut at ground level and stone riprap will be placed at the edge of the river channel for scour protection. The bridge will be closed during construction and traffic will be detoured. Construction of a temporary detour bridge is not proposed.

GM2 Associates, Inc. is responsible for the engineering design and preparation of NEPA documentation for the project. We noted that the Blackwater River is shown as Essential Fish Habitat for Atlantic salmon on the EFH Mapper and assume that EFH consultation may be required. Any comments or input you may have will assist in the preparation of the environmental documents.

Thanks,

Jenn

CT | RI | NH | MA | NY | FL

www.gm2inc.com

JENNIFER RIORDAN, CWS, CPESC

Senior Environmental Scientist

P 603.856.7854
C 603.724.4950

United States Department of the Interior

FISH AND WILDLIFE SERVICE
New England Ecological Services Field Office
70 Commercial Street, Suite 300
Concord, NH 03301-5094
Phone: (603) 223-2541 Fax: (603) 223-0104

In Reply Refer To: 04/05/2024 17:35:21 UTC
Project Code: 2024-0040096
Project Name: Andover 40392

Subject: List of threatened and endangered species that may occur in your proposed project location or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed, and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through IPaC by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at: https://www.fws.gov/sites/default/files/documents/endangered-species-consultation-handbook.pdf

Migratory Birds: In addition to responsibilities to protect threatened and endangered species under the Endangered Species Act (ESA), there are additional responsibilities under the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act (BGEPA) to protect native birds from project-related impacts. Any activity, intentional or unintentional, resulting in take of migratory birds, including eagles, is prohibited unless otherwise permitted by the U.S. Fish and Wildlife Service (50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)). For more information regarding these Acts, see Migratory Bird Permit | What We Do | U.S. Fish & Wildlife Service (fws.gov).

The MBTA has no provision for allowing take of migratory birds that may be unintentionally killed or injured by otherwise lawful activities. It is the responsibility of the project proponent to comply with these Acts by identifying potential impacts to migratory birds and eagles within applicable NEPA documents (when there is a federal nexus) or a Bird/Eagle Conservation Plan (when there is no federal nexus). Proponents should implement conservation measures to avoid or minimize the production of project-related stressors or minimize the exposure of birds and their resources to the project-related stressors. For more information on avian stressors and recommended conservation measures, see https://www.fws.gov/library/collections/threats-birds.

In addition to MBTA and BGEPA, Executive Order 13186: *Responsibilities of Federal Agencies to Protect Migratory Birds*, obligates all Federal agencies that engage in or authorize activities that might affect migratory birds, to minimize those effects and encourage conservation measures that will improve bird populations. Executive Order 13186 provides for the protection of both migratory birds and migratory bird habitat. For information regarding the implementation of Executive Order 13186, please visit https://www.fws.gov/partner/council-conservation-migratory-birds.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Code in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment(s):

- Official Species List

OFFICIAL SPECIES LIST

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

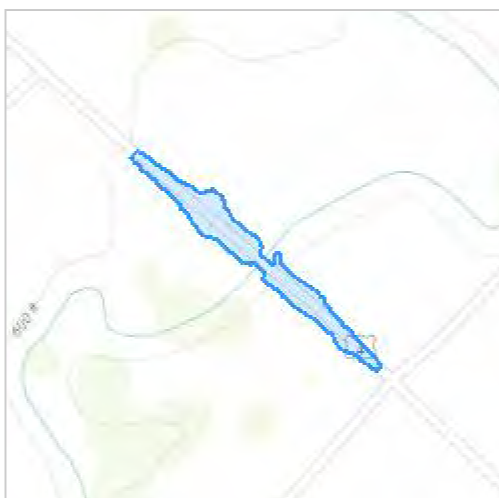
New England Ecological Services Field Office
70 Commercial Street, Suite 300
Concord, NH 03301-5094
(603) 223-2541

PROJECT SUMMARY

Project Code:	2024-0040096
Project Name:	Andover 40392
Project Type:	Bridge - Replacement
Project Description:	The project involves the replacement of the existing bridge that carries US Route 4 over the Blackwater River (Bridge No. Bridge No. 143/077) in Andover. The existing bridge has a 70-foot span and is on the State's Red List. Proposed work would include the replacement of the bridge with a 104-foot clear span bridge with new abutments, and roadway approach work extending approximately 500 feet from each end of the bridge. The bridge will be widened 8 feet and the roadway will be raised 4.5 feet near the bridge. The bridge would be closed during construction and traffic would be detoured. Tree clearing along the roadway is required and is currently anticipated to occur during the winter/early spring, with bridge work proposed for the summer months. A total of 9,368 square feet and 275 linear feet of permanent wetland and watercourse impact and 1,332 square feet and 77 linear feet of temporary wetland and watercourse impact is proposed.

Project Location:

The approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/@43.421842850000004,-71.77696557549001,14z



Counties: Merrimack County, New Hampshire

ENDANGERED SPECIES ACT SPECIES

There is a total of 3 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

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1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

MAMMALS

NAME	STATUS
Northern Long-eared Bat *Myotis septentrionalis* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/9045	Endangered
Tricolored Bat *Perimyotis subflavus* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/10515	Proposed Endangered

INSECTS

NAME	STATUS
Monarch Butterfly *Danaus plexippus* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/9743	Candidate

CRITICAL HABITATS

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

YOU ARE STILL REQUIRED TO DETERMINE IF YOUR PROJECT(S) MAY HAVE EFFECTS ON ALL ABOVE LISTED SPECIES.

IPAC USER CONTACT INFORMATION

Agency: GM2 Associates, Inc.
Name: Ethan Maskiell
Address: 197 Loudon Road
Address Line 2: Suite 310
City: Concord
State: NH
Zip: 03301
Email emaskiell@gm2inc.com
Phone: 6038567854

LEAD AGENCY CONTACT INFORMATION

Lead Agency: Federal Highway Administration

United States Department of the Interior

FISH AND WILDLIFE SERVICE
New England Ecological Services Field Office
70 Commercial Street, Suite 300
Concord, NH 03301-5094
Phone: (603) 223-2541 Fax: (603) 223-0104

In Reply Refer To: February 06, 2024
Project code: 2024-0040096
Project Name: Andover 40392

Subject: Concurrence verification letter for the 'Andover 40392' project under the amended February 5, 2018, FHWA, FRA, FTA Programmatic Biological Opinion (dated March 23, 2023) for Transportation Projects within the Range of the Indiana Bat and Northern Long-eared Bat (NLEB).

To whom it may concern:

The U.S. Fish and Wildlife Service (Service) has received your request dated February 06, 2024 to verify that the **Andover 40392** (Proposed Action) may rely on the concurrence provided in the amended February 5, 2018, FHWA, FRA, FTA Programmatic Biological Opinion (dated March 23, 2023) for Transportation Projects within the Range of the Indiana Bat and Northern Long-eared Bat (PBO) to satisfy requirements under Section 7(a)(2) of the Endangered Species Act of 1973 (ESA) (87 Stat.884, as amended; 16 U.S.C. 1531 *et seq.*).

Based on the information you provided (Project Description shown below), you have determined that the Proposed Action is within the scope and adheres to the criteria of the PBO, including the adoption of applicable avoidance and minimization measures. **At least one of the qualification interview questions indicated an activity or portion of your project is consistent with a not likely to adversely affect determination therefore, the overall determination for your project is, may affect, <u>and is not likely to adversely affect (NLAA)</u> the endangered Indiana bat (*Myotis sodalis*) and/or the endangered northern long-eared bat (*Myotis septentrionalis*)**. Consultation with the Service pursuant to section 7(a)(2) of ESA (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq*.) is required.

The Service has 14 calendar days to notify the lead Federal action agency or designated non-federal representative if we determine that the Proposed Action does not meet the criteria for a NLAA determination under the PBO. If we do <u>not</u> notify the lead Federal action agency or designated non-federal representative within that timeframe, you may proceed with the Proposed Action under the terms of the NLAA concurrence provided in the PBO. This verification period allows Service Field Offices to apply local knowledge to implementation of the PBO, as we may identify a small subset of actions having impacts that were unanticipated. In such instances, Service Field Offices may request additional information that is necessary to verify inclusion of the proposed action under the PBO.

For Proposed Actions that include bridge/culvert or structure removal, replacement, and/or maintenance activities: If your initial bridge/culvert or structure assessment documented signs of bat use or occupancy, or an assessment failed to detect Indiana bats and/or NLEBs, yet are later detected prior to, or during construction, please submit the Post Assessment Discovery of Bats at Bridge/Culvert or Structure Form (User Guide Appendix E) to this Service Office within 2 working days of any potential take. In these instances, potential incidental take of Indiana bats and/or NLEBs is covered under the Incidental Take Statement in the 2018 FHWA, FRA, FTA PBO (provided that the take is reported to the Service).

If the Proposed Action is modified, or new information reveals that it may affect the Indiana bat and/or northern long-eared bat in a manner or to an extent not considered in the PBO, further review to conclude the requirements of ESA Section 7(a)(2) may be required.

For Proposed Actions that include bridge/culvert or structure removal, replacement, and/or maintenance activities:
If your initial bridge/culvert or structure assessments failed to detect Indiana bats and/or NLEB use or occupancy, yet bats are later detected prior to, or during construction, please submit the Post Assessment Discovery of Bats at Bridge/Culvert or Structure Form (User Guide Appendix E) to this Service Office within 2 working days of the incident. In these instances, potential incidental take of Indiana bats and/or NLEBs may be exempted provided that the take is reported to the Service.

If the Proposed Action may affect any other federally-listed or proposed species, and/or any designated critical habitat, additional consultation between the lead Federal action agency and this Service Office is required. If the proposed action has the potential to take bald or golden eagles, additional coordination with the Service under the Bald and Golden Eagle Protection Act may also be required. In either of these circumstances, please contact this Service Office.

The following species may occur in your project area and **are not** covered by this determination:

- Monarch Butterfly *Danaus plexippus* Candidate

PROJECT DESCRIPTION

The following project name and description was collected in IPaC as part of the endangered species review process.

NAME

Andover 40392

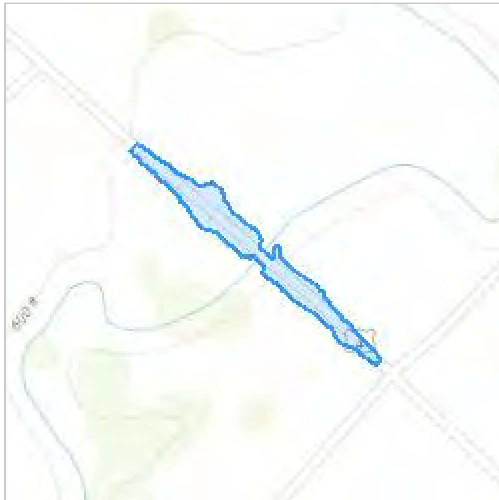
DESCRIPTION

The project involves the replacement of the existing bridge that carries US Route 4 over the Blackwater River (Bridge No. Bridge No. 143/077) in Andover. The existing bridge has a 70-foot span and is on the State's Red List. Proposed work would include the replacement of the bridge with a 101-foot clear span bridge with new abutments, and roadway approach work extending approximately 500 feet from each end of the bridge. The bridge will be widened 8 feet and the roadway will be raised 4.5 feet near the bridge. The bridge would be closed during construction and traffic would be detoured.

Tree clearing along the roadway is required and is currently anticipated to occur during the winter/early spring, with bridge work proposed for the summer months.

A total of 9,335 square feet and 256 linear feet of permanent wetland and watercourse impact and 1,332 square feet and 213 linear feet of temporary wetland and watercourse impact is proposed.

The approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/@43.42184115,-71.77696436929295,14z



DETERMINATION KEY RESULT

Based on your answers provided, this project(s) may affect, but is not likely to adversely affect the endangered Indiana bat and/or the endangered northern long-eared bat, therefore, consultation with the U.S. Fish and Wildlife Service pursuant to Section 7(a)(2) of the Endangered Species Act of 1973 (ESA) (87 Stat. 884, as amended 16 U.S.C. 1531 *et seq.*) is required. However, also based on your answers provided, this project may rely on the concurrence provided in the amended February 5, 2018, FHWA, FRA, FTA Programmatic Biological Opinion (dated March 23, 2023) for Transportation Projects within the Range of the Indiana Bat and Northern Long-eared Bat.

QUALIFICATION INTERVIEW

1. Is the project within the range of the Indiana bat[1]?

   [1] See Indiana bat species profile

   Automatically answered
   No

2. Is the project within the range of the northern long-eared bat[1]?

   [1] See northern long-eared bat species profile

   Automatically answered
   Yes

3. Which Federal Agency is the lead for the action?

   A) Federal Highway Administration (FHWA)

4. Are *all* project activities limited to non-construction[1] activities only? (examples of non-construction activities include: bridge/abandoned structure assessments, surveys, planning and technical studies, property inspections, and property sales)

   [1] Construction refers to activities involving ground disturbance, percussive noise, and/or lighting.

