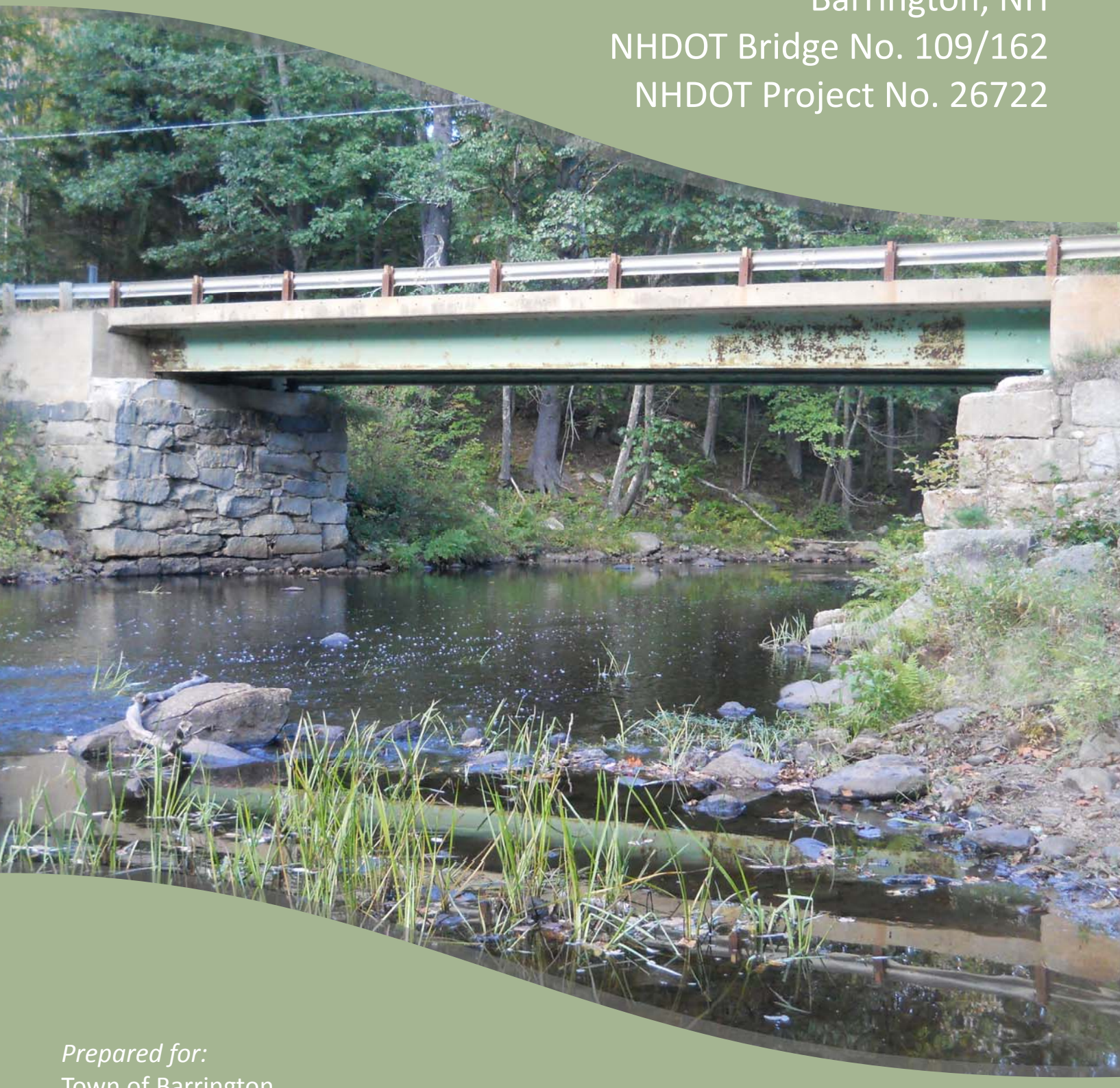
Engineering Study

Greenhill Road Bridge over the Isinglass River
Barrington, NH
NHDOT Bridge No. 109/162
NHDOT Project No. 26722



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May 2015

Hoyle, Tanner & Associates, Inc.

TABLE OF CONTENTS

LOCATION MAP 1

1 PROJECT DESCRIPTION 2

2 EXISTING CONDITIONS 3
2.1 Greenhill Road 3
2.1.1 Traffic 3
2.1.2 Roadway Geometry 3
2.1.3 Roadway Typical Section 4
2.1.4 Roadway Side Slope and Guardrail 4
2.1.5 Drainage 4
2.1.6 Intersection Sight Distance and Vehicle Turning Movements 5
2.2 Bridge No. 109/162 5

3 DESIGN CRITERIA 6
3.1 Greenhill Road 6
3.2 Bridge Replacement 6

4 PROPOSED ROADWAY IMPROVEMENTS 7
4.1 Roadway Geometry 7
4.2 Roadway Typical Section 7
4.3 Roadway Side Slopes and Guardrail 7
4.4 Roadway Drainage 8
4.5 Intersection Sight Distance, Vehicle Turning Movements, Driveways 8

5 FOUNDATION CONSIDERATIONS 9
5.1 Subsurface Investigation Program 9
5.2 Foundation Recommendations 9

6 TRAFFIC CONTROL PLAN CONSIDERATIONS 10
6.1 Bridge Closure with Detour 10
6.2 Phased Construction 10
6.3 Temporary Bridge 10
6.4 Traffic Control Recommendations 11

7 UTILITIES 11

8 ENVIRONMENTAL CONSIDERATIONS 12
8.1 Stream Crossing Considerations 12
8.2 Other Considerations 14

9 HYDRAULICS 14

10 CULTURAL RESOURCE CONSIDERATIONS 15

11 MAINTENANCE 16

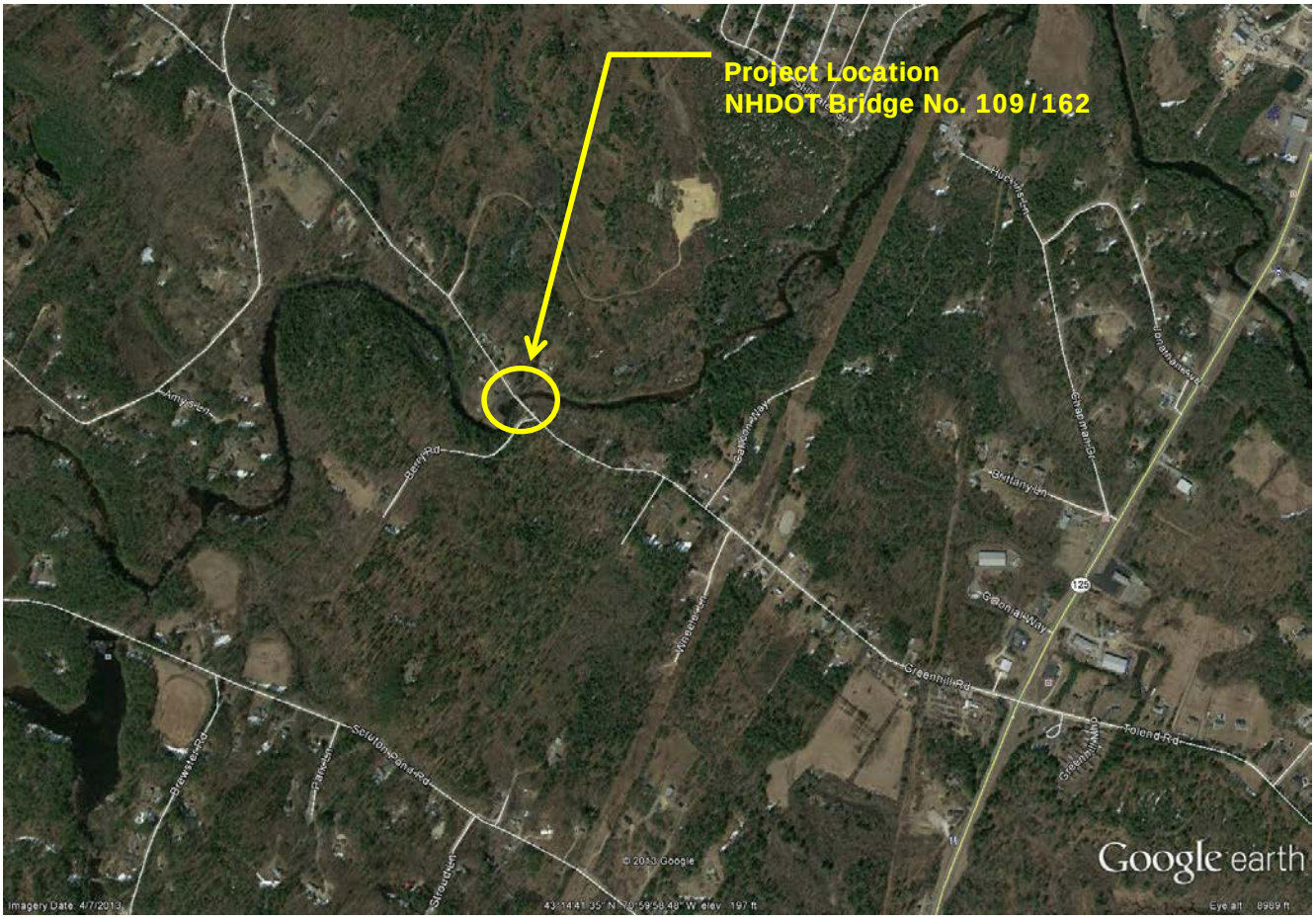
12 BRIDGE REPLACEMENT/REHABILITATION ALTERNATIVES 16
12.1 Alternative 1 - "No Build" 17
12.2 Alternative 2 – Rehabilitation 17
12.3 Alternative 3 – Complete Replacement 17
12.3.1 Superstructure Alternative 3A - Steel Beams 18
12.3.2 Superstructure Alternative 3B – Prestressed Concrete NEBT Beams 18
12.3.3 Substructure Alternative 3A – Conventional Abutments 19
12.3.4 Substructure Alternative 3B – Integral Abutments 19

CONCLUSIONS AND RECOMMENDATIONS 20

APPENDICES

A. Plans of Proposed Improvements
B. Boring Layout Plan and Boring Logs
C. Engineer's Estimate of Probable Construction Costs
D. NHDOT Bridge Inspection Report
E. 1954 Existing Plans
F. Hydrologic and Hydraulic Analysis
G. Individual Inventory Form
H. Greenhill Rd / Isinglass River Bridge Closure: Traffic Re-routing and Travel Times
I. Wetlands Study
J. Glossary

LOCATION MAP



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1 PROJECT DESCRIPTION

In accordance with the agreement between the Town of Barrington and Hoyle, Tanner & Associates, Inc., this Engineering Study (Study) has been prepared to investigate potential replacement options for the municipally owned New Hampshire Department of Transportation (NHDOT) Bridge No. 109/162, Greenhill Road Bridge over Isinglass River. This investigation was conducted in a manner consistent with the American Association of State Highway and Transportation Officials (AASHTO) specifications with improvements limited to the area around the bridge. Roadway improvements for this project are also limited to the area around the bridge. This study is administered, and the majority of funding provided through, the NHDOT Municipally Managed Bridge Aid Program.

The Study was compiled using information available from existing State of New Hampshire Department of Public Works and Highways bridge design drawings, NHDOT bridge inspection and load rating information, hydrologic and hydraulic information available from USGS and FHWA, as well as data collected and photographs taken during site visits by Hoyle, Tanner and their subconsultants. The intent of this Study is to evaluate existing conditions and project purpose and need, and to recommend a solution which best accomplishes the project goals.

The need for the project is due to the functionally obsolete Greenhill Road Bridge while the purpose is to improve safety by improving roadway geometry and providing a new rail system while minimizing cost and construction duration. The goal of this Study is to identify a rehabilitation or replacement alternative of the Greenhill Road Bridge that best meets the project purpose and need.

To aid the reader's understanding of the replacement alternatives evaluated, it is important to provide a brief overview of the terminology used to describe the alternatives considered. Three bridge alternatives were investigated in this Study. The three bridge alternatives investigated are referred to as Alternative 1 ("No Build"), Alternative 2 (Rehabilitation), and Alternative 3 (Complete Replacement). Four alternatives were investigated under Alternative 3 (Complete Replacement) including two superstructure alternatives and two substructure alternatives, referred to as Superstructure Alternative 3A (Steel Beams), Superstructure Alternative 3B (Prestressed Concrete NEBT Beams), Substructure Alternative 3A (Conventional Abutments) and Substructure Alternative 3B (Integral Abutments). Either of the superstructure alternatives can be combined with either of the substructure alternatives. Two roadway horizontal alignments and three profiles alternatives were evaluated. The roadway alignments and profiles evaluated are discussed in Section 4, Proposed Roadway Improvements. The bridge structure alternatives were considered independently from the roadway geometry alternatives, as none of the bridge structure alternatives is dependent upon the roadway geometry.

For the purposes of this Study, west is assumed to be the upstream direction from the bridge. The project limits considered for this report are located approximately 250' north and 230' south of the proposed bridge for a total project length of 575'. In addition, the project limits extend approximately 90' west along Seavey Bridge Road.

2 EXISTING CONDITIONS

2.1 Greenhill Road

Greenhill Road Looking North

Greenhill Road is a 2.5 mile long local road contained within the Town of Barrington. Its western terminus is at a four-way intersection with NH Route 202 (Washington Street) and Pond Hill Road. Greenhill Road continues southeastward to its eastern terminus at a four-way intersection with NH Route 125 (Calef Highway) and Tolend Road. The Greenhill Road Bridge is located approximately 150' to the west of the Greenhill Road and Seavey Bridge Road intersection and carries Greenhill Road over the Isinglass River. The posted speed limit is 30 mph. "One Lane Bridge" warning signs with 20 mph advisory speed plaques are located prior to the bridge in either approach. There are no pavement markings on the roadway.

2.1.1 Traffic

The Annual Average Daily Traffic Volume (AADT) is 1848 vehicles on Greenhill Road according to the Stafford Regional Planning Commission traffic counts conducted on May 5, 2014.

2.1.2 Roadway Geometry

The existing horizontal alignment is laid out generally northwest to southeast. Starting approximately 400' northwest of the bridge there is a 950' radius curve to the left for approximately 235', followed by a 100' tangent section and then a 2000' radius curve to the right for approximately 74' ending approximately 80' prior to the bridge. The horizontal alignment then continues on a tangent section over the bridge for a distance of approximately 133' and starts to curve to the left approximately 15' after the bridge with a 1146' radius curve for 130' and then to a tangent section.

Greenhill Road Looking South

Along the horizontal alignment, the vertical profile grades vary on the northwest side of the bridge between -4.26% to -9.71% with vertical curves adequate for a vehicle speed of 30

mph. Entering the bridge location the profile grade is -6.74%, and exiting the bridge location the profile grade is +3.95%. A sag vertical curve exists through the bridge location. The sag vertical curve has a K-value of 18 which is adequate for a vehicle speed of 20 mph. On the southeasterly side of the bridge beyond the sag vertical curve the profile grades range from +3.95% to +1.92% with vertical curves adequate for a vehicle speed of 30 mph.

There are several driveways located relatively close to the bridge. On north side of Greenhill Road, northwest of the bridge, there are driveways located 55', 310' and 385' from the bridge. On south side of Greenhill Road, northwest of the bridge, there are driveways located 130', 230' and 300' from the bridge. Seavey Bridge Road intersects Greenhill Road on the south side with a splitter island with one leg approximately 80' from the bridge and the other leg approximately 210' from the bridge.

2.1.3 Roadway Typical Section

Greenhill Road is a 22' wide paved roadway consisting of two 11' wide lanes, except at the bridge where the roadway narrows to a single 18' wide lane. There are gravel shoulders 1' to 2' wide along both sides of the roadway beyond the bridge limits. There is an existing paved ditch along the edge of the roadway on the north side of Greenhill Road west of the bridge which begins just beyond the first driveway after the bridge and continues for approximately 230' to the next driveway.

Greenhill Road is generally crowned throughout the project area, with a crown of approximately 1.0% to 2.0%.

2.1.4 Roadway Side Slope and Guardrail

Roadway side slopes in the vicinity of the bridge and river are 2H:1V along all four quadrants. Beyond the bridge limits the roadway side slopes start to become flatter. Guardrail length and terminal sections at all approaches do not meet current standards.

2.1.5 Drainage

Stormwater runoff sheet flows off Greenhill Road into roadside ditches/shoulders and eventually discharges to the Isinglass River and the wetlands surrounding it. Southeast of the bridge, a 12" dia. CMP conveys drainage from the south side to the north side of Greenhill Road prior to Seavey Bridge Road. The drainage from this culvert enters the Isinglass River on the north side of the bridge.

Northwest of the bridge, on the north side of Greenhill Road, drainage runoff is collected in a paved roadside ditch which outlets into a 12" dia. CMP drive culvert and enters the Isinglass River on the north side of the bridge. On the south side of the road the drainage runoff is collected in a roadside ditch, crosses a drive through a 12" ADS pipe, and enters the Isinglass River on the south side of the bridge.

2.1.6 Intersection Sight Distance and Vehicle Turning Movements

Seavey Bridge Road intersects with Greenhill Road in the southern approach to the bridge and is a gravel road with undefined horizontal roadway geometry. The entrance to Seavey Bridge Road is divided by a naturally made splitter island, and one leg of the entrance intersects Greenhill Road at an extreme skew angle. Improving the intersection layout will be evaluated for the proposed layout. Intersection Sight Distance (ISD) exceeds current requirements for the 30 mph posted speed limit; no improvements are envisioned to improve ISD.

2.2 Bridge No. 109/162

Downstream Elevation View

The date of construction of the Greenhill Road Bridge is unknown, however, in 1955 the superstructure was replaced and the substructure was rehabilitated. The existing 62' single span bridge consists of three steel I-beams and a concrete deck. The bridge superstructure is supported by masonry stone abutments with concrete caps and backwalls. There are masonry stone u-back wingwalls in each quadrant with concrete caps and masonry stone retaining walls along the southern banks. The total out-to-out width of the bridge is 20'-8" and carries one lane of traffic on an 18' wide paved roadway. The bridge is currently posted with 'C-2' load posting signs.

According to the latest NHDOT Bridge Inspection Report, the NBIS Status of the bridge is functionally obsolete and the deck geometry is intolerable. Greenhill Road serves as a cut-through connection between NH Route 202 and NH Route 125, with a relatively high volume of commuter traffic on this single lane bridge. Therefore, the Town of Barrington and NHDOT are undertaking efforts to investigate replacement options.

Upstream Elevation View

Personnel from Hoyle, Tanner visited the site several times while preparing this Study to gather measurements and other pertinent information for the Study. Our observations are generally in agreement with our review of the latest NHDOT Bridge Inspection Report (See Appendix D for the lasted NHDOT Bridge Inspection Report). The superstructure is in good condition and the substructure is in satisfactory condition. However, the superstructure is considered non-redundant with three beams and causes the bridge to be a structural concern.

3 DESIGN CRITERIA

3.1 Greenhill Road

ROADWAY FUNCTIONAL CLASS:	Rural, Local
DESIGN SPEED:	30 MPH (posted speed)
DESIGN MANUALS:	1) AASHTO "A Policy on Geometric Design of Highways and Streets", 2011, 6th Edition. 2) AASHTO "Roadside Design Guide", 2011, 4th Edition. 3) NHDOT Highway Design Manual, 1999.
CONSTRUCTION SPECIFICATIONS:	1) NHDOT Standard Specifications for Road and Bridge Construction, 2010.
DESIGN GUIDELINES:	1) NCHRP Report 480; "A Guide to Best Practices for Achieving Context Sensitive Solutions", 2002. 2) AASHTO "A Guide for Achieving Flexibility in Highway Design", May 2004.

3.2 Bridge Replacement

DESIGN LOADING:	HL-93
DESIGN MANUALS:	1) NHDOT Bridge Design Manual, 2015
DESIGN & CONSTRUCTION SPECIFICATIONS:	1) AASHTO LRFD Bridge Design Specifications 7th Edition with 2015 Interims
CONSTRUCTION SPECIFICATIONS	1) NHDOT Standard Specifications for Road and Bridge Construction, 2010.
DESIGN GUIDELINES:	1) "New Hampshire Stream Crossing Guidelines", May 2009, the University of New Hampshire.

4 PROPOSED ROADWAY IMPROVEMENTS

4.1 Roadway Geometry

Two roadway horizontal alignments were evaluated. The first horizontal alignment evaluated closely matches the existing conditions as discussed above, and the second horizontal alignment evaluated provides a modification to the existing alignment by removing the slight reverse curve on the northwesterly side of the bridge. The second horizontal alignment evaluated is the preferred alignment as it improves roadway geometry and has minimal impacts.

Three vertical roadway profiles were evaluated. The first was a profile which closely matched the existing condition profile as discussed above. The profile for this condition was adequate for a vehicle speed of 20-mph at the bridge location. The second profile evaluated provides for an increased K-value over the bridge which is adequate for a vehicle speed of 25-mph. The third profile evaluated provides for an increased K-value over the bridge which is adequate for the posted speed limit of 30-mph. Slope impacts were evaluated for each profile alternative.

Each profile evaluated was presented at a Public Information Meeting in October, 2014. The slope impacts and approximate construction cost differences between the profiles were discussed. After discussing the profiles and receiving public input, the Select Board voted to move forward with the 30-mph profile. With the direction provided by the Select Board, a detailed analysis of the impacts and costs were prepared for the preferred alternative only.

The 30 mph profile was selected as the preferred roadway profile since 30 mph is the minimum design speed typically used for roadways classified as rural local and it is also adequate for the posted speed limit for this section of roadway.

4.2 Roadway Typical Section

The typical roadway section for Greenhill Road will consist of two (2) 11' travel lanes (22' total pavement width) with a minimum 1' gravel shoulder, which mimics the existing condition. Seavey Bridge Road will consist of 16' of pavement and 1' gravel shoulders. Both roadways will have a normal crown of 2.0%. For estimating purposes, the roadway structural section for Greenhill Road will consist of 4.5" of hot bituminous pavement, including a 1.5" wearing course and 3.0" binder course, as well as 6" of crushed gravel underlain by 12" of bank run gravel. Although this pavement section is greater than the Town standard, it is intend to be consistent with the existing pavement on the roadway that was identified in the borings. Seavey Bridge Road will consist of 3.5" of hot bituminous pavement and 6" of crushed gravel with 12" of gravel. This pavement design will be further evaluated in the design phase of the project to verify the material depths of the roadway section.

4.3 Roadway Side Slopes and Guardrail

Proposed guardrail is designed utilizing the 2011 AASHTO Roadside Design Guide.

Roadway side slopes on the northwest quadrant will require 2H:1V slopes from the bridge to the driveway at Sta 103+64 Rt. Guardrail is warranted throughout this location. This guardrail section is proposed to terminate with a Curved Radial Terminal (CRT) unit along the edge of drive radius.

Roadway side slopes on the northeast quadrant will be constructed with 4H:1V slopes from the river to the driveway at Sta 104+40 Lt. Although 4H:1V slopes typically do not warrant guardrail, due to the close proximity from the bridge to the driveway a guardrail section will be proposed in this location. The proposed bridge approach rail will taper beyond the roadway clear zone at an 8:1 flare rate and will be wrapped along the edge of the driveway similar to the existing condition.

Roadway side slopes on the southeast quadrant requires 1.5H:1V slopes near the bridge to avoid permanent Right-of-Way slope impacts. Stone rip-rap will be proposed on this slope. The side slopes transition to 4H:1V relatively quickly, approximately 100 feet from the bridge. Guardrail is warranted due to the steep slope. This section of guardrail will terminate with a 25' Energy Absorbing Guardrail Terminal (EAGRT) unit.

Roadway side slopes on the southwest quadrant requires 1.5H:1V slopes near the bridge. Stone rip-rap will be proposed on this slope. The side slopes transition to 4H:1V relatively quickly, approximately 75 feet from the bridge. Guardrail is warranted due to the steep slope and will terminate in an EAGRT unit prior to the Seavey Bridge Road.

4.4 Roadway Drainage

Stormwater runoff is proposed to sheet flow off Greenhill Road into roadside ditches/shoulders to the Isinglass River and the surrounding wetlands similar to the existing conditions. Southeast of the bridge, the 12" CMP will be replaced with a 15" RCP and continue to convey drainage from the south side of Greenhill Road to the north side. The drainage will then flow along a ditch and then enter the Isinglass River on the north side of the bridge.

West of Seavey Bridge Road the drainage runoff will sheet flow off of Greenhill Road and travel overland to the Isinglass River.

On the northwest quadrant of Greenhill Road drainage runoff is collected in a paved ditch, which outlets into a 12" CMP drive culvert and enters the Isinglass River on the north side of the bridge. This culvert is proposed to be replaced with a 12" HDPE pipe. The paved ditch will be proposed to be removed and replaced with a proper lining to prevent erosion.

On the east side of the road the drainage runoff is collected in a road side ditch, crosses the drive at 103+64 Rt through a 12" HDPE pipe and enters the Isinglass River on the east side of the bridge. With the raise in grade this pipe may require extensions on both ends. The proposed design intent is to maintain the existing inlet and outlet conditions and allow the drainage to flow as it does in the existing conditions.

4.5 Intersection Sight Distance, Vehicle Turning Movements, Driveways

Seavey Bridge Road is proposed to be realigned to a more standardized "T" intersection. The intersection sight distance is adequate for the design speed of 30 mph. The corner radii proposed at the intersection are adequate for school buses and single unit trucks traveling southbound on Greenhill Road to turn right onto Seavey Bridge Road and remain within their travel lane.

As the preferred alternative will raise the profile elevation at the existing drive at Sta. 103+64 RT, further analysis will be needed during the preliminary design to determine if additional driveway reconstruction can provide a gentler grade or if a driveway relocation is desired.

5 FOUNDATION CONSIDERATIONS

5.1 Subsurface Investigation Program

On May 26, 2014, two bridge borings and one probe was performed by Northern Test Boring, Inc. (NTB). A copy of the boring logs (prepared by NTB) and the boring location plan are included in Appendix B. The subsurface explorations were terminated at refusal depths of 40.2' and 45.3' below the existing roadway elevation for the bridge borings, and at 24.4' below the existing roadway elevation for the probe.

The two bridge borings exhibited similar soil characteristics. From the top of existing roadway to a depth of 2', soils consisted of brown fine-medium sand and gravel trace silt (select gravel materials used in roadway construction), followed by 20' of brown fine-medium sand and gravel trace silt. The bottom soil layer consisted of grey silty fine sand (glacial till), underlain by bedrock. Bedrock was encountered at 30.2' at boring B-1 and 40.8' at boring B-2. Groundwater was located at depths of approximately 12.7' and 14.4' for borings B-1 and B-2, respectively.

For the probe, glacial till was encountered at a depth of 17', and augur refusal was at a depth of 24.4'. Given the results of the borings, it is expected that refusal for the probe was a boulder or cobble in the glacial till layer, and not bedrock. The historic boring information shown on the 1959 design plans indicates bedrock at or near the depth of refusal for the probes; however, it is assumed that the historic borings were terminated at obstructions above bedrock (boulders or cobbles), similar to what was encountered with the probe.

5.2 Foundation Recommendations

Calculations were performed to determine the ultimate bearing strength of the soil based on the borings taken and AASHTO LRFD Bridge Design Specifications. The supporting soils at the bridge were determined to have a nominal bearing resistance of 9 tons per square foot and a resistance factor (Φ) equal to 0.45. The existing granular materials are considered suitable for direct support of spread footings, for Substructure Alternative 3A (Conventional Abutments), due to the bearing strength, relative uniformity of the soil stratum and the absence of organic or cohesive soils.

For Substructure Alternative 3B (Integral Abutments), the rock quality of bedrock is adequate to support end bearing piles. Therefore, the site conditions are also considered adequate for

a pile supported foundation structure.

Groundwater will most likely be encountered during the excavation necessary for the construction of the spread footings. Foundation subgrade preparation and foundation construction shall be performed "in the dry" by implementing a suitable dewatering system.

6 TRAFFIC CONTROL PLAN CONSIDERATIONS

Three traffic control options were considered as part of this Study:

6.1 Bridge Closure with Detour

Complete closure of the bridge during construction is feasible for this project. Strafford Regional Planning Commission (SRPC) prepared a report summarizing detour routes around the bridge and their associated distances and expected travel times. The report, titled *Greenhill Rd / Isinglass River Bridge Closure: Traffic Re-routing and Travel Times*, is included in Appendix H.

6.2 Phased Construction

The second option considered during the study was to construct the bridge using phased construction. The bridge would be replaced in two phases while maintaining a single lane of alternating two-way traffic at all times. Due to the narrow width of the existing bridge, this traffic control alternative would require a permanent shift of the horizontal roadway alignment, or an over-widened new bridge to accommodate a single lane of traffic during construction. In addition, the existing bridge would be phased such that the deck overhang at the construction joint would be significant and would require additional bracing from the deck to the existing beam. This alternative would add considerable expense, require additional ROW acquisitions, and would extend the construction duration of the project.

6.3 Temporary Bridge

The use of a temporary bridge structure with either a single lane of alternating two-way traffic, or a wider structure carrying two lanes of traffic, was also considered. A residential structure is located immediately upstream of the bridge in the north approach, in close proximity to the existing right-of-way and bridge structure. Therefore, the only viable location for a temporary bridge structure would be downstream of the existing bridge. The downstream slopes adjacent to the existing bridge are steep and a considerable amount of fill would be required to construct the temporary bridge structure; placement of the fill would require additional clearing of vegetation as well as temporary stream and wetland impacts. Compared to a detour, a temporary bridge structure would increase both the construction duration and cost of the project because of the following reasons:

- Need for additional temporary right-of-way acquisitions
- Construction of temporary roadway approaches
- Rental and installation of the temporary bridge structure
- Temporary bridge removal and restoration of temporary impact areas

6.4 Traffic Control Recommendations

The proposed traffic control options considered during preparation of the study were presented at the Public Information meeting on October 20, 2014. After some discussion, which included input from the Town of Barrington Fire Chief on the insignificant impact of a bridge closure on emergency services response time, the Selectboard voted to move forward with the bridge closure with detour during construction traffic control alternative. This alternative has the least environmental and ROW impacts, lowest construction cost, and shortest construction duration of the traffic control alternatives considered. Further, there is an additional benefit of higher quality construction due to the elimination of the phasing joints necessary in the phased construction approach.

7 UTILITIES

Overhead utility lines are located parallel with Greenhill Road on the east side of the road and include electric, telephone and cable services. The utility lines span from a utility pole located southeast of the project limits to a utility pole located northeast of the project limits and are approximately 10' offset from the existing bridge fascia. Overhead line relocation or shielding may be required prior to the start of construction to allow installation of the new bridge.

Effective June 19, 2013, per RSA 371.17, public utility companies that construct or relocate overhead wires upon a new or existing line of poles over, under, or across any of the "public waters" of the state, or over, under, or across any of the land owned by the state are required to file a petition requesting a license from the Public Utilities Commission (PUC). NHDES maintains the Official List of Public Waters (OLPW) and it essentially includes waterbodies protected under the Shoreland Water Quality Protection Act. The review of the petition requesting a license can take a minimum of six months and may require a public hearing if one is requested. It is typical for this process to take up to 12 months.

RSA 371:18 provides for an exception to this rule, stating that a license may be waived when it is requested by the public utility for the exclusive purpose of furnishing or relocating overhead utility lines at the request of the state or any department or agency thereof. Thus, any projects that receive funding from state or federal funds are eligible for this exception. A written letter from a state department or agency requesting such exemption must be submitted to the utility companies required to apply for a license for the project for their submittal to the PUC. It is essential that coordination between Hoyle, Tanner, NHDOT and the utility companies should be completed early in project design phase to ensure that the required waivers are obtained and overhead utility lines are relocated prior to the commencement of construction.

There are no known underground utilities within the project area based on review of available records and the field verification site visit by Dig-Safe.

8 ENVIRONMENTAL CONSIDERATIONS

8.1 Stream Crossing Considerations

The NHDES Stream Crossing Rules (Env-Wt 900) (Rules) and New Hampshire Stream Crossing Guidelines (Guidelines) became effective in May 2010 and established additional standards for the design, construction and permitting of stream crossings in New Hampshire. The Rules and Guidelines require new and replacement stream crossings to be both hydraulically and geomorphically compatible with the dimensions of the existing stream. In addition to a traditional hydraulic analysis, the guidelines provide several requirements for sizing a new or replacement stream crossing based on the characteristics and geometry of the stream.

Looking Downstream

Looking Upstream

The drainage area of the Isinglass River at Greenhill Road is 66.1 square miles which is greater than one square mile and, therefore, it is classified as a Tier 3 crossing. As a result, the replacement structure must be either a span structure or an open-bottomed culvert per NHDES and the recently adopted wetland rules (Env-Wt 904.01) of the NHDES Stream Crossing Rules. This project, assuming replacement of the existing bridge with steel beams or prestressed NEBT beams, will have minor impacts on Isinglass River since both alternatives provide an open-bottom and can be dimensioned to maintain existing habitat and flow.

Per the Stream Crossing Guidelines, the width of a new or replacement stream crossing structure should provide for the adequate passage of water, sediment, and organic matter at all flow levels. In an attempt to standardize adequate stream crossings, an opening of 1.2 times the bankfull width plus 2' is provided as a minimum requirement in Section III of the Guidelines. The bankfull width of the Isinglass River at the Greenhill Road crossing in the vicinity of the bridge ranges from 60' to 70', with an outlier measurement of 130' directly upstream of the bridge. The 130' bankfull width measurement is not typical of the Isinglass River at any point along its length from the outlet of Bow Lake to its confluence with the Cocheco River; therefore, this measurement was not used in calculating the average bankfull width (65') or the required bridge opening. Based solely on this guideline, the replacement

structure would require a minimum opening of 80' if the average measured bankfull width is used, and the guideline of 1.2 times bankfull width plus 2' is followed.

The Stream Crossing Guidelines provide an additional criterion for adequately dimensioning a new or replacement stream crossing which is based on the entrenchment ratio of the stream within the natural range of variability for the stream type. This guideline suggests that the width of new or replacement bridges be at least equal to the bankfull width times the entrenchment ratio of the stream crossing. Based on the Hydrologic and Hydraulic Analysis performed by Hoyle, Tanner, Isinglass River at Greenhill Road is a B3c-type Stream. B3c-type streams are characterized, in part, by entrenchment ratios between 1.4 and 2.2. Therefore, based solely on this guideline, the replacement structure would require a minimum opening size equal to 1.4 times the bankfull width. For the Isinglass River crossing at Greenhill Road, any replacement structure would require a 91'-wide opening based on this guideline if the average bankfull width is used.

The area available for the opening of the bridge is limited by the location of a driveway in the northwest quadrant and Seavey Bridge Road in the southeast quadrant of the project site. Replacement of the existing structure with an opening at or near the maximum entrenchment ratio and/or the maximum bankfull width would be cost prohibitive and impracticable due to the restrictions of the site constraints. As such, it is reasonable to select a bridge span of 95' which corresponds to a bridge opening (clear span) of 93'.

Another specification in the Stream Crossing Guidelines for the replacement of Tier 3 crossings indicates that there should be no increase in the 100-year flood elevations on abutting properties [Env-Wt 904.05(e)(1)]. All three bridge replacement alternatives that were evaluated in this study increase the hydraulic opening of the stream crossing. Based on the hydrologic and hydraulic analysis performed by Hoyle, Tanner, the 100-year flood levels will decrease slightly as a result of the proposed bridge replacement alternatives.

The Rules state that an alternative design can be proposed if a specific rule stated in the guidelines is not practicable (Env-Wt 904.09). Practicable is defined by Env-Wt 101.73 as "available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes." A written request sealed by a professional engineer or environmental scientist must be submitted to NHDES that explains how the proposed alternative demonstrates that adhering strictly to the stream crossing guidelines is not practicable in this case. This request must also state how the proposed alternative meets specific design criteria specified in Env-Wt 904.05 to the maximum extent practicable and also satisfies all general design criteria specified in Env-Wt 904.01.

This project will impact areas under the jurisdiction of the NHDES Wetlands Bureau. Therefore, in accordance with RSA 482-A, a Standard Dredge and Fill Permit from the NHDES Wetlands Bureau will be required to construct the project. The Isinglass River is classified as a Designated River and therefore is jurisdictional under the Shoreland Water Quality Protection Act (SWQPA) and as such, an NHDES Shoreland Permit will also be required. However, because this is a public infrastructure project, it will qualify for a Shoreland Permit By Notification (PBN).

8.2 Other Considerations

Based on the results of our consultation with New Hampshire Natural Heritage Bureau (NHB), it was determined that, although there was a NHB record present in the vicinity of the project, the NHB does not expect that it will be impacted by the proposed project.

A database search of the New Hampshire Department of Environmental Services (NHDES) OneStop Data Geographic Information indicated the presence of a remediation site; DES Site #201204061. An oil spill was detected in March 2012 in the basement of a foreclosed house, at 78 Greenhill Road, and included the release of home heating oil from an above ground storage tank. Ground water at the site was assessed and monitored for approximately one year. In July 2013 a close-out memo from NHDOT noted that the site remediation has been completed and NHDES issued a Certificate of No Further Action for the site. The location of the oil spill is approximately 2,400' from the project site; therefore, the proposed project would not disturb this remediation site since it is located well beyond the project limits (See Exhibit F).

9 HYDRAULICS

Hydrologic and hydraulic analyses were performed for the Isinglass River crossing at the Greenhill Road Bridge. The analysis results are summarized herein; comprehensive results are provided in Appendix F.

The NHDOT requires the 50-year design flood flow (Q_{50}) and corresponding water surface elevation to be determined. The Q_{50} design flood event has a 2% chance of being met or exceeded each year. The low chord elevation is required to be a minimum of 1' above the Q_{50} elevation. The 10-, 50- and 100-year flood flows were predicted in the hydraulic report using three methods – the USGS Streamstats program, the Federal Highway Administration (FHWA) 7-parameter method, and the area-relationship method using USGS gauging station flow data. All three methods produce similar flows; therefore, the results of the FHWA 7-parameter method were used for the hydraulic analyses. The results shown below indicate that the existing bridge passes both the Q_{50} and Q_{100} events with adequate freeboard to the low chord.