   No

5. Does the project include *any* activities that are **greater than** 300 feet from existing road/rail surfaces[1]?

   [1] Road surface is defined as the actively used [e.g. motorized vehicles] driving surface and shoulders [may be pavement, gravel, etc.] and rail surface is defined as the edge of the actively used rail ballast.

   No

6. Does the project include *any* activities **within** 0.5 miles of a known Indiana bat and/or NLEB hibernaculum[1]?

   [1] For the purpose of this consultation, a hibernaculum is a site, most often a cave or mine, where bats hibernate during the winter (see suitable habitat), but could also include bridges and structures if bats are found to be hibernating there during the winter.

   No

7. Is the project located **within** a karst area?

   No

8. Is there *any* suitable[1] summer habitat for Indiana Bat or NLEB **within** the project action area[2]? (includes any trees suitable for maternity, roosting, foraging, or travelling habitat)

   [1] See the Service's summer survey guidance for our current definitions of suitable habitat.

   [2] The action area is defined as all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR Section 402.02). Further clarification is provided by the User's Guide for the Range-wide Programmatic Consultation for Indiana Bat and Northern Long-eared Bat.

   Yes

9. Will the project remove *any* suitable summer habitat[1] and/or remove/trim any existing trees **within** suitable summer habitat?

   [1] See the Service's summer survey guidance for our current definitions of suitable habitat.

   Yes

10. Will the project clear more than 20 acres of suitable habitat per 5-mile section of road/rail?

    No

11. Have presence/probable absence (P/A) summer surveys[1][2] been conducted[3][4] **within** the suitable habitat located within your project action area?

    [1] See the Service's summer survey guidance for our current definitions of suitable habitat.

    [2] Presence/probable absence summer surveys conducted within the fall swarming/spring emergence home range of a documented Indiana bat hibernaculum (contact local Service Field Office for appropriate distance from hibernacula) that result in a negative finding requires additional consultation with the local Service Field Office to determine if clearing of forested habitat is appropriate and/or if seasonal clearing restrictions are needed to avoid and minimize potential adverse effects on fall swarming and spring emerging Indiana bats.

    [3] For projects within the range of either the Indiana bat or NLEB in which suitable habitat is present, and no bat surveys have been conducted, the transportation agency will assume presence of the appropriate species. This assumption of presence should be based upon the presence of suitable habitat and the capability of bats to occupy it because of their mobility.

    [4] Negative presence/probable absence survey results obtained using the summer survey guidance are valid for a minimum of two years from the completion of the survey unless new information (e.g., other nearby surveys) suggest otherwise.

    No

12. Does the project include activities **within documented NLEB habitat**[1][2]?

    [1] Documented roosting or foraging habitat – for the purposes of this consultation, we are considering documented habitat as that where Indiana bats and/or NLEB have actually been captured and tracked using (1) radio telemetry to roosts; (2) radio telemetry biangulation/triangulation to estimate foraging areas; or (3) foraging areas with repeated use documented using acoustics. Documented roosting habitat is also considered as suitable summer habitat within 0.25 miles of documented roosts.)

    [2] For the purposes of this key, we are considering documented corridors as that where Indiana bats and/or NLEB have actually been captured and tracked to using (1) radio telemetry; or (2) treed corridors located directly between documented roosting and foraging habitat.

    No
13. Will the removal or trimming of habitat or trees occur **within** suitable but **undocumented NLEB** roosting/foraging habitat or travel corridors?

    Yes
14. What time of year will the removal or trimming of habitat or trees **within** suitable but **undocumented NLEB** roosting/foraging habitat or travel corridors occur?

    B) During the inactive season
15. Will *any* tree trimming or removal occur **within** 100 feet of existing road/rail surfaces?

    Yes
16. Will *any* tree trimming or removal occur **between** 100-300 feet of existing road/rail surfaces?

    No
17. Are *all* trees that are being removed clearly demarcated?

    Yes
18. Will the removal of habitat or the removal/trimming of trees include installing new or replacing existing **permanent** lighting?

    No
19. Does the project include wetland or stream protection activities associated with compensatory wetland mitigation?

    No
20. Does the project include slash pile burning?

    No
21. Does the project include *any* bridge removal, replacement, and/or maintenance activities (e.g., any bridge repair, retrofit, maintenance, and/or rehabilitation work)?

    Yes
22. Is there *any* suitable habitat[1] for Indiana bat or NLEB **within** 1,000 feet of the bridge? (includes any trees suitable for maternity, roosting, foraging, or travelling habitat)

    [1] See the Service's current summer survey guidance for our current definitions of suitable habitat.

    Yes

23. Has a bridge assessment[1] been conducted **within** the last 24 months[2] to determine if the bridge is being used by bats?

    [1] See [User Guide Appendix D] for bridge/structure assessment guidance

    [2] Assessments must be completed no more than 2 years prior to conducting any work below the deck surface on all bridges that meet the physical characteristics described in the Programmatic Consultation, regardless of whether assessments have been conducted in the past. Due to the transitory nature of bat use, a negative result in one year does not guarantee that bats will not use that bridge/structure in subsequent years.

    Yes

    SUBMITTED DOCUMENTS

    - *Andover 40392 bat bridge form 2022.pdf https://ipac.ecosphere.fws.gov/project/TOXDP6JLMJHNNAQVWBSVCGVVNU/projectDocuments/137494221*

24. Did the bridge assessment detect *any* signs of Indiana bats and/or NLEBs roosting in/under the bridge (bats, guano, etc.)[1]?

    [1] If bridge assessment detects signs of *any* species of bats, coordination with the local FWS office is needed to identify potential threatened or endangered bat species. Additional studies may be undertaken to try to identify which bat species may be utilizing the bridge prior to allowing *any* work to proceed.

    Note: There is a small chance bridge assessments for bat occupancy do not detect bats. Should a small number of bats be observed roosting on a bridge just prior to or during construction, such that take is likely to occur or does occur in the form of harassment, injury or death, the PBO requires the action agency to report the take. Report all unanticipated take within 2 working days of the incident to the USFWS. Construction activities may continue without delay provided the take is reported to the USFWS and is limited to 5 bats per project.

    No

25. Will the bridge removal, replacement, and/or maintenance activities include installing new or replacing existing **permanent** lighting?

    No

26. Does the project include the removal, replacement, and/or maintenance of *any* structure other than a bridge? (e.g., rest areas, offices, sheds, outbuildings, barns, parking garages, etc.)

    No

27. Will the project involve the use of **temporary** lighting *during* the active season?

    Yes

28. Is there *any* suitable habitat **within** 1,000 feet of the location(s) where **temporary** lighting will be used?

    Yes

29. Will the project install new or replace existing **permanent** lighting?

    No

30. Does the project include percussives or other activities (**not including tree removal/ trimming or bridge/structure work**) that will increase noise levels above existing traffic/ background levels?

    No

31. Are *all* project activities that are **not associated with** habitat removal, tree removal/ trimming, bridge and/or structure activities, temporary or permanent lighting, or use of percussives, limited to actions that DO NOT cause any additional stressors to the bat species?

    Examples: lining roadways, unlighted signage , rail road crossing signals, signal lighting, and minor road repair such as asphalt fill of potholes, etc.

    Yes

32. Will the project raise the road profile **above the tree canopy**?

    No

33. Are the project activities that are not associated with habitat removal, tree removal/ trimming, bridge and/or structure activities, temporary or permanent lighting, or use of percussives consistent with a No Effect determination in this key?

    Automatically answered
    Yes, other project activities are limited to actions that DO NOT cause any additional stressors to the bat species as described in the BA/BO

34. Is the habitat removal portion of this project consistent with a Not Likely to Adversely Affect determination in this key?

    Automatically answered
    Yes, because the tree removal/trimming that occurs outside of the NLEB's active season occurs greater than 0.5 miles from the nearest hibernaculum, is less than 100 feet from the existing road/rail surface, includes clear demarcation of the trees that are to be removed, and does not alter documented roosts and/or surrounding summer habitat within 0.25 miles of a documented roost.

35. Is the bridge removal, replacement, or maintenance activities portion of this project consistent with a No Effect determination in this key?

    Automatically answered
    Yes, because the bridge has been assessed using the criteria documented in the BA and no signs of bats were detected

36. **General AMM 1**
    Will the project ensure *all* operators, employees, and contractors working in areas of known or presumed bat habitat are aware of *all* FHWA/FRA/FTA (Transportation Agencies) environmental commitments, including all applicable Avoidance and Minimization Measures?

    Yes

37. **Tree Removal AMM 1**

    Can *all* phases/aspects of the project (e.g., temporary work areas, alignments) be modified, to the extent practicable, to avoid tree removal[1] in excess of what is required to implement the project safely?

    Note: Tree Removal AMM 1 is a minimization measure, the full implementation of which may not always be practicable. Projects may still be NLAA as long as Tree Removal AMMs 2, 3, and 4 are implemented and LAA as long as Tree Removal AMMs 3, 5, 6, and 7 are implemented.

    [1] The word "trees" as used in the AMMs refers to trees that are suitable habitat for each species within their range. See the USFWS' current summer survey guidance for our latest definitions of suitable habitat.

    Yes

38. **Tree Removal AMM 3**

    Can tree removal be limited to that specified in project plans and ensure that contractors understand clearing limits and how they are marked in the field (e.g., install bright colored flagging/fencing prior to any tree clearing to ensure contractors stay within clearing limits)?

    Yes

39. **Tree Removal AMM 4**

    Can the project avoid cutting down/removal of *all* (1) **documented**[1] Indiana bat or NLEB roosts[2] (that are still suitable for roosting), (2) trees **within** 0.25 miles of roosts, and (3) documented foraging habitat any time of year?

    [1] The word documented means habitat where bats have actually been captured and/or tracked.

    [2] Documented roosting or foraging habitat – for the purposes of this consultation, we are considering documented habitat as that where Indiana bats and/or NLEB have actually been captured and tracked using (1) radio telemetry to roosts; (2) radio telemetry biangulation/triangulation to estimate foraging areas; or (3) foraging areas with repeated use documented using acoustics. Documented roosting habitat is also considered as suitable summer habitat within 0.25 miles of documented roosts.)

    Yes

40. **Lighting AMM 1**

    Will *all* **temporary** lighting be directed away from suitable habitat during the active season?

    Yes

PROJECT QUESTIONNAIRE

1. Have you made a No Effect determination for *all* other species indicated on the FWS IPaC generated species list?

   N/A

2. Have you made a May Affect determination for *any* other species on the FWS IPaC generated species list?

   N/A

3. How many acres[1] of trees are proposed for removal between 0-100 feet of the existing road/rail surface?

   [1] If described as number of trees, multiply by 0.09 to convert to acreage and enter that number.

   0.4

4. Please describe the proposed bridge work:

   The project involves replacing the existing bridge (Bridge No. 143/077) that carries US Route 4 over the Blackwater River in the Town of Andover, NH. Work includes replacement of the existing bridge structure, constructing new abutments behind the existing abutments, and roadway approach work (approximately 500 feet at each end of the bridge). The bridge will be closed during construction and traffic will be detoured.

5. Please state the timing of all proposed bridge work:

   Bridge work is anticipated to occur during the summer.

6. Please enter the date of the bridge assessment:

   6/10/2022

AVOIDANCE AND MINIMIZATION MEASURES (AMMS)

This determination key result includes the committment to implement the following Avoidance and Minimization Measures (AMMs):

TREE REMOVAL AMM 1

Modify all phases/aspects of the project (e.g., temporary work areas, alignments) to avoid tree removal.

LIGHTING AMM 1

Direct temporary lighting away from suitable habitat during the active season.

TREE REMOVAL AMM 2

Apply time of year restrictions for tree removal when bats are not likely to be present, or limit tree removal to 10 or fewer trees per project at any time of year within 100 feet of existing road/rail surface and **outside of documented** roosting/foraging habitat or travel corridors; visual emergence survey must be conducted with no bats observed.

TREE REMOVAL AMM 3

Ensure tree removal is limited to that specified in project plans and ensure that contractors understand clearing limits and how they are marked in the field (e.g., install bright colored flagging/fencing prior to any tree clearing to ensure contractors stay within clearing limits).

TREE REMOVAL AMM 4

Do not remove **documented** Indiana bat or NLEB roosts that are still suitable for roosting, or trees within 0.25 miles of roosts, or
documented foraging habitat any time of year.

GENERAL AMM 1

Ensure all operators, employees, and contractors working in areas of known or presumed bat habitat are aware of all FHWA/FRA/FTA (Transportation Agencies) environmental commitments, including all applicable AMMs.

DETERMINATION KEY DESCRIPTION: FHWA, FRA, FTA PROGRAMMATIC CONSULTATION FOR TRANSPORTATION PROJECTS AFFECTING NLEB OR INDIANA BAT

This key was last updated in IPaC on October 30, 2023. Keys are subject to periodic revision.

This decision key is intended for projects/activities funded or authorized by the Federal Highway Administration (FHWA), Federal Railroad Administration (FRA), and/or Federal Transit Administration (FTA), which may require consultation with the U.S. Fish and Wildlife Service (Service) under Section 7 of the Endangered Species Act (ESA) for the endangered **Indiana bat** (*Myotis sodalis*) and the endangered **northern long-eared bat** (NLEB) (*Myotis septentrionalis*).

This decision key should only be used to verify project applicability with the Service's amended February 5, 2018, FHWA, FRA, FTA Programmatic Biological Opinion (dated March 23, 2023) for Transportation Projects. The programmatic biological opinion covers limited transportation activities that may affect either bat species, and addresses situations that are both likely and not likely to adversely affect either bat species. This decision key will assist in identifying the effect of a specific project/activity and applicability of the programmatic consultation. The programmatic biological opinion is not intended to cover all types of transportation actions. Activities outside the scope of the programmatic biological opinion, or that may affect ESA-listed species other than the Indiana bat or NLEB, or any designated critical habitat, may require additional ESA Section 7 consultation.

IPAC USER CONTACT INFORMATION

Agency: New Hampshire Department of Transportation
Name: Melilotus Dube
Address: NH Department of Transportation
Address Line 2: 7 Hazen Drive
City: Concord
State: NH
Zip: 03302
Email melilotus.m.dube@dot.nh.gov
Phone: 6032713226

LEAD AGENCY CONTACT INFORMATION

Lead Agency: Federal Highway Administration

New Hampshire DOT
Department of Transportation

William Cass, P.E.
Commissioner

THE STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION

David Rodrigue, P.E.
Assistant Commissioner
Andre Briere, Colonel, USAF (RET)
Deputy Commissioner

ANDOVER
X-A004(384)
40392
RPR 10289

No Historic Properties Affected

In order to assist the Federal Highway Administration (FHWA) in complying with Section 106 of the National Historic Preservation Act of 1966 and its amendments, The New Hampshire Department of Transportation (NHDOT), in consultation with the New Hampshire Division of Historical Resources (SHPO), has reviewed this undertaking according to the standards and procedures detailed in the 2018 Programmatic Agreement regarding the Federal-Aid Highway Program in New Hampshire.

Project Description
The project involves the replacement of the existing bridge (Bridge No. 143/077) that carries US Route 4 over the Blackwater River in the Town of Andover, New Hampshire. Work will include replacement of the existing bridge structure, constructing new abutments behind the existing abutments, and roadway approach work (approximately 500 feet on each end of the bridge). The bridge will be closed during construction and traffic will be detoured.

Identification
Bridge No. 143/077, a single span through-plate girder bridge that was built in 1934, was evaluated for its National Register eligibility and determined not eligible.

A combined Phase IA/IB archaeological survey was completed for the project area. No evidence of archaeological features was found, and no further surveys were recommended.

The property at 338 Plains Road (Parcel 3) contains a building constructed in 1957. Based on coordination with NHDHR, an inventory of this building was not determined to be necessary since it is situated away from US Route 4 and will be minimally impacted by the project.

Public Consultation
A Public Information Meeting was held on August 28, 2019. The public did not express concerns regarding cultural resources at the meeting.

The Andover Historical Society was contacted in 2018 and 2021 but a response was not received.

The New Hampshire Division of Historical Resources (NHDHR) was contacted via Request for Project Review in December 2018. Meetings with NHDHR occurred in December 2020 and August 2022.

Determination of Effect
Bridge No. 143/077 was determined to be not eligible for the National Register so its replacement will not result in an adverse effect.

Although the area adjacent to the project is considered sensitive for archaeological resources, a Phase IA/IB archaeological survey did not find evidence of archaeological features within the project limits.

For the purposes of Section 106 review, the property at 338 Plains Road (Parcel 3) was not surveyed to determine National Register eligibility, as the project involves only a minor amount of impact adjacent to the roadway from minor vegetation clearing and a small amount of fill, from the construction of the proposed bridge. There is a logging business on the parcel that will not be impacted as part of the project, as the driveways will remain intact, and no buildings will be impacted.

Based on a review pursuant to 36 CFR 800.4, NHDOT has determined that no historic or archaeological resources are affected in the project area and that no further survey work is needed.

The result of identification and evaluation for the proposed contract is a finding of **No Historic Properties Affected**.

In accordance with the Advisory Council's regulations, we will continue to consult, as appropriate, as this project proceeds.

Jill Edelmann — 3/16/23
Jill Edelmann — Date
Cultural Resources Manager

Concurred with by the NH State Historic Preservation Officer:

Nadine Miller — 3/7/23
Nadine Miller — Date
Deputy State Historic Preservation Officer
NH Division of Historical Resources

S:\Environment\PROJECTS\ANDOVER\40392\Cultural\Andover40392_NoAffectMemo v2.docx

US Army Corps of Engineers®
New England District

Appendix B
New Hampshire General Permits
Required Information and USACE Section 404Checklist

USACE Section 404 Checklist

1. Attach any explanations to this checklist. Lack of information could delay a USACE permit determination.
2. All references to "work" include all work associated with the project construction and operation. Work includes filling, clearing, flooding, draining, excavation, dozing, stumping, etc.
3. See GC 3 for information on single and complete projects.
4. Contact USACE at (978) 318-8832 with any questions.
5. The information requested below is generally required in the NHDES Wetland Application. See page 61 for NHDES references and Admin Rules as they relate to the information below.

1. Impaired Waters	Yes	No
1.1 Will any work occur within 1 mile upstream in the watershed of an impaired water? See the following to determine if there is an impaired water in the vicinity of your work area. * https://nhdes-surface-water-quality-assessment-site-nhdes.hub.arcgis.com/ https://www.des.nh.gov/water/rivers-and-lakes/water-quality-assessment https://www4.des.state.nh.us/onestopdatamapper/onestopmapper.aspx		X
2. Wetlands	Yes	No
2.1 Are there are streams, brooks, rivers, ponds, or lakes within 200 feet of any proposed work?	X*	
2.2 Are there proposed impacts to tidal SAS, prime wetlands, or priority resource areas? Applicants may obtain information from the NH Department of Resources and Economic Development Natural Heritage Bureau (NHB) DataCheck Tool for information about resources located on the property at https://www4.des.state.nh.us/NHB-DataCheck/.	X*	
2.3 If wetland crossings are proposed, are they adequately designed to maintain hydrology, sediment transport & wildlife passage?	X	
2.4 Would the project remove part or all of a riparian buffer? (Riparian buffers are lands adjacent to streams where vegetation is strongly influenced by the presence of water. They are often thin lines of vegetation containing native grasses, flowers, shrubs and/or trees that line the stream banks. They are also called vegetated buffer zones.)	X	
2.5 The overall project site is more than 40 acres?		X
2.6 What is the area of the previously filled wetlands?	~30,000 SF	
2.7 What is the area of the proposed fill in wetlands?	7,802 SF	
2.8 What % of the overall project sire will be previously and proposed filled wetlands?	~40%	
3. Wildlife	Yes	No
3.1 Has the NHB & USFWS determined that there are known occurrences of rare species, exemplary natural communities, Federal and State threatened and endangered species and habitat, in the vicinity of the proposed project? (All projects require an NHB ID number & a USFWS IPAC determination.) NHB DataCheck Tool: https://www4.des.state.nh.us/NHB-DataCheck/. USFWS IPAC website: https://ipac.ecosphere.fws.gov/	X*	

3.2 Would work occur in any area identified as either "Highest Ranked Habitat in N.H." or "Highest Ranked Habitat in Ecological Region"? (These areas are colored magenta and green, respectively, on NH Fish and Game's map, "2010 Highest Ranked Wildlife Habitat by Ecological Condition.") Map information can be found at: • PDF: https://wildlife.state.nh.us/wildlife/wap-high-rank.html. • Data Mapper: www.granit.unh.edu. • GIS: www.granit.unh.edu/data/downloadfreedata/category/databycategory.html.	X*	
3.3 Would the project impact more than 20 acres of an undeveloped land block (upland, wetland/waterway) on the entire project site and/or on an adjoining property(s)?		X
3.4 Does the project propose more than a 10-lot residential subdivision, or a commercial or industrial development?		X
3.5 Are stream crossings designed in accordance with the GC 31?	X	
4. Flooding/Floodplain Values	Yes	No
4.1 Is the proposed project within the 100-year floodplain of an adjacent river or stream?	X	
4.2 If 4.1 is yes, will compensatory flood storage be provided if the project results in a loss of flood storage?	N/A - No substantial loss of flood storage anticipated*	
5. Historic/Archaeological Resources		
For a minimum, minor or major impact project - a copy of the RPR Form (www.nh.gov/nhdhr/review) with your DES file number shall be sent to the NH Division of Historical Resources as required on Page 37 GC 14(d) of the GP document**	X	
6. Minimal Impact Determination (for projects that exceed 1 acre of permanent impact)	Yes	No
Projects with greater than 1 acre of permanent impact must include the following: • Functional assessment for aquatic resources in the project area. • On and off-site alternative analysis. • Provide additional information and description for how the below criteria are met.	N/A - The project does not involve greater than 1 acre of permanent impact.	
6.1 Will there be complete loss of aquatic resources on site?		
6.2 Have the impacts to the aquatic resources been avoided and minimized to the greatest extent practicable?		
6.3 Will all aquatic resource function be lost?		
6.4 Does the aquatic resource (s) have regional significance (watershed or ecoregion)?		
6.5 Is there an on-site alternative with less impact?		
6.6 Is there an off-site alternative with less impact?		
6.7 Will there be a loss to a resource dependent species?		
6.8 Are indirect impacts greater than 1 acre within and adjacent to the project area?		
6.9 Does the proposed mitigation replace aquatic resource function for direct, indirect, and cumulative impacts?		

*Although this checklist utilizes state information, its submittal to USACE is a federal requirement.
** If your project is not within Federal jurisdiction, coordination with NH DHR is not required under Federal law.

USACE Section 404 Checklist (Appendix B) Supplemental Information

2.1. The project involves the repair of the bridge that carries US Route 4 over the Blackwater River.

2.2. The project proposes approximately 7,802 square feet of permanent wetland impact. This includes approximately 4,463 square feet of permanent impact to prime wetlands. All of the wetlands impacted by the project are considered Priority Resource Areas (floodplain wetlands contiguous to a Tier 3 watercourse).

2.4 The project will involve a small amount of clearing adjacent to the bridge abutments.

3.1. The NH Natural Heritage Bureau (NHB) Report (NHB23-3680) did not include any records of protected species or exemplary natural communities.

The USFWS IPaC report identified northern long-eared bat (NLEB) and monarch butterfly as potentially occurring within the project area. It was determined that the project is within the scope and adheres to the criteria of the FHWA, FRA, FTA Programmatic Biological Opinion for Transportation Projects within the Range of the Indiana Bat and Northern Long-Eared Bat (PBO) and may affect, but is not likely to adversely affect NLEB. A concurrence letter was received from the US Fish and Wildlife Service in February 2024. Tree removal is proposed during the bat inactive season.

Any impacts to potential monarch butterfly habitat would be temporary during construction. The project includes the use of slope seed mixes that contain native wildflowers post-construction.

3.2. The Blackwater River and adjacent wetlands within the project area are mapped as “Highest Ranked Habitat in NH”.

4.2 The segment of the Blackwater River within the project area has a Zone A floodplain but there is no regulatory floodway, based on a review of the FEMA Flood Insurance Rate Map. Given the extensive floodplain within the surrounding area, proposed fill would not be expected to have a noticeable impact on overall flood storage.

Photo 1. View southeast of the Blackwater River and Bridge No. 143/077, looking toward the northeast bridge quadrant (Impact Areas K, L, and M). Photo taken on 7/19/2019.

Photo 2. View northwest of the Blackwater River and bank in the northwest bridge quadrant (Impact Areas D, E, F, and G). Photo taken on 7/19/2019.

Photo 3. View northwest of the Blackwater River and bank in the southwest bridge quadrant (Impact Areas H, I, and J). Photo taken on 7/19/2019.

Photo 4. View east of the Blackwater River, bank, and Bridge No. 143/077 in the southeast bridge quadrant (Impact Areas N, O, and P). Photo taken on 7/19/2019.