Existing Hydraulic Data:
50-Year and 100-Year Storms

	50-Year	100-Year
Drainage Area:	66.1 square miles	66.1 square miles
Water Surface Elevation:	170.1 feet	170.9 feet
Water Surface Flow:	5,000 cfs	5,900 cfs
Water Surface Velocity:	13.4 fps	14.2 fps
Bridge Opening:	754 sf	754 sf
Bridge Waterway Opening Below The Design Flood Elevation:	400 sf	433 sf
% Opening Full During the Design Flood:	53%	57%

The proposed bridge opening was sized based on the Stream Crossing Guidelines, as previously discussed. These guidelines suggest a minimum stream crossing of 1.2 times the bankfull width plus 2'. The bankfull width was measured in the field to be an average of 65' which results in a superstructure span length of at least 80'. Additional Stream Crossing Guidelines suggest a superstructure span length equal the embankment ratio times the bankfull width. Given the stream type and embankment ratio of this stream crossing, a 95'-wide hydraulic opening is recommended. The results of hydraulic modeling of a replacement structure with a 95'-wide opening, it is proposed that all replacement options have the hydraulic characteristics listed below:

Proposed Hydraulic Data:
50-Year and 100-Year Storms – Alternative 3 (Complete Replacement)

	50-Year	100-Year
Drainage Area:	66.1 square miles	66.1 square miles
Water Surface Elevation:	169.5 feet	170.2 feet
Water Surface Flow:	5,000 cfs	5,900 cfs
Water Surface Velocity:	12.4 fps	13.2 fps
Bridge Opening (Superstructure Alternative 3A – Steel Beams):	1260 sf	1260 sf
Bridge Opening (Superstructure Alternative 3B – NEBT Beams):	1247 sf	1247 sf
Bridge Waterway Opening Below The Design Flood Elevation:	484 sf	536 sf
% Opening Full During the Design Flood (Superstructure Alternative 3A – Steel Beams):	38%	43%
% Opening Full During the Design Flood (Superstructure Alternative 3B – NEBT Beams):	39%	43%

The hydraulic opening for Substructure Alternative 3A (Conventional Abutments) was considered in the proposed hydraulic analyses. The clear span for the integral abutment alternative is slightly shorter than that of the conventional abutments alternative; however, the difference in clear span length would have no appreciable impact on the hydraulic analyses for the crossing. Therefore, separate hydraulic analyses were not performed for Substructure Alternative 3B (Integral Abutments).

10 CULTURAL RESOURCE CONSIDERATIONS

In accordance with RSA 227-C:9 "Directive for Cooperation in Protection of Historical Resources", Hoyle, Tanner presented the Greenhill Road Bridge project at the monthly NHDOT Cultural Resources meeting held on November 13, 2014. The Cultural Resources Committee agreed that preparing individual inventory forms (IIF) for the residential structures within the project area was not required since there was not "tremendous impact to the roadway profile because of the project". However, the Committee requested that an IIF be completed for the bridge.

Hoyle, Tanner contracted with Historic Documentation Company, Inc. to complete the IIF for the bridge; a copy of the report prepared is included in Appendix G. The IIF conclusion was that the bridge lacks characteristics that can be associated with the original crossing, and is a simple bridge that followed standard specifications and details and does not possess important design characteristics that would make it an important example of its Designer's work. Therefore, it was found to not be eligible for the National Register. A draft IIF was transmitted to the Cultural Resources Committee for review and comment, and a final version of the IIF was prepared to address review comments.

New Hampshire Division of Historical Resources (NHDHR) requested that a Phase IA archaeological assessment be completed for the project, in the area(s) where excavation for substructure construction is anticipated. This assessment will be completed as part of the next phase of the project, preliminary design. Hoyle, Tanner intends to contract with Independent Archaeological Consulting, LLC (IAC) to complete the Phase IA assessment.

The results of the Phase IA assessment will be reviewed with the Committee at follow-up cultural resources meeting(s), to be attended during the preliminary design phase of the project. The purpose of the meeting(s) will be to arrive at a determination of impact that the project will have on historic and archeological properties, and to complete the Memorandum of Effect (MOE) based on the determination. Stipulations of the MOE will be incorporated into the design of the replacement structure.

11 MAINTENANCE

In accordance with RSA 234:20 "Town Bridge Maintenance", the Town shall provide continuing maintenance of bridge aid funded bridges to the satisfaction of the Commissioner of Transportation. To assist the Town in meeting this requirement, Hoyle, Tanner will provide a maintenance plan for the Town at the completion of construction.

12 BRIDGE REPLACEMENT/REHABILITATION ALTERNATIVES

The need for the project is due to the functionally obsolete Greenhill Road Bridge while the purpose is to improve safety by improving roadway geometry and providing a new rail system while minimizing cost and construction duration.

Alternatives for the Greenhill Road structure were evaluated to determine the feasibility of each to meet the project need and purpose and the project goals. The following is a summary of design parameters that apply to Alternative 2 (Rehabilitation) and Alternative 3 (Replacement):

- Rail-to-rail width is 24'-0" to accommodate two travel lanes and out-to-out bridge width is 27'-0".
- The proposed horizontal alignment along Greenhill Road modifies the existing alignment by removing the slight reverse curve on the northwesterly side of the bridge.
- The proposed vertical alignment is adequate for 30 mph.
- Vehicular traffic control will be maintained with a detour.
- It is anticipated that steel sheeting will be required for support of excavation, to limit construction impacts and required roadway reconstruction.

- Roadway slopes will be retained with flared wingwalls.
- Cost estimates were developed utilizing standard NHDOT Item Numbers, NHDOT cost data, and Hoyle, Tanner municipal bridge cost-estimating experience.

12.1 Alternative 1 - "No Build"

This alternative consists of not performing any work to the Greenhill Road Bridge and therefore, does not address the substandard bridge geometry and rail system. As mentioned in Sections 2.1.2 and 2.1.3, the approach roadway consists of two travel lanes and has a profile that is adequate for vehicle speed of 30 mph. The two travel lanes reduce to one travel lane over the bridge and the profile is adequate for vehicle speed of 20mph. Greenhill Road carries a relatively high volume of commuter traffic, therefore, the bridge poses a safety concern as traffic has to slow down or stop prior to passing over the bridge. Therefore, Alternative 1 – "No Build" was eliminated from consideration since it does not meet the project need and purpose.

12.2 Alternative 2 – Rehabilitation

Rehabilitation of the existing bridge structure was deemed inappropriate for this project for the following reasons:

- Roadway profile cannot easily be improved to meet design criteria for a 30 mph design speed without major substructure modifications.
- Modifications to the roadway horizontal alignment are limited.
- Hydraulic opening of the bridge cannot be improved if existing substructure is retained.
- Bridge width cannot easily be increased without major substructure impacts/modifications.
- The existing steel beams are likely covered with lead paint, increasing cost of rehabilitation.
- The expected service life of the bridge after rehabilitation is expected to be approximately 30 to 40 years; less than that of a complete replacement structure.

A detailed cost estimate was not performed for this alternative, however, it is expected that the cost of rehabilitation would be comparable to the cost of complete replacement due to the major substructure modification to accommodate a 30 mph design speed and a wider superstructure. Rehabilitation was discussed with the Town, but was discounted because it did not meet the project need and purpose. Therefore, Alternative 2 – Rehabilitation was eliminated from further consideration.

12.3 Alternative 3 – Complete Replacement

This study evaluated complete replacement of the existing bridge, including comparing the use of steel beams versus prestressed concrete NEBT for superstructure alternatives and conventional abutments versus integral abutments for substructure alternatives. Prestressed concrete box beams were not investigated for a superstructure alternative due to the inability to inspect inside the voids of the beams.

12.3.1 Superstructure Alternative 3A - Steel Beams

This alternative (see Appendix A, Figure 5) consists of four 61½" deep rolled weathering steel beams with a cast-in-place concrete deck. The total superstructure depth is 74¼". Major work items for this alternative include:

- Removal of existing stone substructure, steel superstructure, concrete deck, and guardrail
- Installation of temporary water diversion and support of excavation.
- Construction of new substructure (see Sections 12.3.3 and 12.3.4).
- Construction of new, 95' long, 61½" deep steel beams, cast-in-place concrete deck, and asphalt wearing surface.
- Installation of T3 bridge rail, approach rail, and terminal units.
- Full depth roadway reconstruction along Greenhill Road for approximately 480'.
- The expected service life of each bridge replacement alternative is expected to be at least 75 years.

The construction cost of Superstructure Alternative 3A is $1,855,792 and includes the construction cost for Substructure Alternative 3A – Conventional Abutments, (See Appendix C for Engineer's Estimate of Probable Costs). All costs are in 2015 dollars including a 15% contingency. The project is programmed in the NHDOT Municipally Managed Bridge Aid Program for Fiscal Year 2022. The cost in 2022 dollars assuming 3% annual inflation is $2,282,390.

The construction cost of Superstructure Alternative 3A in combination with the construction cost of Substructure Alternative 3B – Integral Abutments is $1,814,277 in 2015 dollars including a 15% contingency (See Appendix C for Engineer's Estimate of Probable Costs. The cost in 2022 dollars assuming a 3% annual inflation is $2,231,332.

12.3.2 Superstructure Alternative 3B – Prestressed Concrete NEBT Beams

This alternative (see Appendix A, Figure 6) consists of four 63" prestressed NEBT beams with a cast-in-place concrete deck. The total superstructure depth is 76". The major work items for this alternative include:

- Removal of existing stone substructure, steel superstructure, concrete deck, and guardrail
- Installation of temporary water diversion and support of excavation.
- Construction of new substructure (see Sections 12.3.3 and 12.3.4).
- Construction of new, 95' long, 63" prestressed NEBT beams, cast-in-place concrete deck, and asphalt wearing surface.
- Installation of T3 bridge rail, approach rail, and terminal units.
- Full depth roadway reconstruction along Greenhill Road for approximately 480'.

The construction cost of Superstructure Alternative 3B is $1,896,675 and includes the construction cost for Substructure Alternative 3A – Conventional Abutments, (See Appendix C for Engineer's Estimate of Probable Costs). All costs are in 2015 dollars including a 15%

contingency. The project is programmed in the NHDOT Municipally Managed Bridge Aid Program for Fiscal Year 2022. The cost in 2022 dollars assuming 3% annual inflation is $2,332,671.

12.3.3 Substructure Alternative 3A – Conventional Abutments

This alternative consists of cast-in-place cantilever abutments and flared cast-in-place wingwalls on spread footings. The spread footings will bear on the glacial till soil layer as discussed in Section 5. The depth to glacial till from proposed finished grade is relatively deep and therefore the height of the abutments and wingwalls will be significant. The tall substructure will require extensive support of excavation and it is anticipated that steel sheet piling will be necessary. The driveway located on the northeast quadrant of the bridge will have to be temporarily relocated to facilitate the excavation limits, even with the use of steel sheet piling. The quantity of steel sheet piling required for the support of excavation and the quantity of cast-in-place concrete required for the substructure will increase the construction costs and duration as compared to Substructure Alternative 3B – Integral Abutments, as discussed below.

12.3.4 Substructure Alternative 3B – Integral Abutments

This alternative consists of cast-in-place integral abutments and wingwalls supported by steel H-piles bearing on bedrock. The wingwall system will consist of short cast-in-place u-back wingwalls combined with longer flared steel sheet pile wingwalls with a cast-in-place concrete facing. The sheet pile wingwalls will be used to retain the side slopes, since u-back integral wingwalls are necessary for proper integral abutment performance but do not provide the necessary length to support the proposed slope grading. The integral abutments will be relatively tall due to the depth of the channel bed below the roadway surface, however, they would be shorter than with conventional abutments. The steel piles will be driven to bedrock, however, the sloping bedrock will cause the south abutment piles to be shorter than the north abutment piles. Also, the south abutment piles are anticipated to be close to the minimum pile length threshold. The abutment heights, different pile lengths, and short south abutment piles are all at the limitations of the design criteria. In addition, the project site consists of large boulders and obstruction removal may be required during the installation of the abutment piles and permanent and temporary steel sheet piling. The use of steel sheet pile wingwalls reduces the amount of temporary support of excavation required to construct the substructure as compared to what is required for Substructure Alternative 3A – Conventional Abutments, as previously discussed. The shorter integral abutment substructure and elimination of footings also reduce the support of excavation required. The cost savings realized on the reduced steel sheet piling required for the support of excavation and the decreased quantity of cast-in-place concrete required for the substructure reduces construction costs and duration as compared to Substructure Alternative 3A – Conventional Abutments.

CONCLUSIONS AND RECOMMENDATIONS

The table below shows the major advantages and disadvantages of the alternatives studied in detail in this engineering study.

Table 13.1 – Comparison of Bridge Replacement Alternatives

Alternative Number	Advantages	Disadvantages	Cost (2015 Dollars)
Alternative 1 – "No Build"	• No construction cost. • No impacts to the traveling public or environment.	• Does not meet project need and purpose of addressing functionally obsolete bridge.	N/A
Alternative 2 - Rehabilitation		• 30-40 year service life. • Not compliant with NHSCG. • Impractical because of significant substructure modifications and associated cost.	N/A
Superstructure Alternative 3A – Steel Beams	• 75-year service life. • Compliant with NHSCG. • Lowest cost.		$1,855,792[1] $1,814,277[2]
Superstructure Alternative 3B - Prestressed NEBT Beams	• 75-year service life. • Compliant with NHSCG.	• Heavier beam weight. • More deck dead load due to wider top flange. • Unpredictable camber. • Highest Cost.	$1,896,675[1]
Substructure Alternative 3A – Conventional Abutments	• 75-year service life. • Compliant with NHSCG.	• Extensive support of excavation/steel sheet piling and excavation. • Highest substructure cost.	N/A

Alternative Number	Advantages	Disadvantages	Cost (2015 Dollars)
Substructure Alternative 3B – Integral Abutments	• 75-year service life. • Compliant with NHSCG. • Lowest substructure cost.	• At limit of design criteria for abutment height and pile lengths. • Possible obstructions during pile-driving.	N/A

[1] Cost includes Substructure Alternative 3A – Conventional Abutments cost.
[2] Cost includes Substructure Alternative 3B – Integral Abutments cost.

The proposed bridge is located within a sag vertical curve of the proposed profile. Due to the sag, the concrete haunches for both alternatives will be thicker than typical at the ends of the beams, creating greater dead loads. The NEBT beams have 42" flanges, which are significantly wider than the 12" flange width of the steel beams; therefore, the haunch dead load for the NEBT beams will be higher than for the steel beams. Additionally, the NEBT beams have unpredictable camber, which may be a concern being located within a sag vertical curve. The selfweight of the NEBT beams are also significantly heavier than the steel beams, which may result in a more complicated and costly and erection procedure because of the use of either heavier or additional cranes.

Based on the information contained herein, Hoyle, Tanner recommends the Town move forward with Bridge Alternative 3, Complete Replacement with Superstructure Alternative 3A – Steel Beams and Substructure Alterative 3B – Integral Abutments. This alternative will provide a structure that meets current statutory load requirements, increases the bridge hydraulic capacity, minimizes impacts to the surrounding environment, and will have the lowest construction cost and duration of the two alternatives evaluated in this study. The Town's share of estimated construction costs for the recommended alternative is approximately $362,855 while the NHDOT's share is $1,451,422 in 2015 dollars.

This Engineering Study has been completed utilizing information available as of May, 2015. This information may include the Design Criteria listed in Section 3, permitting requirements, field data obtained by Hoyle, Tanner and reports or survey information prepared by others, which are subject to change. In particular, the condition of an existing bridge can change rapidly or the bridge be damaged through manmade or natural events that could alter the conclusions reached herein. Therefore, it should be noted that the conceptual design, estimate of construction cost, and conclusions reached in this Engineering Study should not be relied upon for an extended period of time.

APPENDIX A

Plans of Proposed Improvements

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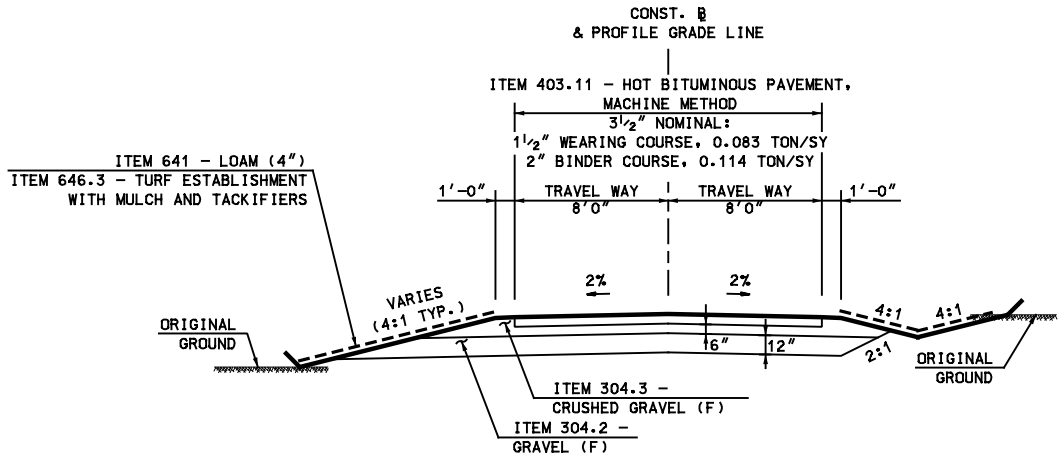

SEAVEY BRIDGE ROAD
STA. 200+00 – 200+84
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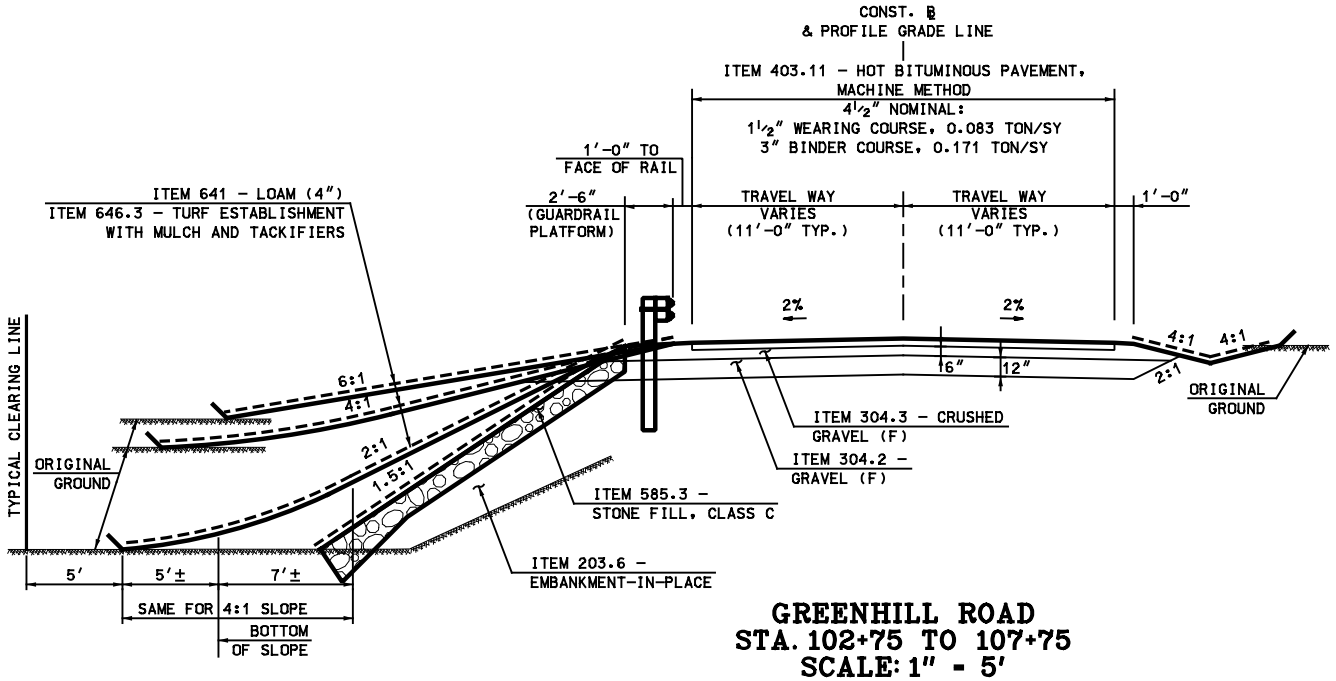

GREENHILL ROAD
STA. 102+75 TO 107+75
SCALE: 1" = 5'

FIGURE 1 OF 6

FIGURE 1

TOWN OF BARRINGTON
BARRINGTON, NEW HAMPSHIRE

GREENHILL ROAD OVER ISINGLASS RIVER

ROADWAY TYPICAL SECTIONS

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922404TYP01	SCS
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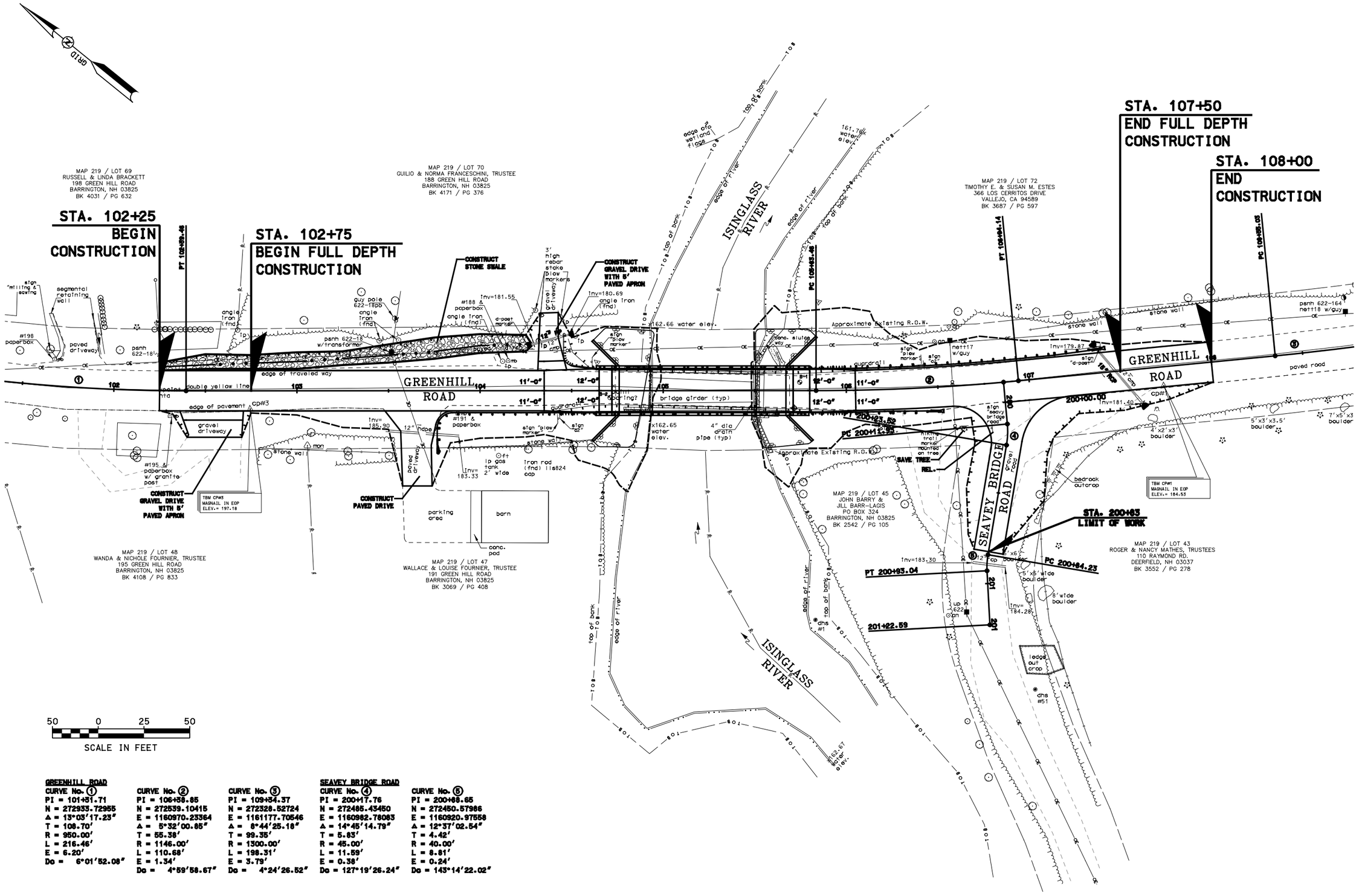

GREENHILL ROAD

CURVE No. ①	CURVE No. ②	CURVE No. ③
PI = 101+31.71	PI = 106+38.85	PI = 109+34.37
N = 272953.72955	N = 272539.10415	N = 272326.52724
E = 1160970.23364	E = 1160970.23364	E = 1161177.70546
Δ = 13°03'17.23"	Δ = 5°32'00.85"	Δ = 8°44'25.18"
T = 108.70'	T = 55.38'	T = 99.35'
R = 950.00'	R = 1146.00'	R = 1300.00'
L = 216.46'	L = 110.68'	L = 198.31'
E = 6.20'	E = 1.34'	E = 3.79'
Dc = 6°01'52.08"	Dc = 4°59'58.67"	Dc = 4°24'26.52"

SEAVEY BRIDGE ROAD

CURVE No. ④	CURVE No. ⑤
PI = 200+17.76	PI = 200+88.65
N = 272485.43450	N = 272450.57986
E = 1160982.76063	E = 1160920.97558
Δ = 14°45'14.79"	Δ = 12°37'02.54"
T = 5.83'	T = 4.42'
R = 45.00'	R = 40.00'
L = 11.59'	L = 8.81'
E = 0.38'	E = 0.24'
Dc = 127°19'26.24"	Dc = 143°14'22.02"

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TOWN OF BARRINGTON
BARRINGTON, NEW HAMPSHIRE
GREENHILL ROAD OVER ISINGLASS RIVER

ROADWAY PLAN

FIGURE
2
FIGURE 2 OF 6

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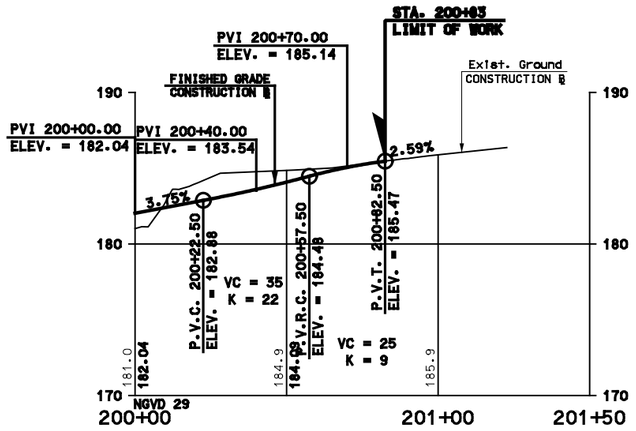

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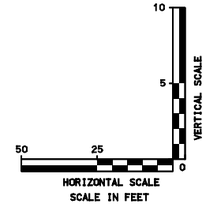

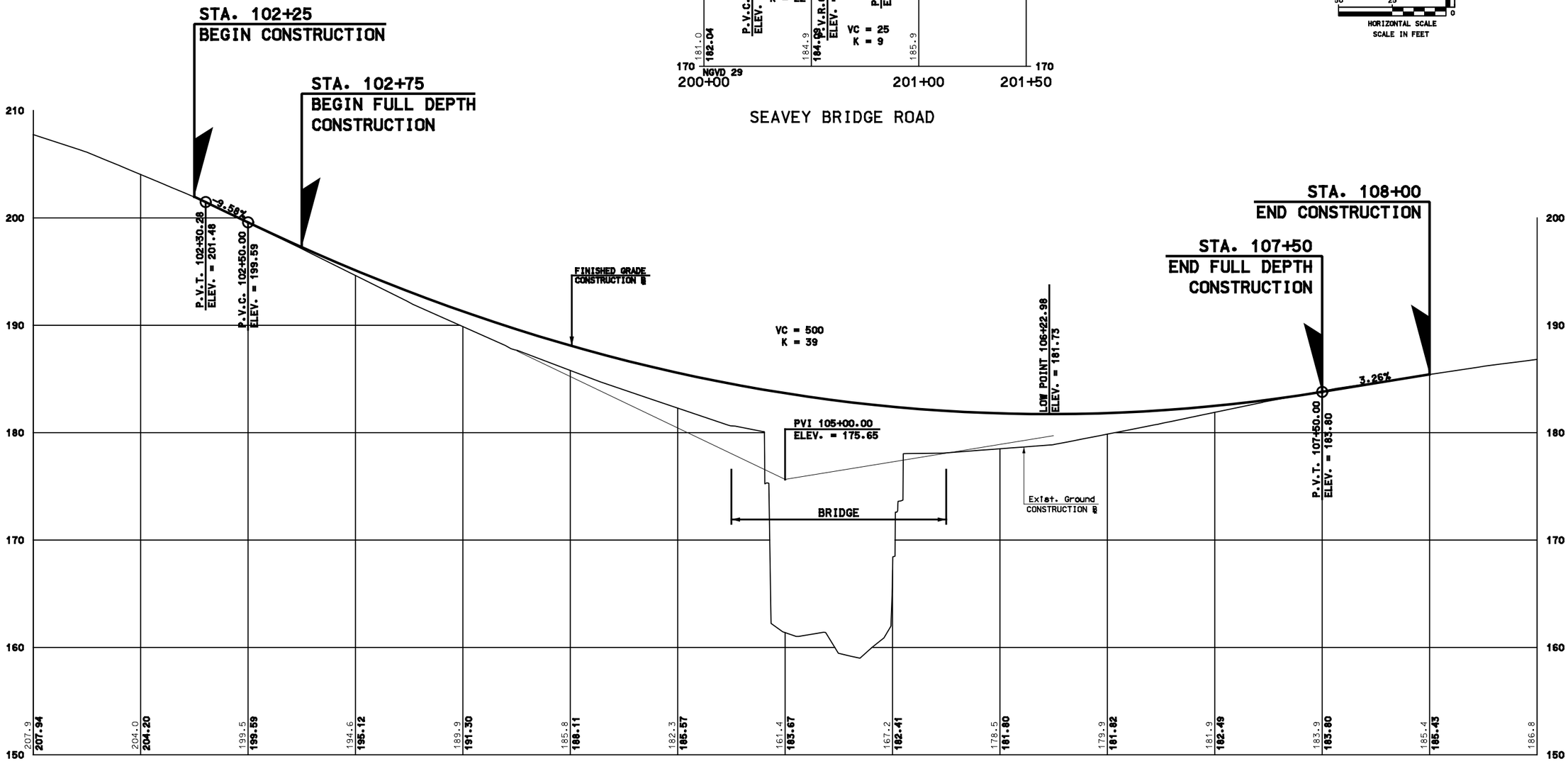

GREEN HILL ROAD

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TOWN OF BARRINGTON
BARRINGTON, NEW HAMPSHIRE
GREENHILL ROAD OVER ISINGLASS RIVER

ROADWAY PROFILES

FIGURE
3
FIGURE 3 OF 6

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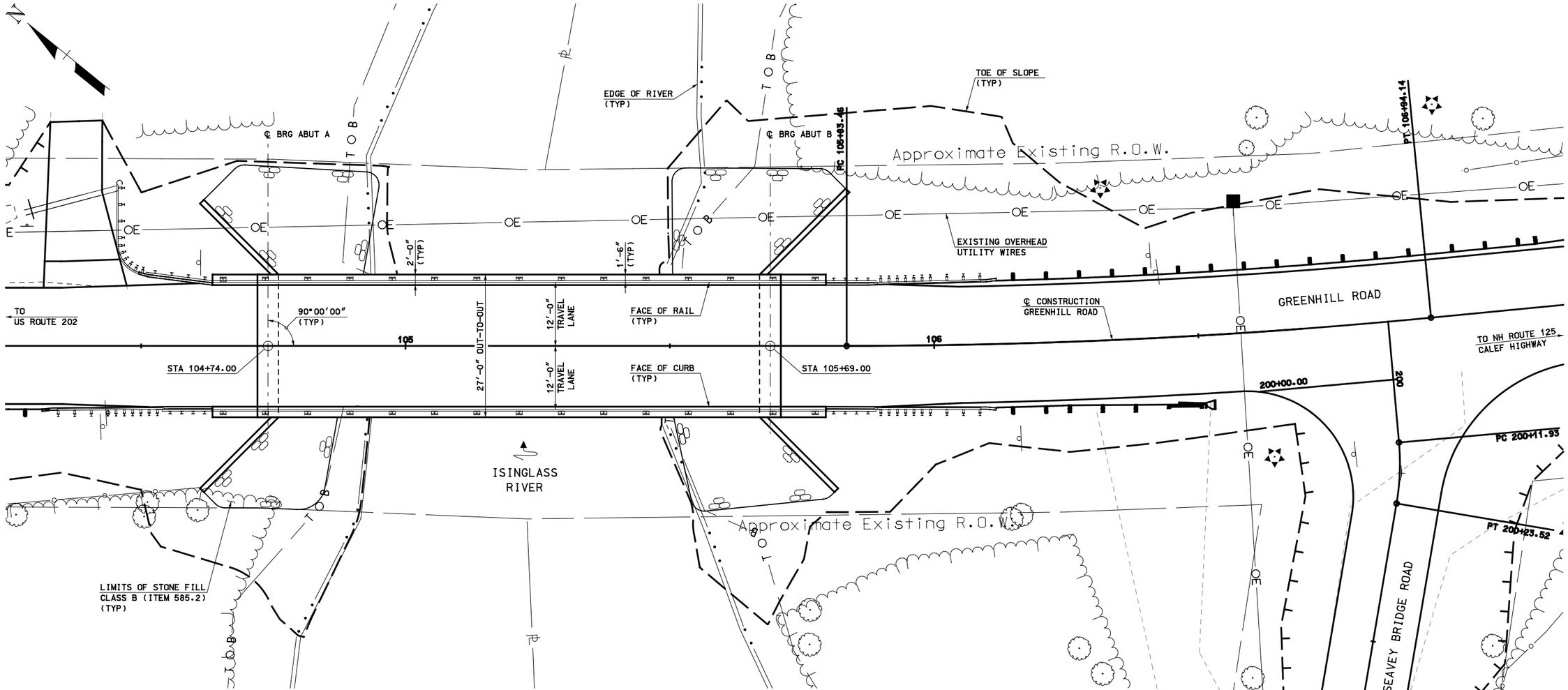

PLAN
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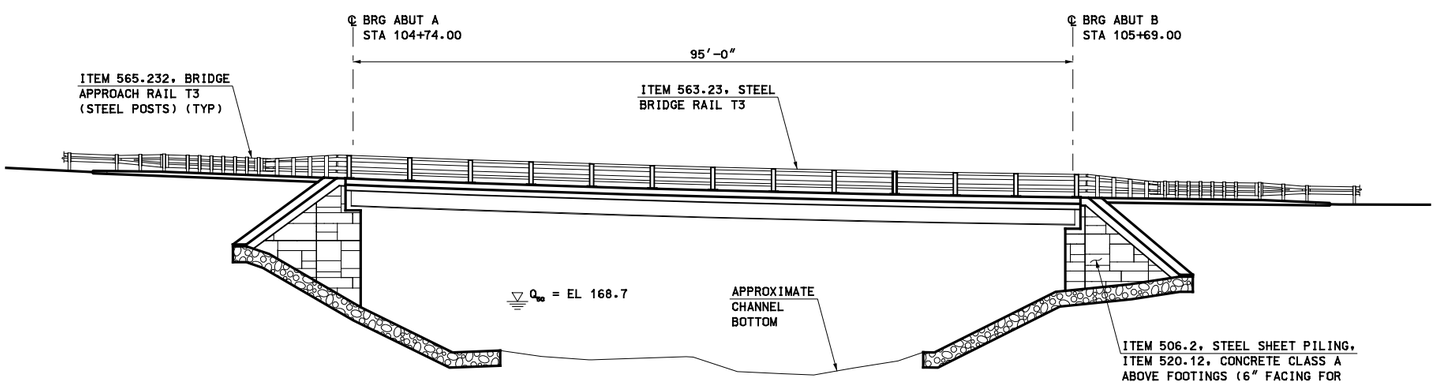

ELEVATION
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		DATE: APRIL 2015

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TOWN OF BARRINGTON
BARRINGTON, NEW HAMPSHIRE
GREENHILL ROAD OVER THE ISINGLASS RIVER
GENERAL PLAN AND ELEVATION
BRIDGE REPLACEMENT ALTERNATIVE NO. 1

FIGURE
4
FIGURE 4 OF 6

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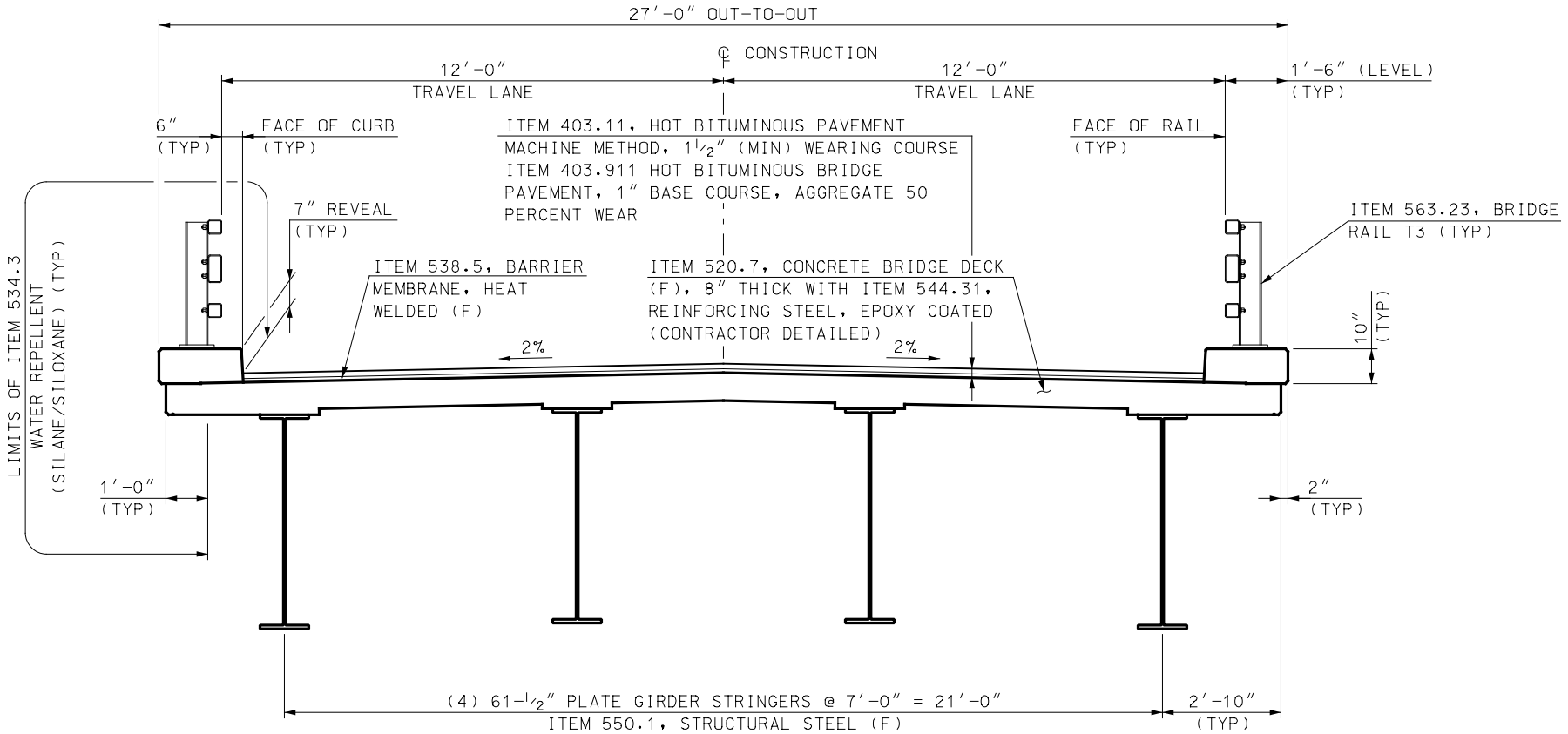