Photo 5. View southeast toward Impact Area R (Wetland 6), located in the northeast bridge quadrant. Photo taken on 7/19/2019.

Photo 6. View south toward Prime Wetland Impact Areas T and U (Wetland 7), located in the southeast bridge quadrant. Photo taken on 7/19/2019.

Photo 7. View southeast toward Impact Area C (Wetland 2), located in the southwest bridge quadrant. Photo taken on 4/21/2023.

Photo 8. View northwest toward Impact Areas A and B (Wetland 1), located in the northwest bridge quadrant. The inundated area is Prime Wetland. Photo taken on 4/21/2023.

Photo 9. View northwest toward Impact Areas A and B (Wetland 1), located in the northwest bridge quadrant. The inundated area is Prime Wetland. Photo taken on 4/21/2023.

Photo 10. View southeast toward Bridge No. 143/077. Photo taken on 7/19/2019.

Construction Sequence

1. Install perimeter controls.
2. Perform necessary clearing operations for access and staging.
3. Close road and detour traffic.
4. Excavate for bridge foundations above ordinary high water/top of bank (outside of jurisdictional areas). Work will be conducted from either side of the river, with equipment located outside of the channel.
5. Install steel piles on each side of the river.
6. Install precast concrete abutment walls and wing walls on each side of the river.
7. Backfill structures partially.
8. Install sheet piles and/or sandbag cofferdams around work areas in river channel. A portion of the existing abutments will remain in place. Dewater work area.
9. Cut existing bridge abutments at ground level and remove.
10. Grade areas adjacent to proposed abutments and place riprap. Backfill flatter areas adjacent to abutments with finer material (crushed stone) to create wildlife crossing shelves.
11. Remove sheet piles/cofferdams from work areas in river channel.
12. Erect structural steel and precast concrete deck panels.
13. Construct cast-in-place concrete closure pours.
14. Complete structure backfilling.
15. Construct roadway subgrade and side slopes.
16. Install new drainage structures and construct stormwater treatment swale.
17. Pave roadway and bridge.
18. Install guardrail.
19. Open road. Remove detour signs.
20. Stabilize disturbed areas.
21. Remove perimeter controls.

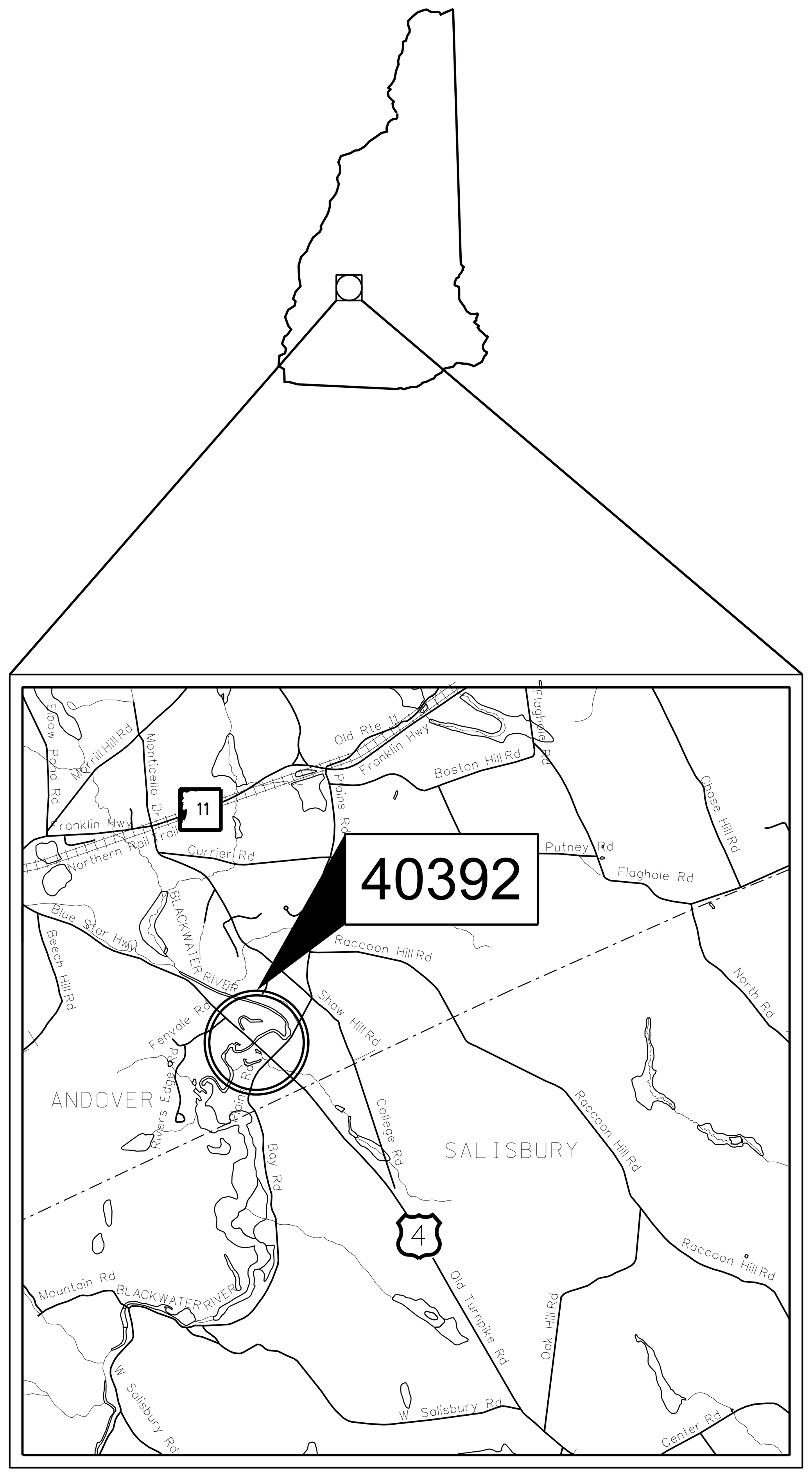
STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION

WETLAND PLANS
BRIDGE REPLACEMENT PROJECT

N.H. PROJECT NO. 40392
US ROUTE 4 OVER BLACKWATER RIVER
BRIDGE NO. 143/077

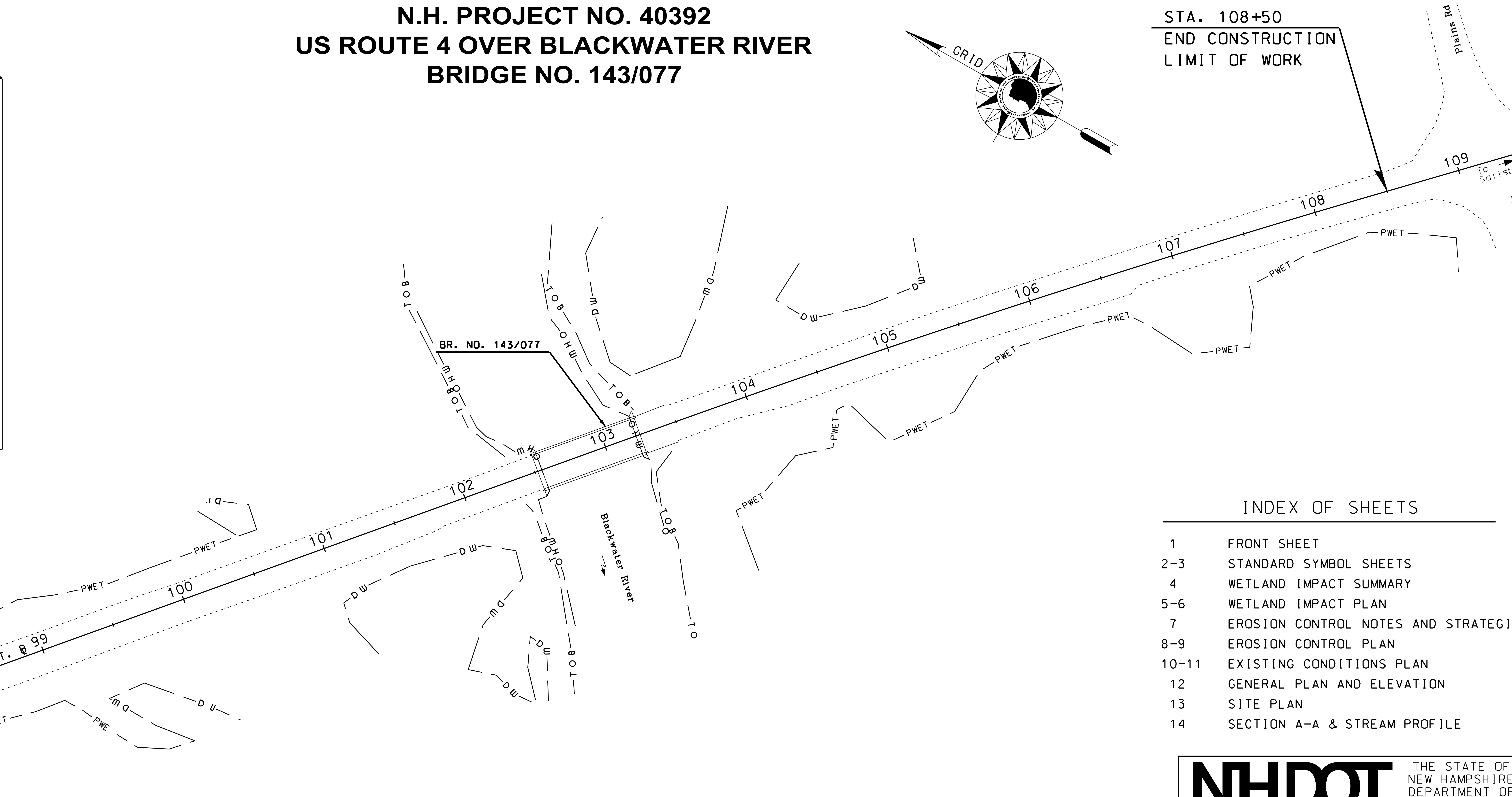
DESIGN DATA

AVERAGE DAILY TRAFFIC 20 22	2211
AVERAGE DAILY TRAFFIC 20 –	–
PERCENT OF TRUCKS	–
DESIGN SPEED	50 MPH
LENGTH OF PROJECT	1175 FT



LOCATION MAP

GRAPHIC SCALE



INDEX OF SHEETS

1	FRONT SHEET
2-3	STANDARD SYMBOL SHEETS
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5-6	WETLAND IMPACT PLAN
7	EROSION CONTROL NOTES AND STRATEGIES
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10-11	EXISTING CONDITIONS PLAN
12	GENERAL PLAN AND ELEVATION
13	SITE PLAN
14	SECTION A-A & STREAM PROFILE

DRAWN BY C. SWEET DATE 4/25/2024
CHECKED BY J. MERCER DATE 4/25/2024

STATE OF NEW HAMPSHIRE Jennifer Riordan No. 269 CERTIFIED WETLAND SCIENTIST

DELINEATION

DESIGN

TOWN OF ANDOVER
COUNTY OF MERRIMACK

SCALE: 1" = 40'

FOR CONSTRUCTION AND ALIGNMENT DETAILS - SEE CONSTRUCTION PLANS

GM2 Associates, Inc.
197 Loudon Road, Suite 310
Concord, NH 03301
Tel: 603-856-7854
Fax: 603-856-7855

NHDOT THE STATE OF NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION

RECOMMENDED FOR APPROVAL:

DIRECTOR OF PROJECT DEVELOPMENT DATE

APPROVED:

ASSISTANT COMMISSIONER AND CHIEF ENGINEER DATE

FEDERAL PROJECT NO.	STATE PROJECT NO.	SHEET NO.	TOTAL SHEETS
X-A004(384)	40392	1	14

GENERAL

	PROPOSED ROADWAY	existing roadway	(pavement removed outside slope lines)
EDGE OF PAVEMENT			
TRAVELED WAY			

DRIVEWAYS — (labelsurface type)

BUILDINGS — (label house or type of building) — (building to be removed)

FOUNDATION — (label type)

LEACH FIELD — leach field

BRIDGE CROSSINGS — STREAM — OVERPASS

STEPS AND WALK — (label type)

INTERMITTENT WATER COURSE

SHORE LINE — river/stream — pond — (label name of water body)

POTENTIAL WET AREA SYMBOL

BRUSH OR WOODS LINE

TREES (PLANS) — (deciduous) (coniferous) (stump)

(show station, circumference in feet & type)

TREE OR STUMP (CROSS-SECTIONS)

HEDGE — (label type)

MONITORING WELL — mon

WELL

FLAG POLE — fp

ORIGINAL GROUND (TYPICALS)

ROCK OUTCROP

ROCK LINE (TYPICALS & SECTIONS ONLY)

	existing	PROPOSED
GUARDRAIL (label type)	bgr / cgr	
JERSEY BARRIER		
CURB (LABEL TYPE)		
STONE WALL		
RETAINING WALL (LABEL TYPE)		(points toward retained ground)
FENCE (LABEL TYPE)		

SIGNS — (single post) — (double post)

GAS PUMP — gp

FUEL TANK (ABOVE GROUND) — ft (label size & type)

STORAGE TANK FILLER CAP — fc

SEPTIC TANK — S

GRAVE — gr

MAILBOX — mb

VENT PIPE — vp

SATELLITE DISH ANTENNA — da

PHONE — ph

GROUND LIGHT/LAMP POST — gl — lp

BORING LOCATION — B

TEST PIT — TP

INTERSTATE NUMBERED HIGHWAY — 293

UNITED STATES NUMBERED HIGHWAY — 3

STATE NUMBERED HIGHWAY — 102

SHORELAND - WETLAND

WETLAND DESIGNATION AND TYPE	2 PUB2E
DELINEATED WETLAND	DW
ORDINARY HIGH WATER	OHW
TOP OF BANK	TOB
TOP OF BANK & ORDINARY HIGH WATER	TOBOHW
NORMAL HIGH WATER	NHW
WIDTH AT BANK FULL	WBF
PRIME WETLAND	PWET
PRIME WETLAND 100' BUFFER	PWET100
NON-JURISDICTIONAL DRAINAGE AREA	NJDA
COWARDIN DISTINCTION LINE	CDL
TIDAL BUFFER ZONE	TBZ
DEVELOPED TIDAL BUFFER ZONE	DTBZ
HIGHEST OBSERVABLE TIDE LINE	HOTL
MEAN HIGH WATER	MHW
MEAN LOW WATER	MLW
VERNAL POOL	VP
SPECIAL AQUATIC SITE	SAS
REFERENCE LINE	REF
WATER FRONT BUFFER	WB50
NATURAL WOODLAND BUFFER	NWB150
PROTECTED SHORELAND	PS250
INVASIVE SPECIES LABEL	I.S. I — I.S. II
INVASIVE SPECIES	INV

FLOODPLAIN / FLOODWAY

500 YEAR FLOODPLAIN BOUNDARY	FP500
100 YEAR FLOODPLAIN BOUNDARY	FP100
FLOODWAY	FW

ENGINEERING

CONSTRUCTION BASELINE — 30 31 32

PC, PT, POT (ON CONST BASELINE)

PI (IN CONSTRUCTION BASELINES)

INTERSECTION OR EQUATION OF TWO LINES

ORIGINAL GROUND LINE (PROFILES AND CROSS-SECTIONS)

PROFILE GRADE LINE (PROFILES AND CROSS-SECTIONS)

SLOPE LINE — CLEARING LINE

CLEARING LINE

SLOPE LINE

SLOPE LINE (FILL)

SLOPE LINE (CUT)

PROFILES AND CROSS SECTIONS:
ORIGINAL GROUND ELEVATION (LEFT) — 72.5
FINISHED GRADE ELEVATION (RIGHT) — 79.14

SHEET 1 OF 2

STATE OF NEW HAMPSHIRE

DEPARTMENT OF TRANSPORTATION ∘ BUREAU OF HIGHWAY DESIGN

STANDARD SYMBOLS

REVISION DATE	DGN	STATE PROJECT NO.	SHEET NO.	TOTAL SHEETS
11-21-2014	40392STDSYMB 1	40392	2	14

DRAINAGE

MANHOLE	(existing) / (PROPOSED)
CATCH BASIN	cb (existing) / (PROPOSED)
DROP INLET	di (existing) / (PROPOSED)
DRAINAGE PIPE (existing)	(label size & type)
DRAINAGE PIPE (PROPOSED)	
UNDERDRAIN (existing) W/ FLUSHING BASIN	fb (label size & type)
UNDERDRAIN (PROPOSED) W/ FLUSHING BASIN	show direction of flow
HEADER (existing & PROPOSED)	(with stone outlet protection)
END SECTION (existing & PROPOSED)	METAL or PLASTIC; RCP
OPEN DITCH (PROPOSED)	
EROSION CONTROL/ STONE SLOPE PROTECTION	

BOUNDARIES / RIGHT-OF-WAY

RIGHT-OF-WAY LINE	(label type)
RR RIGHT-OF-WAY LINE	
PROPERTY LINE	P P
PROPERTY LINE (COMMON OWNER)	Z Z
TOWN LINE	BOW / CONCORD
COUNTY LINE	COOS / GRAFTON
STATE LINE	MAINE / NEW HAMPSHIRE
NATIONAL FOREST	
CONSERVATION LAND	LC LC
BENCH MARK / SURVEY DISK	
BOUND	bnd; (PROPOSED)
STATE LINE/ TOWN LINE MONUMENT	S/L; T/L
NHDOT PROJECT MARKER	
IRON PIPE OR PIN	ip
DRILL HOLE IN ROCK	dh
TAX MAP AND LOT NUMBER	156 14; 1642/341; 6.80 Ac.±
PROPERTY PARCEL NUMBER	12
HISTORIC PROPERTY	H

UTILITIES

	existing	PROPOSED
TELEPHONE POLE	(plot point at face not center of symbol)	
POWER POLE		
JOINT OCCUPANCY		
MISCELLANEOUS/UNKNOWN POLE		
GUY POLE OR PUSH BRACE		
LIGHT POLE		
LIGHT ON POWER POLE		
LIGHT ON JOINT POLE		
POLE STATUS: REMOVE, LEAVE, PROPOSED, OR TEMPORARY AS APPLICABLE e.g.:	R; L	P+04 25.0'; T+04 25.0'
RAILROAD	(label ownership)	
RAILROAD SIGN		
RAILROAD SIGNAL		
UTILITY JUNCTION BOX	jb	JB
OVERHEAD WIRE	OW OW (label type)	OW OW

UNDERGROUND UTILITIES

	existing	PROPOSED
WATER (on existing lines label size, type and note if abandoned)	W W	PW PW
SEWER	S S	PS PS
TELEPHONE	T T	PT PT
ELECTRIC	E E	PE PE
GAS	G G	PG PG
LIGHTING	L L	PL PL
INTELLIGENT TRANSPORTATION SYSTEM	ITS ITS	PITS PITS
FIBER OPTIC	FO FO	PFO PFO
WATER SHUT OFF	WSO	WSO
GAS SHUT OFF	GSO	GSO
HYDRANT	hyd	HYD

MANHOLES

	existing	PROPOSED
SEWER	s	MHS
TELEPHONE	t	MHT
ELECTRICAL	e	MHE
GAS	g	MHG
UNKNOWN	u	

TRAFFIC SIGNALS / ITS

	existing	PROPOSED
MAST ARM (existing)		30' MA (NOTE ANGLE FROM ℄)
OPTICOM RECEIVER		
OPTICOM STROBE		
TRAFFIC SIGNAL		
PEDESTAL WITH PEDESTRIAN SIGNAL HEADS AND PUSH BUTTON UNIT		
SIGNAL CONDUIT	C C C	PC PC PC
CONTROLLER CABINET	cc	CC
METER PEDESTAL	mp	MP
PULL BOX	pb	PB
LOOP DETECTOR (QUADRUPOLE)		(label size)
LOOP DETECTOR (RECTANGULAR)		(label size)
CAMERA POLE (CCTV)		
FIBER OPTIC DELINEATOR	fod	FOD
FIBER OPTIC SPLICE VAULT	f	SVF
ITS EQUIPMENT CABINET	its	ITS
VARIABLE SPEED LIMIT SIGN		
DYNAMIC MESSAGE SIGN		
ROAD AND WEATHER INFO SYSTEM		

CONSTRUCTION NOTES

CURB MARK NUMBER - BITUMINOUS	B-1
CURB MARK NUMBER - GRANITE	G-1
CLEARING AND GRUBBING AREA	A
DRAINAGE NOTE	1
EROSION CONTROL NOTE	A
FENCING NOTE	A
GUARDRAIL NOTE	1
ITS NOTE	1
LIGHTING NOTE	A
TRAFFIC SIGNAL NOTE	1

SHEET 2 OF 2

STATE OF NEW HAMPSHIRE

DEPARTMENT OF TRANSPORTATION ∘ BUREAU OF HIGHWAY DESIGN

STANDARD SYMBOLS

REVISION DATE	DGN	STATE PROJECT NO.	SHEET NO.	TOTAL SHEETS
9-1-2016	40392STDSYMB 2	40392	3	14

WETLAND CLASSIFICATION CODES	
PEM1E	PALUSTRINE, EMERGENT, PERSISTENT, SEASONALLY FLOODED/SATURATED
PFO1E	PALUSTRINE, FORESTED, BROAD-LEAVED DECIDUOUS, SEASONALLY FLOODED/SATURATED
R2UBH	RIVERINE, LOWER PERENNIAL, UNCONSOLIDATED BOTTOM, PERMANENTLY FLOODED
PUBF	PALUSTRINE, UNCONSOLIDATED BOTTOM, SEMIPERMANENTLY FLOODED

LEGEND

TYPE OF WETLAND IMPACT	SHADING/ HATCHING
NEW HAMPSHIRE WETLANDS BUREAU (PERMANENT NON-WETLAND)	
NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND)	
TEMPORARY IMPACTS	

\# WETLAND DESIGNATION NUMBER

\# WETLAND IMPACT LOCATION

\# WETLAND MITIGATION AREA

MITIGATION

NOTES:

1. WETLANDS WERE DELINEATED BY JENNIFER RIORDAN (CWS #269) OF GM2 ASSOCIATES, INC. ON NOVEMBER 28, 2018 AND JULY 19, 2019 IN ACCORDANCE WITH THE US ARMY CORPS OF ENGINEERS (USACE) 1987 METHODOLOGY AND THE USACE NORTHCENTRAL AND NORTHEAST REGIONAL SUPPLEMENT (2012). WETLAND BOUNDARIES WERE FIELD-CHECKED AND UPDATED ON JUNE 10 AND 14, 2022 AND APRIL 21, 2023.

2. THE 100-YEAR FLOODPLAIN ENCOMPASSES THE ENTIRE PROJECT LIMITS. THEREFORE, IT IS NOT SHOWN ON THE WETLAND IMPACT PLAN.

WETLAND IMPACT SUMMARY												
WETLAND NUMBER	WETLAND CLASS	LOCATION IDENTIFIER	WOTUS (Y/N)	AREA IMPACTS						LINEAR STREAM IMPACTS FOR MITIGATION		
				PERMANENT				TEMPORARY		PERMANENT		
				NHWB JURISDICTION		NHWB & ACOE JURISDICTION				BANK LEFT	BANK RIGHT	CHANNEL
				SF	LF	SF	LF	SF	LF	LF	LF	LF
1	PFO1E	A	Y			4116						
1	PFO1E	B	Y			660						
2	PFO1E	C	Y			1209						
4	BANK	D	Y	205	50						50	
4	BANK	E	Y					50	12			
3	R2UBH	F	Y			329	52					52
3	R2UBH	G	Y					728	17			
3	R2UBH	H	Y			400	54					54
4	BANK	I	Y	208	43						43	
4	BANK	J	Y					24	8			
5	BANK	K	Y					199	34			
5	BANK	L	Y	139	22					22		
3	R2UBH	M	Y					313				
3	R2UBH	N	Y			162	32					32
5	BANK	O	Y					18	6			
5	BANK	P	Y	123	22					22		
6	PFO1E	Q	Y			70						
6	PFO1E	R	Y			1400						
7	PFO1E	S	Y			185						
7	PUBF	T	Y			161						
7	PUBF	U	Y			1						
			TOTAL	675	137	8693	138	1332	77	44	93	138