TYPICAL SECTION

SCALE: ¼″ = 1′-0″

FIGURE 5 OF 6

FIGURE 5

TOWN OF BARRINGTON
BARRINGTON, NEW HAMPSHIRE

GREENHILL ROAD OVER THE ISINGLASS RIVER

BRIDGE REPLACEMENT ALTERNATIVE NO. 1
STEEL BEAMS

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PROJECT NO.	DRAWN BY
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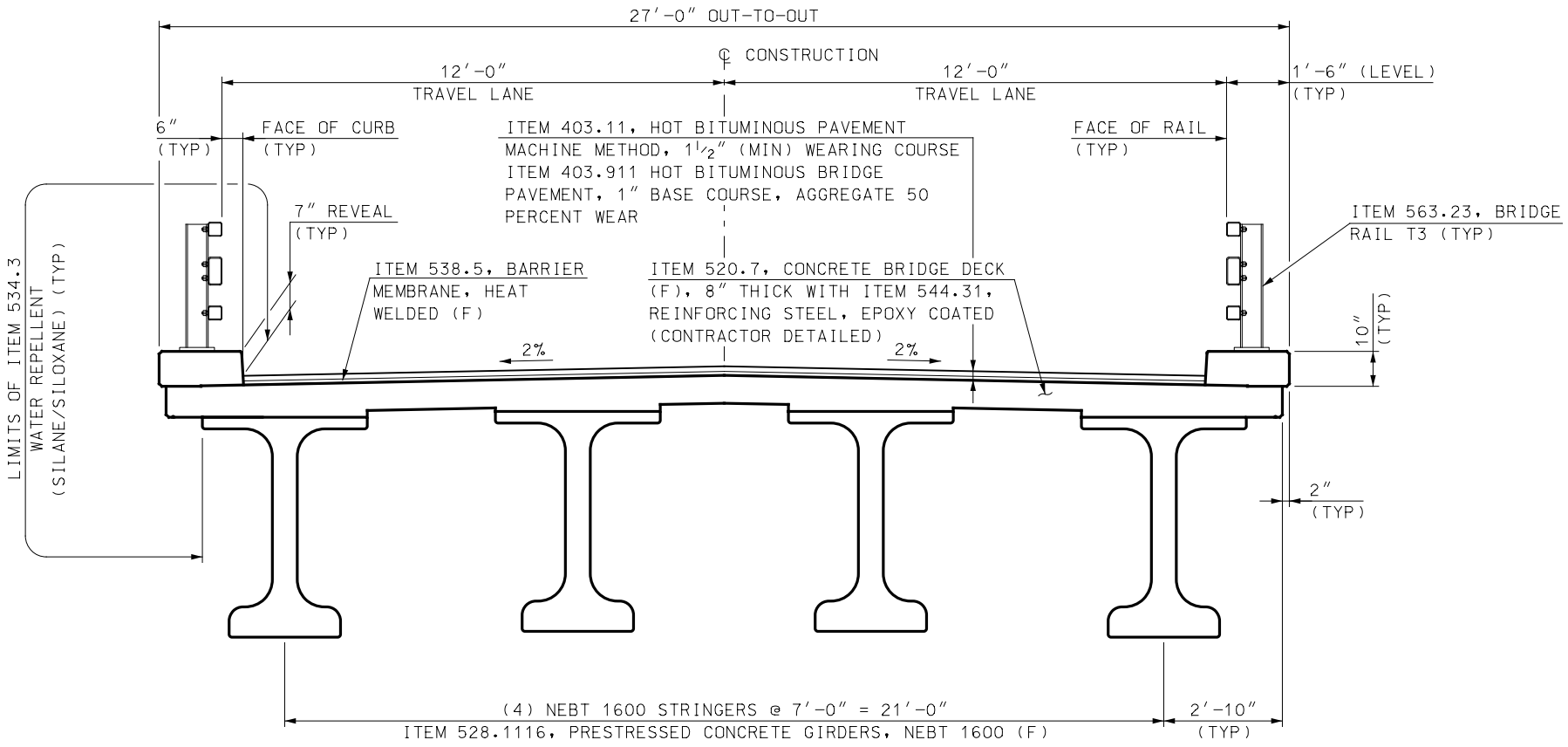

TYPICAL SECTION

SCALE: ¼″ = 1′-0″

FIGURE 6 OF 6

FIGURE 6

TOWN OF BARRINGTON
BARRINGTON, NEW HAMPSHIRE

GREENHILL ROAD OVER THE ISINGLASS RIVER

BRIDGE REPLACEMENT ALTERNATIVE NO. 2
PRESTRESSED CONCRETE NEBT BEAMS

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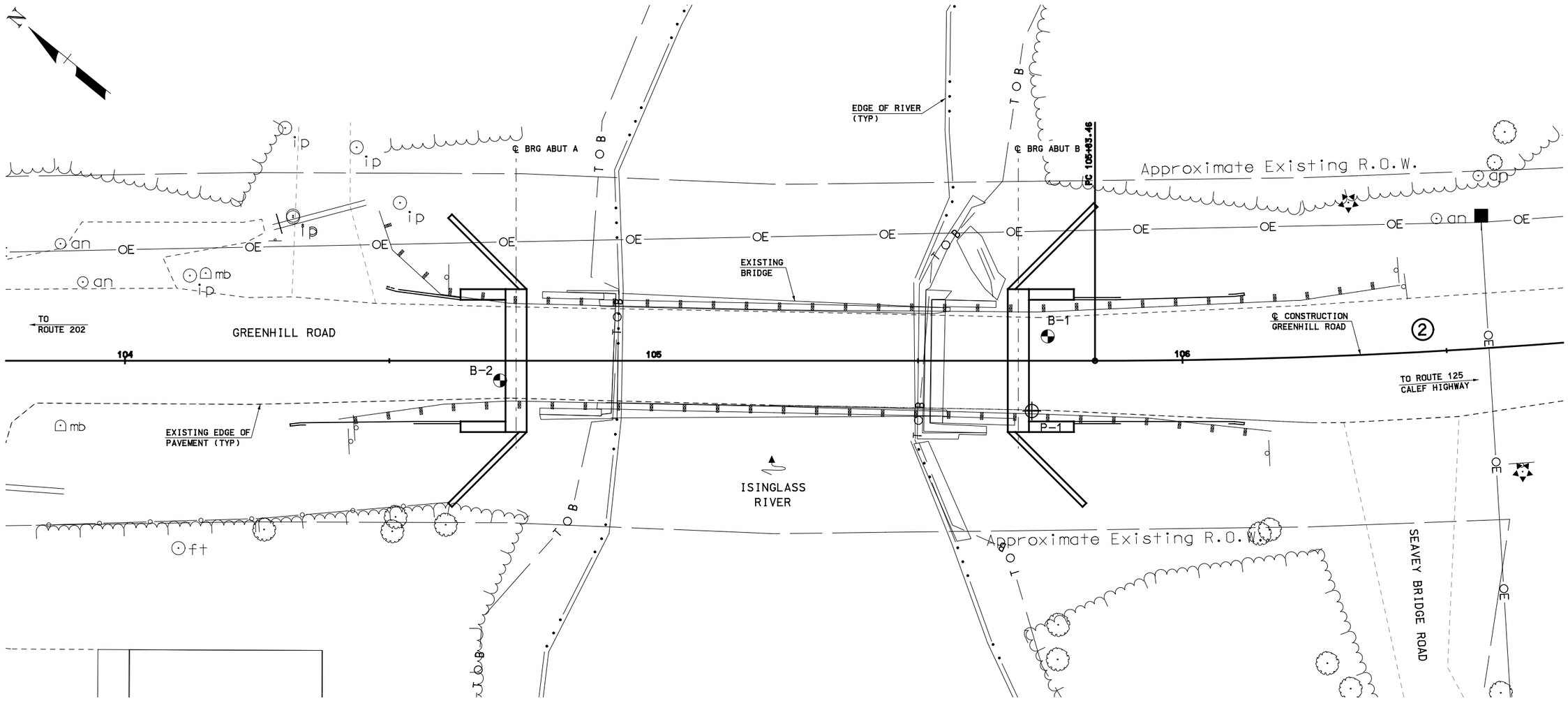
APPENDIX B

Boring Layout Plan and Boring Logs



BORING LOCATION PLAN

SCALE: 1″ = 10′-0″

BORING LOCATIONS TABLE					
NO.	STATION	OFFSET	NORTHING	EASTING	GROUND EL
B-1	105+74.55	4.58′ LT	272591.9272	1160933.2930	178.0
B-2	104+70.96	3.75′ RT	272665.1364	1160861.5741	180.7
P-1	105+71.54	9.53′ RT	272585.3775	1160920.4387	178.0

BORING NOTES

1. BORINGS AND PROBE INDICATED THUS ◔ AND ⊕ RESPECTIVELY, WERE MADE BY NORTHERN TEST BORING, INC. ON MAY 26, 2014. BLOW COUNTS INDICATE THE NUMBER OF BLOWS REQUIRED TO DRIVE A 1⅜″ I.D. STANDARD SPLIT SPOON SAMPLER 6″, USING A 140 LB WEIGHT FALLING 30″.
2. ELEVATIONS SHOWN RELATIVE TO NGVD 1929.
3. BORINGS ARE FOR DESIGN PURPOSES, SHOWING CONDITIONS AT BORING POINTS ONLY, AND DO NOT NECESSARILY INDICATE MATERIAL TO BE ENCOUNTERED DURING CONSTRUCTION.
4. ROCK CORES WERE MADE USING A 2″ I.D. CORE BARREL.
5. GROUND WATER LEVELS WERE MEASURED AT THE TIME OF EXPLORATION. THE WATER LEVELS ENCOUNTERED DURING CONSTRUCTION MAY VARY CONSIDERABLY DUE TO PREVAILING CLIMATE, RAINFALL OR OTHER FACTORS.
6. AUGER REFUSAL WAS ENCOUNTERED AT 24.4′ AT PROBE P-1.

PROJECT NO.: 922404
MODEL NAME: 922404Borlay
SCALE: AS SHOWN
DRAWN BY: PBD
DESIGN BY: JAS
CHKD. BY: AML
DATE: APRIL 2015

Hoyle, Tanner & Associates, Inc.
150 Dow Street, Manchester, NH 03101-1227
Tel (603) 669-5555 · Fax (603) 669-4168
www.hoyletanner.com

TOWN OF BARRINGTON
BARRINGTON, NEW HAMPSHIRE
GREENHILL ROAD OVER THE ISINGLASS RIVER
BORING LOCATION PLAN

FIGURE
1
FIGURE 1 OF 1

5/28/2015
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K:\922404\2-CADD\BRC\Study\922404Borlay.dgn

Northern Test Boring, Inc. Boring Log

Client: HTA	Project Name: Green Hill Road
Location: Barrington, NH	Driller: Mike Nadeau

	Casing	Sample	Core	Ground Water Observation
Type	HW	SS		12.7’
Size	4”	1 3/8”		Start Date: 5/26/14 Finish Date: 5/26/14
Hammer Wt.		140		
Hammer Fall		30”		

No.	Pen	Rec	Sample Depth	Sample Blow Counts				Depth	Stratum Description
S-1	24”	14”	0’-2’	10	6	4	2		6” Pavement Brown Fine-Medium Sand and Gravel Trace Silt
S-2	24”	12”	2’-4’	2	2	2	2		
S-3	24”	10”	5’-7’	2	1	2	2	5’	Brown Silty Fine Sand Some Gravel
S-4	24”	4”	10’-12’	17	8	7	9	10’	Brown Fine-Medium Sand and Gravel Trace Silt
S-5	24”	8”	15’-17’	17	9	9	10	15’	
S-6	24”	9”	20’-22’	17	19	21	27	20’	
S-7	24”	17”	25’-27’	10	11	11	14	25’	Grey Silty Fine Sand (Glacial Till)
S-8	3”	2”	30’	50/2				30’	Bedrock Surface @ 30.2’

Boring #: B-1
Sheet: 1 of 2

Northern Test Boring, Inc. Boring Log

Client: HTA	Project Name: Green Hill Road
Location: Barrington, NH	Driller: Mike Nadeau

	Casing	Sample	Core	Ground Water Observation
Type	HW	SS		12.7’
Size	4”	1 3/8”		Start Date: 5/26/14 Finish Date: 5/26/14
Hammer Wt.		140		
Hammer Fall		30”		

No.	Pen	Rec	Sample Depth	Sample Blow Counts				Depth	Stratum Description
								35’	R-1 30.2’- 35.2’ (RQD = 12%) R-2 35.2’-40.2’ (RQD = 53%) Bottom of Exploration @ 40.2’
								40’	
								45’	
								50’	

Boring #: B-1
Sheet: 2 of 2

Northern Test Boring, Inc. Boring Log

Client: HTA	Project Name: Green Hill Road
Location: Barrington, NH	Driller: Mike Nadeau

	Casing	Sample	Core	Ground Water Observation
Type	HW	SS		14.4’
Size	4”	1 3/8”		Start Date: 5/26/14 Finish Date: 5/26/14
Hammer Wt.		140		
Hammer Fall		30”		

No.	Pen	Rec	Sample Depth	Sample Blow Counts				Depth	Stratum Description
S-1	24”	6”	0’-2’	19	17	10			4.5” Pavement Brown Fine-Medium Sand and Gravel Trace Silt
S-2	24”	3”	2’-4’	2	1	1	2		
S-3	24”	18”	5’-7’	3	2	2	2	5’	Brown Fine Sand Some Gravel Trace Silt
S-4	24”	3”	10’-12’	9	5	4	4	10’	
S-5	24”	11”	15’-17’	9	9	17	14	15’	Brown Fine-Medium Sand and Gravel Trace Silt
S-6	24”	3”	20’-22’	50/3				20’	
S-7	24”	17”	25’-27’	12	10	14	28	25’	Grey Silty Fine Sand (Glacial Till)
S-8	24”	6”	30’-32’	14	17	19	19	30’	

Boring #: B-2
Sheet: 1 of 2

Northern Test Boring, Inc. Boring Log

Client: HTA	Project Name: Green Hill Road
Location: Barrington, NH	Driller: Mike Nadeau

	Casing	Sample	Core	Ground Water Observation
Type	HW	SS		14.4’
Size	4”	1 3/8”		Start Date: 5/26/14 Finish Date: 5/26/14
Hammer Wt.		140		
Hammer Fall		30”		

No.	Pen	Rec	Sample Depth	Sample Blow Counts				Depth	Stratum Description
S-9	24”	18”	35’-37’	17	20	25	29	35’	Grey Silty Sand (Glacial Till)
S-10	9”	8”	40’-42’	39	50/3			40’	Bedrock Surface @ 40.8’
								45’	R-1 40.8’- 45.2’ (RQD = 59%)
								50’	Bottom of Exploration @ 45.3’

Boring #: B-2
Sheet: 2 of 2

Northern Test Boring, Inc. Boring Log

Client: HTA	Project Name: Green Hill Road
Location: Barrington, NH	Driller: Mike Nadeau

	Casing	Sample	Core	Ground Water Observation
Type	HW	SS		
Size	4”	1 3/8”		Start Date: 5/26/14 Finish Date: 5/26/14
Hammer Wt.		140		
Hammer Fall		30”		

No.	Pen	Rec	Sample Depth	Sample Blow Counts				Depth	Stratum Description
									5” Pavement
								5’	
								10’	
								15’	
									Glacial Till @ 17’
								20’	
								25’	
									Auger Refusal
									Bottom of Exploration @ 24.4’
									(Probable Bedrock Surface/Possible Boulder)
								30’	

Boring #: P-1
Sheet: 1 of 1

APPENDIX C

Engineer's Estimate of Probable Construction Costs

Hoyle, Tanner & Associates, Inc.
150 Dow Street
Manchester, NH 03101 (603) 669-5555

Calc. By:	JAS/SCS	Date:	5/14/2015
Chck. By:	AML/SBH	Date:	5/14/2015
Chck. By:	STJ	Date:	5/27/2015
Chck. By:		Date:	

Greenhill Road over the Isinglass River, NHDOT Br. No. 109/162
Engineers Estimate of Probable Construction Costs
Bridge Replacement Alternative 3 - Complete Replacement
Superstructure Alternative 3A - Steel Beams
Substructure Alternative 3A - Conventional Abutments
Hoyle, Tanner Project No. 922404/NHDOT Project No. 26722

ITEM NO	ITEM DESCRIPTION	Quantity		Cost	
		Unit	Amount	Unit	Total
201.21	REMOVING SMALL TREES	EA	4	$250.00	$1,000
202.7	REMOVAL OF GUARDRAIL	LF	380	$4.00	$1,520
203.1	COMMON EXCAVATION	CY	650	$15.00	$9,750
203.2	ROCK EXCAVATION	CY	50	$100.00	$5,000
203.5525	PORTABLE CHANGEABLE MESSAGE SIGN PLATFORM	U	2	$600.00	$1,200
203.6	EMBANKMENT-IN-PLACE (F)	CY	575	$15.00	$8,625
203.5555	GUARDRAIL 25' EAGRT PLATFORM	U	2	$1,200.00	$2,400
209.201	GRANULAR BACKFILL (BRIDGE) (F)	CY	1000	$40.00	$40,000
304.2	GRAVEL (F)	CY	500	$22.00	$11,000
304.3	CRUSHED GRAVEL (F)	CY	300	$25.00	$7,500
304.35	CRUSHED GRAVEL FOR DRIVES	CY	60	$35.00	$2,100
403.11	HOT BITUMINOUS PAVEMENT, MACHINE METHOD	TON	372	$120.00	$44,640
403.12	HOT BITUMINOUS PAVEMENT, HAND METHOD	TON	12	$120.00	$1,440
403.911	HOT BITUMINOUS BRIDGE PAVEMENT 1 IN BASE COURSE, AGGREGATE 50 PERCENT WEAR	TON	15	$200.00	$3,000
403.6	PAVEMENT JOINT ADHESIVE	LF	675	$0.40	$270
417	COLD PLANING BITUMINOUS SURFACES	SY	150	$25.00	$3,750
502	REMOVAL OF EXISTING BRIDGE STRUCTURE	U	1	$40,000.00	$40,000
503.101	WATER DIVERSION STRUCTURES	U	1	$50,000.00	$50,000
503.201	COFFERDAMS	U	1	$175,000.00	$175,000
504.1	COMMON BRIDGE EXCAVATION (F)	CY	1500	$30.00	$45,000
508	STRUCTURAL FILL	CY	80	$50.00	$4,000
520.12	CONCRETE CLASS A, ABOVE FOOTINGS (F)	CY	350	$800.00	$280,000
520.213	CONCRETE CLASS B, FOOTINGS (ON SOIL) (F)	CY	150	$400.00	$60,000
520.7	CONCRETE BRIDGE DECK (F)	CY	90	$1,000.00	$90,000
534.3	WATER REPELLENT (SILANE/ SILOXANE)	GAL	25	$100.00	$2,500
538.2	BARRIER MEMBRANE, PEEL AND STICK - VERTICAL SURFACES (F)	SY	50	$30.00	$1,500
538.5	BARRIER MEMBRANE, HEAT WELDED (F)	SY	275	$30.00	$8,250
541.4	PVC WATERSTOPS, NH TYPE 4 (F)	LF	95	$10.00	$950
541.5	PVC WATERSTOPS, NH TYPE 5 (F)	LF	55	$10.00	$550
544.3	REINFORCING STEEL (CONTRACTOR DETAILED)	LB	70000	$1.50	$105,000
544.31	REINFORCING STEEL, EPOXY COATED (CONTRACTOR DETAILED)	LB	25000	$2.00	$50,000
547	SHEAR CONNECTORS (F)	EA	770	$5.00	$3,850
548.21	ELASTOMERIC BEARING ASSEMBLIES (F)	EA	8	$1,000.00	$8,000
550.1	STRUCTURAL STEEL (F)	LB	80000	$2.00	$160,000
559.4	ELASTOMERIC PLUG TYPE EXPANSION JOINT (F)	LF	54	$150.00	$8,100
562.1	SILICONE JOINT SEALANT (F)	LF	115	$10.00	$1,150
563.23	BRIDGE RAIL T3	LF	200	$150.00	$30,000
565.232	BRIDGE APPROACH RAIL, T3 (STEEL POSTS)	U	4	$5,500.00	$22,000
572.1	RECONSTRUCTING STONE WALL ONE STONE WIDE	LF	30	$125.00	$3,750
585.2	STONE FILL, CLASS B	CY	300	$60.00	$18,000
585.3	STONE FILL, CLASS C	CY	150	$40.00	$6,000
593.411	GEOTEXTILE; PERM. CONTROL CL. 1, NON-WOVEN	SY	1075	$3.00	$3,225
603.00215	15" R.C. PIPE, 2000D	LF	45	$50.00	$2,250
603.36115	15" ALUMINIZED STEEL END SECTION	EA	4	$250.00	$1,000
603.36118	18" ALUMINIZED STEEL END SECTION	EA	2	$300.00	$600
603.80212	12" PLASTIC PIPE (SMOOTH INTERIOR)	LF	82	$70.00	$5,740
606.120	BEAM GUARDRAIL (STANDARD SECTION) (STEEL POST)	LF	175	$18.00	$3,150
606.141	BEAM GUARDRAIL (CURVED W/CRT POSTS)	LF	50	$32.00	$1,600
606.1255	BEAM GUARDRAIL (TERM. UNIT TYPE EAGRT 25 FT) (STEEL POST)	U	2	$1,800.00	$3,600
606.417	PORTABLE CONCRETE BARRIER FOR TRAFFIC CONTROL	LF	60	$25.00	$1,500
606.84	ANCHOR FOR CURVED GUARD- RAIL W/CRT POSTS	U	1	$2,500.00	$2,500
609.01	STRAIGHT GRANITE CURB	LF	28	$40.00	$1,120
615.03	TRAFFIC SIGN TYPE C (F)	SF	3	$45.00	$135
615.033	REMOVING TRAFFIC SIGN TYPE C	U	6	$150.00	$900
615.034	RELOCATING TRAFFIC SIGN, TYPE C	U	1	$150.00	$150
619.1	MAINTENANCE OF TRAFFIC	U	1	$5,000.00	$5,000
619.25	PORTABLE CHANGEABLE MESSAGE SIGN	U	2	$2,500.00	$5,000
622.1	STEEL WITNESS MARKERS	EA	2	$30.00	$60
628.2	SAWED BITUMINOUS PAVEMENT	LF	125	$2.00	$250
641	LOAM	CY	100	$30.00	$3,000
645.51	HAY BALES FOR TEMPORARY EROSION CONTROL	EA	250	$8.00	$2,000
645.52	RYEGRASS FOR TEMPORARY EROSION CONTROL	LB	10	$2.50	$25

Hoyle, Tanner & Associates, Inc.
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Chck. By:	STJ	Date:	5/27/2015
Chck. By:		Date:	

Greenhill Road over the Isinglass River, NHDOT Br. No. 109/162
Engineers Estimate of Probable Construction Costs
Bridge Replacement Alternative 3 - Complete Replacement
Superstructure Alternative 3A - Steel Beams
Substructure Alternative 3A - Conventional Abutments
Hoyle, Tanner Project No. 922404/NHDOT Project No. 26722

645.531	SILT FENCE	LF	700	$3.00	$2,100
645.7	STORM WATER POLLUTION PREVENTION PLAN	U	1	$3,500.00	$3,500
645.71	MONITORING SWPPP AND EROSION AND SEDIMENT CONTROLS	EA	50	$100.00	$5,000
646.3	TURF ESTABLISHMENT WITH MULCH AND TACKIFIERS	A	0.2	$1,900.00	$380
692	MOBILIZATION	U	1	$140,000.00	$140,000
699	MISCELLANEOUS TEMPORARY EROSION AND SEDIMENT CONTROL	$	1	$7,500.00	$7,500

CONSTRUCTION (CON)

CONSTRUCTION SUBTOTAL	$1,518,080.00
CONTINGENCY (15%)	$227,712.00
HOYLE , TANNER CONSTRUCTION ENGINEERING (ESTIMATED)	$110,000.00
CONSTRUCTION (CON) TOTAL FOR NHDOT FY PLANNING	**$1,855,792.00**

RIGHT OF WAY (ROW)

EASEMENTS	**$5,000.00**

PRELIMINARY ENGINEERING (PE)

ENGINEERING STUDY	$66,000.00
DESIGN (ESTIMATED)	$105,000.00
BID (ESTIMATED)	$6,000.00
PRELIMINARY ENGINEERING (PE) TOTAL	**$177,000.00**

PROJECT TOTAL COST (CON, ROW, PE)	**$2,037,792.00**

K:\922404\4-Design\Estimates\BSG Eng Study\[EstOfCost_EngStudy.xls]Steel Beams

This Engineers Estimate of Probable Construction Costs is based on the anticipated scope of work, as well as HTA's experience with similar projects and understanding of current industry trends. The estimate has not been based on a final design for this project, and as such, it is intended to be preliminary in nature. It should be noted that changes in material or labor costs in the construction industry could impact the project cost in either direction.

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Chck. By:		Date:	

Greenhill Road over the Isinglass River, NHDOT Br. No. 109/162
Engineers Estimate of Probable Construction Costs
Bridge Replacement Alternative 3 - Complete Replacement
Superstructure Alternative 3B - Prestressed Concrete NEBT Beams
Substructure Alternative 3A - Conventional Abutments
Hoyle, Tanner Project No. 922404/NHDOT Project No. 26722

ITEM NO	ITEM DESCRIPTION	Quantity		Cost	
		Unit	Amount	Unit	Total
201.21	REMOVING SMALL TREES	EA	4	$250.00	$1,000
202.7	REMOVAL OF GUARDRAIL	LF	380	$4.00	$1,520
203.1	COMMON EXCAVATION	CY	650	$15.00	$9,750
203.2	ROCK EXCAVATION	CY	50	$100.00	$5,000
203.5525	PORTABLE CHANGEABLE MESSAGE SIGN PLATFORM	U	2	$600.00	$1,200
203.6	EMBANKMENT-IN-PLACE (F)	CY	575	$15.00	$8,625
203.5555	GUARDRAIL 25' EAGRT PLATFORM	U	2	$1,200.00	$2,400
209.201	GRANULAR BACKFILL (BRIDGE) (F)	CY	1000	$40.00	$40,000
304.2	GRAVEL (F)	CY	500	$22.00	$11,000
304.3	CRUSHED GRAVEL (F)	CY	300	$25.00	$7,500
304.35	CRUSHED GRAVEL FOR DRIVES	CY	60	$35.00	$2,100
403.11	HOT BITUMINOUS PAVEMENT, MACHINE METHOD	TON	372	$120.00	$44,640
403.12	HOT BITUMINOUS PAVEMENT, HAND METHOD	TON	12	$120.00	$1,440
403.6	PAVEMENT JOINT ADHESIVE	LF	675	$0.40	$270
403.911	HOT BITUMINOUS BRIDGE PAVEMENT 1 IN BASE COURSE, AGGREGATE 50 PERCENT WEAR	TON	15	$200.00	$3,000
417	COLD PLANING BITUMINOUS SURFACES	SY	150	$25.00	$3,750
502	REMOVAL OF EXISTING BRIDGE STRUCTURE	U	1	$40,000.00	$40,000
503.101	WATER DIVERSION STRUCTURES	U	1	$50,000.00	$50,000
503.201	COFFERDAMS	U	1	$175,000.00	$175,000
504.1	COMMON BRIDGE EXCAVATION (F)	CY	1500	$30.00	$45,000
508	STRUCTURAL FILL	CY	80	$50.00	$4,000
520.01	CONCRETE CLASS AA	CY	10	$450.00	$4,500
520.12	CONCRETE CLASS A, ABOVE FOOTINGS (F)	CY	350	$800.00	$280,000
520.213	CONCRETE CLASS B, FOOTINGS (ON SOIL) (F)	CY	150	$400.00	$60,000
520.7	CONCRETE BRIDGE DECK (F)	CY	100	$1,000.00	$100,000
528.1116	PRESTRESSED CONCRETE GIRDERS, NEBT 1600 (F)	LF	386	$500.00	$193,000
534.3	WATER REPELLENT (SILANE/ SILOXANE)	GAL	25	$100.00	$2,500
538.2	BARRIER MEMBRANE, PEEL AND STICK - VERTICAL SURFACES (F)	SY	50	$30.00	$1,500
538.5	BARRIER MEMBRANE, HEAT WELDED (F)	SY	275	$30.00	$8,250
541.4	PVC WATERSTOPS, NH TYPE 4 (F)	LF	95	$10.00	$950
541.5	PVC WATERSTOPS, NH TYPE 5 (F)	LF	55	$10.00	$550
544.3	REINFORCING STEEL (CONTRACTOR DETAILED)	LB	70000	$1.50	$105,000
544.31	REINFORCING STEEL, EPOXY COATED (CONTRACTOR DETAILED)	LB	25000	$2.00	$50,000
548.21	ELASTOMERIC BEARING ASSEMBLIES (F)	EA	8	$1,000.00	$8,000
562.1	SILICONE JOINT SEALANT (F)	LF	115	$10.00	$1,150
563.23	BRIDGE RAIL T3	LF	200	$150.00	$30,000
565.232	BRIDGE APPROACH RAIL, T3 (STEEL POSTS)	U	4	$5,500.00	$22,000
572.1	RECONSTRUCTING STONE WALL ONE STONE WIDE	LF	30	$125.00	$3,750
585.2	STONE FILL, CLASS B	CY	300	$60.00	$18,000
585.3	STONE FILL, CLASS C	CY	150	$40.00	$6,000
593.411	GEOTEXTILE; PERM. CONTROL CL. 1, NON-WOVEN	SY	1075	$3.00	$3,225
603.00215	15" R.C. PIPE, 2000D	LF	45	$50.00	$2,250
603.36115	15" ALUMINIZED STEEL END SECTION	EA	4	$250.00	$1,000
603.36118	18" ALUMINIZED STEEL END SECTION	EA	2	$300.00	$600
603.80212	12" PLASTIC PIPE (SMOOTH INTERIOR)	LF	82	$70.00	$5,740
606.120	BEAM GUARDRAIL (STANDARD SECTION) (STEEL POST)	LF	175	$18.00	$3,150
606.141	BEAM GUARDRAIL (CURVED W/CRT POSTS)	LF	50	$32.00	$1,600
606.1255	BEAM GUARDRAIL (TERM. UNIT TYPE EAGRT 25 FT) (STEEL POST)	U	2	$1,800.00	$3,600
606.417	PORTABLE CONCRETE BARRIER FOR TRAFFIC CONTROL	LF	60	$25.00	$1,500
606.84	ANCHOR FOR CURVED GUARD- RAIL W/CRT POSTS	U	1	$2,500.00	$2,500
609.01	STRAIGHT GRANITE CURB	LF	28	$40.00	$1,120
615.03	TRAFFIC SIGN TYPE C (F)	SF	3	$45.00	$135
615.033	REMOVING TRAFFIC SIGN TYPE C	U	6	$150.00	$900
615.034	RELOCATING TRAFFIC SIGN, TYPE C	U	1	$150.00	$150
619.1	MAINTENANCE OF TRAFFIC	U	1	$5,000.00	$5,000
619.25	PORTABLE CHANGEABLE MESSAGE SIGN	U	2	$2,500.00	$5,000
622.1	STEEL WITNESS MARKERS	EA	2	$30.00	$60
628.2	SAWED BITUMINOUS PAVEMENT	LF	125	$2.00	$250
641	LOAM	CY	100	$30.00	$3,000
645.51	HAY BALES FOR TEMPORARY EROSION CONTROL	EA	250	$8.00	$2,000
645.52	RYEGRASS FOR TEMPORARY EROSION CONTROL	LB	10	$2.50	$25
645.531	SILT FENCE	LF	700	$3.00	$2,100

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Chck. By:		Date:	

Greenhill Road over the Isinglass River, NHDOT Br. No. 109/162
Engineers Estimate of Probable Construction Costs
Bridge Replacement Alternative 3 - Complete Replacement
Superstructure Alternative 3B - Prestressed Concrete NEBT Beams
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Hoyle, Tanner Project No. 922404/NHDOT Project No. 26722

645.7	STORM WATER POLLUTION PREVENTION PLAN	U	1	$3,500.00	$3,500
645.71	MONITORING SWPPP AND EROSION AND SEDIMENT CONTROLS	EA	50	$100.00	$5,000
646.3	TURF ESTABLISHMENT WITH MULCH AND TACKIFIERS	A	0.2	$1,900.00	$380
692	MOBILIZATION	U	1	$140,000.00	$140,000
699	MISCELLANEOUS TEMPORARY EROSION AND SEDIMENT CONTROL	$	1	$7,500.00	$7,500

CONSTRUCTION (CON)

CONSTRUCTION SUBTOTAL	$1,553,630.00
CONTINGENCY (15%)	$233,044.50
HOYLE , TANNER CONSTRUCTION ENGINEERING (ESTIMATED)	$110,000.00
CONSTRUCTION (CON) TOTAL FOR NHDOT FY PLANNING	**$1,896,674.50**

RIGHT OF WAY (ROW)

EASEMENTS	**$5,000.00**

PRELIMINARY ENGINEERING (PE)

ENGINEERING STUDY	$66,000.00
DESIGN (ESTIMATED)	$105,000.00
BID (ESTIMATED)	$6,000.00
PRELIMINARY ENGINEERING (PE) TOTAL	**$177,000.00**

PROJECT TOTAL COST (CON, ROW, PE)	**$2,078,674.50**

K:\922404\4-Design\Estimates\BSG Eng Study\[EstOfCost_EngStudy.xls]Steel Beams

This Engineers Estimate of Probable Construction Costs is based on the anticipated scope of work, as well as HTA's experience with similar projects and understanding of current industry trends. The estimate has not been based on a final design for this project, and as such, it is intended to be preliminary in nature. It should be noted that changes in material or labor costs in the construction industry could impact the project cost in either direction.

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150 Dow Street
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Calc. By:	JAS/SCS	Date:	5/14/2015
Chck. By:	AML/SBH	Date:	5/14/2015
Chck. By:	STJ	Date:	5/27/2015
Chck. By:		Date:	

Greenhill Road over the Isinglass River, NHDOT Br. No. 109/162
Engineers Estimate of Probable Construction Costs
Bridge Replacement Alternative 3 - Steel Beams with Integral Abutments
Superstructure Alternative 3A - Steel Beams
Substructure Alternative 3B - Integral Abutments
Hoyle, Tanner Project No. 922404/NHDOT Project No. 26722

ITEM NO	ITEM DESCRIPTION	Quantity		Cost	
		Unit	Amount	Unit	Total
201.21	REMOVING SMALL TREES	EA	4	$250.00	$1,000
202.7	REMOVAL OF GUARDRAIL	LF	380	$4.00	$1,520
203.1	COMMON EXCAVATION	CY	650	$15.00	$9,750
203.2	ROCK EXCAVATION	CY	50	$100.00	$5,000
203.5525	PORTABLE CHANGEABLE MESSAGE SIGN PLATFORM	U	2	$600.00	$1,200
203.6	EMBANKMENT-IN-PLACE (F)	CY	575	$15.00	$8,625
203.5555	GUARDRAIL 25' EAGRT PLATFORM	U	2	$1,200.00	$2,400
209.201	GRANULAR BACKFILL (BRIDGE) (F)	CY	300	$40.00	$12,000
304.2	GRAVEL (F)	CY	500	$22.00	$11,000
304.3	CRUSHED GRAVEL (F)	CY	300	$25.00	$7,500
304.35	CRUSHED GRAVEL FOR DRIVES	CY	60	$35.00	$2,100
403.11	HOT BITUMINOUS PAVEMENT, MACHINE METHOD	TON	372	$120.00	$44,640
403.12	HOT BITUMINOUS PAVEMENT, HAND METHOD	TON	12	$120.00	$1,440
403.911	HOT BITUMINOUS BRIDGE PAVEMENT 1 IN BASE COURSE, AGGREGATE 50 PERCENT WEAR	TON	15	$200.00	$3,000
403.6	PAVEMENT JOINT ADHESIVE	LF	675	$0.40	$270
417	COLD PLANING BITUMINOUS SURFACES	SY	150	$25.00	$3,750
502	REMOVAL OF EXISTING BRIDGE STRUCTURE	U	1	$40,000.00	$40,000
503.101	WATER DIVERSION STRUCTURES	U	1	$50,000.00	$50,000
503.201	COFFERDAMS	U	1	$25,000.00	$25,000
504.1	COMMON BRIDGE EXCAVATION (F)	CY	450	$30.00	$13,500
504.2	ROCK BRIDGE EXCAVATION	CY	90	$125.00	$11,250
506.2	STEEL SHEET PILING	LB	35000	$2.50	$87,500
508	STRUCTURAL FILL	CY	20	$50.00	$1,000
510.1	PILE DRIVING EQUIPMENT	U	1	$50,000.00	$50,000
510.2	PILE LOADING TESTS	EA	2	$3,000.00	$6,000
510.61	FURNISHING & DRIVING STEEL BEARING PILES	LB	20000	$1.00	$20,000
510.65	DRIVING-POINTS FOR STEEL BEARING PILES	EA	8	$500.00	$4,000
520.12	CONCRETE CLASS A, ABOVE FOOTINGS (F)	CY	325	$1,200.00	$390,000
520.7	CONCRETE BRIDGE DECK (F)	CY	90	$1,000.00	$90,000
534.3	WATER REPELLENT (SILANE/ SILOXANE)	GAL	25	$100.00	$2,500
538.5	BARRIER MEMBRANE, HEAT WELDED (F)	SY	300	$30.00	$9,000
541.4	PVC WATERSTOPS, NH TYPE 4 (F)	LF	95	$10.00	$950
541.5	PVC WATERSTOPS, NH TYPE 5 (F)	LF	55	$10.00	$550
544.3	REINFORCING STEEL (CONTRACTOR DETAILED)	LB	50000	$1.50	$75,000
544.31	REINFORCING STEEL, EPOXY COATED (CONTRACTOR DETAILED)	LB	20000	$2.00	$40,000
547	SHEAR CONNECTORS (F)	EA	770	$5.00	$3,850
550.1	STRUCTURAL STEEL (F)	LB	80000	$2.00	$160,000
562.1	SILICONE JOINT SEALANT (F)	LF	115	$10.00	$1,150
563.23	BRIDGE RAIL T3	LF	230	$150.00	$34,500
565.232	BRIDGE APPROACH RAIL, T3 (STEEL POSTS)	U	4	$5,500.00	$22,000
572.1	RECONSTRUCTING STONE WALL ONE STONE WIDE	LF	30	$125.00	$3,750
585.2	STONE FILL, CLASS B	CY	300	$60.00	$18,000
585.3	STONE FILL, CLASS C	CY	150	$40.00	$6,000
593.411	GEOTEXTILE; PERM. CONTROL CL. 1, NON-WOVEN	SY	1075	$3.00	$3,225
603.00215	15" R.C. PIPE, 2000D	LF	45	$50.00	$2,250
603.36115	15" ALUMINIZED STEEL END SECTION	EA	4	$250.00	$1,000
603.36118	18" ALUMINIZED STEEL END SECTION	EA	2	$300.00	$600
603.80212	12" PLASTIC PIPE (SMOOTH INTERIOR)	LF	82	$70.00	$5,740
606.120	BEAM GUARDRAIL (STANDARD SECTION) (STEEL POST)	LF	175	$18.00	$3,150
606.141	BEAM GUARDRAIL (CURVED W/CRT POSTS)	LF	50	$32.00	$1,600
606.1255	BEAM GUARDRAIL (TERM. UNIT TYPE EAGRT 25 FT) (STEEL POST)	U	2	$1,800.00	$3,600
606.417	PORTABLE CONCRETE BARRIER FOR TRAFFIC CONTROL	LF	60	$25.00	$1,500
606.84	ANCHOR FOR CURVED GUARD- RAIL W/CRT POSTS	U	1	$2,500.00	$2,500
609.01	STRAIGHT GRANITE CURB	LF	28	$40.00	$1,120
615.03	TRAFFIC SIGN TYPE C (F)	SF	3	$45.00	$135
615.033	REMOVING TRAFFIC SIGN TYPE C	U	6	$150.00	$900
615.034	RELOCATING TRAFFIC SIGN, TYPE C	U	1	$150.00	$150
619.1	MAINTENANCE OF TRAFFIC	U	1	$5,000.00	$5,000
619.25	PORTABLE CHANGEABLE MESSAGE SIGN	U	2	$2,500.00	$5,000
622.1	STEEL WITNESS MARKERS	EA	2	$30.00	$60
628.2	SAWED BITUMINOUS PAVEMENT	LF	125	$2.00	$250
641	LOAM	CY	100	$30.00	$3,000

Hoyle, Tanner & Associates, Inc.
150 Dow Street
Manchester, NH 03101 (603) 669-5555

Calc. By:	JAS/SCS	Date:	5/14/2015
Chck. By:	AML/SBH	Date:	5/14/2015
Chck. By:	STJ	Date:	5/27/2015
Chck. By:		Date:	

Greenhill Road over the Isinglass River, NHDOT Br. No. 109/162
Engineers Estimate of Probable Construction Costs
Bridge Replacement Alternative 3 - Steel Beams with Integral Abutments
Superstructure Alternative 3A - Steel Beams
Substructure Alternative 3B - Integral Abutments
Hoyle, Tanner Project No. 922404/NHDOT Project No. 26722

645.51	HAY BALES FOR TEMPORARY EROSION CONTROL	EA	250	$8.00	$2,000
645.52	RYEGRASS FOR TEMPORARY EROSION CONTROL	LB	10	$2.50	$25
645.531	SILT FENCE	LF	700	$3.00	$2,100
645.7	STORM WATER POLLUTION PREVENTION PLAN	U	1	$3,500.00	$3,500
645.71	MONITORING SWPPP AND EROSION AND SEDIMENT CONTROLS	EA	50	$100.00	$5,000
646.3	TURF ESTABLISHMENT WITH MULCH AND TACKIFIERS	A	0.2	$1,900.00	$380
692	MOBILIZATION	U	1	$140,000.00	$140,000
699	MISCELLANEOUS TEMPORARY EROSION AND SEDIMENT CONTROL	$	1	$7,500.00	$7,500

CONSTRUCTION (CON)

CONSTRUCTION SUBTOTAL	$1,481,980.00
CONTINGENCY (15%)	$222,297.00
HOYLE , TANNER CONSTRUCTION ENGINEERING (ESTIMATED)	$110,000.00
CONSTRUCTION (CON) TOTAL FOR NHDOT FY PLANNING	**$1,814,277.00**

RIGHT OF WAY (ROW)

EASEMENTS	**$5,000.00**

PRELIMINARY ENGINEERING (PE)

ENGINEERING STUDY	$66,000.00
DESIGN (ESTIMATED)	$105,000.00
BID (ESTIMATED)	$6,000.00
PRELIMINARY ENGINEERING (PE) TOTAL	**$177,000.00**

PROJECT TOTAL COST (CON, ROW, PE)	**$1,996,277.00**

K:\922404\4-Design\Estimates\BSG Eng Study\[EstOfCost_EngStudy.xls]Steel Beams

This Engineers Estimate of Probable Construction Costs is based on the anticipated scope of work, as well as HTA's experience with similar projects and understanding of current industry trends. The estimate has not been based on a final design for this project, and as such, it is intended to be preliminary in nature. It should be noted that changes in material or labor costs in the construction industry could impact the project cost in either direction.

APPENDIX D

NHDOT Bridge Inspection Report

Bridge Inspection Report

Barrington 109/162

Date of Inspection: 09/03/2013
Date Report Sent: 1/3/2014
☐ Picture taken during inspection
Owner: Municipality

GREEN HILL ROAD
Over
ISINGLASS RIVER

Recommended Postings:

Weight: C2 ☑ Weight Sign OK

Width: Not Required ☑ Width Sign OK
SIGNED NARROW BRIDGE

Primary Height Sign Recommendation: *None* ☑ Height Signs OK
Optional Centerline Height Sign Rec: *None*

Clearances: (Feet) Over:
Under: 0.00
Route:

Condition: Not on the Redlist
Deck: 6 Satisfactory
Superstructure: 7 Good
Substructure: 6 Satisfactory
Culvert: N N/A (NBI)

Structure Type and Materials:
Number of Spans Main Unit: 1
Number of Approach Spans: 0

Main Span Material and Design Type
Steel Multiple Beam

Sufficiency Rating: 69.1%
NBI Status: Functionally Obsolete

Bridge Rail: Substandard
Rail Transition: Substandard
Bridge Approach Rail: Substandard
Approach Rail Ends: Substandard

NH Bridge Type: I Beams w/ Concrete Deck
Deck Type: Concrete, Cast in Place
Wearing Surface: Bituminous
Membrane: None
Deck Protection: None
Pavement thickness: 3.0 in
Curb Reveal: 6.0 in
Plan Location: Unknown

Bridge Dimensions:

Length Maximum Span: 62.0 ft
Total Bridge Length: 66.0 ft
Left Curb/Sidewalk Width: 0.0 ft
Right Curb/Sidewalk Width: 0.0 ft
Width Curb to Curb: 18.0 ft
Total Bridge Width: 19.8 ft
Approach Roadway Width (W/ Shoulders): 18.0 ft
Median: No median
Bridge Skew: 0.00 °

Bridge Service:

Type of Service on Bridge: Highway
Year Built: 1955
Type of Service under: Waterway
Year Rebuilt: Not Rebuilt
Lanes on bridge: 2
Detour Length: 2.0 mi
Lanes Under: NA

AADT: 1800
Percent Trucks: 4%
Year of AADT: 2011
Future AADT: 2664
Year of Future AADT: 2034

Bridge Inspection Report

Barrington 109/162

Federal or State Definition Bridge:	Fed. Definition Bridge
Roadway Functional Class:	Rural Local
New Hampshire Highway System and Class:	Municipal Highway
Eligibility for the National Register of Historic Places:	Possibly eligible
Traffic Direction:	Two-way traffic

National Bridge Inventory (NBI) Appraisal Ratings:

Deck Geometry:	Intolerable, Replacement
Underclearances:	Not Applicable (NBI)
Approach Alignment:	Equal Minimum Criteria
Structural Evaluation:	Equal Minimum Criteria
Channel/Channel Protection:	Minor Damage
Waterway Adequacy:	Above Desirable Criteria
Bridge Scour Critical Status:	Stable for extreme flood
Riprap Condition:	Fair Condition
Debris Present:	No Debris Present
Date of Underwater Inspection:	Not Applicable

AASHTO CoRe Element Condition State Data:

No.	Description	Env.	Material Notes and Condition Notes
13	Concrete Deck - Unprotected, with Asphalt Pavement	Moderate	*ASPHALT - HEAVILY CRACKED WITH MEMBRANE BUBBLES, PATCHED, POTHOLED WITH DECK EXPOSED AT WEST DECK END. CURB - CRACKS AND SPALLED WITH REBAR EXPOSED AT NORTHEAST.*
107	Painted Steel Beam or Girder (Open Web)	Moderate	*STRINGERS HAVE LIGHT RUST IN AREAS. PAINT IS FLAKING.*
217	Other Material Abutment	Moderate	*STONE MASONRY ABUTMENTS AND WINGS. WITH CONCRETE CAP AND BACKWALLS.* *BACKWALLS HAVE FINE CRACKS, MINOR SPALLS. BRIDGESEATS HAVE FINE CRACKS AND MODERATE SPALLS WITH REBAR EXPOSED AT WEST; LIGHT SPALLS AT EAST.*
311	Moveable Bearing (roller, sliding, etc.)	Moderate	*BEARINGS ARE RUSTED.*
334	Coated Metal Bridge Railing	Moderate	*** W-Beam ** PAINTED STEEL POSTS.* *PAINTED STEEL POSTS RUSTED. MINOR DAMAGE TO RAIL.*
359	Soffit of Conc Deck or Slab Condition Warning Flag	Moderate	*DECK UNDERSIDE HAS FINE CRACKS, MODERATE LEAKING, LIGHT EFFLORESCENCE; RUST STAINS AT EXTERIORS. MINOR SPALLS.*

No.	Description	Env.	Quantity	Units	State 1	State 2	State 3	State 4	State 5
13	Concrete Deck - Unprotected, with Asph	Moderate	1,302	(SF)	0 %	0 %	100 %	0 %	0 %
107	Painted Steel Beam or Girder (Open We	Moderate	197	(LF)	0 %	34 %	33 %	33 %	0 %

Bridge Inspection Report

Barrington 109/162

No.	Description	Env.	Quantity	Units	State 1	State 2	State 3	State 4	State 5
217	Other Material Abutment	Moderate	161	(LF)	0 %	100 %	0 %	0 %	
311	Moveable Bearing (roller, sliding, etc.)	Moderate	6	(EA)	0 %	100 %	0 %		
334	Coated Metal Bridge Railing	Moderate	121	(LF)	0 %	0 %	100 %	0 %	0 %
359	Soffit of Conc Deck or Slab Condition W	Moderate	1	(EA)	100 %	0 %	0 %	0 %	0 %

Bridge Notes:

Approach and Roadway Notes: *ASPHALT - (5) CRACKED, SETTLED AND POTHOLED AT DECK END.*
W- BEAM RAIL - DAMAGED.
EMBANKMENTS ARE WASHED.

Inspection History:

Inspection Date: 09/03/2013 **Inspector:** MAS

Deck: 6 Satisfactory
Super: 7 Good
Substr: 6 Satisfactory
Culvert: N N/A (NBI)

Notes:

MAS - inspection comments -
DECK: ASPHALT - HEAVILY CRACKED AND PATCHED, POTHOLED AT WEST DECK END. CURBS - CRACKS AND SPALLS WITH REBAR EXPOSED. RAIL - MINOR DAMAGE AND RUSTING, SPALLS AT POST BASES. SOFFIT - FINE CRACKS AND LEAKING WITH EFFLORESCENCE AND FEW RUST STAINS, MINOR SPALLS.
SUPERSTRUCTURE: PAINT - POOR CONDITION. PEELING / FLAKING WITH EXPOSED METAL RUSTING. BEAMS AND BEARINGS - LIGHT RUST IN AREAS UNDER LEAKAGE.
SUBSTRUCTURE: MASONRY - CRACKED AND MISSING MORTAR WITH FEW VOIDS BETWEEN STONES. CONCRETE - CRACKS AND MINOR TO MODERATE SPALLS WITH REBAR EXPOSED. EMBANKMENTS ARE WASHED.

Inspection Date: 09/15/2011 **Inspector:** MAS

Deck: 6 Satisfactory
Super: 7 Good
Substr: 6 Satisfactory
Culvert: N N/A (NBI)

Notes:

MAS - inspection comments -
DECK: DECK UNDERSIDE HAS FINE CRACKS, MODERATE LEAKING. CONCRETE CURBS HAVE FINE CRACKS AND SPALLS WITH REBAR EXPOSED AT NORTHEAST. MINOR SPALLS AT POSTS. W-BEAM RAIL WITH PAINTED STEEL POSTS; POSTS RUSTED.
SUPERSTRUCTURE: STRINGERS HAVE LIGHT RUST AREAS. PAINT IS FLAKING. BEARINGS ARE RUSTED.
SUBSTRUCTURE: BREASTWALLS ARE MASONRY. CONCRETE BACKWALLS HAVE FINE CRACKS, MINOR SPALLS. CONCRETE BRIDGESEATS HAVE FINE CRACKS, MODERATE SPALLS AT SOUTH WITH REBAR EXPOSED AT SOUTHWEST; LIGHT SPALLS AT NORTH. WINGS ARE CONCRETE AND MASONRY. RIP- RAP INSTALLED AT SOUTHEAST EMBANKMENT.

PICTURES: C437-
31. CURB SPALLED WITH REBAR EXPOSED AT NORTHEAST.
32. ASPHALT POTHOLED WITH DECK EXPOSED.
33. SPALL WITH REBAR EXPOSED AT SOUTHWEST ABUTMENT.

Inspection History:

Inspection Date: 06/12/2009 **Inspector:** DPC

Deck: 6 Satisfactory
Super: 7 Good
Substr: 6 Satisfactory
Culvert: N N/A (NBI)

Notes:

DPC/KLM inspection comments -
DECK: ELEMENTS IN SATISFACTORY CONDITION. DECK UNDERSIDE HAS FINE CRACKS, MODERATE LEAKING. CONCRETE CURBS HAVE FINE CRACKS AND SPALLS WITH REBAR EXPOSED AT NORTHEAST. MINOR SPALLS AT POSTS. W-BEAM RAIL WITH PAINTED STEEL POSTS; POSTS RUSTED.
SUPERSTRUCTURE: ELEMENTS IN GOOD CONDITION. STRINGERS HAVE LIGHT RUST AREAS. BEARINGS ARE RUSTED.
SUBSTRUCTURE: ELEMENTS IN SATISFACTORY CONDITION. BREASTWALLS ARE MASONRY. CONCRETE BACKWALLS HAVE FINE CRACKS, MINOR SPALLS. CONCRETE BRIDGESEATS HAVE FINE CRACKS, MODERATE SPALLS AT SOUTH WITH REBAR EXPOSED AT SOUTHWEST; LIGHT SPALLS AT NORTH. WINGS ARE CONCRETE AND MASONRY. RIP- RAP INSTALLED AT SOUTHEAST EMBANKMENT.

Inspection Date: 09/17/2007 **Inspector:** RLM

Deck: 6 Satisfactory
Super: 7 Good
Substr: 6 Satisfactory
Culvert: N N/A (NBI)

Notes:

RLM inspection comments -
DECK: DECK UNDERSIDE HAS FINE CRACKS, MINOR LEAKING. CONCRETE CURBS HAVE FINE CRACKS AND A SPALL WITH REBAR EXPOSED AT NORTHEAST. MINOR SPALLS AT POSTS. W-BEAM RAIL WITH PAINTED STEEL POSTS; POSTS RUSTED.
SUPERSTRUCTURE: STRINGERS HAVE LIGHT RUST AREAS. BEARINGS ARE RUSTED.
SUBSTRUCTURE: BREASTWALLS ARE MASONRY. CONCRETE BACKWALLS HAVE FINE CRACKS, MINOR SPALLS. CONCRETE BRIDGESEATS HAVE FINE CRACKS, MODERATE SPALLS AT SOUTH WITH REBAR EXPOSED AT SOUTHWEST; LIGHT SPALLS AT NORTH. WINGS ARE CONCRETE AND MASONRY. RIP- RAP INSTALLED AT SOUTHEAST EMBANKMENT.

PICTURE: C357- 15.

Inspection Date: 10/04/2005 **Inspector:** DPC

Deck: 6 Satisfactory
Super: 7 Good
Substr: 6 Satisfactory
Culvert: N N/A (NBI)

Notes:

DPC inspection comments -
DECK: DECK UNDERSIDE HAS FINE CRACKS, MINOR LEAKING. CONCRETE CURBS HAVE FINE CRACKS AND A SPALL WITH REBAR EXPOSED AT NORTHEAST. MINOR SPALLS AT POSTS. W-BEAM RAIL WITH PAINTED STEEL POSTS; POSTS RUSTED.
SUPERSTRUCTURE: STRINGERS HAVE LIGHT RUST AREAS. BEARINGS ARE RUSTED.
SUBSTRUCTURE: BREASTWALLS ARE MASONRY. CONCRETE BACKWALLS HAVE FINE CRACKS, MINOR SPALLS. CONCRETE BRIDGESEATS HAVE FINE CRACKS, MODERATE SPALLS AT SOUTH WITH REBAR EXPOSED AT SOUTHWEST; LIGHT SPALLS AT NORTH. WINGS ARE CONCRETE AND MASONRY. FOOTINGS ARE NOT VISIBLE.

Inspection Date: 08/27/2003 **Inspector:** RLM

Deck: 6 Satisfactory
Super: 7 Good
Substr: 6 Satisfactory
Culvert: N N/A (NBI)

Notes:

Sufficiency Rating Calculation Accepted by DEP at 7/20/2004 14:25:47
RLM inspection comments -
DECK: ASPHALT CRACKS WITH DELAMINATED DECK UNDERNEATH. DECK UNDERSIDE HAS FINE CRACKS, MINOR LEAKING. CONCRETE CURBS HAVE FINE CRACKS AND A SPALL WITH REBAR EXPOSED AT NORTHEAST. MINOR SPALLS AT POSTS. W-BEAM RAIL WITH PAINTED STEEL POSTS; POSTS RUSTED.
SUPERSTRUCTURE: STRINGERS HAVE LIGHT RUST AREAS. BEARINGS ARE RUSTED.
SUBSTRUCTURE: BREASTWALLS ARE MASONRY. CONCRETE BACKWALLS HAVE FINE CRACKS, MINOR SPALLS. CONCRETE BRIDGESEATS HAVE FINE CRACKS, MODERATE SPALLS AT SOUTH WITH REBAR EXPOSED AT SOUTHWEST; LIGHT SPALLS AT NORTH. WINGS ARE CONCRETE AND MASONRY. FOOTINGS ARE NOT VISIBLE.

PICTURE: C192-13.

Bridge Inspection Report

Barrington 109/162

Inspection History:

Inspection Date: 08/17/2001 **Inspector:** RLM

Deck: 7 Good
Super: 7 Good
Substr: 6 Satisfactory
Culvert: N N/A (NBI)

Notes:

Sufficiency Rating Calculation Accepted by DEP at 01-16-2002 09:42:35
RLM inspection comments -
DECK: ASPHALT CRACKS WITH DELAMINATED DECK UNDERNEATH. DECK UNDERSIDE HAS FINE CRACKS, MINOR LEAKING. CONCRETE CURBS HAVE FINE CRACKS AND A SPALL WITH REBAR EXPOSED AT NORTHEAST. MINOR SPALLS AT POSTS. W-BEAM RAIL WITH PAINTED STEEL POSTS; POSTS RUSTED.
SUPERSTRUCTURE: STRINGERS HAVE LIGHT RUST AREAS. BEARINGS ARE RUSTED.
SUBSTRUCTURE: BREASTWALLS ARE MASONRY. CONCRETE BACKWALLS HAVE FINE CRACKS, MINOR SPALLS. CONCRETE BRIDGESEATS HAVE FINE CRACKS, MODERATE SPALLS AT SOUTH WITH REBAR EXPOSED AT SOUTHWEST; LIGHT SPALLS AT NORTH. WINGS ARE CONCRETE AND MASONRY. FOOTINGS ARE NOT VISIBLE.

Inspection Date: 09/17/1999 **Inspector:** RLM

Deck: 7 Good
Super: 7 Good
Substr: 7 Good
Culvert: N N/A (NBI)

Notes:

RLM inspection comments -
DECK: ASPHALT IS OK. DECK UNDERSIDE HAS FINE CRACKS, MINOR LEAKING. CONCRETE CURBS HAVE FINE CRACKS AND
A SPALL WITH REBAR EXPOSED AT NORTHEAST. W-BEAM RAIL WITH PAINTED STEEL POSTS; POSTS RUSTED.
SUPERSTRUCTURE: STRINGERS HAVE LIGHT RUST AREAS. BEARINGS ARE RUSTED.
SUBSTRUCTURE: BREASTWALLS ARE MASONRY. CONCRETE BACKWALLS HAVE FINE CRACKS, MINOR SPALLS. CONCRETE BRIDGESEATS HAVE FINE CRACKS, MODERATE SPALLS AT SOUTH WITH REBAR EXPOSED AT SOUTHWEST; LIGHT SPALLS AT NORTH. WINGS ARE CONCRETE AND MASONRY. FOOTINGS ARE NOT VISIBLE.

Inspection Date: 09/01/1997 **Inspector:** Not Available

Deck: 7 Good
Super: 7 Good
Substr: 7 Good
Culvert: N N/A (NBI)

Notes:

Inspection Date: 09/01/1995 **Inspector:** Not Available

Deck: 7 Good
Super: 7 Good
Substr: 7 Good
Culvert: N N/A (NBI)

Notes:

Inspection Date: 02/01/1994 **Inspector:** Not Available

Deck: 6 Satisfactory
Super: 8 Very Good
Substr: 7 Good
Culvert: N N/A (NBI)

Notes:

Inspection Date: 08/01/1991 **Inspector:** Not Available

Deck: 6 Satisfactory
Super: 8 Very Good
Substr: 7 Good
Culvert: N N/A (NBI)

Notes:

Copy Distribution:

- [x] (2) Bureau of Municipal Hghways
- [ ] (3) Bureau of Municipal Hghways
- [ ] Bureau of Turnpikes
- [ ] Border State
- [ ] Bureau of Rail and Transit
- [ ] Army Corps Of Engineers
- [ ] Railroad
- [ ] Dept. of Res. and Econ. Dev.
- [ ] Dept. of Environmental Services
- [ ] USDA Forest Service
- [ ] Bureau of Traffic

APPENDIX E

1954 Existing Plans

FED. ROAD DIV. NO.	STATE	TRB PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
1	N.H.	T-2787		1	

INDEX OF SHEETS

SHEET NO. 1 TITLE PAGE
2-3 PLAN SHEETS
4-11 BRIDGE SHEETS
12-14 CROSS SECTION SHEETS
15 STANDARD SHEET NO. 5 REVISED MAR. 10, 1954
16 " " " " 6 " DEC. 22, 1953

STATE OF NEW HAMPSHIRE
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS

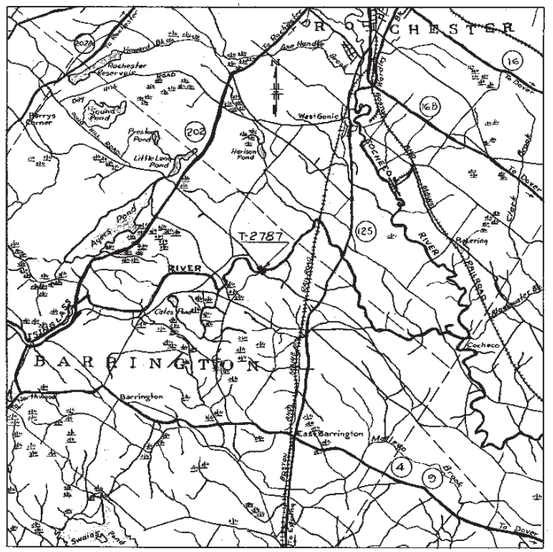
PLANS OF PROPOSED

T R B

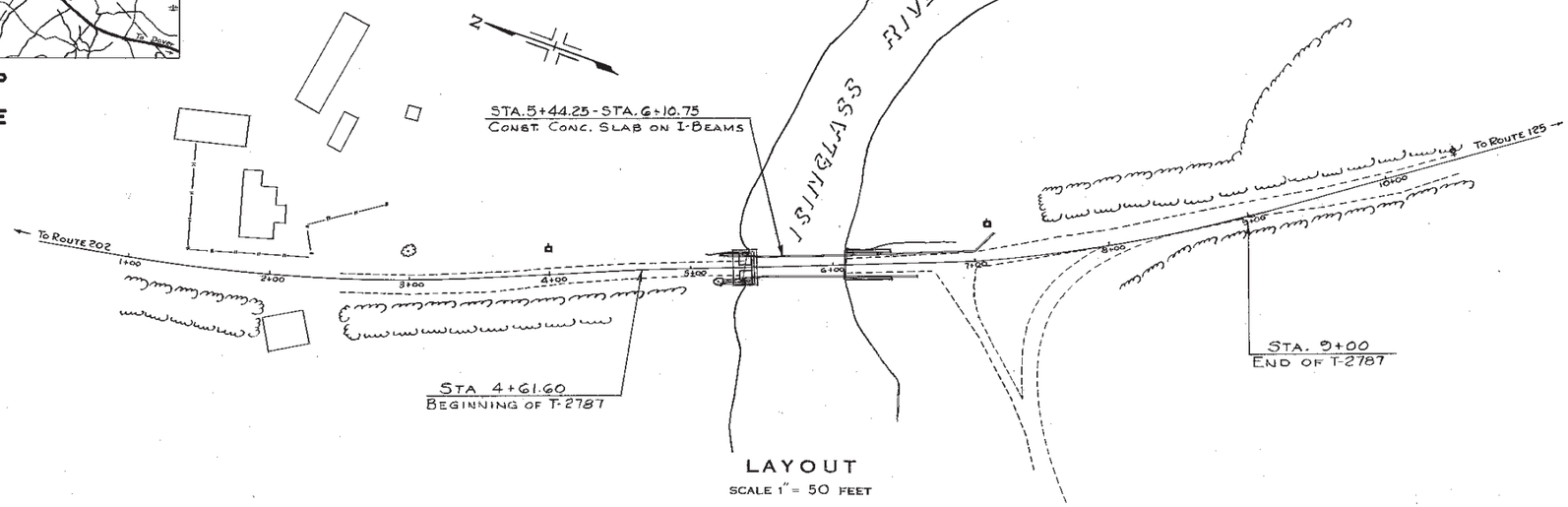
T-2787

BRIDGE NO. 109/162

THIS PROJECT TO BE CONSTRUCTED IN ACCORDANCE WITH STANDARD SPECIFICATIONS DATED July 1 1954 AND STANDARD SHEETS LISTED IN THE INDEX ON FILE WITH THE BUREAU OF PUBLIC ROADS AND SPECIAL PROVISIONS ATTACHED TO PROPOSAL.



LOCATION MAP
SCALE 1"=1MILE



LAYOUT
SCALE 1" = 50 FEET

CONVENTIONAL SIGNS

STATE LINE		R O W LINE	
TOWN LINE		SURVEY LINE	
FENCE		CULVERTS	
STONE WALL		POWER POLES	
UNFENCED PROPERTY		TELEPHONE POLES	
TRAVELED WAY		GROUND ELEVATION	
RAILROADS		GRADE ELEVATION	
RETAINING WALL		SLOPE LINE	
SEWER MANHOLE		CATCH BASIN	
HYDRANT		DROP INLET	
		BRUSH LINE	

TOWN OF BARRINGTON
COUNTY OF STRAFFORD

RECOMMENDED FOR APPROVAL: DATE _____
John O. Morton
DEPUTY COMMISSIONER & CHIEF ENGINEER
APPROVED:
Frank D. Merrill
COMMISSIONER

DRAWN BY F. Ystueta DATE 11-4-54
CHECKED BY DATE

FILE NO. 3-4-4-2

PROJ NO.	SHEET NO.	TOTAL SHEETS
T-2787	1	16

200-2-60 Eugene Dietzgen Co., New York, N. Y.

FED. ROAD DIV. NO.	STATE	TRB PROJ.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
1	N. H.	T-2787		2	16

N

5+05 - 5+45 Lt.
Const. 40'x Wood Guard Rail (Single Rail) G.R.-3A

4+00 - 4+61.60
Const. Approach to Project

Field

NET & T 13 18 P.S.Co.

38.22'

S 23°-35'-30" E

4+00

To Route #202

57.77'

5+00

65.38'

4+19 Rt.
Match Existing Drive to New Roadway

Woods

Field

P.S.Co. 8

12" Apple

Pay line for Gravel Backfill Item 16.2

Sta. 4+61.60
Beginning of T-2787

5+05 - 5+45 Rt.
Const. 40'x Wood Guard Rail (Single Rail) G.R.-3A

Flow

Isinglass River

5+45 - 6+82 Lt.
Const. 137'x Bridge Rail D

Field

P.I. = 7+88.68
Δ = 12°-50'
D = 5°-00'
T = 128.85'
L = 256.65'
R = 1146.00

P.C. = 6+59.83

NET & T 481/12 P.S.Co. 17

6+82 - 6+98 Lt.
Const. 16'x Wood Guard Rail (Single Rail) G.R.-3A

For Typical Details See Sheet 13

S 21°-50' E

6+00

7+00

Retain

B.M. #1

6+75 Rt. (Const.)
Match Existing Drive to New Roadway

5+45 - 6+58 Rt.
Const. 113'x Bridge Rail D

B.M. #1 Sta 7+20 16' Rt. Spike in root of 7' White Pine El. 100.00

6+58 - 6+80 Rt.
Const. 32'x Wood Guard Rail (Single Rail) G.R.-3A

NOTE:— Borings indicated thus ● made by NHDPW&Highways November 1954. Figures in right hand column indicate number of blows required to drive 1⅜" pipe on foot using a 135# weight falling two feet. Borings are for design and show conditions at boring points only and do not necessarily indicate material to be encountered during construction. Samples of materials encountered may be examined at the office of the Bridge Engineer, Concord, N.H.

PLAN

V.C. = 100'
M.O. .775'

-9.2%

Grade Line - ℄ Finished Roadway

P.I. Elev. = 102.00

-3.0%

5+46.5 ℄ Bearings (Exp) FG. El. = 98.86'

6+08.5 ℄ Bearings (Fixed) FG. El. = 98.00'

V.C. = 50'
M.O. = .42'

+3.78%

P.I. Elev. = 96.75'

DATUM ELEV. = 90.00'

DATUM ELEV. = 60.00'

4+00 +19 +61.60 5+00 +36.80 6+00 +97.20 +75.60 +08.80 7+00

+25 +75 +25 +25 +75 +74

108.9 108.90 | 107.2 101.15 | 104.9 104.49 | 102.78 | 102.0 101.44 | 100.50 | 84.9 ℄ 97.2 100.09 | 82.9 99.75 | 82.4 ℄ 96.20 99.16 | 81.7 ℄ 96.20 98.78 | 81.4 98.85 | 82.3 ℄ 94.4 97.99 | 97.4 97.17 | 97.9 97.85 | 98.2 98.64

Sheet Scale 1"=10'-0"

PROFILE

① DATUM ELEV. = 65.00
Stream Bed El. 80.8
Gravel — Boulders
Sandy Hardpan
El. 75±
Refusal on Ledge

② Stream Bed El. 82.4
Gravel — Boulders
Sandy Hardpan
El. 74±
Refusal on Ledge

③ Ground El. 83.7
Gravel
Sandy Hardpan
El. 78±
Refusal on Ledge

③A Grnd. +36.80 ± El. 85±
Gravel to Sandy Hardpan
El. 79±
Refusal on Ledge

④ +97.20 +75.60 Ground El. 84.2
Sand and Boulders
Sandy to Silty Hardpan
El. 72±
Refusal on Ledge

⑤ +08.80 Ground El. 83.8
Boulders
Silty Gravel
El. 78±
Refusal on Ledge

Δ	DESCRIPTION	BY	DATE
	REVISIONS		

STATE OF NEW HAMPSHIRE
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BRIDGE DIVISION

TOWN Barrington — BRIDGE NO. 109/162
FEDERAL PROJECT — STATE PROJECT T-2787
ROUTE NO. — OVER Isinglass River
LOCATION Approx. 1 Mi. West of Route #125

PLAN & PROFILE

	BY	DATE		BY	DATE	BRIDGE SHEET NO.
DESIGNED	F.Y.	11-54	CHECKED	J.T.H.	11-54	OF
DRAWN	F.Y.	11-54	CHECKED	J.T.H.	11-54	
TRACED	F.Y.	11-54	CHECKED			FILE NUMBER
QUANTITIES	F.Y.	11-54	CHECKED	J.T.H.	11-54	3-4-4-2

PROJ. NO.	SHEET NO.	TOTAL SHEETS
T-2787	2	16

FED. ROAD DIV. NO.	STATE	TRB PROJ.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
1	N. H.	T-2787		3	16

P.I. = 7+88.68
Δ = 12°50'
D = 5°00'
T = 128.85'
L = 256.65'
R = 1146.00

N

Field

Field

Woods

Woods

Woods

Woods

Woods

7" Elm

43.71'

481/12
17

P.T. = 9+16.48 (Const.)

9+00 - 9+48.5 Const.
Const. Approach to Project

Slope lines

34.93'

7+00

S 21°-50' E

Const. Line

8+00

Survey Line

8+00

9+00

S 34°-40' E

10+50
To Route #125

B.M. #1

Retain

33.23'

8" Pine

70.45'

18" Pine

7+90 Rt. (Const.)
Match Existing Drive
to New Roadway.

PLAN

Sta. 9+00
End of T-2787

49.75'

35.95'

5" Elm

5" Elm

Slope lines

Grade Line - ℄ Finished Roadway

+3.78%

+3.2 %

	7+00	7+50 S / 7+50.5 C	8+00 S / 7+99 C	8+50 S / 8+48.5 C	9+00 S / 8+98.5 C	9+50 S / 9+48.5 C
	98.2	100.5	103.5	104.4	106.2	107.8
	98.64	100.63	102.42	104.31	106.20	107.80

DATUM ELEV. = 60.00'

PROFILE

Sheet Scale 1" = 10'-0"

STATE OF NEW HAMPSHIRE
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BRIDGE DIVISION

TOWN Barrington BRIDGE NO. 109/162
FEDERAL PROJECT ——— STATE PROJECT T-2787
ROUTE NO. ——— OVER Isinglass River
LOCATION Approx. 1 Mi. West of Route # 125

PLAN & PROFILE

	BY	DATE
DESIGNED	F.Y.	11-54
DRAWN	F.Y.	11-54
TRACED	—	
QUANTITIES	F.Y.	11-54
CHECKED	J.T.H.	11-54
CHECKED	J.T.H.	11-54
CHECKED		
CHECKED	J.T.H.	1-54

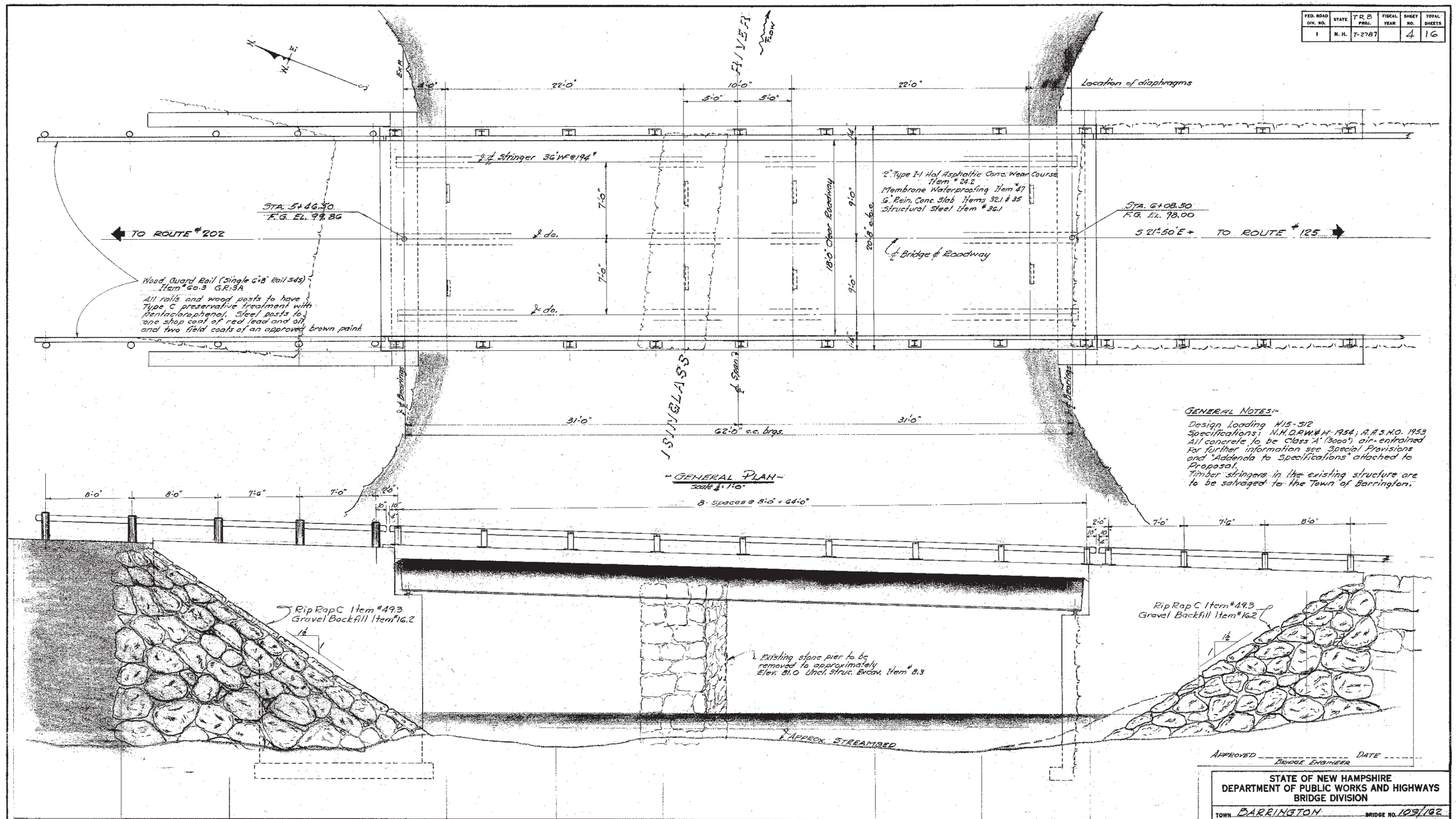
BRIDGE SHEET NO. OF
FILE NUMBER 3-4-4-2

PROJ. NO.	SHEET NO.	TOTAL SHEETS
T-2787	3	16

Δ	DESCRIPTION	BY	DATE

REVISIONS

FED. ROAD DIV. NO.	STATE	T R B PROJ.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
1	N. H.	T-2787		4	16



– GENERAL PLAN –
Scale ⅛" = 1'-0"

UPSTREAM ELEVATION

GENERAL NOTES:-

Design Loading H 15-S 12
Specifications: N.H.D.P.W.& H. 1954; A.A.S.H.O. 1953
All concrete to be Class "A" (3000#) air-entrained
For further information see Special Provisions and "Addenda to Specifications" attached to Proposal.
Timber stringers in the existing structure are to be salvaged to the Town of Barrington.