PERMANENT IMPACTS: 9368 SF
TEMPORARY IMPACTS: 1332 SF

TOTAL IMPACTS: 10700 SF

REVISIONS AFTER PROPOSAL

NUMBER	DATE	STATION	STATION	DESCRIPTION

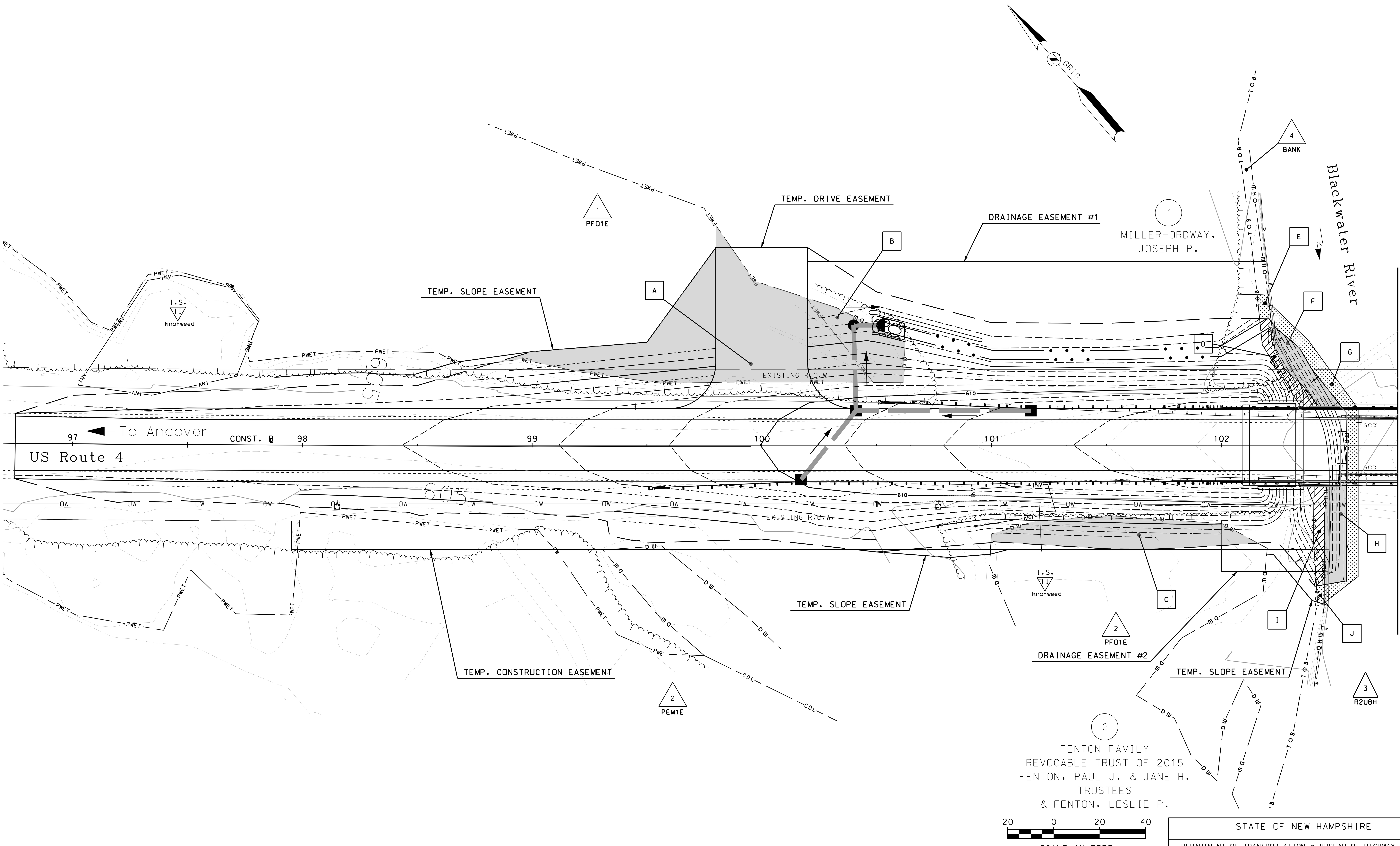
SDR PROCESSED C. SWEET DATE 4/25/2024
NEW DESIGN S. HILL DATE 4/25/2024
SHEET CHECKED J. MERCER DATE 4/25/2024
AS BUILT DETAILS DATE

STATE OF NEW HAMPSHIRE

DEPARTMENT OF TRANSPORTATION ∘ BUREAU OF HIGHWAY DESIGN

WETLAND IMPACT SUMMARY

DGN	STATE PROJECT NO.	SHEET NO.	TOTAL SHEETS
40392WET_SUM	40392	4	14



REVISIONS AFTER PROPOSAL

NUMBER	DATE	STATION	STATION	DESCRIPTION

SDR PROCESSED	C. SWEET	DATE 4/25/2024
NEW DESIGN	S. HILL	DATE 4/25/2024
SHEET CHECKED	J. MERCER	DATE 4/25/2024
AS BUILT DETAILS		DATE

STATE OF NEW HAMPSHIRE

DEPARTMENT OF TRANSPORTATION ∘ BUREAU OF HIGHWAY DESIGN

WETLAND IMPACT PLAN

DGN	STATE PROJECT NO.	SHEET NO.	TOTAL SHEETS
40392WET_1	40392	5	14

STATE OF NEW HAMPSHIRE

DEPARTMENT OF TRANSPORTATION ∘ BUREAU OF HIGHWAY DESIGN

WETLAND IMPACT PLAN

DGN	STATE PROJECT NO.	SHEET NO.	TOTAL SHEETS
40392WET_2	40392	6	14

REVISIONS AFTER PROPOSAL

NUMBER	DATE	STATION	STATION	DESCRIPTION

SDR PROCESSED	C. SWEET	DATE	4/25/2024
NEW DESIGN	S. HILL	DATE	4/25/2024
SHEET CHECKED	J. MERCER	DATE	4/25/2024
AS BUILT DETAILS		DATE	

EROSION CONTROL NOTES AND STRATEGIES

1. Erosion Control/Stormwater Control Selection, Sequencing and Maintenance
   1.1. Comply with RSA 485-A:17 Terrain Alteration.
   1.2. Install and maintain all erosion control/stormwater controls in accordance with the New Hampshire Stormwater Management Manual, Volume 3, Erosion and Sediment Controls During Construction, December 2008 (BMP Manual), available from the NH Department of Environmental Services (NHDES).
   1.3. Install erosion control/stormwater control measures prior to the start of work and in accordance with the manufacturer's recommendations.
   1.4. Select erosion control/stormwater control measures based on the size and nature of the project and physical characteristics of the site, including slope, soil type, vegetative cover, and proximity to jurisdictional areas.
   1.5. Install perimeter controls prior to earth disturbing activities.
   1.6. Install stormwater treatment ponds and drainage swales before rough grading the site.
   1.7. Clean, replace, and augment stormwater control measures and infiltration basins as necessary to prevent sedimentation beyond project limits throughout the project duration.
   1.8. Inspect erosion and sediment control measures in accordance with Section 645 of the specifications, weekly, and within 24 hours (during normal work hours), of any storm event greater than 0.25 inches of rain in a 24-hour period.
   1.9. Contain stockpiles with temporary perimeter controls. Protect inactive soil stockpiles with soil stabilization measures (temporary erosion control seed mix and mulch, soil binder) or cover them with anchored tarps. If the stockpile is to remain undisturbed for more than 14 days, mulch the stockpile.
   1.10. Maintain temporary erosion and stormwater control measures in place until the area has been permanently stabilized.
   1.11. An area is considered stable if one of the following has occurred:
      - Base course gravels have been installed in areas to be paved;
      - A minimum of 85% vegetative growth has been established;
      - A minimum of 3"of non-erosive material such as stone or rip-rap has been installed;
      - Temporary slope stabilization has been properly installed (see Table 1).
   1.12. Direct runoff to temporary practices until permanent stormwater infrastructure is constructed and stabilized.
   1.13. Use temporary mulching, permanent mulching, temporary vegetative cover, and permanent vegetative cover to reduce the need for dust control. Use mechanical sweepers on paved surfaces where necessary to prevent dust buildup. Apply water, or other dust inhibiting agents or tackifiers.
   1.14. Plan activities to account for sensitive site conditions
      - Sequence construction to limit the duration and area of exposed soils.
      - Clearly flag areas to be protected in the field and provide construction barrier to prevent trafficking outside of work areas.
      - Protect and maximize existing native vegetation and natural forest buffers between construction activities and sensitive areas.
      - When work is undertaken in a flowing watercourse, implement stream flow diversion methods prior to any excavation or filling activity.
   1.15. Utilize storm drain inlet protection to prevent sediment from entering a storm drainage system prior to the permanent stabilization of the contributing disturbed area.
   1.16. Use care to ensure that sediments do not enter any existing catch basins during construction. Place temporary inlet protection at inlets in areas of soil disturbance that are subject to sedimentation.
   1.17. Construct, stabilize, and maintain temporary and permanent ditches in a manner that will minimize scour. Direct temporary and permanent ditches to drain to sediment basins or stormwater collection areas.
   1.18. Supplement channel protection measures with perimeter control measures when ditch lines occur at the bottom of long fill slopes. Install the perimeter controls on the fill slope to minimize the potential for fill slope sediment deposits in the ditch line.
   1.19. Divert sediment laden water away from drainage inlet structures to the extent possible.
   1.20. Install sediment barriers and sediment traps at drainage inlets to prevent sediment from entering the drainage system.
   1.21. Clean catch basins, drainage pipes, and culverts if significant sediment is deposited.
   1.22. Construct and stabilize dewatering infiltration basins prior to any excavation that may require dewatering.
   1.23. Place and stabilize temporary sediment basins or traps at locations where concentrated flow (channels and pipes) discharge to the surrounding environment from areas of unstabilized earth disturbing activities.
   1.24. Stabilize, to appropriate anticipated velocities, conveyance channels or pumping systems needed to convey construction stormwater to basins and discharge locations prior to use.
   1.25. Size temporary sediment basins to contain the 2-year, 24 hour storm event.
   1.26. Size temporary sediment traps to contain 3,600 cubic feet of storage for each acre of drainage area.
   1.27. Construct detention basins to accommodate the 2-year, 24-hour storm event.

2. Construction Planning
   2.1. Divert off site runoff or clean water away from the construction activities to reduce the volume that needs to be treated on site.
   2.2. Divert storm runoff from upslope drainage areas away from disturbed areas, slopes and around active work areas to a stabilized outlet location.
   2.3. Construct impermeable barriers, as necessary, to collect or divert concentrated flows from work or disturbed areas.
   2.4. Locate staging areas and stockpiles outside of wetlands jurisdiction.
   2.5. Do not store, maintain, or repair mobile heavy equipment in wetlands, unless equipment cannot be practicably removed and secondary containment is provided.
   2.6. Provide a water truck to control excessive dust, at the discretion of the Contract Administrator.

3. Site Stabilization
   3.1. Stabilize all areas of unstabilized soil as soon as practicable, but no later than 45 days after initial disturbance.
   3.2. Limit unstabilized soil to a maximum of 5 acres unless documentation is provided that demonstrates that cuts and fills are such that 5 acres is unreasonable.
   3.3. Use erosion control seed mix in all inactive construction areas that will not be permanently seeded within two weeks of disturbance and prior to September 15th of any given year in order to achieve vegetative stabilization prior to the end of the growing season.
   3.4. Apply, and reapply as necessary, soil tackifiers in accordance with the manufacturer's specifications to minimize soil and mulch loss until permanent vegetation is established.
   3.5. Stabilize basins, ditches and swales prior to directing runoff to them.
   3.6. Stabilize roadway and parking areas within 72 hours of achieving finished grade.
   3.7. Stabilize cut and fill slopes within 72 hours of achieving finished grade.
   3.8. When temporarily stabilizing soils and slopes, utilize the techniques outlined in Table 1.
   3.9. Stabilize all areas that can be stabilized prior to opening up new areas to construction activities.
   3.10. Utilize Table 1 when selecting temporary soil stabilization measures.
   3.11. Divert off-site water through the project in an appropriate manner so as not to disturb the upstream or downstream soils, vegetation or hydrology beyond the permitted area.
   3.12. Install and maintain construction exits anywhere traffic leaves a construction site onto a public right-of-way.
   3.13. Sweep all construction related debris and soil from the adjacent paved roadways, as necessary.

4. Slope Protection
   4.1. Intercept and divert storm runoff from upslope drainage areas away from unprotected and newly established areas and slopes to a stabilized outlet or conveyance.
   4.2. Consider how groundwater seepage on cut slopes may impact slope stability and incorporate appropriate measures to minimize erosion.
   4.3. Convey storm water down the slope in a stabilized channel or slope drain.
   4.4. The outer face of the fill slope should be in a loose, ruffled condition prior to turf establishment.

5. Winter Construction
   5.1. To minimize erosion and sedimentation impacts, limit the extent and duration of winter excavation and earthwork activities. The maximum amount of disturbed earth shall not exceed a total of 5 acres from May 1st through October 15th, or exceed one acre during winter months, unless the contractor demonstrates to the Department that the additional area of disturbance is necessary to meet the contractor's Critical Path Method (CPM) schedule, and the contractor has adequate resources available to ensure that environmental requirements will be met.
   5.2. Construction performed any time between October 15th and May 1st of any year is considered winter construction. During winter construction:
      - Stabilize all proposed vegetation areas which do not exhibit a minimum of 85% vegetative growth by October 15th, or which are disturbed after October 15th, in accordance with Table 1.
      - Stabilize all ditches or swales which do not exhibit a minimum of 85% vegetative growth by October 15th, or which are disturbed after October 15th, in accordance with Table 1.
      - Protect incomplete road surfaces, where base course gravels have not been installed, and where work has stopped for the season after October 15th, in accordance with Table 1.
      - Unless a winter construction plan has been approved by NHDOT, conduct winter excavation and earthwork such that no more than 1 acre of the project is without stabilization an any one time.