APPROVED _____ DATE _____
BRIDGE ENGINEER

STATE OF NEW HAMPSHIRE
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BRIDGE DIVISION

TOWN BARRINGTON BRIDGE NO. 105/102
FEDERAL PROJECT _____ STATE PROJECT T-2787
ROUTE NO. _____ OVER ISINGLASS RIVER
LOCATION Approx. 1 Mi. West of Rt # 125

GENERAL PLAN - UPSTREAM ELEV.

	BY	DATE
DESIGNED H.E.L.		9/54
DRAWN R.I.P.		9/54
TRACED		
QUANTITIES F.Y.		11-54
CHECKED E.I.P.		9/54
CHECKED F.Y.		10/54
CHECKED		
CHECKED J.T.H.		11-54

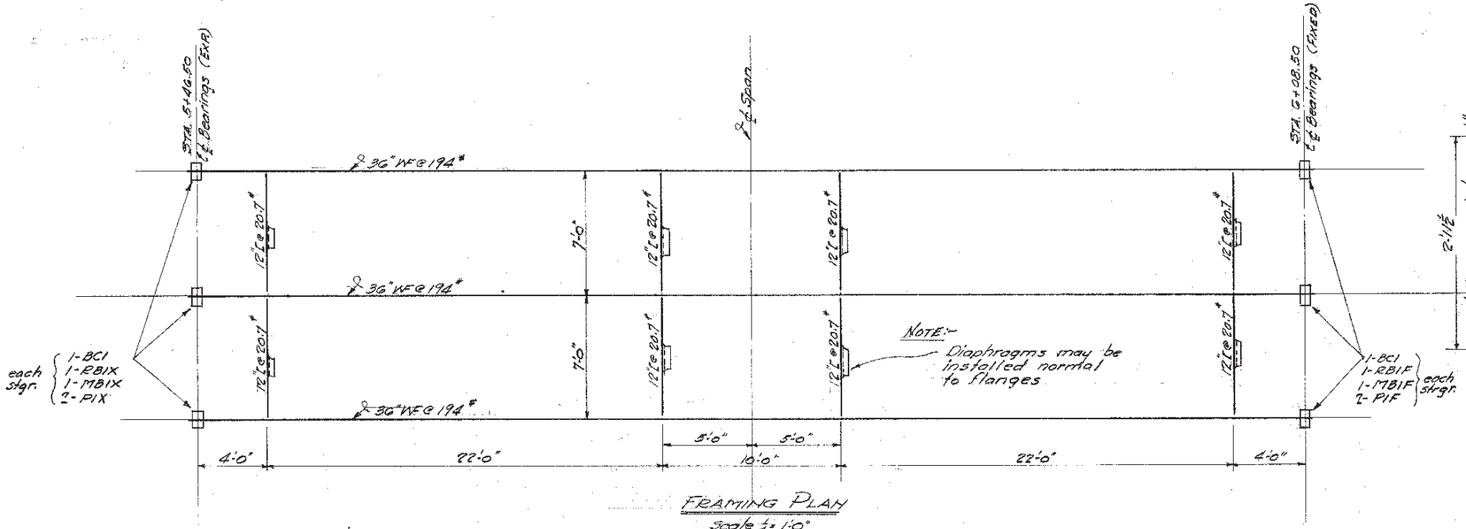
BRIDGE SHEET NO. 1 OF 8
FILE NUMBER 3-4-4-2

△	DESCRIPTION	BY	DATE

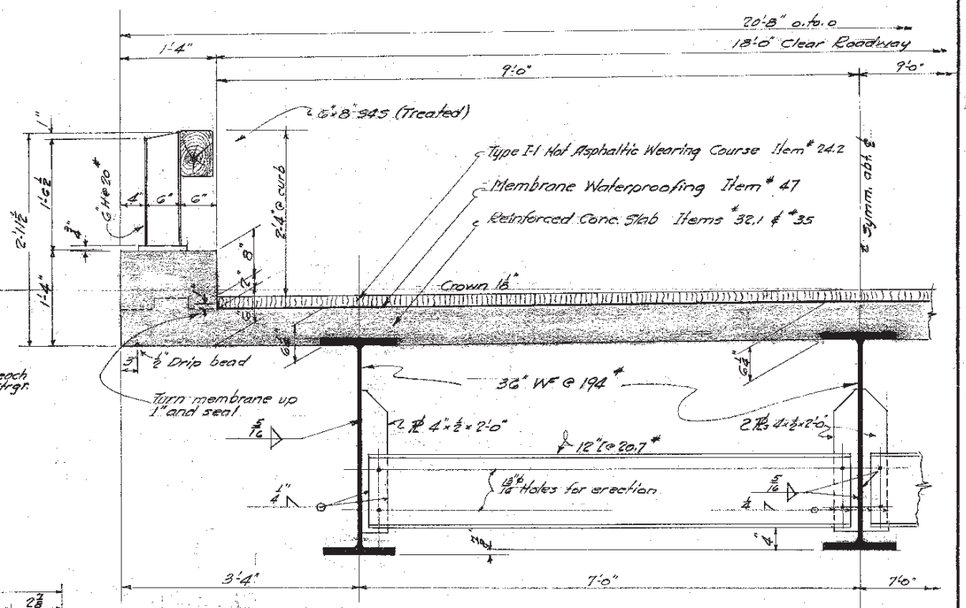
REVISIONS

PROJ. NO.	SHEET NO.	TOTAL SHEETS
T-2787	4	16

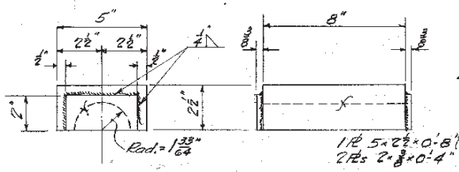
FED. ROAD DIV. NO.	STATE	T.R.B. PROJ.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
1	N.H.	T-2787		5	16



FRAMING PLAN
Scale ¼" = 1'-0"



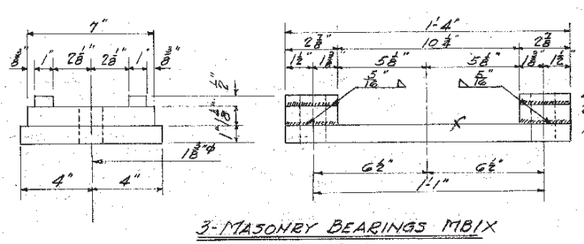
TYPICAL HALF CROSS SECTION
Scale 1" = 1'-0"



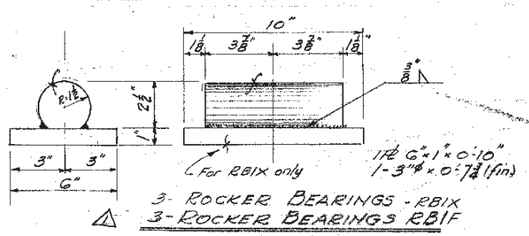
6- BEARING CAPS - BCI
Scale 3" = 1'-0"

1 Pl 5"x2¾"x0'-0 1/8" (Fin.)
2 Pls 2"x⅜"x0'-1 4"

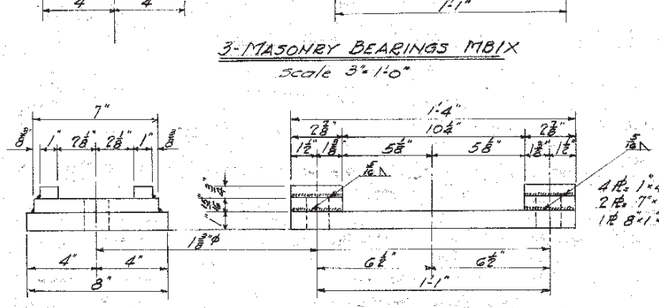
NOTE:- Bearing caps BCI to be shop welded to stringers with cont. 3/16" fillet weld. Caps to be carefully centered beneath and at right angles to beam webs. Distance center to center of caps measured along the bottom flange is 62'-0 1/4"



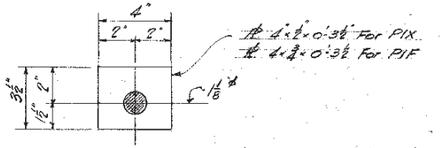
3- MASONRY BEARINGS MBIX
Scale 3" = 1'-0"



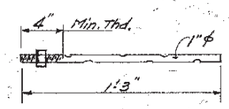
3- ROCKER BEARINGS - RBIX
3- ROCKER BEARINGS RBIF
Scale 3" = 1'-0"



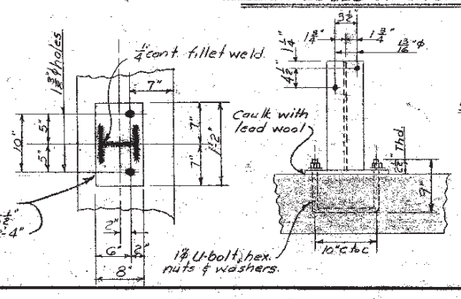
3- MASONRY BEARINGS MBIF
Scale 3" = 1'-0"



6- HOLD DOWN Pls - PIX
6- CLAMPING Pls - PIF
Scale 3" = 1'-0"

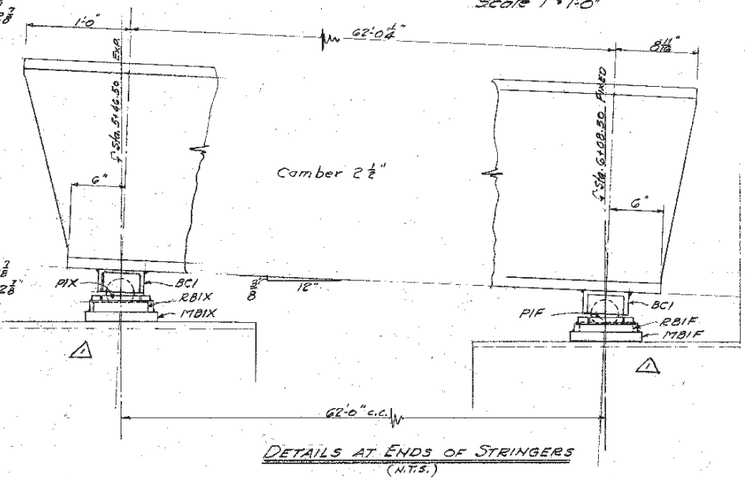


12- SWEDGED ANCHOR BOLTS



DETAILS OF RAIL POST
(35 REQ'D)
Scale 1" = 1'-0"

Note: Steel posts & plates to have one shop coat red lead & oil and 2 field coats of approved brown paint. Portions of posts in contact with wood rail shall be painted before erection. Base plates shall be flat & true after welding.



DETAILS AT ENDS OF STRINGERS
(N.T.S.)

NOTE:-
All material, bearing caps, rocker bearings and plates between bottom flanges and top of concrete bridge seat to be paid for as Item # 36.2 "Bridge Shoes"
Finished surfaces which provide for rotation or sliding shall be given one coat of white lead and tallow in the shop.

1 Assembly Sketch

2	Junction for Anchor Bearings at Rail Sketch	J.S.B.	1/10/64
1	Details of Rail Post	J.S.B.	1/10/64
△	DESCRIPTION	BY	DATE

REVISIONS

STATE OF NEW HAMPSHIRE
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BRIDGE DIVISION

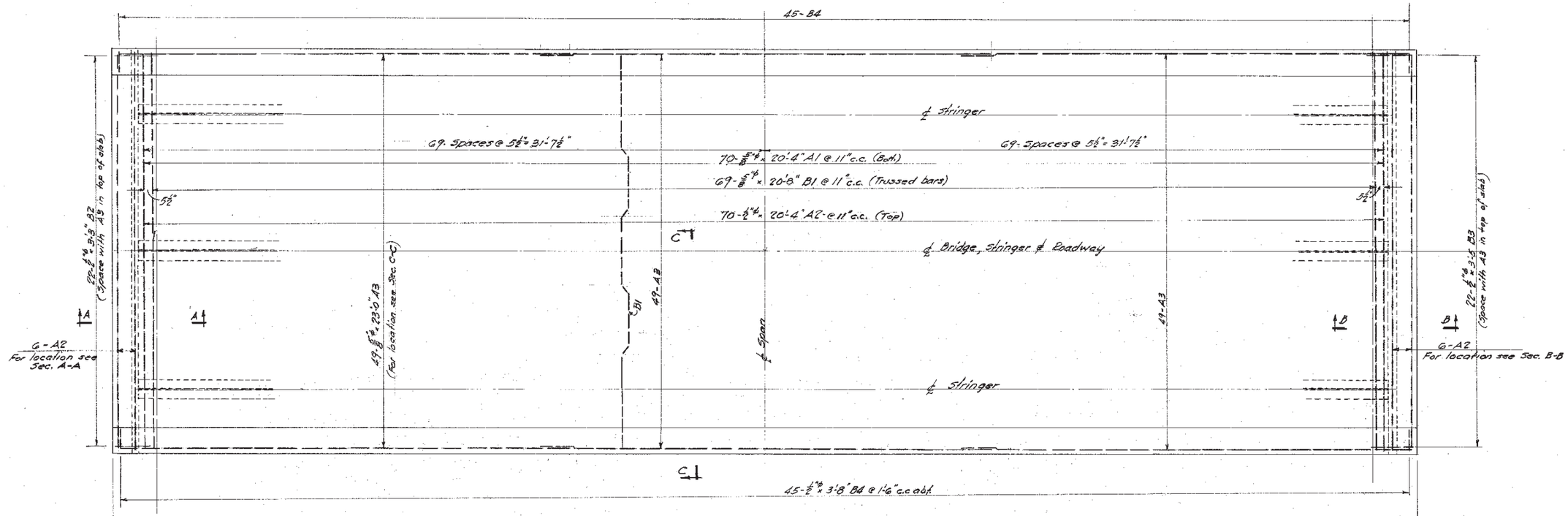
TOWN BARRINGTON BRIDGE NO. 109/162
FEDERAL PROJECT ——— STATE PROJECT T-2787
ROUTE NO. ——— OVER ISINGLASS RIVER
LOCATION APPROX. 1 MI. WEST OF RT. # 125

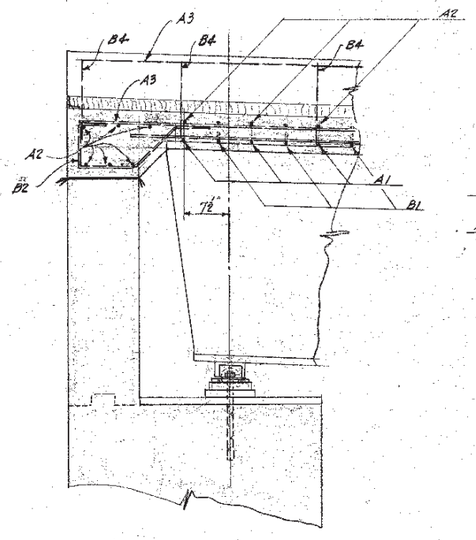
HALF-CROSS SECTION & STRUC. DETAILS

	BY	DATE		BY	DATE	
DESIGNED	N.E.L.	9/64	CHECKED	R.J.P.	9/64	BRIDGE SHEET NO. 2 OF 8
DRAWN	R.J.P.	10/64	CHECKED	F.Y.	10/64	
TRACED			CHECKED			FILE NUMBER 3-4-4-2
QUANTITIES	F.Y.	11-64	CHECKED	J.T.H.	1-65	

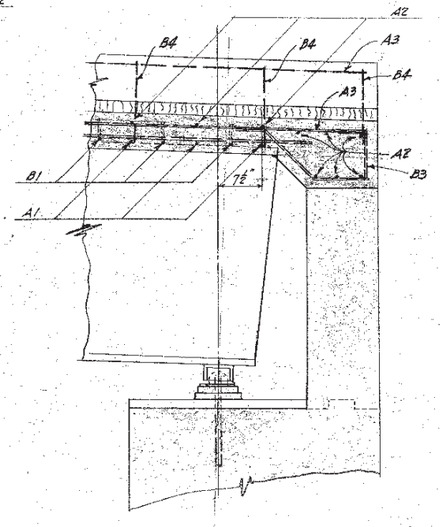
PROJ. NO.	SHEET NO.	TOTAL SHEETS
T-2787	5	16

FED. ROAD DIV. NO.	STATE	T R B PROJ.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
1	N. H.	T-2787		6	16



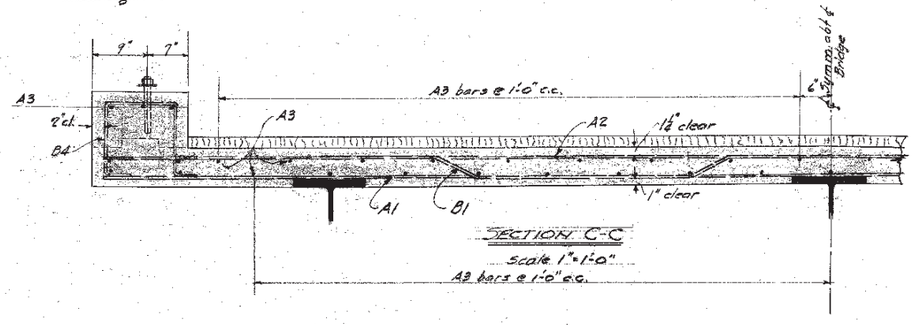


SECTION A-A
Scale 1"=1'-0"



SECTION B-B
Scale 1"=1'-0"

SLAB REINFORCEMENT
Scale ⅜"=1'-0"



SECTION C-C
Scale 1"=1'-0"
A3 bars @ 1'-0" c.c.

Deck slab & curbs:-
Concrete Cl. A. 33 cyds.
Reinforcing 7920 lbs.

STATE OF NEW HAMPSHIRE
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BRIDGE DIVISION

TOWN BARRINGTON BRIDGE NO. 109/162
FEDERAL PROJECT ——— STATE PROJECT T2787
ROUTE NO. ——— OVER ISINGLASS RIVER
LOCATION APPROX. 1 MI. WEST OF ROUTE #125

SLAB REINFOREMENT

	BY	DATE
DESIGNED	H.E.L.	9/54
DRAWN	R.J.P.	10/54
TRACED		
QUANTITIES	F.Y.	11-54
CHECKED	R.J.P.	11/54
CHECKED	F.Y.	10/54
CHECKED	J.T.H.	11-54

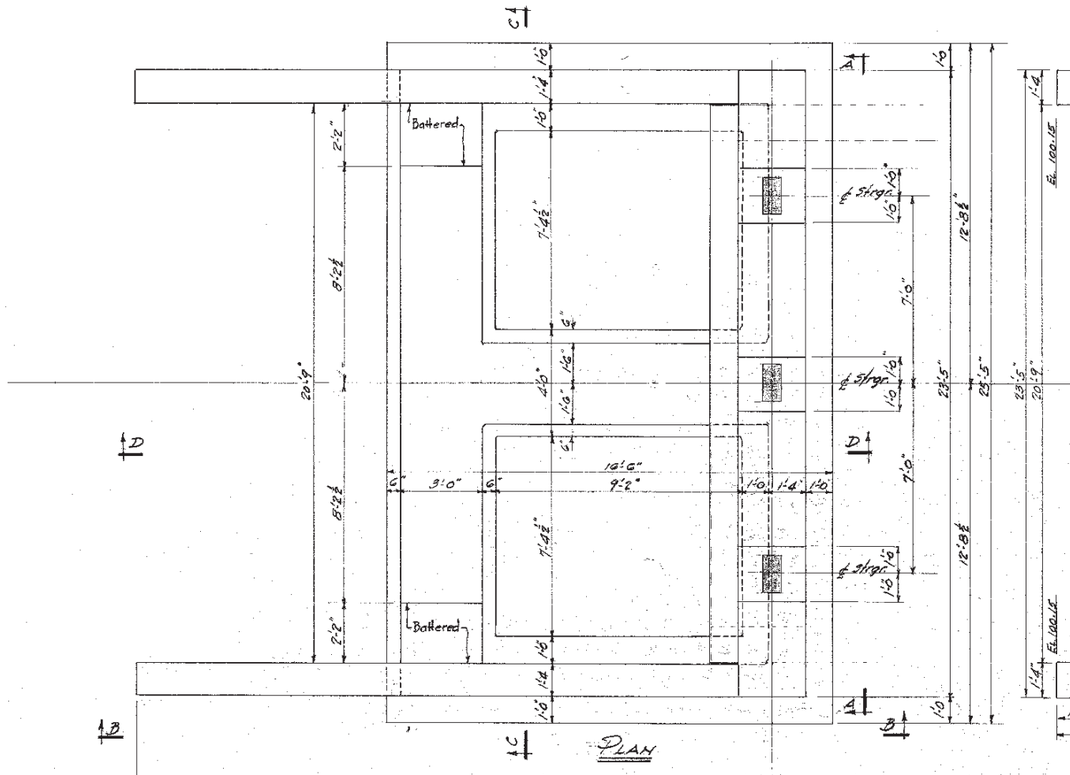
BRIDGE SHEET NO. 3 OF 8
FILE NUMBER 3-4-4-2

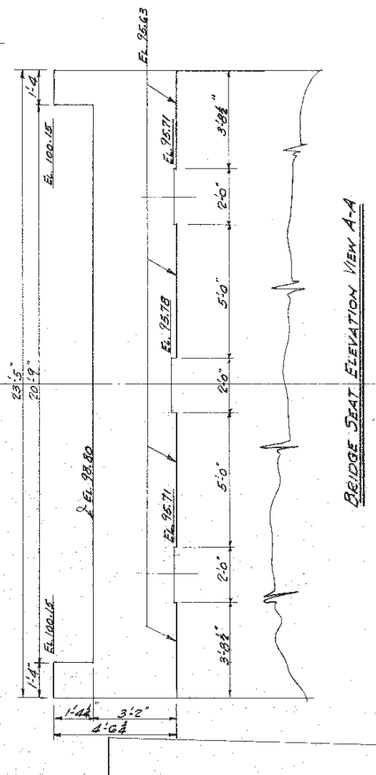
PROJ. NO.	SHEET NO.	TOTAL SHEETS
T-2787	6	16

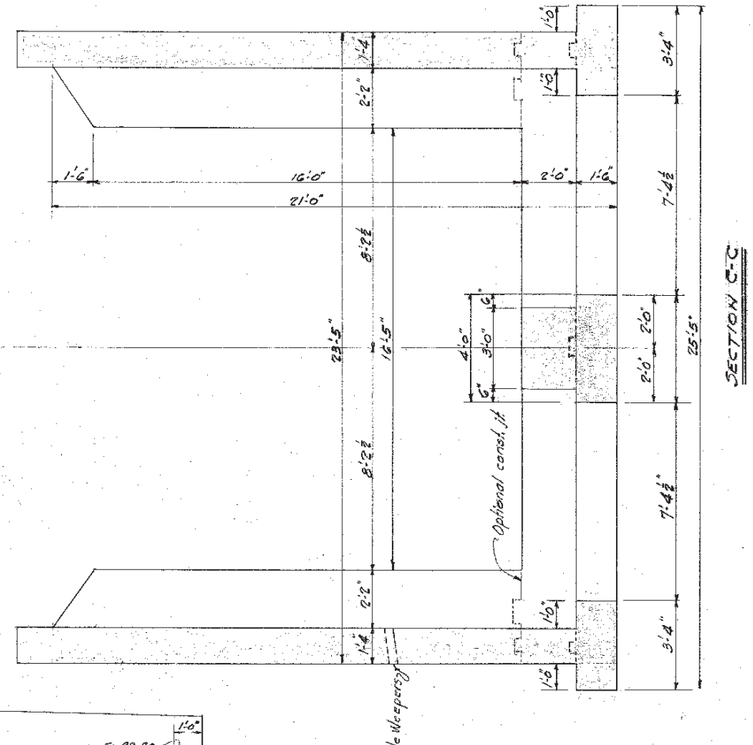
REVISIONS

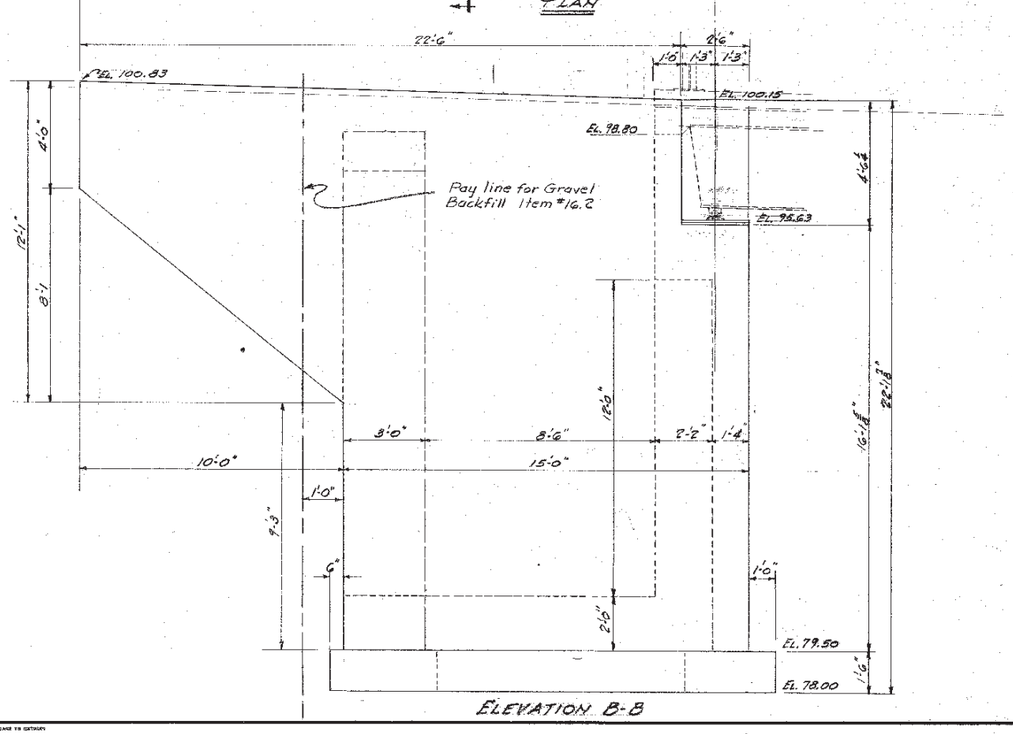
△	DESCRIPTION	BY	DATE

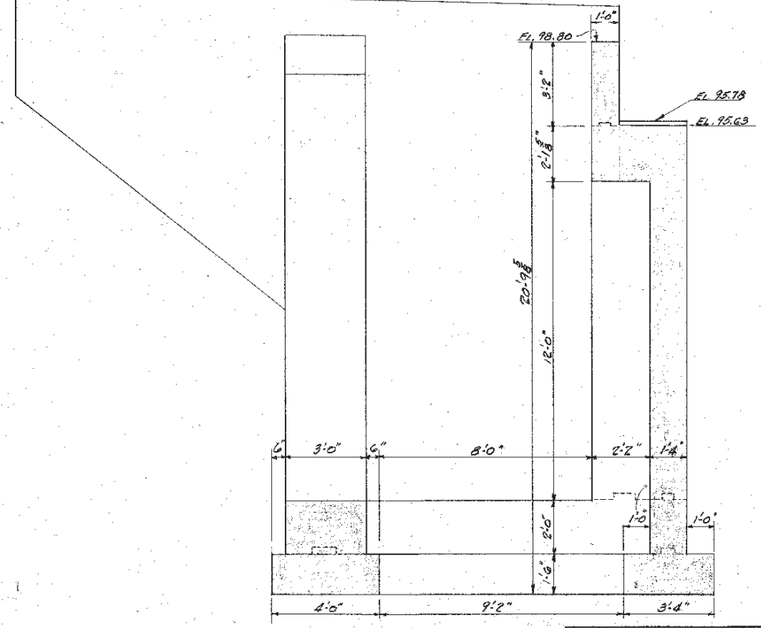
FED. ROAD DIV. NO.	STATE	T R B PROJ.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
1	N. H.	T-2787		7	16











WEST ABUTMENT

Concrete Cl. A 94.0 c.y.
Reinforcing 10,250 lbs.

SHEET SCALE 3/8"=1'-0"

STATE OF NEW HAMPSHIRE
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BRIDGE DIVISION

TOWN BARRINGTON BRIDGE NO. 109/162
FEDERAL PROJECT ——— STATE PROJECT T-2787
ROUTE NO. ——— OVER ISINGLASS RIVER
LOCATION APPROX. 1 MI. WEST OF ROUTE #125

WESTERLY ABUTMENT

	BY	DATE		BY	DATE
DESIGNED	M.E.K.	9/54	CHECKED	R.J.P.	9/54
DRAWN	R.J.P.	10/54	CHECKED	F.Y.	10/54
TRACED			CHECKED		
QUANTITIES	F.Y.	11-54	CHECKED	J.T.H.	11-54

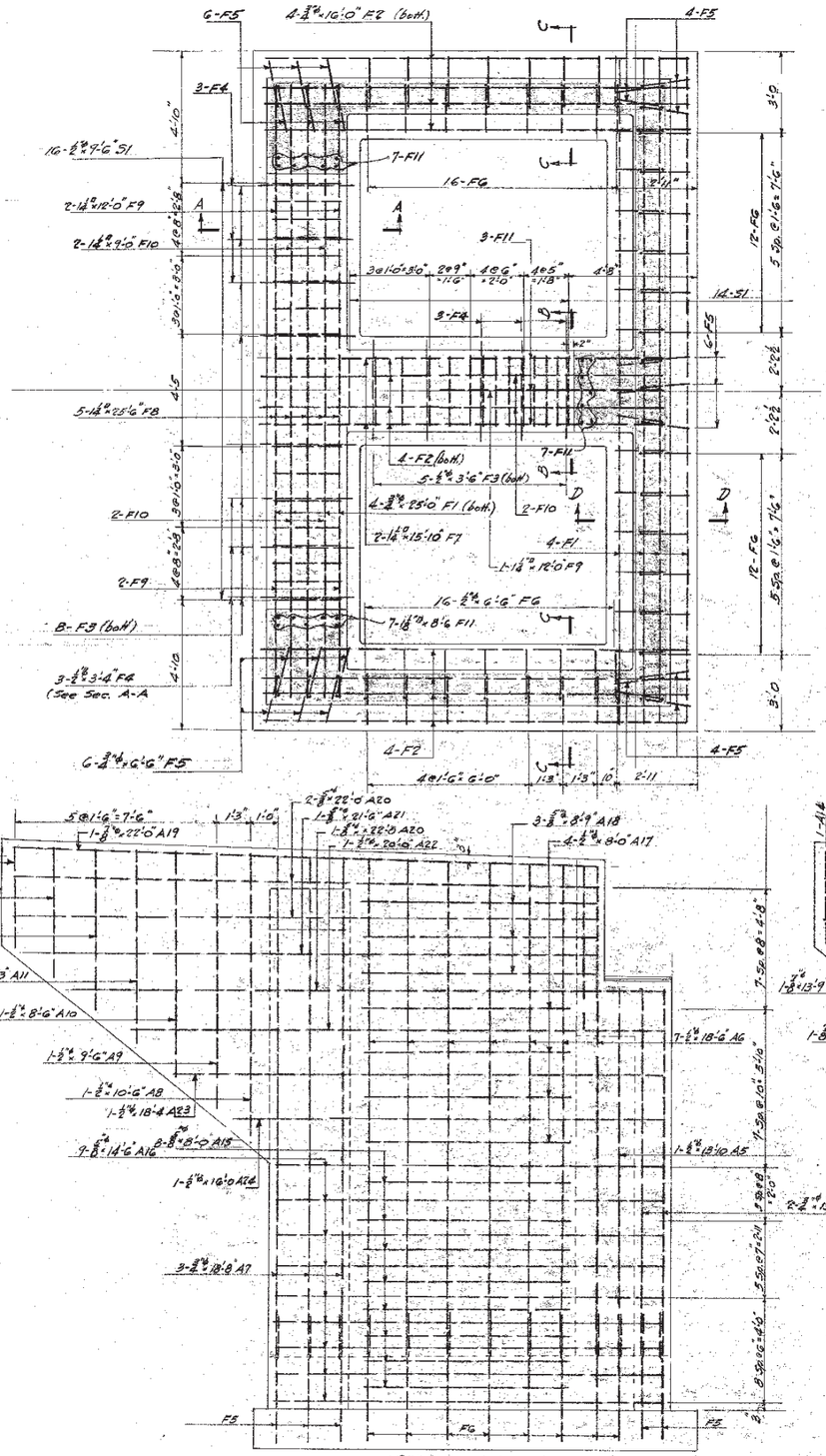
BRIDGE SHEET NO. 4 OF 8
FILE NUMBER 3-4-4-2

PROJ. NO.	SHEET NO.	TOTAL SHEETS
T-2787	7	16

Δ	DESCRIPTION	BY	DATE

REVISIONS

FED. ROAD DIV. NO.	STATE	TRB PROJ.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
1	N. H.	T-2787		8	16



Sheet Scale ⅜"=1'-0 except as noted
See Sheet ②, for other reinforcing.

STATE OF NEW HAMPSHIRE
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BRIDGE DIVISION

TOWN BARRINGTON BRIDGE NO. 109/162
FEDERAL PROJECT ——— STATE PROJECT T-2787
ROUTE NO. ——— OVER ISINGLASS RIVER
LOCATION APPROX. 1 MI. WEST OF ROUTE "125

WESTERLY ABUT. REINFORCING ①

	BY	DATE
DESIGNED H.E.L		9/64
DRAWN R.J.P		10/64
TRACED		
QUANTITIES F.Y.		11-59
CHECKED R.J.P		10/64
CHECKED F.Y.		11/64
CHECKED J.I.H.		11-59

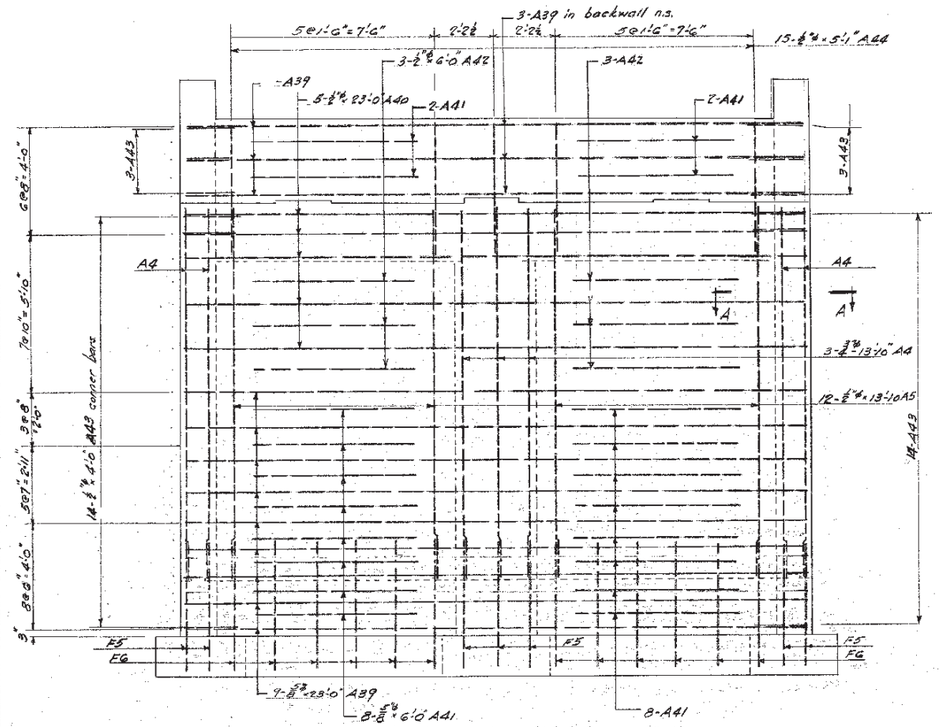
BRIDGE SHEET NO. 5 OF 8
FILE NUMBER 3-4-4-2

Δ	DESCRIPTION	BY	DATE

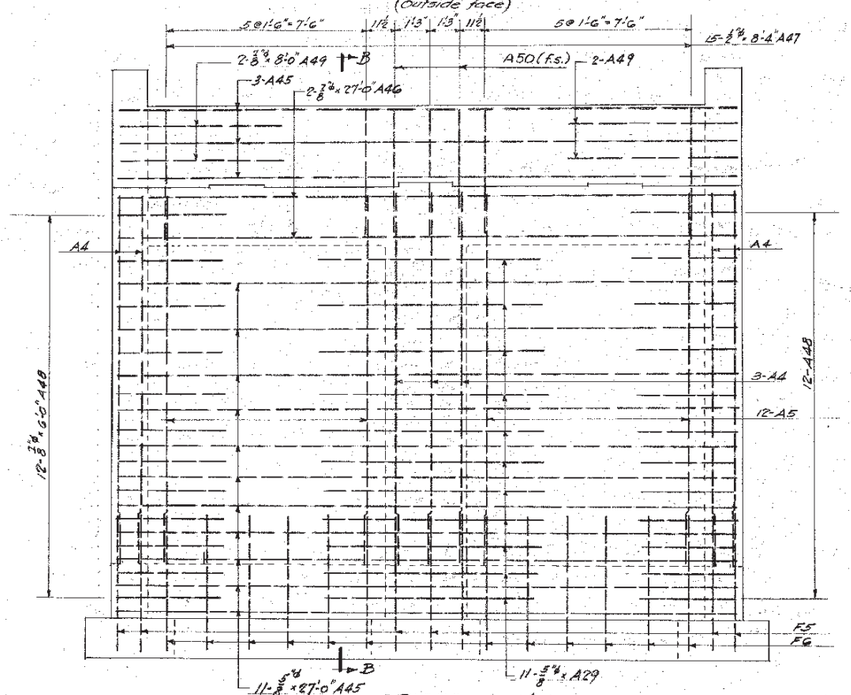
REVISIONS

PROJ. NO.	SHEET NO.	TOTAL SHEETS
T-2787	8	16

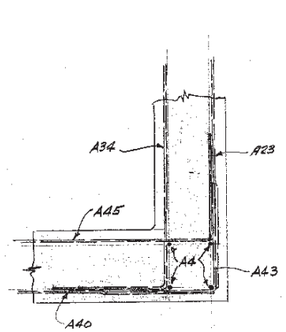
FED. ROAD DIV. NO.	STATE	T R B PROJ.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
1	N. H.	T-2787		9	16



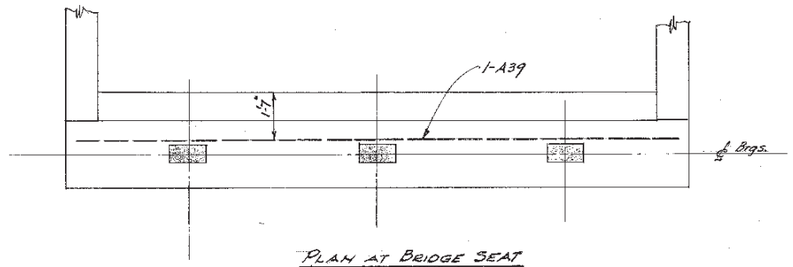
BREASTWALL & BACKWALL
(Outside face)



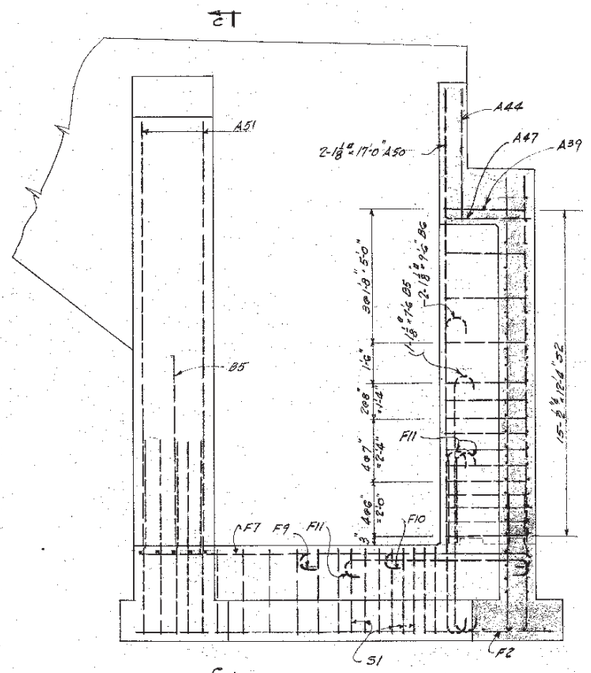
BREASTWALL & BACKWALL
(Inside face)



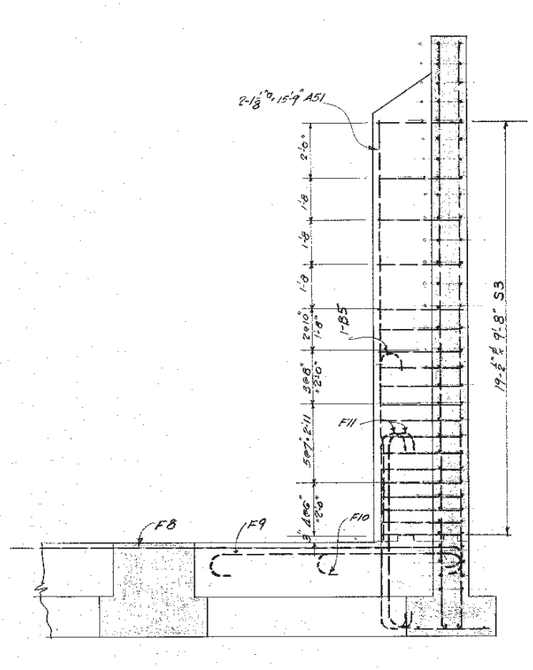
SECTION A-A
Scale ⅜"=1'-0"



PLAN AT BRIDGE SEAT



SECTION B-B



SECTION C-C

Sheet Scale ⅜"=1'-0" except as noted.

△	DESCRIPTION	BY	DATE

REVISIONS

STATE OF NEW HAMPSHIRE
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BRIDGE DIVISION

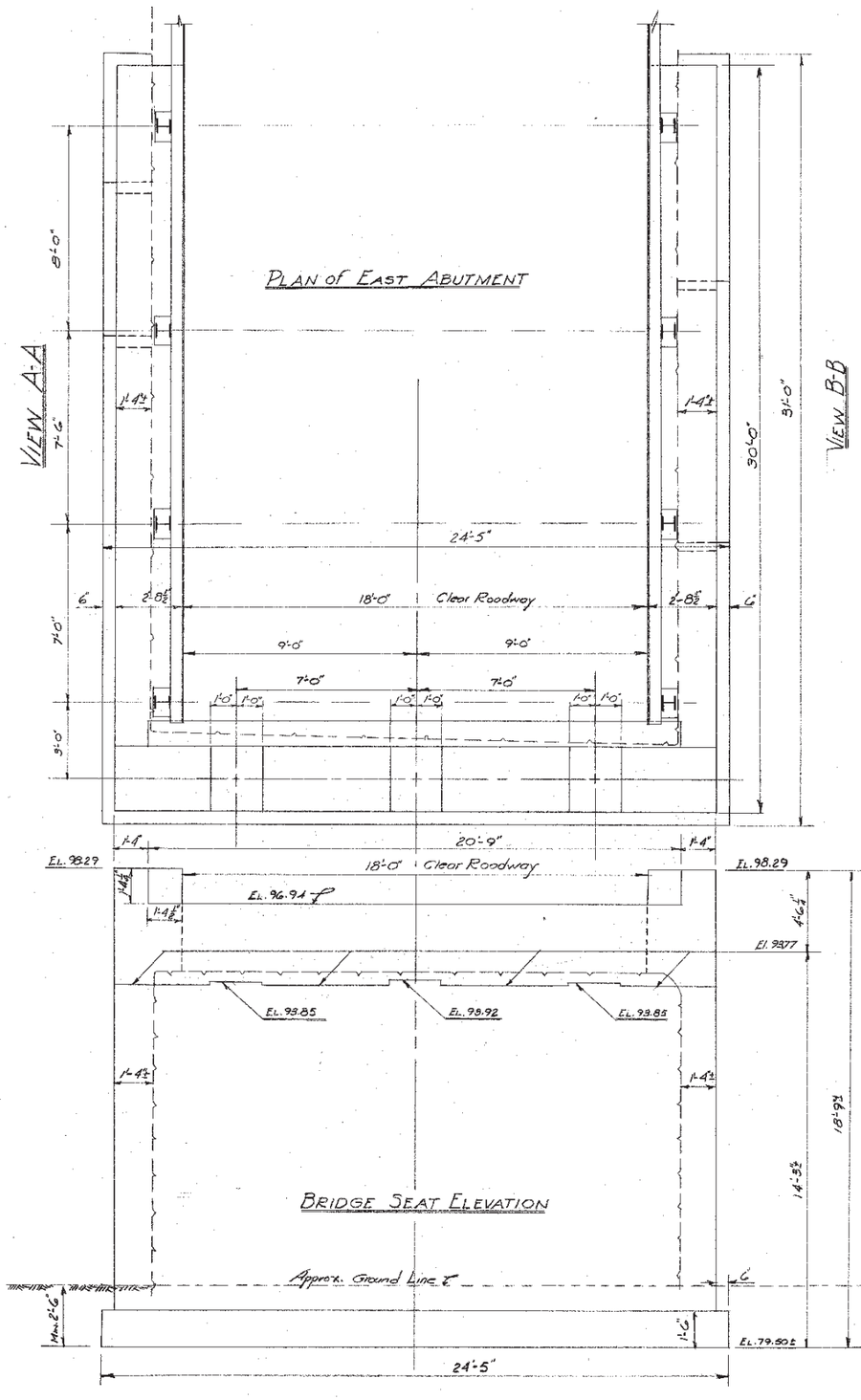
TOWN BARRINGTON BRIDGE NO. 109/162
FEDERAL PROJECT ——— STATE PROJECT T-2787
ROUTE NO. ——— OVER ISINGLASS RIVER
LOCATION APPROX. 1 MI. WEST OF ROUTE #125

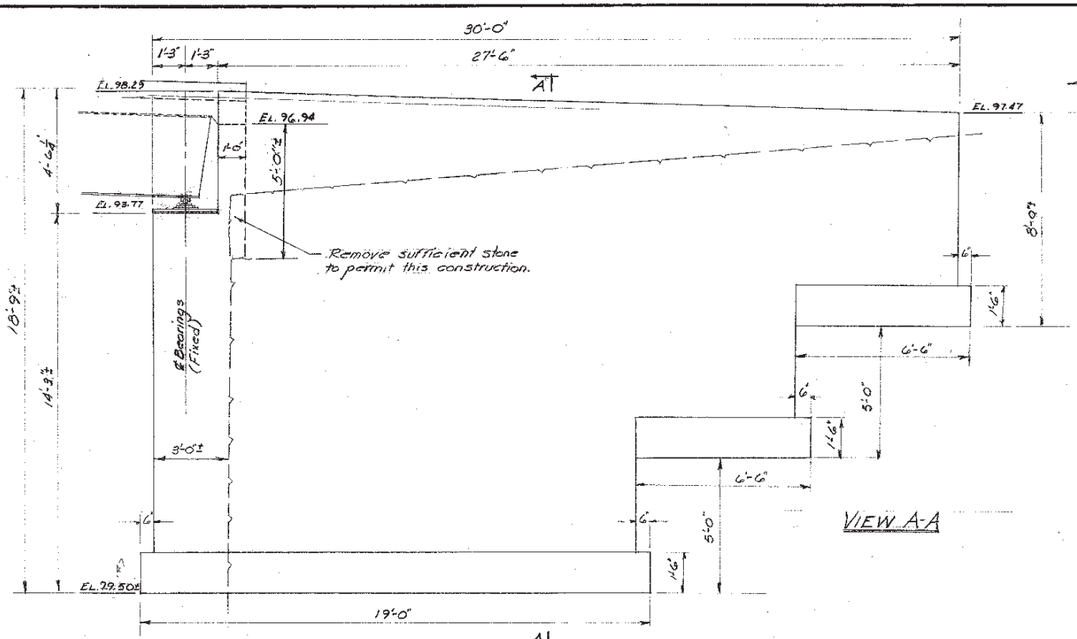
WESTERLY ABUT. REINFORCING (2)

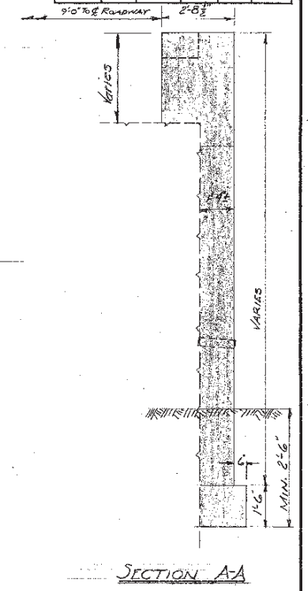
	BY	DATE		BY	DATE	BRIDGE SHEET NO.
DESIGNED	M.G.L.	9/54	CHECKED	R.J.B.	10/54	6 OF 8
DRAWN	R.J.R.	10/54	CHECKED	F.Y.	10/54	
TRACED			CHECKED			FILE NUMBER
QUANTITIES	F.Y.	11-54	CHECKED	J.T.H.	11-54	3-4-4-2

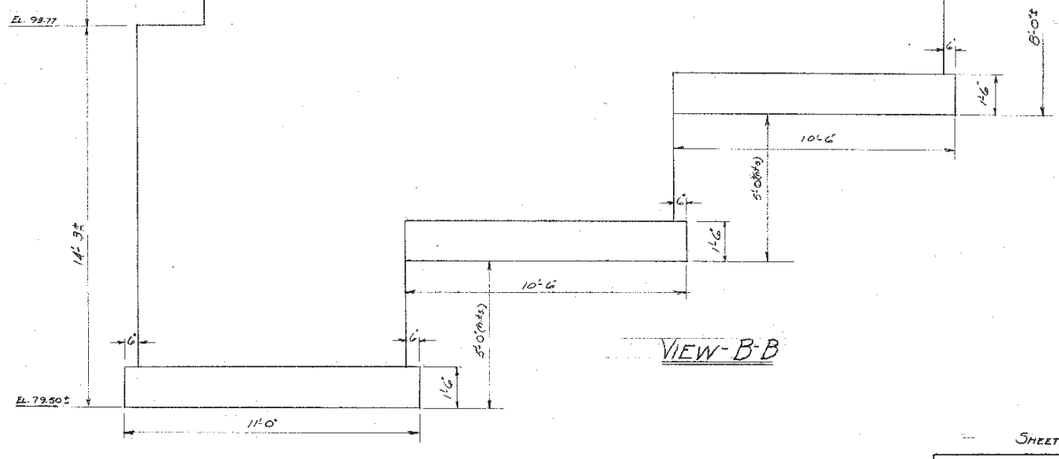
PROJ. NO.	SHEET NO.	TOTAL SHEETS
T-2787	9	16

FED. ROAD DIV. NO.	STATE	TRB PROJ.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
1	N. H.	T-2787		10	16









NOTE:- Elevation of the bottom of footings is approximate. Footings are to extend a minimum of 2'-6" below existing ground line. In the event the existing stone abutment does not extend to this depth, the abutment is to be underpinned by the alternate section method.

Sheet Scale: 3/8"=1'0"

STATE OF NEW HAMPSHIRE
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BRIDGE DIVISION

TOWN BARRINGTON BRIDGE NO. 109-162
FEDERAL PROJECT ——— STATE PROJECT T-2787
ROUTE NO. ——— OVER ISINGLASS RIVER
LOCATION APPROX. 1.0 MI. WEST OF ROUTE 125

EASTERLY ABUTMENT

	BY	DATE		BY	DATE
DESIGNED	JTH	11-54	CHECKED	F.Y.	11-54
DRAWN	J.T.H.	11-54	CHECKED	F.Y.	11-54
TRACED			CHECKED		
QUANTITIES	F.Y.	11-54	CHECKED	JTH	11-54

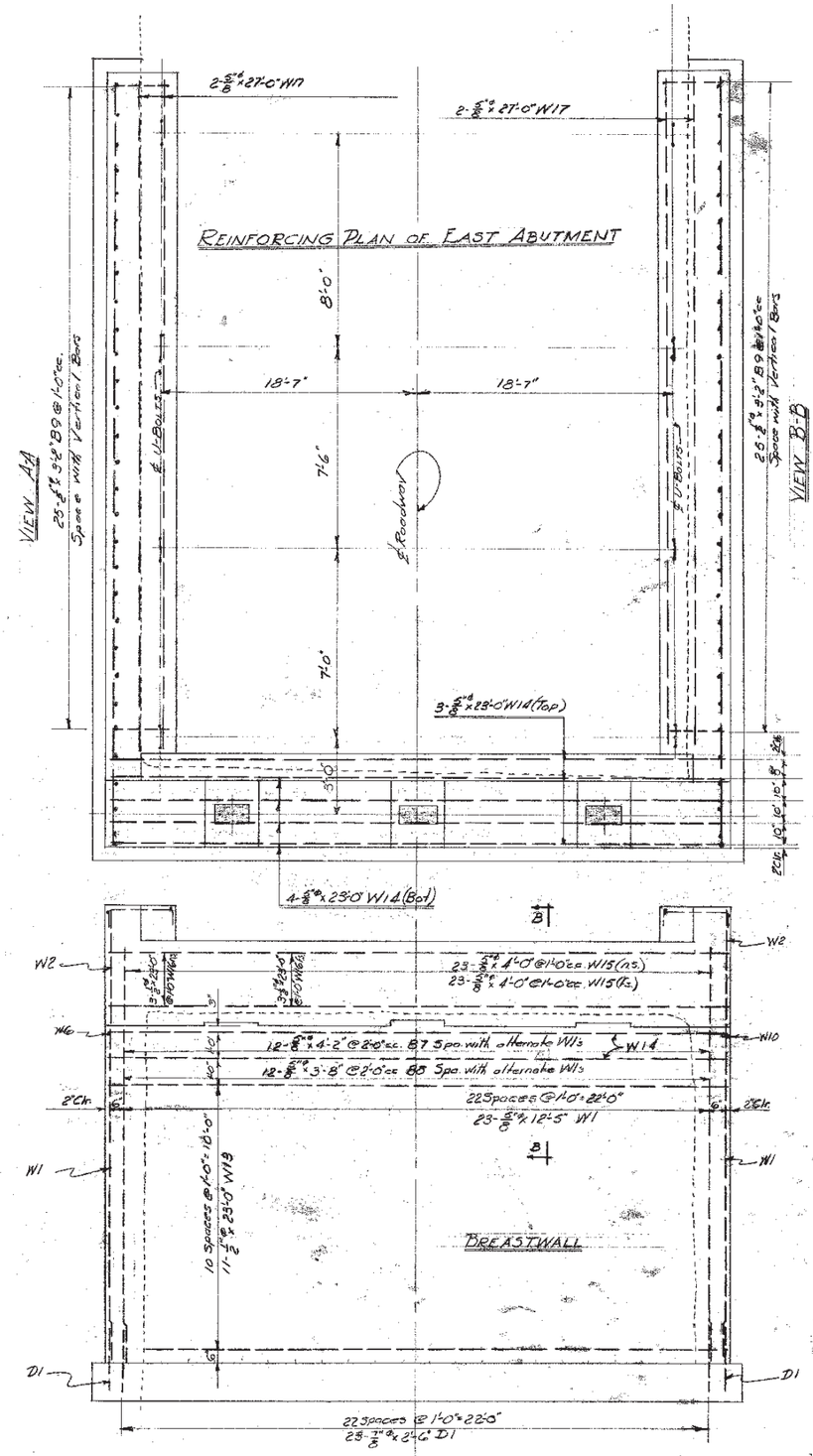
BRIDGE SHEET NO. 7 OF 8
FILE NUMBER 3-4-42

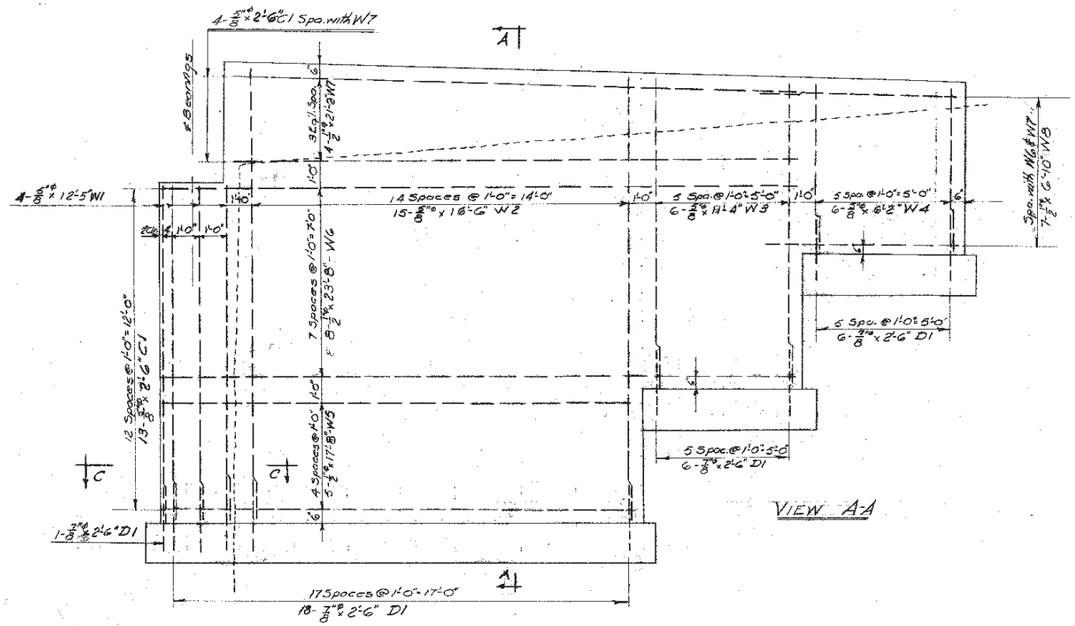
PROJ. NO.	SHEET NO.	TOTAL SHEETS
T-2787	10	16

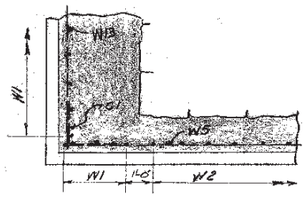
Δ	DESCRIPTION	BY	DATE
	REVISIONS		

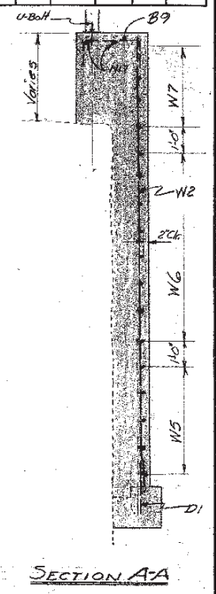
FED. ROAD DIV. NO.	STATE	TRB PROJ.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
1	N. H.	T-2787			

REINFORCING PLAN OF EAST ABUTMENT

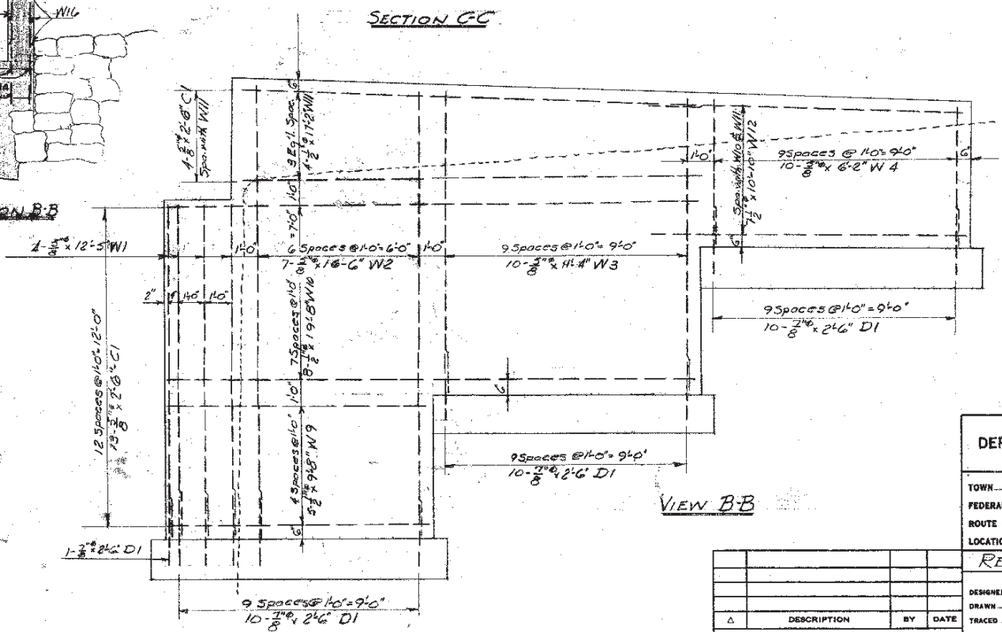








NOTE:-
Footing dowels are to be imbedded in base 1'-0" and in wall 1'-6".



Sheet Scale ⅜"-1'-0"

STATE OF NEW HAMPSHIRE
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BRIDGE DIVISION

TOWN BARRINGTON BRIDGE NO. 109/162
FEDERAL PROJECT ——— STATE PROJECT T-2787
ROUTE NO. ——— OVER ISINGLASS RIVER
LOCATION APPROX. 1.0 Mi. WEST OF Rt. 125

REINFORCING FOR EAST ABUTMENT

△	DESCRIPTION	BY	DATE

REVISIONS

	BY	DATE		BY	DATE
DESIGNED	JTH	11-54	CHECKED	F.Y.	11-54
DRAWN	JTH	11-54	CHECKED	F.Y.	11-54
TRACED			CHECKED		
QUANTITIES	JTH	11-54	CHECKED	F.Y.	11-54

BRIDGE SHEET NO. 8 OF 8
FILE NUMBER 3-4-42

PROJ. NO.	SHEET NO.	TOTAL SHEETS
T-2787	11	16

T.R.B.
T-2787 12 16

5+45 - 6+82 LT.
CONST. 137'× BRIDGE RAIL D

5+05 - 5+45 LT.
CONST. 40'× WOOD GUARD
RAIL (SINGLE RAIL) G.R-3A

5+45 - 6+58 RT.
CONST. 113'× BRIDGE RAIL D

5+05 - 5+45 RT.
CONST. 40'× WOOD GUARD
RAIL (SINGLE RAIL) G.R-3A

102.0
101.44

+18
P.S.Co8

100.1

-24"

T.W.

T.W.

-24"

5+00

94.1
L.O.

104.9
104.49

100.1

-24"

T.W.

T.W.

-24"

100.1

4+61.60
BEGINNING OF T-2787

+50

107.2
107.15

T.W.

-24"

105.8

GRAVEL

4+19 RT.
MATCH EXISTING DRIVE
TO NEW ROADWAY

+19

4+00 - 4+61.60
CONST. APPROACH TO PROJECT

108.9
108.90

108.9

T.W.

12" GRAVEL

T.W.

108.1

+00
NET 4 T.
13/18
P.S.Co.

4+00

℄

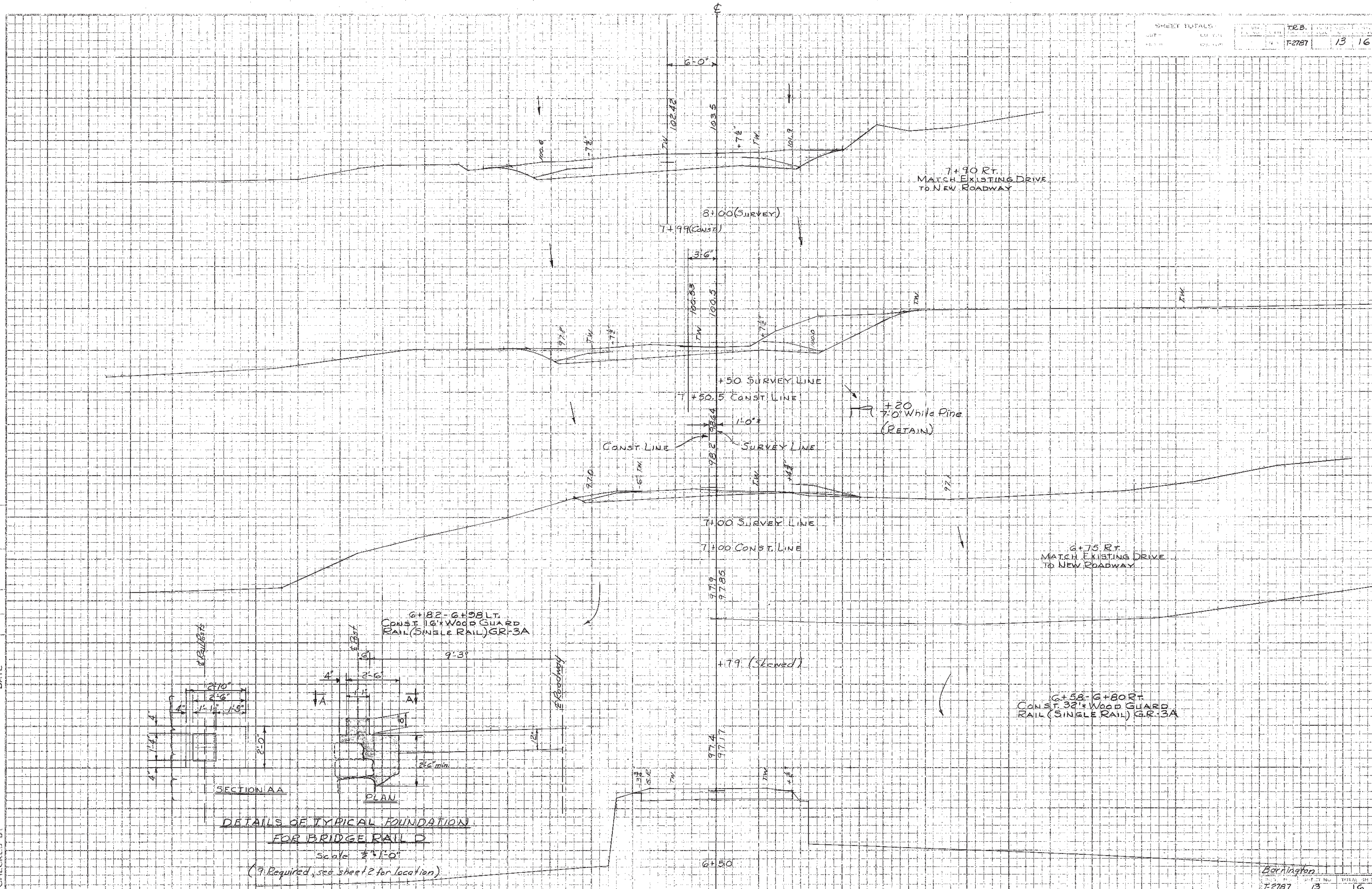
11-15-54
11-15-54
11-15-54
11-15-54

Ystueta
Ystueta
Ystueta
Ramos

Barrington
T-2787 12 16
3-4-4-2

NOTE BOOKS

BOOK NO. | PAGE NO.



SECTIONS PLOTTED BY Ystueta DATE 11-15-54
CHECKED DATE
TEMPLET PLOTTED BY Ystueta DATE 11-16-54
CHECKED DATE
AREAS PLANIM. BY Ystueta DATE 11-18-54
CHECKED Howard DATE 11-22-54
INKED BY DATE
CHECKED BY DATE

T.R.B.	SHEET NO.	TOTAL SHTS.
T-2787	13	16

Barrington

T.R.B.	SHEET NO.	TOTAL SHTS.
T-2787	13	16

3-4-4-2

NOTE BOOKS

BOOK NO.	PAGE NO.

DESCRIPTION

	DATE	STATION
SECTIONS PLOTTED BY Ystueta	DATE 11-18-54	
" CHECKED "	DATE	
TEMPLET PLOTTED BY Ystueta	DATE 11-18-54	
" CHECKED "	DATE	
AREAS PLANIM. BY Ystueta	DATE 11-18-54	
" CHECKED "	DATE 11-22-54	
INKED BY	DATE	
CHECKED BY	DATE	

SHEET TOTALS		FED. ROAD DIV. NO.	STATE	TRB PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
CUT =	CU. YDS.	1	N. H.	T-2787	.	14	16
FILL =	CU. YDS.						

ITEM 201 CLASS A ASPHALT SURFACE TREATMENT
(1.25 GALS. PER Sq. Yd.)

4'-0" | 1'-0" | 2'-0" | 9'-0" | 9'-0" | 2'-0" | 2'-6" | 1'-0"

TOP OF CUT SLOPES TO BE ROUNDED AS SHOWN ON ST. D. R.S.-1

18:1 | 2¼" CROWN | 2¼" CROWN | 18:1

ITEM 16.1 GRAVEL
12" = 8.48 CU. YDS. PER 100 LIN. FT.

ITEM 16.1 GRAVEL
4:1 EARTH 4:1 LEDGE
12" = 12.39 CU. YDS. PER 100 LIN. FT.

EARTH FILL

2:1 INFILLS UP TO 10 FEET

2:1

OLD GROUND

ITEM 16.1 GRAVEL
12" = 13.33 13.48 CU. YDS. PER 100 LIN. FT.

TYPICAL SECTION OF IMPROVEMENT

Scale 3/8" = 1'-0"

107.8
107.30
T.W.
P.V.
102.4

9+50 (SURVEY) = 9+48.5 (CONST.)

9+00 - 9+48.5
CONST. APPROACH TO PROJECT

9+00
END OF T-2787

104.6
T.W.
T.W. 105.2
105.20
105.3

9+00 (SURVEY) & 8+98.5 (CONST.)

1.9"
104.31
104.4
T.W.
102.5
T.W.
Wall
105.8

8+50 SURVEY

8+48.5 CONST.

Barrington

PROJ. NO.	SHEET NO.	TOTAL SHTS
T-2787	14	16

3-4-4-2

7M-1-14-54-198-M Ageproof Vellum, Boston Blue Print Co. Inc., Boston, Mass.

APPENDIX F

Hydrologic and Hydraulic Analysis

NOTES AND ASSUMPTIONS:

- The 2.33, 25, 50 and 100 year discharges for the Greenhill Road crossing at the Isinglass River are computed based on the following methods.
  1. USGS StreamStats
  2. FHWA 7 - Parameter
  3. USGS Gauging Station Flow Data - Area Relationship Method
- The FHWA 7-Parameter is used over the 5-Parameter method due to the multiple tributaries that flow into the Isinglass River in the contributing watershed.
- Additional information is taken from the USGS Report entitled: "Flood of May 2006 in New Hampshire" and the FEMA report entitled: "Independent Evaluation of Recent Flooding in New Hampshire" (July 2008).
- References:
  - Method 1: USGS StreamStats; http://water.usgs.gov/osw/streamstats/
  - Method 2: Report No. FHWA-RFD-77-159; "Runoff Estimates for Small Rural Watersheds and Development of a Sound Design Method"; Vol. II Recommendations for Preparing Design Manuals and Appendices B, C, D, E, F, G and H; dated October 1977. (FHWA Manual)
  - Method 3: State of Vermont Agency of Transportation; Hydraulic Manual, Chapter Four: Hydrology, page 4-28.

METHOD No. 1: Determine Discharges by The StreamStats Method

- USGS StreamStats Ungaged Site Report consists of peak flows for 2, 50 and 100 year flood event.
- See calculation sheet DC-3 for the USGS StreamStats Ungaged Site Report.