6. Wildlife Protection Measures
   6.1. Report all observations of threatened and endangered species on the project site to the Department's Bureau of Environment by phone at 603-271-3226 or by email at Bureau16@dot.nh.gov, indicating in the subject line the project name, number, and that a threatened/endangered species was found.
   6.2. Photograph the observed species and nearby elements of habitat or areas of land disturbance and provide them to the Department's Bureau of Environment at the above email address.
   6.3. In the event that a threatened or endangered species is observed on the project during work, the species shall not be disturbed, handled, or harmed prior to receiving direction from the Bureau of Environment.
   6.4. Utilize wildlife friendly erosion control methods when:
      - Erosion control blankets are used,
      - A protected species or habitat is documented,
      - The proposed work is in or adjacent to a priority resource area, and/or when specifically requested by NHB or NHF&G

GUIDANCE ON SELECTING TEMPORARY SOIL STABILIZATION MEASURES
TABLE 1

APPLICATION AREAS	DRY MULCH METHODS				HYDRAULICALLY APPLIED MULCHES[2]				ROLLED EROSION CONTROL BLANKETS[3]			
	HMT	WC	SG	CB	HM	SMM	BFM	FRM	SNSB	DNSB	DNSCB	DNCB
SLOPES[1]												
STEEPER THAN 2:1	NO	NO	YES	NO	NO	NO	NO	YES	NO	NO	NO	YES
2:1 SLOPE	YES1	YES1	YES	YES	NO	NO	YES	YES	NO	YES	YES	YES
3:1 SLOPE	YES	YES	YES	YES	NO	YES	YES	YES	YES	YES	YES	NO
4:1 SLOPE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	NO	NO
WINTER STABILIZATION	4T/AC	YES	YES	YES	NO	NO	YES	YES	YES	YES	YES	YES
CHANNELS												
LOW FLOW CHANNELS	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	YES	YES
HIGH FLOW CHANNELS	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	YES

ABBREV.	STABILIZATION MEASURE	ABBREV.	STABILIZATION MEASURE	ABBREV.	STABILIZATION MEASURE
HMT	HAY MULCH & TACK	HM	HYDRAULIC MULCH	SNSB	SINGLE NET STRAW BLANKET
WC	WOOD CHIPS	SMM	STABILIZED MULCH MATRIX	DNSB	DOUBLE NET STRAW BLANKET
SG	STUMP GRINDINGS	BFM	BONDED FIBER MATRIX	DNSCB	2 NET STRAW-COCONUT BLANKET
CB	COMPOST BLANKET	FRM	FIBER REINFORCED MEDIUM	DNCB	2 NET COCONUT BLANKET

NOTES:
1. All slope stabilization options assume a slope length ≤ 10 times the horizontal distance component of the slope, in feet.
2. Do not apply products containing polyacrylamide (PAM) directly to, or within 100 feet of any surface water without NHDES approval.
3. Install all methods in Table 1 per the manufacturer's recommendation for time of year and steepness of slope.

STATE OF NEW HAMPSHIRE

DEPARTMENT OF TRANSPORTATION ∘ BUREAU OF HIGHWAY DESIGN

EROSION CONTROL PLANS

	REVISION DATE	DGN	STATE PROJECT NO.	SHEET NO.	TOTAL SHEETS
erosstrat-ce	02-29-2024	sd-erostrat-02292024	40392	7	14

EROSION CONTROL LEGEND

PC — PERIMETER CONTROL
- SILT FENCE
- EROSION CONTROL MIX BERM
- EROSION CONTROL MIX SOX
- TURBIDITY CURTAIN
- SHEET PILE
- COFFER DAM

NB/PC — NATURAL BUFFER/PERIMETER CONTROL
- SILT FENCE
- EROSION CONTROL MIX BERM
- EROSION CONTROL MIX SOX
- TURBIDITY CURTAIN
- SHEET PILE
- COFFER DAM

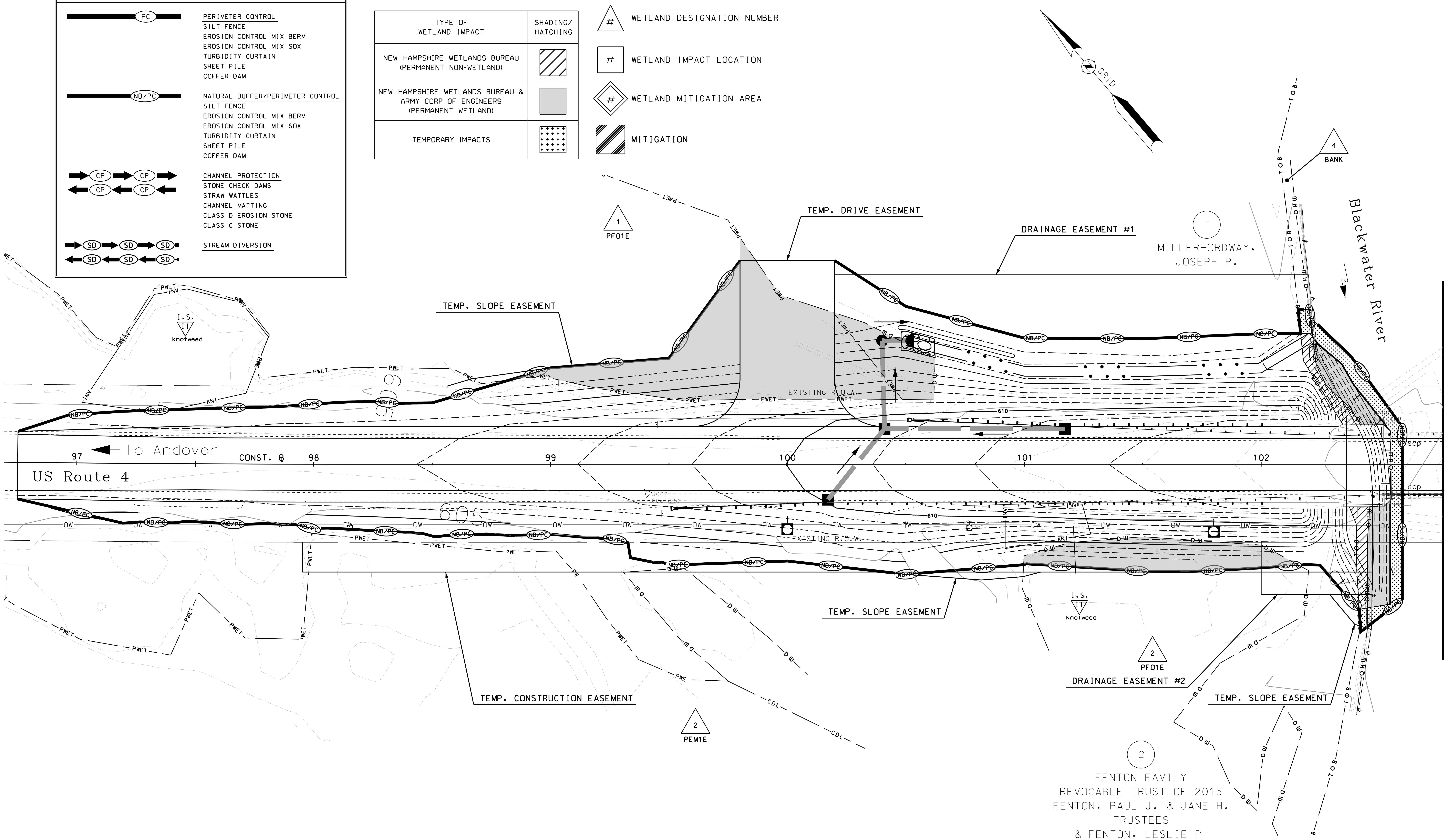
CP — CHANNEL PROTECTION
- STONE CHECK DAMS
- STRAW WATTLES
- CHANNEL MATTING
- CLASS D EROSION STONE
- CLASS C STONE

SD — STREAM DIVERSION

LEGEND

TYPE OF WETLAND IMPACT	SHADING/ HATCHING
NEW HAMPSHIRE WETLANDS BUREAU (PERMANENT NON-WETLAND)	hatched
NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND)	shaded
TEMPORARY IMPACTS	dotted

- △ # — WETLAND DESIGNATION NUMBER
- □ # — WETLAND IMPACT LOCATION
- ◇ # — WETLAND MITIGATION AREA
- MITIGATION



20 0 20 40
SCALE IN FEET

REVISIONS AFTER PROPOSAL			
NUMBER	DATE	STATION	DESCRIPTION

SDR PROCESSED C. SWEET DATE 4/25/2024
NEW DESIGN S. HILL DATE 4/25/2024
SHEET CHECKED J. MERCER DATE 4/25/2024
AS BUILT DETAILS DATE

GM2

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION ◦ BUREAU OF HIGHWAY DESIGN

EROSION CONTROL PLAN

DGN	STATE PROJECT NO.	SHEET NO.	TOTAL SHEETS
40392EROC_1	40392	8	14

REVISIONS AFTER PROPOSAL			
NUMBER	DATE	STATION	DESCRIPTION

SDR PROCESSED	C. SWEET	DATE 4/25/2024
NEW DESIGN	S. HILL	DATE 4/25/2024
SHEET CHECKED	J. MERCER	DATE 4/25/2024
AS BUILT DETAILS		DATE

STATE OF NEW HAMPSHIRE

DEPARTMENT OF TRANSPORTATION • BUREAU OF HIGHWAY DESIGN

EROSION CONTROL PLAN

DGN	STATE PROJECT NO.	SHEET NO.	TOTAL SHEETS
40392EROC_2	40392	9	14

REVISIONS AFTER PROPOSAL

NUMBER	DATE	STATION	STATION	DESCRIPTION

SDR PROCESSED C. SWEET DATE 4/25/2024
NEW DESIGN S. HILL DATE 4/25/2024
SHEET CHECKED J. MERCER DATE 4/25/2024
AS BUILT DETAILS DATE

STATE OF NEW HAMPSHIRE

DEPARTMENT OF TRANSPORTATION ◦ BUREAU OF HIGHWAY DESIGN

EXISTING CONDITIONS PLAN

GM2

DGN	STATE PROJECT NO.	SHEET NO.	TOTAL SHEETS
40392ECO_1	40392	10	14

REVISIONS AFTER PROPOSAL

NUMBER	DATE	STATION	STATION	DESCRIPTION

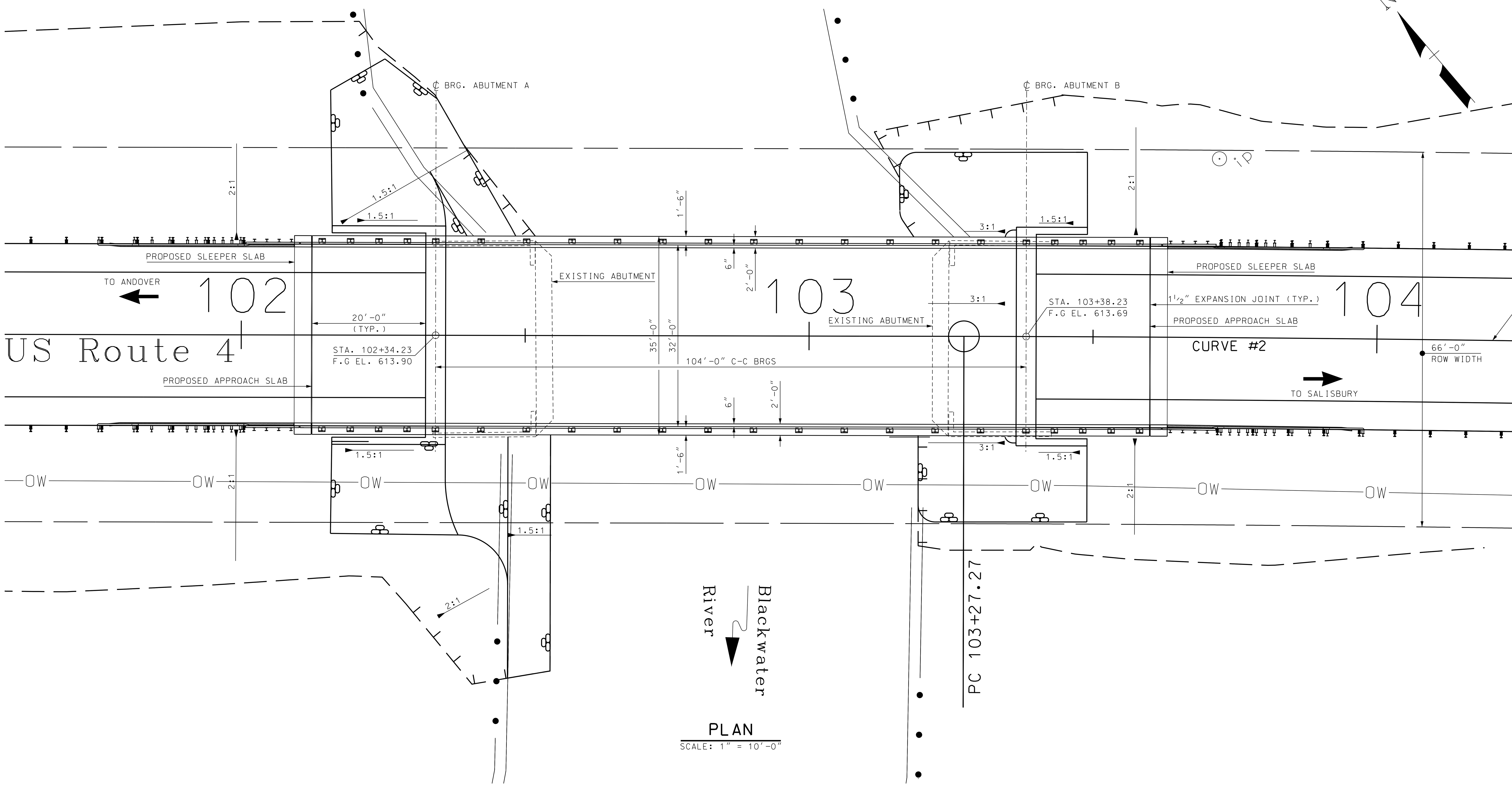
SDR PROCESSED	C. SWEET	DATE	4/25/2024
NEW DESIGN	S. HILL	DATE	4/25/2024
SHEET CHECKED	J. MERCER	DATE	4/25/2024
AS BUILT DETAILS		DATE	