2 Year Flood Event: $Q_{2\_USGS} := 1530cfs$

10 Year Flood Event: $Q_{10\_USGS} := 3100cfs$

25 Year Flood Event: $Q_{25\_USGS} := 3980cfs$

50 Year Flood Event: $Q_{50\_USGS} := 4680cfs$

100 Year Flood Event: $Q_{100\_USGS} := 5510cfs$

USGS
New Hampshire StreamStats

Streamstats Ungaged Site Report

Date: Thu Apr 17 2014 09:42:52 Mountain Daylight Time
Site Location: New_Hampshire
NAD27 Latitude: 43.2455 (43 14 44)
NAD27 Longitude: -71.0046 (-71 00 17)
NAD83 Latitude: 43.2456 (43 14 44)
NAD83 Longitude: -71.0041 (-71 00 15)
Drainage Area: 66.1 mi2

Peak Flows Region Grid Basin Characteristics
100% Peak Flow Statewide SIR2008 5206 (66.1 mi2)

Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	66.1	0.7	1290
Mean April Precipitation (inches)	4.274	2.79	6.23
Percent Wetlands (dimensionless)	9.7882	0	21.8
Stream Slope 10 and 85 Method (feet per mi)	36.7	5.43	543

LowFlows Region Grid Basin Characteristics
100% Low Flow Statewide (66.1 mi2)

Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	66.1	3.26	689
Mean Basin Slope from 30m DEM (percent)	7.490	3.19	38.1
Maximum Basin Elevation (feet)	1393.283	260	6290
Percent Coniferous Forest (percent)	13.1766	3.07	56.2
Jan to Mar Basin Centroid Precip (inches)	8.23	5.79	15.1
Mean Annual Temperature (degrees F)	45.736	36	48.7
Jun to Oct Mean Basinwide Temp (degrees F)	61.725	52.9	64.4
Jun to Oct Gage Precipitation (inches)	17.3	16.5	23.1
Percent Mixed Forest (percent)	37.6951	6.21	46.1
Mar to May Gage Precipitation (inches)	9.4	6.83	11.5

Peak Flows Region Grid Streamflow Statistics

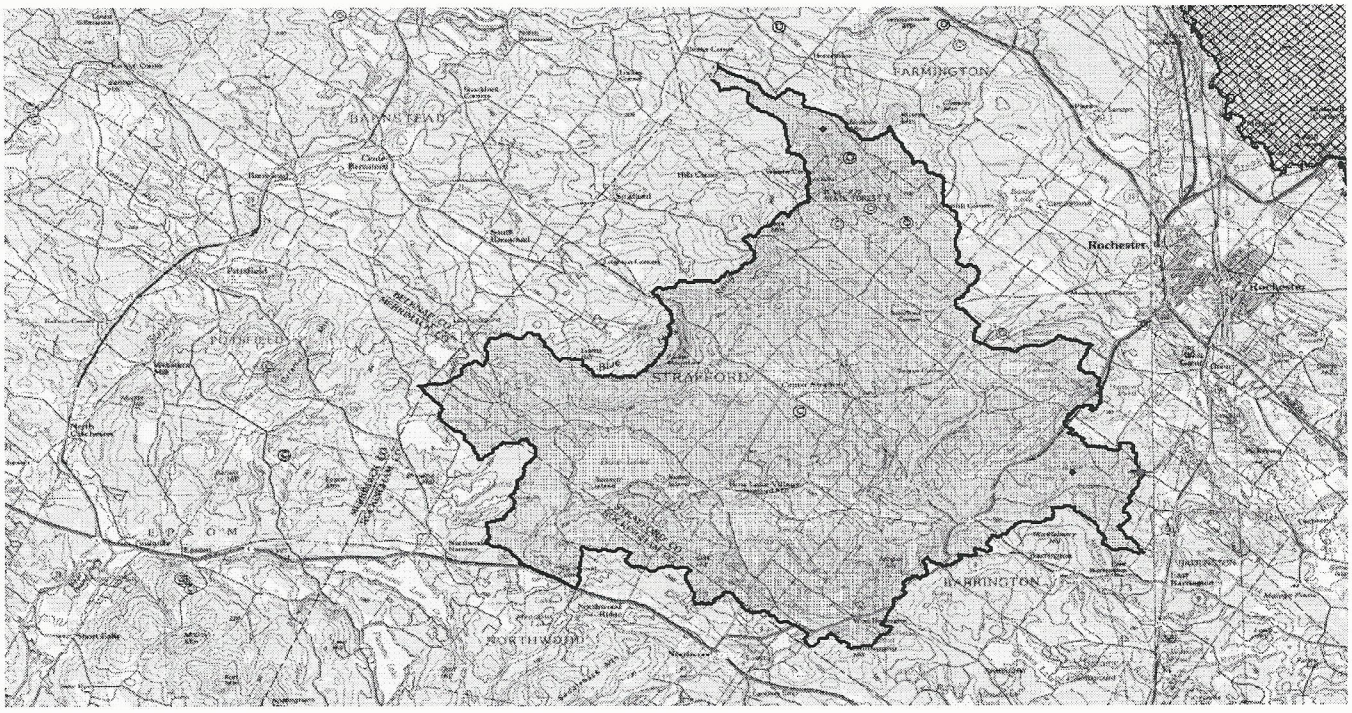
Statistic	Flow (ft^3/s)	Prediction Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
PK2	1530	30	3.2	947	2490
PK5	2410	31	4.7	1470	3950
PK10	3100	32	6.2	1860	5180
PK25	3980	34	8	2310	6850
PK50	4680	36	9	2640	8290
PK100	5510	39	9.8	3010	10100
PK500	7400	44	11	3730	14700

LowFlows Region Grid Streamflow Statistics

Statistic	Flow (ft^3/s)	Prediction Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
D60	39.7	18		29.1	52.6
D70	26	21		18.2	35.8
D80	15.8	28		9.68	24.1
D90	8.4	38		4.34	14.5
D95	5.37	44		2.47	10.1
D98	3.6	54		1.38	7.53
M7D2Y	5.24	56		1.94	10.8

USGS
New Hampshire StreamStats

StreamStats Print Page



Explanation

- NHDHGage2
- NHDHDam2
- GlobalWatershedPoint
- Slp1085Point
- LongestFlowPath3D
- GlobalWatershed
- Stream Grid
- ExcludePoly

- Gaging Station, Continuous Record
- Low Flow, Partial Record
- Peak Flow, Partial Record
- Peak and Low Flow, Partial Record
- Stage Only
- Low Flow, Partial Record, Stage
- Miscellaneous Record
- Unknown

METHOD No. 2: Determine Discharges by The FHWA 7-Parameter Method

STEP 1 DELINEATE WATERSHED:

Area obtained from USGS Streamstats Ungaged Site Report (USGS SUSR):

$A_{drain} := 66.1 mi^2$ ✓ Calculation Sheet DC-3

STEP 2 DETERMINE THE PROBABLE MAXIMUM RUNOFF PEAK, Q_p (max):

$$Q_{pmax} := cfs \cdot 10^{\left[3.92+0.812\cdot\log\left(\frac{A_{drain}}{mi^2},10\right)-0.0325\cdot\left(\log\left(\frac{A_{drain}}{mi^2},10\right)\right)^2\right]}$$

$Q_{pmax} = 195131.216 \cdot cfs$

STEP 3 DETERMINE THE REQUIRED HYDROPHYSIOGRAPHIC PARAMETERS:

a. Iso-erodent factor, R, from from Appendix C, FHWA Manual:

$R_{iso} := 95$ ✓ Calculation Sheet DC -8

b. Elevation Difference of main channel, DH, from USGS StreamStats:

$EL_{high} := 721.619 ft$ ✓ $EL_{low} := 161.065 ft$ ✓ Calculation Sheet DC-9

$DH := EL_{high} - EL_{low}$ $DH = 560.554 ft$ ✓

c. Percent of Water Storage Area, S, from USGS SUSR:

storage := 9.79% ✓ Calculation Sheet DC-3

d. Hydrophsiographic Zone:

All of New Hampshire is in Zone 9 ✓, from Appendix B, FHWA Manual. Use this zone when determining which 10-year runoff peak equation to use. See calculation sheets DC-10 and 11.

e. Principal Drainage Channel Length, L, from USGS StreamStats:

$L_{main} := 17.73 mi$ ✓ Calculation Sheet DC-9

f. 10-year, 60-minute Rainfall Intensity, P_{60}, from Appendix D, FHWA Manual:

$P_{60} := 1.73$ ✓ Calculation Sheet DC-12

METHOD No. 2: Determine Discharges by The FHWA 7-Parameter Method (Cont.)

G. 10-year, 10-minute Rainfall Intensity, P_{10}, from Appendix E, FHWA Manual:

$P_{10} := 4.75$ Calculation Sheet DC-13

H. Cumulative Channel Lengths, LL: Calculation Sheet DC-10

$$LL := \begin{pmatrix} 11.23 + 0.43 + 0.41 + 0.84 + 1.00 + 1.44 + 0.89 + 0.65 + 0.62 + 5.13 + 0.93 \ldots \\ + 0.35 + 1.32 + 2.06 + 4.29 + 1.15 + 0.36 + 0.06 + 1.73 + 3.57 + 0.75 + 0.23 \ldots \\ + 3.89 + 1.94 + 0.46 + 0.35 + 0.36 + 0.55 + 0.84 + 0.43 + 0.51 + 2.36 \end{pmatrix} mi + L_{main} \quad LL = 68.86 \cdot mi$$

STEP 4 DETERMINE THE ESTIMATED 10-YEAR RUNOFF PEAK, q_{10}:

$$q_{10} := 50.8080 cfs \cdot \left(\frac{A_{drain}}{mi^2}\right)^{0.3799} \cdot R_{iso}^{(-0.1432)} \cdot \left(\frac{DH}{ft}\right)^{0.3401} \cdot \left(\frac{L_{main}}{mi}\right)^{0.0917} \cdot \left(\frac{LL}{mi}\right)^{0.2879} \cdot P_{10}^{-0.9655} \cdot P_{60}^{1.8748}$$

$q_{10} = 3059.284 \cdot cfs$ Calculation Sheet DC-15

Adjust q_{10} for storage correct factor, SCF from Figure 5, FHWA Manual:

storage = 9.79·% Calculation Sheet DC-3

SCF := 0.93 Calculation Sheet DC-16

$q_{hat\_10} := q_{10} \cdot SCF$ $q_{hat\_10} = 2845.135 \cdot cfs$

STEP 5 DETERMINE RETURN PERIOD, T_D:

This is specified by NHDOT as 50 years for this bridge.

STEP 6 PREPARE THE EXTRAPOLATION CURVE FOR DETERMINATION Q_{T_D}:

Discharge at 2.33 years: $Q_{2.33\_FHWA} := 0.46921 cfs \cdot \left(\frac{q_{hat\_10}}{cfs}\right)^{1.00243}$ FHWA Manual Eq-8

$\boxed{Q_{2.33\_FHWA} = 1361.017 \cdot cfs}$

Discharge at 50 years: $Q_{50\_FHWA} := 1.45962 cfs \cdot \left(\frac{q_{hat\_10}}{cfs}\right)^{1.02342}$ FHWA Manual Eq-9

$\boxed{Q_{50\_FHWA} = 5003.083 \cdot cfs}$

Discharge at 100 years: $Q_{100\_FHWA} := 1.64380 cfs \cdot \left(\frac{q_{hat\_10}}{cfs}\right)^{1.02918}$ FHWA Manual Eq-10

$\boxed{Q_{100\_FHWA} = 5898.513 \cdot cfs}$

METHOD No. 2: Determine Discharges by The FHWA 7-Parameter Method (Cont.)

STEP 7 DETERMINE Q_{T_D} FROM THE CURVE PREPARED IN STEP VI:

Return Year Flow: $Q_{TD} = (1201.2 \cdot \ln(T_D) + 338.59) \cdot cfs$ Calculation Sheet DC-7A

where, T_D = number of return period in years

Q_{TD} = design flow corresponding to the return period T_D

$T_{D10} := 10$ $Q_{10\_FHWA} := (1201.2 \cdot \ln(T_{D10}) + 338.59) \cdot cfs$ $Q_{10\_FHWA} = 3104.455 \cdot cfs$

$T_{D25} := 25$ $Q_{25\_FHWA} := (1201.2 \cdot \ln(T_{D25}) + 338.59) \cdot cfs$ $Q_{25\_FHWA} = 4205.104 \cdot cfs$

Hoyle, Tanner & Associates, Inc.
150 Dow Street
Manchester, New Hampshire 03101

HTA PROJECT NO. 915302
SHEET DC-7A OF
PROJECT DESCRIPTION Greenhill Road over Isinglass River
TASK Discharge Calculations
CALCULATED BY: JAS DATE: 11/14/14
CHECKED BY: AML DATE: 11/14/14

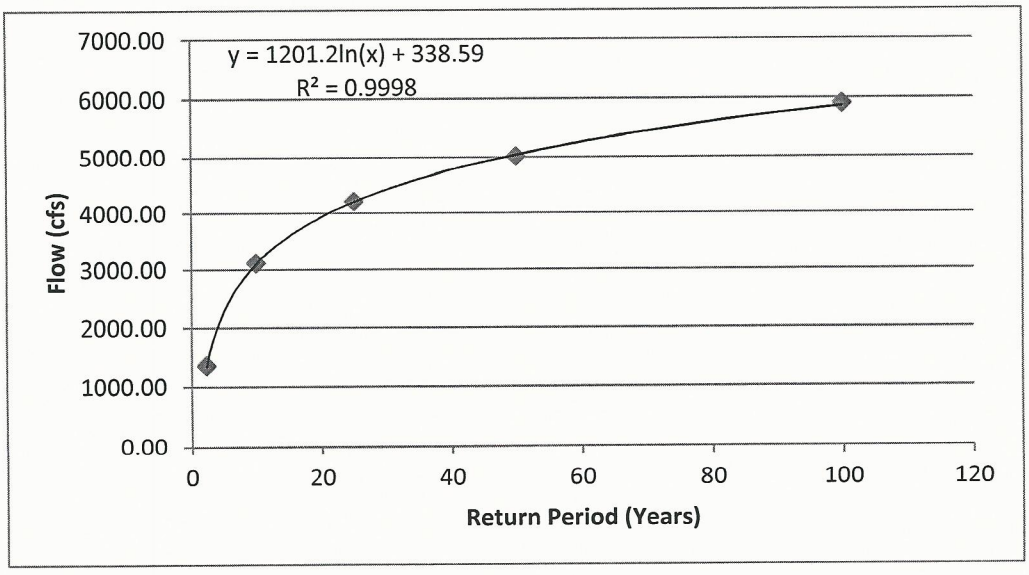
K:\922404\Design\Calcs_Bridge\Hydraulics\H-H calculations\[FHWA Interpolation.xlsx]Sheet1

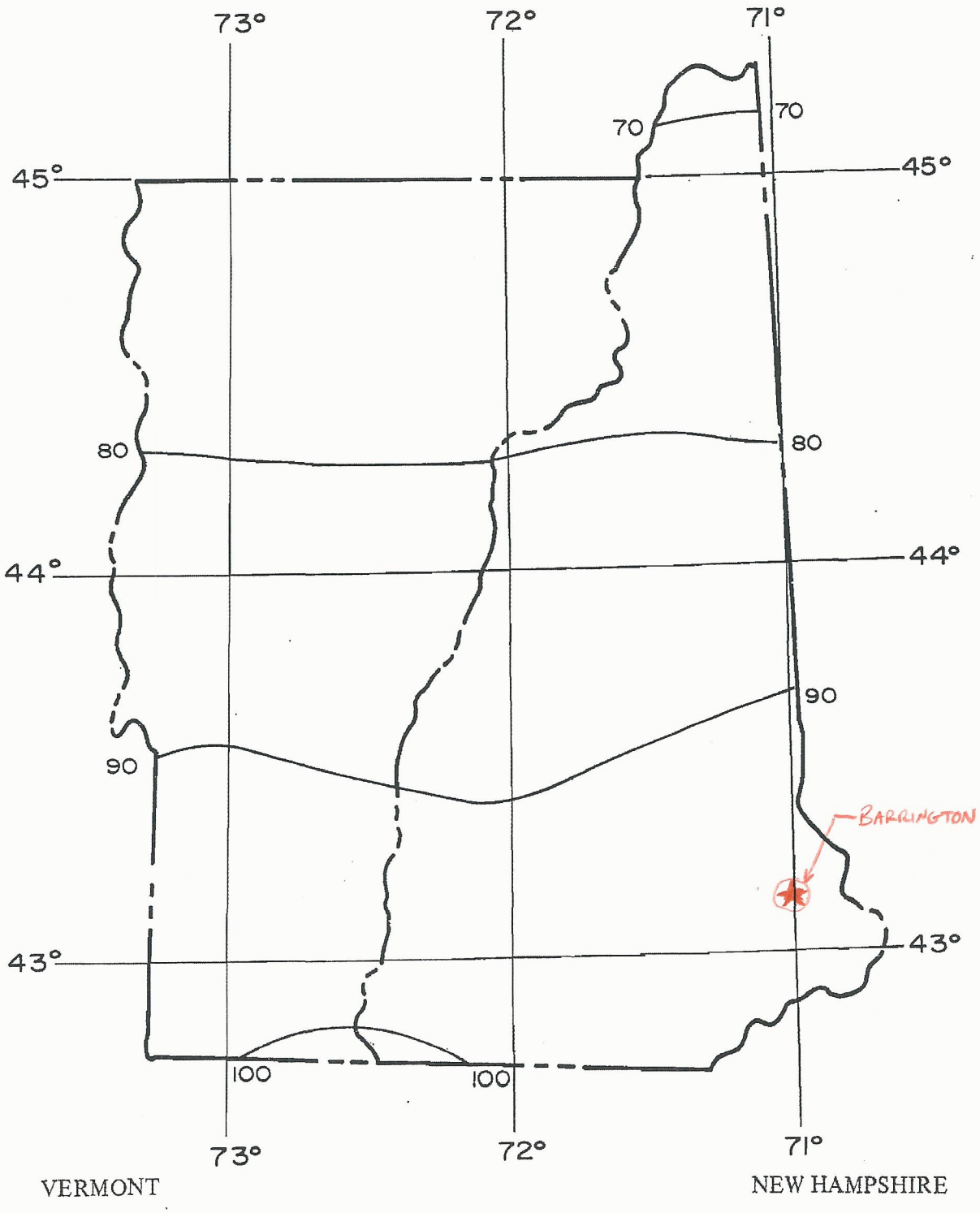
Discharge Calculations

METHOD No. 2: Determine Discharges by the FHWA 7-Parameter Method (Cont.)

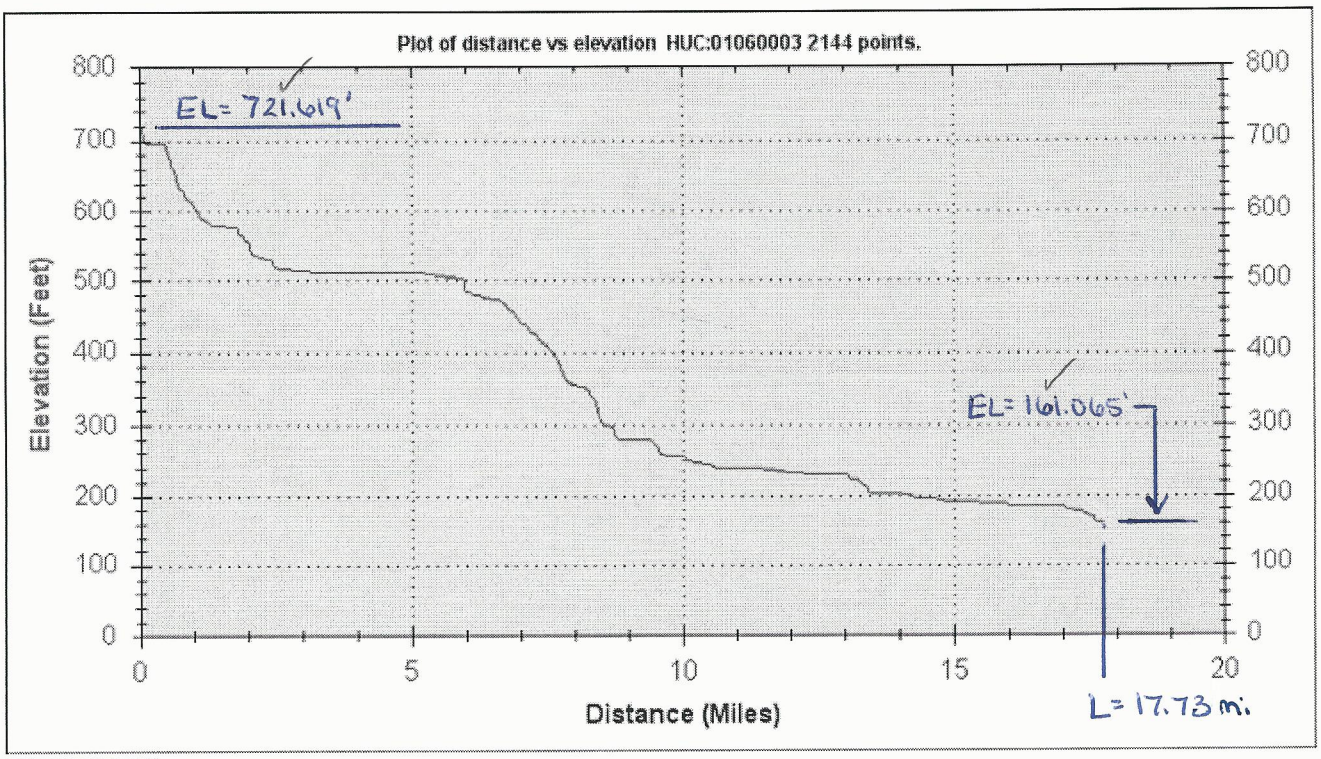
STEP 7 DETERMINE Q_{TD} FROM THE CURVE PREPARED IN STEP IV (Cont.):

Return Years	Flow CFS	
2.33	1361.02	From FHWA regression equation (DC-6)
10	3104.46	Interpolated value from graph
25	4205.10	Interpolated value from graph
50	5003.083	From FHWA regression equation (DC-6)
100	5898.513	From FHWA regression equation (DC-6)





Appendix C-33. Isoerodent, R, map of New Hampshire.
Appendix C-50. Isoerodent, R, map of Vermont.



Save2Excel

S	Z	X	Y	UserPoint
0	721.619	1102995	283935	False
0.01	720.963	1103000.27	283959.73	False
0.01	720.963	1103026.76	283933.24	False
0.02	719.782	1103053.24	283906.76	False
0.03	717.715	1103079.73	283880.27	False
0.04	715.714	1103115	283875	False
0.04	711.088	1103141.49	283848.51	False
0.05	706.167	1103167.97	283822.03	False
0.06	701.705	1103194.46	283795.54	False
0.06	699.211	1103227.54	283785	False
0.07	697.833	1103265	283785	False
0.08	697.144	1103289.73	283760.27	False

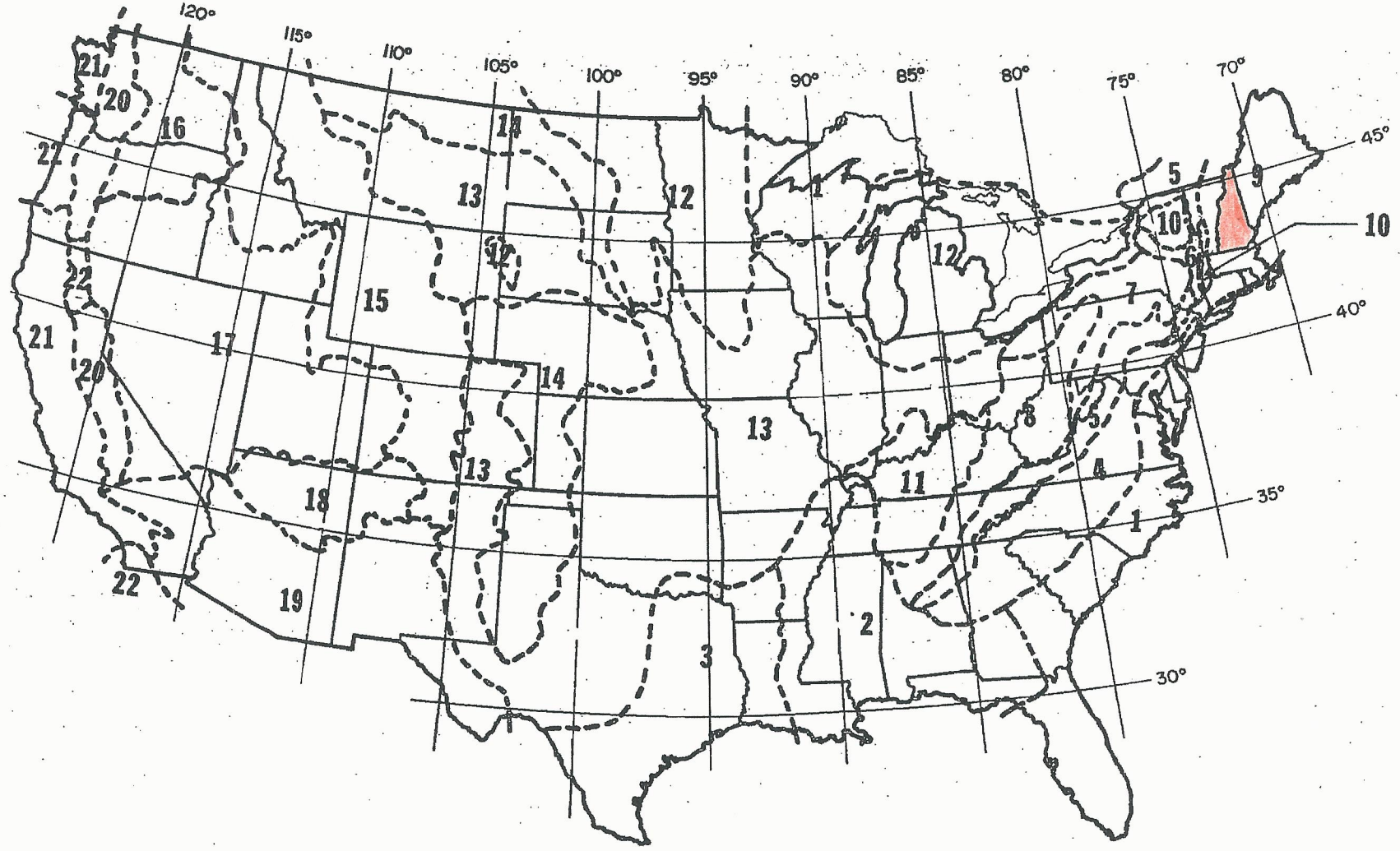
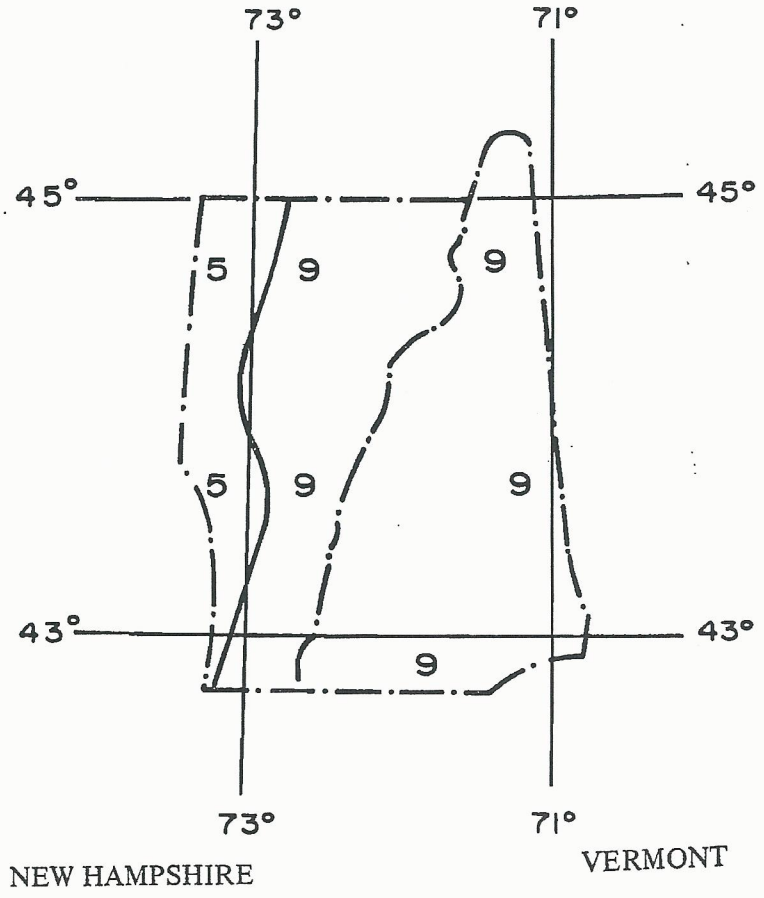
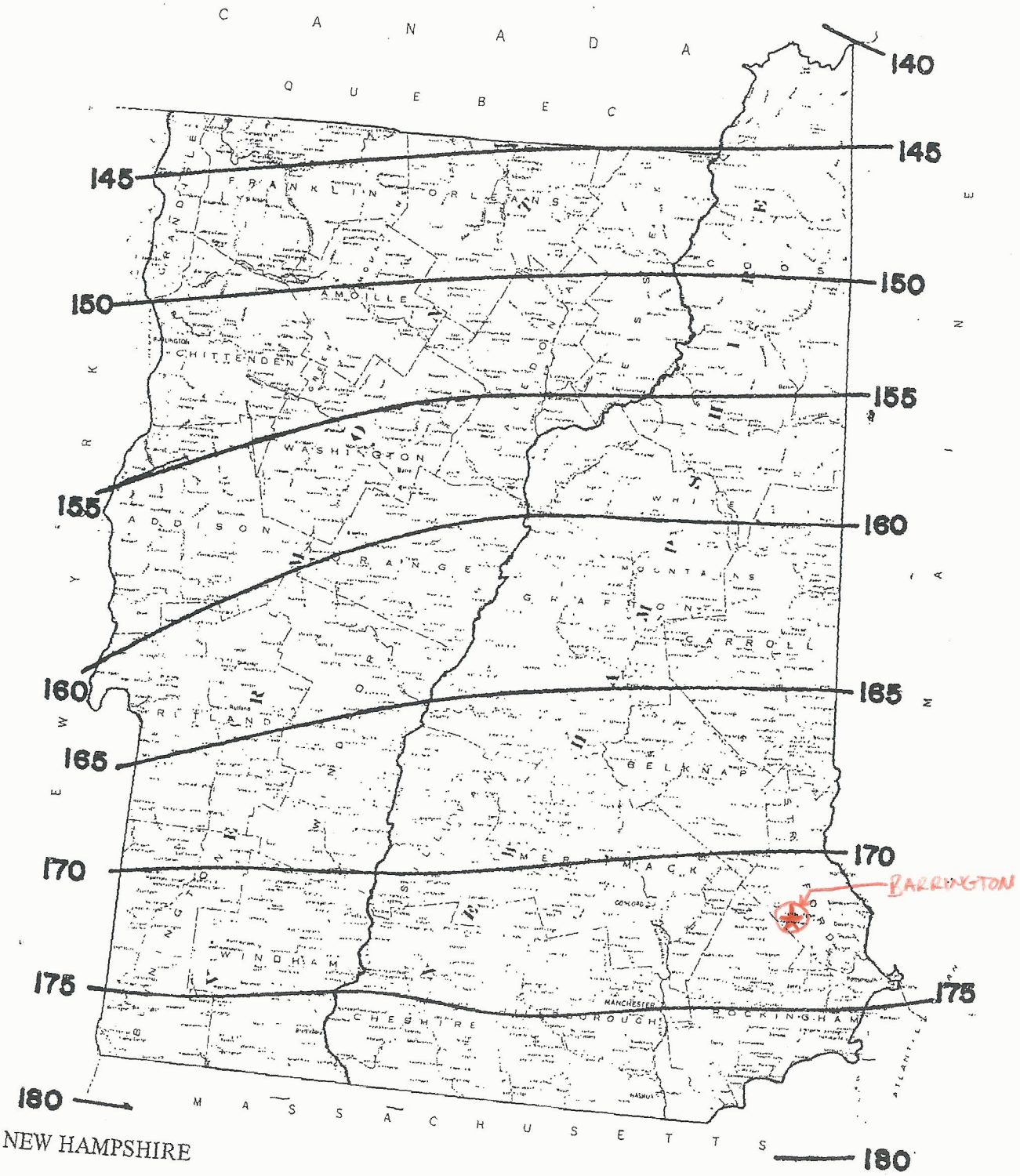


Figure 3. Hydrophysiographic zone map for the contiguous United States. Prepared from an analysis of the physiographic sections of the United States defined by Fenneman and Johnson (ref. 3). (See Figure 38 of Volume I, Research Report.)



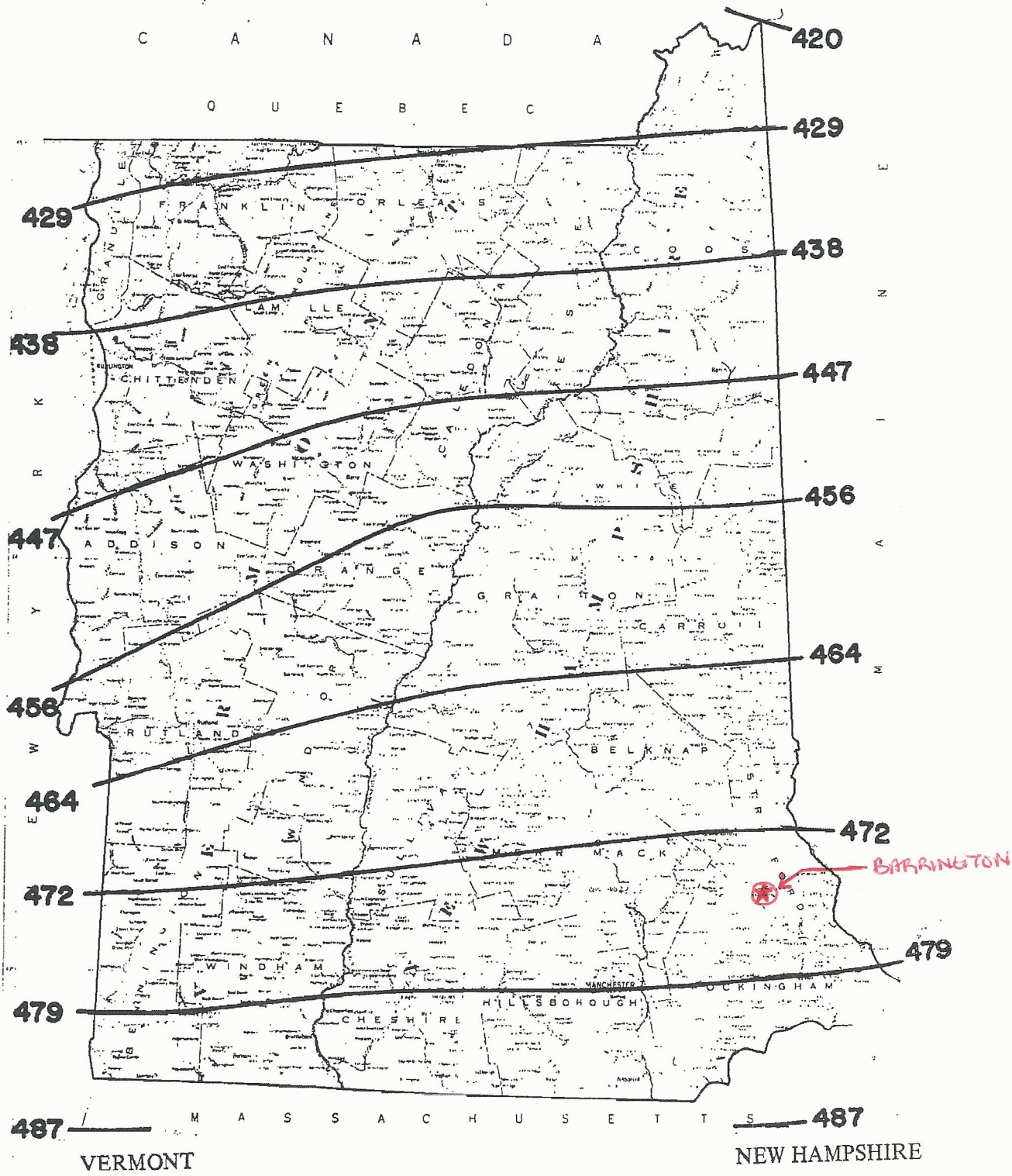
Appendix B-33. Hydrophysiographic zones of New Hampshire.
Appendix B-50. Hydrophysiographic zones of Vermont.

DC-12



Appendix D-33. Isohyetal map of 10-year 1-hour rainfall for New Hampshire.
Appendix D-50. Isohyetal map of 10-year 1-hour rainfall for Vermont.

DC-13



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.

OG-14

MAIN CHANNEL

WATERSHED

L = 11.23 mi.

L = 0.43 mi.

L = 0.93 mi.

L = 5.13 mi.

L = 0.35 mi.

L = 1.32 mi.

L = 3.89 mi.

L = 1.94 mi.

L = 0.84 mi.

L = 0.41 mi.

L = 0.105 mi.

L = 0.89 mi.

L = 0.84 mi.

L = 1.00 mi.

L = 0.43 mi.

L = 0.51 mi.

L = 0.36 mi.

L = 0.35 mi.

L = 2.36 mi.

L = 0.55 mi.

L = 1.15 mi.

L = 0.36 mi.

L = 0.75 mi.

L = 0.46 mi.

L = 1.73 mi.

L = 0.23 mi.

L = 3.57 mi.

L = 0.62 mi.

L = 2.06 mi.

L = 4.29 mi.

L = 1.44 mi.

Table 1-D. The 7-parameter regression equations for each of the 24 hydrophysiographic zones of the United States and Puerto Rico. (See also Appendix H, Table H-3.)