STATE OF NEW HAMPSHIRE

DEPARTMENT OF TRANSPORTATION • BUREAU OF HIGHWAY DESIGN

EXISTING CONDITIONS PLAN

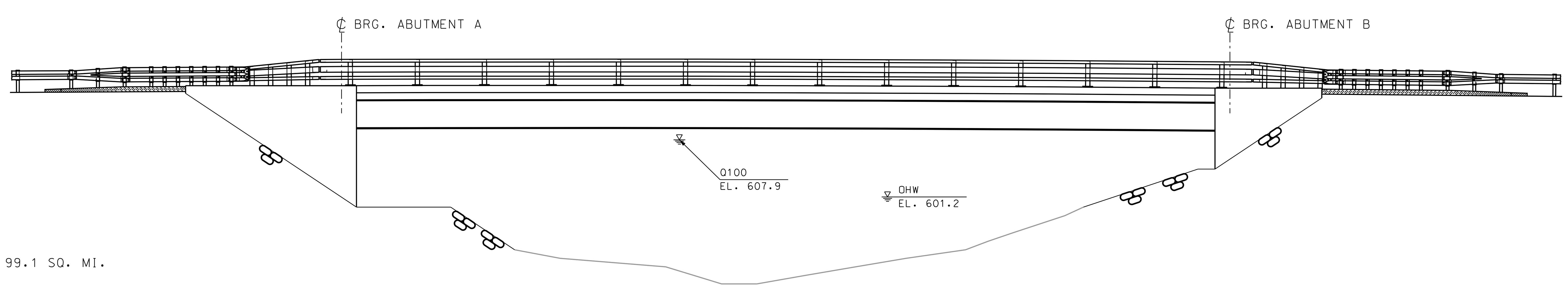
DGN	STATE PROJECT NO.	SHEET NO.	TOTAL SHEETS
40392ECO_2	40392	11	14



PLAN

SCALE: 1" = 10'-0"

CURVE #2 - US ROUTE 4
PI =105+88.47
N =335790.06
E =955206.94
Δ =03°38'56.4" RT
D =0°41'55.4"
R =8200.00'
T =261.21'
L =522.24'
E =4.16'



ELEVATION

SCALE: 1" = 10'-0"

HYDRAULIC DATA

1. DRAINAGE AREA: 99.1 SQ. MI.
2. DESIGN FLOOD: Q100 = 7930 CFS
3. DESIGN VELOCITY: 3.7 FPS
4. DESIGN FLOOD ELEVATION: Q100 ELEV. = 607.9'
5. BRIDGE WATERWAY OPENING: 1256 SF

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION * BUREAU OF BRIDGE DESIGN

TOWN | BRIDGE NO. | STATE PROJECT

LOCATION

GENERAL PLAN AND ELEVATION

BRIDGE SHEET 1 OF 3

FILE NUMBER

REVISIONS AFTER PROPOSAL

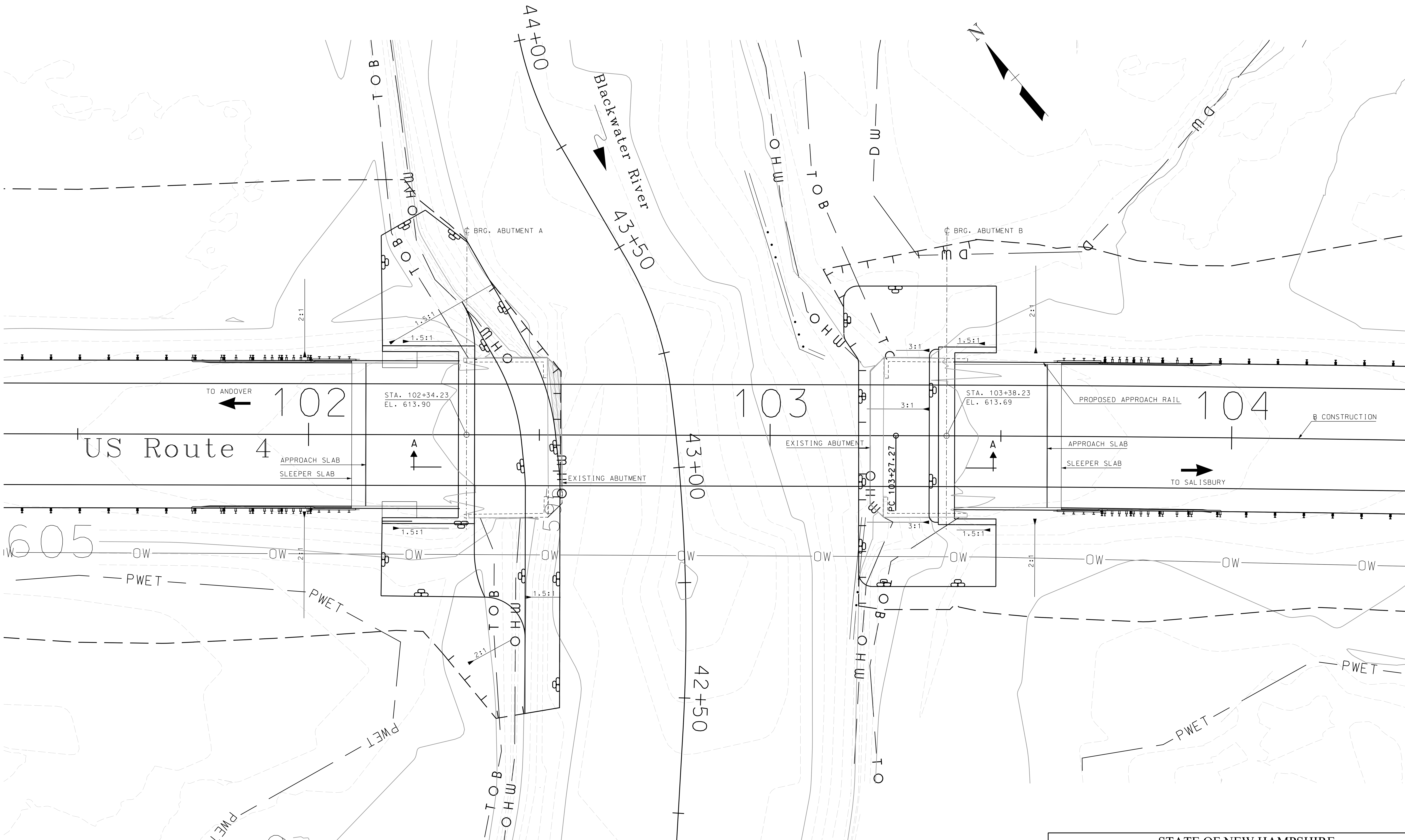
	BY	DATE		BY	DATE
DESIGNED	BJL	08/23	CHECKED	TPL	11/23
DRAWN	BJL	08/23	CHECKED	TPL	11/23
QUANTITIES	BJL	08/23	CHECKED	TPL	11/23

ISSUE DATE | FEDERAL PROJECT NO. | SHEET NO. 12 | TOTAL SHEETS 14

REV. DATE

GM2

SUBDIRECTORY	.DGN LOCATOR	SHEET SCALE
BRC/BRSITE	40392gen-env	1" = 10'-0"



SITE PLAN

SCALE: 1" = 10'-0"

SUBDIRECTORY	.DGN LOCATOR	SHEET SCALE
BRC/BRSITE	40392site-env	1" = 10'-0"

STATE OF NEW HAMPSHIRE

DEPARTMENT OF TRANSPORTATION * BUREAU OF BRIDGE DESIGN

TOWN | BRIDGE NO. | STATE PROJECT

LOCATION

SITE PLAN

REVISIONS AFTER PROPOSAL

	BY	DATE		BY	DATE
DESIGNED	BJL	02/24	CHECKED	TPL	02/24
DRAWN	BJL	02/24	CHECKED	TPL	02/24
QUANTITIES	BJL	02/24	CHECKED	TPL	02/24

ISSUE DATE

REV. DATE

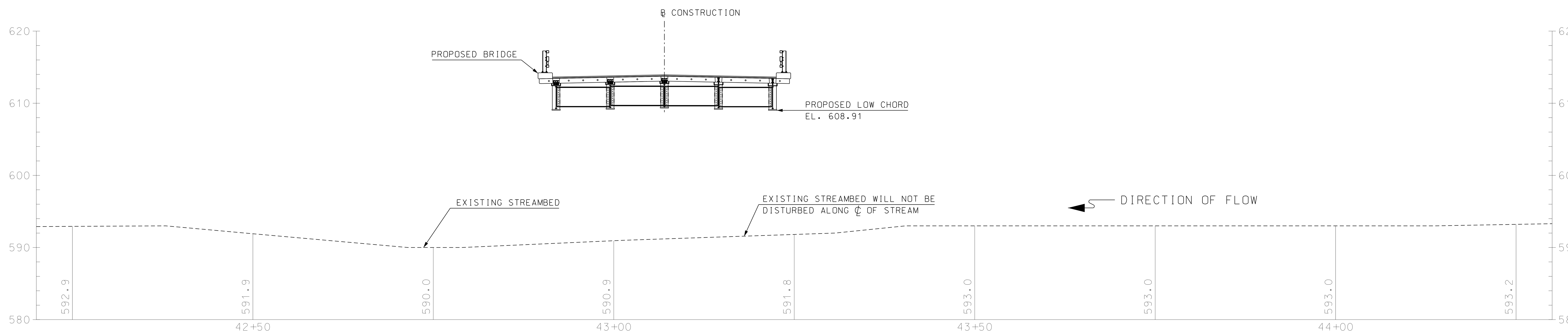
BRIDGE SHEET 2 OF 3

FILE NUMBER

FEDERAL PROJECT NO.	SHEET NO.	TOTAL SHEETS
	13	14

SECTION A-A

SCALE: 3/16" = 1'-0"



BLACKWATER RIVER PROFILE

SCALE: 1/8" = 1'-0"

SUBDIRECTORY	.DGN LOCATOR	SHEET SCALE
BRC/BRSITE	40392profile-env	AS NOTED

STATE OF NEW HAMPSHIRE

DEPARTMENT OF TRANSPORTATION * BUREAU OF BRIDGE DESIGN

TOWN | BRIDGE NO. | STATE PROJECT

LOCATION

SECTION A-A & STREAM PROFILE

BRIDGE SHEET 3 OF 3

FILE NUMBER

REVISIONS AFTER PROPOSAL

	BY	DATE		BY	DATE
DESIGNED	BJL	02/24	CHECKED	TPL	10/23
DRAWN	BJL	02/24	CHECKED	TPL	10/23
QUANTITIES	-	-	CHECKED	-	-

ISSUE DATE | FEDERAL PROJECT NO. | SHEET NO. 14 | TOTAL SHEETS 14

REV. DATE