Zone	Equation
All Zone	$\hat{q}_{10} = 1.8816\ A^{0.3977}\ R^{0.8322}\ DH^{0.1461} L^{-0.0236}\ LL^{0.2613} P_{10}^{-0.1891}\ P_{60}^{0.4668}$
1	$\hat{q}_{10} = 10^{-9.9593} A^{-0.2759}\ R^{0.7417}\ DH^{0.5174} L^{0.2372}\ LL^{0.7087} P_{10}^{17.7125}\ P_{60}^{-16.1845}$
2	$\hat{q}_{10} = 10^{-7.1187} A^{0.8277}\ R^{0.3514}\ DH^{0.2154} L^{-0.9658}\ LL^{0.3287} P_{10}^{17.2401}\ P_{60}^{-17.2234}$
3	$\hat{q}_{10} = 10^{-16.2047} A^{0.9416}\ R^{0.1385}\ DH^{0.3787} L^{-0.5201}\ LL^{-0.1639} P_{10}^{34.1291}\ P_{60}^{-31.9517}$
4	$\hat{q}_{10} = 21.8893\ A^{0.6964}\ R^{0.1096}\ DH^{0.0598} L^{-0.1066}\ LL^{-0.0016} P_{10}^{0.5004}\ P_{60}^{1.0049}$
5	$\hat{q}_{10} = 2.9109\ A^{1.0119}\ R^{-0.3553}\ DH^{0.2164} L^{-0.1787}\ LL^{-0.1748} P_{10}^{2.5203}\ P_{60}^{-0.0776}$
6	$\hat{q}_{10} = 10^{-5.1795} A^{1.1351}\ R^{5.4283}\ DH^{0.7420} L^{-1.3539}\ LL^{-0.0742} P_{10}^{-2.6780}\ P_{60}^{-10.9168}$
7	$\hat{q}_{10} = 10^{6.6029} A^{0.7048}\ R^{-0.2011}\ DH^{0.1907} L^{-0.0621}\ LL^{0.1642} P_{10}^{-9.2707}\ P_{60}^{10.1924}$
8	$\hat{q}_{10} = 24.1002\ A^{0.0912}\ R^{-0.2570}\ DH^{0.0988} L^{0.5322}\ LL^{0.3114} P_{10}^{1.5265}\ P_{60}^{0.3177}$
9	$\hat{q}_{10} = 50.8080\ A^{0.3799}\ R^{-0.1432}\ DH^{0.3401} L^{0.0917}\ LL^{0.2879} P_{10}^{-0.9655}\ P_{60}^{1.8748}$
10	$\hat{q}_{10} = 10^{-5.0890} A^{0.9409}\ R^{4.1273}\ DH^{-1.0786} L^{-0.4183}\ LL^{0.8884} P_{10}^{0.7275}\ P_{60}^{4.2278}$
11	$\hat{q}_{10} = 5.97844\ A^{0.8616}\ R^{-1.3797}\ DH^{0.6271} L^{-0.7835}\ LL^{0.1630} P_{10}^{5.9753}\ P_{60}^{-3.6368}$
12	$\hat{q}_{10} = 807.3722\ A^{-0.5358}\ R^{1.3781}\ DH^{0.1457} L^{0.7667}\ LL^{0.9198} P_{10}^{-8.7780}\ P_{60}^{9.3897}$
13	$\hat{q}_{10} = 6.4357\ A^{0.7761}\ R^{0.4431}\ DH^{0.0095} L^{-0.4107}\ LL^{0.1424} P_{10}^{1.1422}\ P_{60}^{-0.1525}$
14	$\hat{q}_{10} = 10^{-6.3129} A^{1.1471}\ R^{2.3578}\ DH^{1.2258} L^{-0.9411}\ LL^{-0.5105} P_{10}^{4.8292}\ P_{60}^{-5.6504}$
15	$\hat{q}_{10} = 55.3750\ A^{0.8433}\ R^{-0.2586}\ DH^{-0.1705} L^{-0.1117}\ LL^{0.2228} P_{10}^{1.1934}\ P_{60}^{-1.6825}$
16	$\hat{q}_{10} = 57.4029\ A^{0.3052}\ R^{0.7323}\ DH^{-0.3973} L^{1.0963}\ LL^{-0.1118} P_{10}^{0.0259}\ P_{60}^{1.4146}$
17	$\hat{q}_{10} = 157.4954\ A^{0.5615}\ R^{1.2801}\ DH^{-0.6249} L^{-0.0429}\ LL^{0.4032} P_{10}^{-1.5484}\ P_{60}^{-0.5034}$
18	$\hat{q}_{10} = 10^{16.0040} A^{-0.1026}\ R^{2.0758}\ DH^{0.3202} L^{1.3339}\ LL^{-0.0842} P_{10}^{-35.7861}\ P_{60}^{16.6781}$
19	$\hat{q}_{10} = 48.8575\ A^{0.4962}\ R^{1.2266}\ DH^{0.2391} L^{0.0945}\ LL^{-0.0867} P_{10}^{-3.7389}\ P_{60}^{3.2559}$
20	$\hat{q}_{10} = 7.8890\ A^{0.8760}\ R^{0.8465}\ DH^{-0.0200} L^{-0.1091}\ LL^{0.1515} P_{10}^{-1.1600}\ P_{60}^{1.9548}$
21	$\hat{q}_{10} = 26.7400\ A^{0.7867}\ R^{0.2960}\ DH^{0.0539} L^{0.3939}\ LL^{-0.0486} P_{10}^{-0.4260}\ P_{60}^{0.9483}$
22	$\hat{q}_{10} = 0.00184\ A^{0.1791}\ R^{0.7746}\ DH^{0.0885} L^{0.4975}\ LL^{0.2660} P_{10}^{6.0977}\ P_{60}^{-4.2623}$
23	Insufficient observations for deriving a 7-parameter equation
24	$\hat{q}_{10} = 101.2426\ A^{0.6478}\ R^{1.7080}\ DH^{-0.7366} L^{0.5271}\ LL^{0.1474} P_{10}^{-1.6416}\ P_{60}^{0.0956}$

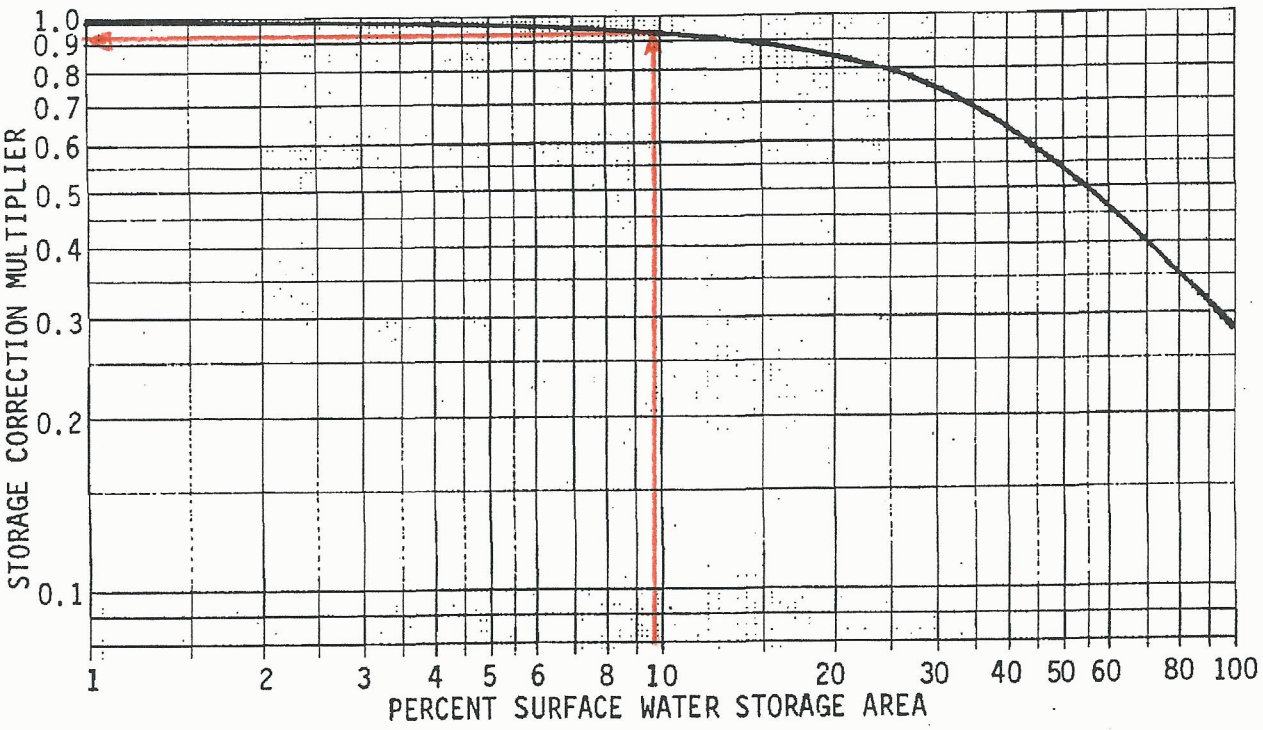


Figure 5. Storage correction curve. (Defines the relationship between the percentage of watershed area covered by lakes, ponds, swamps, playas, etc. and the multiplication factor required to correct a peak runoff estimate for storage.)

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,

$$R_e = 1 - P_0 = 1 - \left(1 - \frac{1}{T}\right)^n \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

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

METHOD No. 3: Area Relationship Method Using Downstream USGS Gauging Station Info.

- Flow information is available from downstream USGS gauging station (Isinglass River at Rochester Neck Road crossing, Gage Station No. 01072870). Peak flow information is available for the 10, 50 and 100 year flood events.
- See calculation sheet DC-20 for the FEMA report containing USGS gauging station data.

STEP 1 FLOW INFORMATION FROM DOWNSTREAM GAUGING STATION:

$A_{drain\_gauge} := 74.0mi^2$ Area of contributing watershed to USGS gauging station Calculation Sheet DC-21

10 Year Flood Event: $Q_{10\_DS} := 2920cfs$ Calculation Sheet DC-20

50 Year Flood Event: $Q_{50\_DS} := 4680cfs$ Calculation Sheet DC-20

100 Year Flood Event: $Q_{100\_DS} := 5620cfs$ Calculation Sheet DC-20

STEP 2 CONVERT DISCHARGE TO DISCHARGE PER AREA FOR WATERSHED #2:

- Ratios are presented in metric units because the Area Relationship Method calculations contain unitless variables that are calculated based on metric input values (see VTrans Hydraulics Manual)

$$Q_{10\_rate\_W2} := \frac{Q_{10\_DS}}{A_{drain\_gauge}} \qquad Q_{10\_rate\_W2} = 0.431 \cdot \frac{cms}{km^2}$$

$$Q_{50\_rate\_W2} := \frac{Q_{50\_DS}}{A_{drain\_gauge}} \qquad Q_{50\_rate\_W2} = 0.691 \cdot \frac{cms}{km^2}$$

$$Q_{100\_rate\_W2} := \frac{Q_{100\_DS}}{A_{drain\_gauge}} \qquad Q_{100\_rate\_W2} = 0.83 \cdot \frac{cms}{km^2}$$

METHOD No. 3: Area Relationship Method Using Downstream USGS Gauging Station Info. (Cont.)

STEP 3 CALCULATE UNITLESS X AND Y PARAMETERS:

- Must use metric units for these parameters

$A_{drain} = 66.1\ mi^2$ Area of contributing watershed to Greenhill Road over Isinglass River

$A_{drain\_gauge} = 74\ mi^2$ Area of contributing watershed to USGS gauging station

$$X := \left[\frac{0.894}{\left(\frac{A_{drain}}{km^2}\right)^{.048}}\right] - 1 \qquad X = -0.302$$

$$Y := \left[\frac{0.894}{\left(\frac{A_{drain\_gauge}}{km^2}\right)^{.048}}\right] - 1 \qquad Y = -0.305$$

STEP 4 CALCULATE DISCHARGES PER AREA FOR WATERSHED #1:

$$Q_{10\_rate\_W1} := \left[\left(\frac{A_{drain}}{km^2}\right)^{X}\right]\left[\frac{Q_{10\_rate\_W2}}{\left(\frac{A_{drain\_gauge}}{km^2}\right)^{Y}}\right] \qquad Q_{10\_rate\_W1} = 0.455 \cdot \frac{cms}{km^2}$$

$$Q_{50\_rate\_W1} := \left[\left(\frac{A_{drain}}{km^2}\right)^{X}\right]\left[\frac{Q_{50\_rate\_W2}}{\left(\frac{A_{drain\_gauge}}{km^2}\right)^{Y}}\right] \qquad Q_{50\_rate\_W1} = 0.73 \cdot \frac{cms}{km^2}$$

$$Q_{100\_rate\_W1} := \left[\left(\frac{A_{drain}}{km^2}\right)^{X}\right]\left[\frac{Q_{100\_rate\_W2}}{\left(\frac{A_{drain\_gauge}}{km^2}\right)^{Y}}\right] \qquad Q_{100\_rate\_W1} = 0.876 \cdot \frac{cms}{km^2}$$

METHOD No. 3: Area Relationship Method Using Downstream USGS Gauging Station Info. (Cont.)

STEP 5 CALCULATE TOTAL DISCHARGES FOR WATERSHED #1:

$Q_{10\_ARM} := Q_{10\_rate\_W1} \cdot A_{drain}$ $\quad Q_{10\_ARM} = 77.947 \cdot cms$ $\quad Q_{10\_ARM} = 2752.668 \cdot cfs$

$Q_{50\_ARM} := Q_{50\_rate\_W1} \cdot A_{drain}$ $\quad Q_{50\_ARM} = 124.929 \cdot cms$ $\quad Q_{50\_ARM} = 4411.81 \cdot cfs$

$Q_{100\_ARM} := Q_{100\_rate\_W1} \cdot A_{drain}$ $\quad Q_{100\_ARM} = 150.021 \cdot cms$ $\quad Q_{100\_ARM} = 5297.943 \cdot cfs$

COMPARISONS OF STREAMSTATS, FHWA 7-PARAMETER AND AREA RELATIONSHIP METHOD DISCHARGES:

STREAMSTATS	FHWA 7-PARAMETER	AREA RELATIONSHIP METHOD
$Q_{2\_USGS} = 1530 \cdot cfs$	N/A	N/A
N/A	$Q_{2.33\_FHWA} = 1361.017 \cdot cfs$	N/A
$Q_{10\_USGS} = 3100 \cdot cfs$	$Q_{10\_FHWA} = 3104.455 \cdot cfs$	$Q_{10\_ARM} = 2752.668 \cdot cfs$
$Q_{25\_USGS} = 3980 \cdot cfs$	$Q_{25\_FHWA} = 4205.104 \cdot cfs$	N/A
$Q_{50\_USGS} = 4680 \cdot cfs$	$Q_{50\_FHWA} = 5003.083 \cdot cfs$	$Q_{50\_ARM} = 4411.81 \cdot cfs$
$Q_{100\_USGS} = 5510 \cdot cfs$	$Q_{100\_FHWA} = 5898.513 \cdot cfs$	$Q_{100\_ARM} = 5297.943 \cdot cfs$

- NHDOT Bridge Design Bureau uses the FHWA 7-Parameter method for streams that are fragmented; more than one "main channel" or several branching tributatires.
- StreamStats and the Area Relationship Method are used as a rough check for a comparision to the FHWA-7 Parameter method.
- As is seen above, design flood flows between the different methods are similar, therefore use the FHWA 7-Parameter method to analyze the existing conditions for this project.

Table A-7: Peak Discharges, Estimated Return Periods, and Other Characteristics for Selected Stream Gages Affected by May 2006 and April 2007 Flooding

n.d., not determined n/a, not available

Gage Station Number	Gage Station Name	Period of Record	Return Period Discharge (cfs)				May 2006 Flood			April 2007 Flood			Maximum Peak of Record
			10-year	50-year	100-year	500-year	Peak Flow (cfs)	Return Period (years)	Runoff (inches)	Peak Flow (cfs)	Return Period (years)	Runoff (inches)	
01072100	Salmon Falls River at Milton, NH	1968–2007	3,190	5,590	6,920	10,900	5,450	10–50	5.0	5,500	10–50	5.5	April 2007
01072800	Cocheco River near Rochester, NH	1995–2007	5,350	9,920	12,500	20,300	5,550	10–50	n.d.	7,240	10–50	n.d.	April 2007
01072870	Isinglass R at Rochester Neck Rd near Dover, NH (see note 1)	2003–2007	2,920	4,680	5,620	8,230	4,370	10–50	n.d.	4,540	10–50	n.d.	n/a
01072880	Cocheco River at Spaulding Turnpike at Dover, NH (see note 1)	1992–1996	6,040	9,300	11,100	15,800	10,800	50–100	n.d.	n.d.	n.d.	n.d.	n/a
01073000	Oyster River near Durham, NH	1934–2007	633	1,020	1,220	1,750	873	10–50	7.8	1,320	100–500	6.1	April 2007
01073460	North River above NH125 near Lee, NH (see note 1)	2004–2006	1,520	2,500	3,020	4,520	3,790	100–500	n.d.	n.d.	n.d.	n.d.	n/a
01073500	Lamprey River near Newmarket, NH	1934–2007	4,660	7,760	9,400	14,100	8,970	50–100	7.3	8,450	50–100	5.7	May 2006
01073587	Exeter River at Haigh Road near Brentwood, NH	1996–2007	3,450	6,690	8,530	14,100	3,450	10–50	n.d.	2,840	2–10	n.d.	May 2006
01073600	Dudley Brook near Exeter, NH	1962–1985	379	646	791	1,210	660	50–100	n.d.	470	10–50	n.d.	May 2006

DC-20

USGS New Hampshire StreamStats

Streamstats Ungaged Site Report

STREAMSTATS UNGAGED SITE REPORT FOR ISINGLASS RIVER @ ROCHESTER NECK ROAD

Date: Tue Apr 29 2014 12:48:37 Mountain Daylight Time
Site Location: New_Hampshire
NAD27 Latitude: 43.2334 (43 14 00)
NAD27 Longitude: -70.9559 (-70 57 21)
NAD83 Latitude: 43.2335 (43 14 01)
NAD83 Longitude: -70.9554 (-70 57 20)
Drainage Area: 74.04 mi2

Peak Flows Region Grid Basin Characteristics

100% Peak Flow Statewide SIR2008 5206 (74 mi2)

Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	74	0.7	1290
Mean April Precipitation (inches)	4.286	2.79	6.23
Percent Wetlands (dimensionless)	9.2796	0	21.8
Stream Slope 10 and 85 Method (feet per mi)	29.7	5.43	543

LowFlows Region Grid Basin Characteristics

100% Low Flow Statewide (74 mi2)

Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	74	3.26	689
Mean Basin Slope from 30m DEM (percent)	7.293	3.19	38.1
Maximum Basin Elevation (feet)	1393.283	260	6290
Percent Coniferous Forest (percent)	13.5108	3.07	56.2
Jan to Mar Basin Centroid Precip (inches)	8.11	5.79	15.1
Mean Annual Temperature (degrees F)	45.841	36	48.7
Jun to Oct Mean Basinwide Temp (degrees F)	61.813	52.9	64.4
Jun to Oct Gage Precipitation (inches)	17.0	16.5	23.1
Percent Mixed Forest (percent)	36.5717	6.21	46.1
Mar to May Gage Precipitation (inches)	9.3	6.83	11.5

Peak Flows Region Grid Streamflow Statistics

Statistic	Flow (ft^3/s)	Prediction Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
PK2	1690	30	3.2	1050	2740
PK5	2650	31	4.7	1620	4330
PK10	3400	32	6.2	2040	5670
PK25	4360	34	8	2530	7500
PK50	5130	36	9	2900	9070
PK100	6040	39	9.8	3300	11100
PK500	8120	44	11	4110	16100

LowFlows Region Grid Streamflow Statistics

Statistic	Flow (ft^3/s)	Prediction Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
D60	43	18		31.5	57
D70	28	21		19.6	38.7
D80	17	28		10.4	26
D90	9.04	38		4.67	15.7
D95	5.79	44		2.66	10.9
D98	3.88	54		1.49	8.11
M7D2Y	5.61	56		2.07	11.6

COMPARISONS OF STREAMSTATS, FHWA 7-PARAMETER AND AREA RELATIONSHIP METHOD DISCHARGES:

STREAMSTATS	FHWA 7-PARAMETER	AREA RELATIONSHIP METHOD
$Q_{2\_USGS} = 1530 \cdot cfs$	N/A	N/A
N/A	$Q_{2.33\_FHWA} = 1361.302 \cdot cfs$	N/A
$Q_{10\_USGS} = 3100 \cdot cfs$	$Q_{10\_FHWA} = 3103.281 \cdot cfs$	$Q_{10\_ARM} = 2752.668 \cdot cfs$
$Q_{25\_USGS} = 3980 \cdot cfs$	$Q_{25\_FHWA} = 4202.463 \cdot cfs$	N/A
$Q_{50\_USGS} = 4680 \cdot cfs$	$Q_{50\_FHWA} = 5004.153 \cdot cfs$	$Q_{50\_ARM} = 4411.81 \cdot cfs$
$Q_{100\_USGS} = 5510 \cdot cfs$	$Q_{100\_FHWA} = 5899.781 \cdot cfs$	$Q_{100\_ARM} = 5297.943 \cdot cfs$

- NHDOT Bridge Design Bureau uses the FHWA 7-Parameter method for streams that are fragmented; more than one "main channel" or several branching tributatires.
- StreamStats and the Area Relationship Method are used as a rough check for a comparision to the FHWA-7 Parameter method.
- As is seen above, design flood flows between the different methods are similar, therefore use the FHWA 7-Parameter method to analyze the existing conditions for this project. ✓

Q50 Flow

Hydrograph for Reach 2R: Section through bridge

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)
5.00	5,000.00	8,983	170.10	5,000.70
5.50	5,000.00	8,983	170.10	5,000.54
6.00	5,000.00	8,983	170.10	5,000.42
6.50	5,000.00	8,982	170.10	5,000.32
7.00	5,000.00	8,982	170.10	5,000.25
7.50	5,000.00	8,982	170.10	5,000.19
8.00	5,000.00	8,982	170.10	5,000.15
8.50	5,000.00	8,982	170.10	5,000.11
9.00	5,000.00	8,982	170.10	5,000.09
9.50	5,000.00	8,982	170.10	5,000.07
10.00	5,000.00	8,982	170.10	5,000.05
10.50	5,000.00	8,982	170.10	5,000.04
11.00	5,000.00	8,982	170.10	5,000.03
11.50	5,000.00	8,982	170.10	5,000.02
12.00	5,000.00	8,982	170.10	5,000.02
12.50	5,000.00	8,982	170.10	5,000.01
13.00	5,000.00	8,982	170.10	5,000.01
13.50	5,000.00	8,982	170.10	5,000.01
14.00	5,000.00	8,982	170.10	5,000.01
14.50	5,000.00	8,982	170.10	5,000.00
15.00	5,000.00	8,982	170.10	5,000.00
15.50	5,000.00	8,982	170.10	5,000.00
16.00	5,000.00	8,982	170.10	5,000.00
16.50	5,000.00	8,982	170.10	5,000.00
17.00	5,000.00	8,982	170.10	5,000.00
17.50	5,000.00	8,982	170.10	5,000.00
18.00	5,000.00	8,982	170.10	5,000.00
18.50	5,000.00	8,982	170.10	5,000.00
19.00	5,000.00	8,982	170.10	5,000.00
19.50	5,000.00	8,982	170.10	5,000.00
20.00	5,000.00	8,982	170.10	5,000.00

Q50 Flow

Stage-Discharge for Reach 2R: Section through bridge

Elevation (feet)	Velocity (ft/sec)	Discharge (cfs)
161.50	0.00	0.00
161.70	1.28	1.32
161.90	1.90	4.59
162.10	2.38	9.96
162.30	2.79	17.69
162.50	3.15	28.04
162.70	3.49	41.27
162.90	3.81	57.65
163.10	4.12	77.42
163.30	4.40	100.81
163.50	4.68	128.07
163.70	4.95	159.21
163.90	4.97	186.38
164.10	4.82	212.77
164.30	4.80	250.24
164.50	4.86	298.59
164.70	4.99	358.40
164.90	5.47	455.00
165.10	5.92	558.97
165.30	6.36	670.72
165.50	6.77	789.84
165.70	7.16	915.94
165.90	7.54	1,048.70
166.10	7.91	1,187.82
166.30	8.26	1,333.02
166.50	8.60	1,484.28
166.70	8.93	1,641.12
166.90	9.24	1,803.35
167.10	9.55	1,970.77
167.30	9.85	2,143.19
167.50	10.15	2,320.45
167.70	10.43	2,502.38
167.90	10.71	2,688.84
168.10	10.98	2,879.68
168.30	11.24	3,074.77
168.50	11.50	3,273.98
168.70	11.75	3,477.20
168.90	11.99	3,684.30
169.10	12.23	3,895.17
169.30	12.47	4,109.72
169.50	12.70	4,327.84
169.70	12.92	4,549.45
169.90	13.15	4,774.43
170.10	13.36	5,002.72
170.30	13.57	5,234.22
170.50	13.78	5,468.86
170.70	13.99	5,706.56
170.90	14.19	5,947.24
171.10	14.38	6,190.84
171.30	14.57	6,437.39
171.50	14.76	6,686.71
171.70	14.95	6,938.74
171.90	15.13	7,193.41
172.10	15.31	7,450.68
172.30	15.49	7,710.48
172.50	15.66	7,972.75
172.70	15.83	8,237.45
172.90	16.00	8,504.52
173.10	16.17	8,773.91
173.30	16.33	9,045.57
173.50	16.49	9,319.46
173.70	16.65	9,595.52
173.90	16.80	9,873.72
174.10	16.96	10,154.01
174.30	17.11	10,436.36
174.50	17.26	10,720.71
174.70	17.40	11,007.04
174.90	17.55	11,295.30
175.10	17.69	11,585.45
175.30	17.83	11,877.46
175.50	17.97	12,171.30
175.70	18.11	12,466.93
175.90	18.24	12,764.32
176.10	18.37	13,063.50
176.30	18.50	13,364.37
176.50	18.63	13,666.90
176.70	18.76	13,971.06
176.90	18.89	14,276.83
177.10	19.01	14,584.16
177.30	19.13	14,893.05
177.50	19.25	15,203.46
177.70	19.37	15,515.36
177.90	19.49	15,828.73
178.10	19.61	16,143.54
178.30	19.72	16,459.77
178.50	19.84	16,777.40
178.70	19.95	17,096.40
178.90	20.06	17,416.75
179.10	20.17	17,738.43
179.30	20.28	18,061.42
179.50	20.38	18,385.69
179.70	20.49	18,711.23
179.90	20.59	19,038.01
180.10	20.70	19,366.02
180.30	20.80	19,695.23
180.50	20.90	20,025.63
180.70	**21.00**	**20,357.21**

Q100 Flow

Hydrograph for Reach 5R: Section through bridge

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)
5.00	5,900.00	10,010	170.86	5,900.90
5.50	5,900.00	10,010	170.86	5,900.70
6.00	5,900.00	10,010	170.86	5,900.55
6.50	5,900.00	10,010	170.86	5,900.43
7.00	5,900.00	10,009	170.86	5,900.33
7.50	5,900.00	10,009	170.86	5,900.26
8.00	5,900.00	10,009	170.86	5,900.20
8.50	5,900.00	10,009	170.86	5,900.16
9.00	5,900.00	10,009	170.86	5,900.12
9.50	5,900.00	10,009	170.86	5,900.10
10.00	5,900.00	10,009	170.86	5,900.07
10.50	5,900.00	10,009	170.86	5,900.06
11.00	5,900.00	10,009	170.86	5,900.05
11.50	5,900.00	10,009	170.86	5,900.04
12.00	5,900.00	10,009	170.86	5,900.03
12.50	5,900.00	10,009	170.86	5,900.02
13.00	5,900.00	10,009	170.86	5,900.02
13.50	5,900.00	10,009	170.86	5,900.01
14.00	5,900.00	10,009	170.86	5,900.01
14.50	5,900.00	10,009	170.86	5,900.01
15.00	5,900.00	10,009	170.86	5,900.01
15.50	5,900.00	10,009	170.86	5,900.00
16.00	5,900.00	10,009	170.86	5,900.00
16.50	5,900.00	10,009	170.86	5,900.00
17.00	5,900.00	10,009	170.86	5,900.00
17.50	5,900.00	10,009	170.86	5,900.00
18.00	5,900.00	10,009	170.86	5,900.00
18.50	5,900.00	10,009	170.86	5,900.00
19.00	5,900.00	10,009	170.86	5,900.00
19.50	5,900.00	10,009	170.86	5,900.00
20.00	5,900.00	10,009	170.86	5,900.00

Q100 Flow

Stage-Discharge for Reach 5R: Section through bridge

Elevation (feet)	Velocity (ft/sec)	Discharge (cfs)
161.50	0.00	0.00
161.70	1.28	1.32
161.90	1.90	4.59
162.10	2.38	9.96
162.30	2.79	17.69
162.50	3.15	28.04
162.70	3.49	41.27
162.90	3.81	57.65
163.10	4.12	77.42
163.30	4.40	100.81
163.50	4.68	128.07
163.70	4.95	159.21
163.90	4.97	186.38
164.10	4.82	212.77
164.30	4.80	250.24
164.50	4.86	298.59
164.70	4.99	358.40
164.90	5.47	455.00
165.10	5.92	558.97
165.30	6.36	670.72
165.50	6.77	789.84
165.70	7.16	915.94
165.90	7.54	1,048.70
166.10	7.91	1,187.82
166.30	8.26	1,333.02
166.50	8.60	1,484.28
166.70	8.93	1,641.12
166.90	9.24	1,803.35
167.10	9.55	1,970.77
167.30	9.85	2,143.19
167.50	10.15	2,320.45
167.70	10.43	2,502.38
167.90	10.71	2,688.84
168.10	10.98	2,879.68
168.30	11.24	3,074.77
168.50	11.50	3,273.98
168.70	11.75	3,477.20
168.90	11.99	3,684.30
169.10	12.23	3,895.17
169.30	12.47	4,109.72
169.50	12.70	4,327.84
169.70	12.92	4,549.45
169.90	13.15	4,774.43
170.10	13.36	5,002.72
170.30	13.57	5,234.22
170.50	13.78	5,468.86
170.70	13.99	5,706.56
170.90	14.19	5,947.24
171.10	14.38	6,190.84
171.30	14.57	6,437.39
171.50	14.76	6,686.71
171.70	14.95	6,938.74
171.90	15.13	7,193.41
172.10	15.31	7,450.68
172.30	15.49	7,710.48
172.50	15.66	7,972.75
172.70	15.83	8,237.45
172.90	16.00	8,504.52
173.10	16.17	8,773.91
173.30	16.33	9,045.57
173.50	16.49	9,319.46
173.70	16.65	9,595.52
173.90	16.80	9,873.72
174.10	16.96	10,154.01
174.30	17.11	10,436.36
174.50	17.26	10,720.71
174.70	17.40	11,007.04
174.90	17.55	11,295.30
175.10	17.69	11,585.45
175.30	17.83	11,877.46
175.50	17.97	12,171.30
175.70	18.11	12,466.93
175.90	18.24	12,764.32
176.10	18.37	13,063.50
176.30	18.50	13,364.37
176.50	18.63	13,666.90
176.70	18.76	13,971.06
176.90	18.89	14,276.83
177.10	19.01	14,584.16
177.30	19.13	14,893.05
177.50	19.25	15,203.46
177.70	19.37	15,515.36
177.90	19.49	15,828.73
178.10	19.61	16,143.54
178.30	19.72	16,459.77
178.50	19.84	16,777.40
178.70	19.95	17,096.40
178.90	20.06	17,416.75
179.10	20.17	17,738.43
179.30	20.28	18,061.42
179.50	20.38	18,385.69
179.70	20.49	18,711.23
179.90	20.59	19,038.01
180.10	20.70	19,366.02
180.30	20.80	19,695.23
180.50	20.90	20,025.63
180.70	**21.00**	**20,357.21**

Q2.33 Flow

Hydrograph for Reach 8R: Section through bridge

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)
5.00	1,360.00	3,922	166.34	1,360.16
5.50	1,360.00	3,922	166.34	1,360.11
6.00	1,360.00	3,922	166.34	1,360.07
6.50	1,360.00	3,922	166.34	1,360.05
7.00	1,360.00	3,922	166.34	1,360.03
7.50	1,360.00	3,922	166.34	1,360.02
8.00	1,360.00	3,922	166.34	1,360.01
8.50	1,360.00	3,922	166.34	1,360.01
9.00	1,360.00	3,922	166.34	1,360.01
9.50	1,360.00	3,922	166.34	1,360.00
10.00	1,360.00	3,922	166.34	1,360.00
10.50	1,360.00	3,922	166.34	1,360.00
11.00	1,360.00	3,922	166.34	1,360.00
11.50	1,360.00	3,922	166.34	1,360.00
12.00	1,360.00	3,922	166.34	1,360.00
12.50	1,360.00	3,922	166.34	1,360.00
13.00	1,360.00	3,922	166.34	1,360.00
13.50	1,360.00	3,922	166.34	1,360.00
14.00	1,360.00	3,922	166.34	1,360.00
14.50	1,360.00	3,922	166.34	1,360.00
15.00	1,360.00	3,922	166.34	1,360.00
15.50	1,360.00	3,922	166.34	1,360.00
16.00	1,360.00	3,922	166.34	1,360.00
16.50	1,360.00	3,922	166.34	1,360.00
17.00	1,360.00	3,922	166.34	1,360.00
17.50	1,360.00	3,922	166.34	1,360.00
18.00	1,360.00	3,922	166.34	1,360.00
18.50	1,360.00	3,922	166.34	1,360.00
19.00	1,360.00	3,922	166.34	1,360.00
19.50	1,360.00	3,922	166.34	1,360.00
20.00	1,360.00	3,922	166.34	1,360.00

Q2.33 Flow

Stage-Discharge for Reach 8R: Section through bridge

Elevation (feet)	Velocity (ft/sec)	Discharge (cfs)
161.50	0.00	0.00
161.70	1.28	1.32
161.90	1.90	4.59
162.10	2.38	9.96
162.30	2.79	17.69
162.50	3.15	28.04
162.70	3.49	41.27
162.90	3.81	57.65
163.10	4.12	77.42
163.30	4.40	100.81
163.50	4.68	128.07
163.70	4.95	159.21
163.90	4.97	186.38
164.10	4.82	212.77
164.30	4.80	250.24
164.50	4.86	298.59
164.70	4.99	358.40
164.90	5.47	455.00
165.10	5.92	558.97
165.30	6.36	670.72
165.50	6.77	789.84
165.70	7.16	915.94
165.90	7.54	1,048.70
166.10	7.91	1,187.82
166.30	8.26	1,333.02
166.50	8.60	1,484.28
166.70	8.93	1,641.12
166.90	9.24	1,803.35
167.10	9.55	1,970.77
167.30	9.85	2,143.19
167.50	10.15	2,320.45
167.70	10.43	2,502.38
167.90	10.71	2,688.84
168.10	10.98	2,879.68
168.30	11.24	3,074.77
168.50	11.50	3,273.98
168.70	11.75	3,477.20
168.90	11.99	3,684.30
169.10	12.23	3,895.17
169.30	12.47	4,109.72
169.50	12.70	4,327.84
169.70	12.92	4,549.45
169.90	13.15	4,774.43
170.10	13.36	5,002.72
170.30	13.57	5,234.22
170.50	13.78	5,468.86
170.70	13.99	5,706.56
170.90	14.19	5,947.24
171.10	14.38	6,190.84
171.30	14.57	6,437.39
171.50	14.76	6,686.71
171.70	14.95	6,938.74
171.90	15.13	7,193.41
172.10	15.31	7,450.68
172.30	15.49	7,710.48
172.50	15.66	7,972.75
172.70	15.83	8,237.45
172.90	16.00	8,504.52
173.10	16.17	8,773.91
173.30	16.33	9,045.57
173.50	16.49	9,319.46
173.70	16.65	9,595.52
173.90	16.80	9,873.72
174.10	16.96	10,154.01
174.30	17.11	10,436.36
174.50	17.26	10,720.71
174.70	17.40	11,007.04
174.90	17.55	11,295.30
175.10	17.69	11,585.45
175.30	17.83	11,877.46
175.50	17.97	12,171.30
175.70	18.11	12,466.93
175.90	18.24	12,764.32
176.10	18.37	13,063.50
176.30	18.50	13,364.37
176.50	18.63	13,666.90
176.70	18.76	13,971.06
176.90	18.89	14,276.83
177.10	19.01	14,584.16
177.30	19.13	14,893.05
177.50	19.25	15,203.46
177.70	19.37	15,515.36
177.90	19.49	15,828.73
178.10	19.61	16,143.54
178.30	19.72	16,459.77
178.50	19.84	16,777.40
178.70	19.95	17,096.40
178.90	20.06	17,416.75
179.10	20.17	17,738.43
179.30	20.28	18,061.42
179.50	20.38	18,385.69
179.70	20.49	18,711.23
179.90	20.59	19,038.01
180.10	20.70	19,366.02
180.30	20.80	19,695.23
180.50	20.90	20,025.63
180.70	**21.00**	**20,357.21**

Q50 Flow

Hydrograph for Reach 2R: Section through bridge

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)
5.00	5,000.00	9,666	169.53	5,000.95
5.50	5,000.00	9,666	169.53	5,000.71
6.00	5,000.00	9,666	169.53	5,000.53
6.50	5,000.00	9,665	169.53	5,000.40
7.00	5,000.00	9,665	169.53	5,000.30
7.50	5,000.00	9,665	169.53	5,000.22
8.00	5,000.00	9,665	169.53	5,000.17
8.50	5,000.00	9,665	169.53	5,000.13
9.00	5,000.00	9,665	169.53	5,000.09
9.50	5,000.00	9,665	169.53	5,000.07
10.00	5,000.00	9,665	169.53	5,000.05
10.50	5,000.00	9,665	169.53	5,000.04
11.00	5,000.00	9,665	169.53	5,000.03
11.50	5,000.00	9,665	169.53	5,000.02
12.00	5,000.00	9,665	169.53	5,000.02
12.50	5,000.00	9,665	169.53	5,000.01
13.00	5,000.00	9,665	169.53	5,000.01
13.50	5,000.00	9,665	169.53	5,000.01
14.00	5,000.00	9,665	169.53	5,000.01
14.50	5,000.00	9,665	169.53	5,000.00
15.00	5,000.00	9,665	169.53	5,000.00
15.50	5,000.00	9,665	169.53	5,000.00
16.00	5,000.00	9,665	169.53	5,000.00
16.50	5,000.00	9,665	169.53	5,000.00
17.00	5,000.00	9,665	169.53	5,000.00
17.50	5,000.00	9,665	169.53	5,000.00
18.00	5,000.00	9,665	169.53	5,000.00
18.50	5,000.00	9,665	169.53	5,000.00
19.00	5,000.00	9,665	169.53	5,000.00
19.50	5,000.00	9,665	169.53	5,000.00
20.00	5,000.00	9,665	169.53	5,000.00

Q50 Flow

Stage-Discharge for Reach 2R: Section through bridge

Elevation (feet)	Velocity (ft/sec)	Discharge (cfs)
161.50	0.00	0.00
161.75	1.46	1.95
162.00	2.15	7.00
162.25	2.69	15.53
162.50	3.15	28.06
162.75	3.58	45.11
163.00	3.97	67.16
163.25	4.33	94.71
163.50	4.68	128.20
163.75	5.02	167.60
164.00	4.88	198.65
164.25	4.80	240.47
164.50	4.86	298.73
164.75	4.96	372.38
165.00	5.53	497.91
165.25	6.06	637.03
165.50	6.56	790.12
165.75	7.03	956.76
166.00	7.49	1,136.62
166.25	7.92	1,329.43
166.50	8.33	1,534.97
166.75	8.73	1,753.05
167.00	9.11	1,983.54
167.25	9.48	2,226.30
167.50	9.84	2,481.23
167.75	10.19	2,748.26
168.00	10.52	3,027.32
168.25	10.85	3,318.35
168.50	11.17	3,621.31
168.75	11.48	3,936.19
169.00	11.79	4,262.95
169.25	12.09	4,601.87
169.50	12.38	4,952.75
169.75	12.66	5,315.50
170.00	12.94	5,690.14
170.25	13.21	6,076.68
170.50	13.48	6,475.13
170.75	13.74	6,885.52
171.00	14.00	7,307.87
171.25	14.26	7,742.22
171.50	14.51	8,188.59
171.75	14.75	8,647.03
172.00	15.00	9,117.56
172.25	15.23	9,600.24
172.50	15.47	10,095.09
172.75	15.70	10,602.18
173.00	15.93	11,120.96
173.25	16.18	11,670.05
173.50	16.46	12,252.41
173.75	16.74	12,853.08
174.00	17.02	13,462.83
174.25	17.29	14,081.45
174.50	17.56	14,708.73
174.75	17.83	15,344.48
175.00	18.09	15,988.52
175.25	18.34	16,640.67
175.50	18.59	17,300.74
175.75	18.84	17,968.57
176.00	19.08	18,644.01
176.25	19.32	19,326.88
176.50	19.56	20,017.04
176.75	19.79	20,714.45
177.00	20.02	21,418.96
177.25	20.24	22,130.33
177.50	20.46	22,848.41
177.75	20.68	23,573.08
178.00	20.90	24,304.21
178.25	21.11	25,041.68
178.50	21.32	25,785.37
178.75	21.53	26,535.17
179.00	21.73	27,290.95
179.25	21.93	28,052.62
179.50	22.13	28,820.07
179.75	22.32	29,593.19
180.00	22.51	30,371.89
180.25	22.70	31,156.06
180.50	22.89	31,945.60
180.75	23.08	32,740.44
181.00	23.26	33,540.47
181.25	23.44	34,345.60
181.50	23.62	35,155.76
181.75	23.79	35,970.85
182.00	23.97	36,790.80
182.25	24.14	37,615.52
182.50	24.31	38,444.94
182.75	24.48	39,278.98
183.00	24.64	40,117.56
183.25	24.81	40,960.62
183.50	24.97	41,808.07
183.75	25.13	42,659.86
184.00	25.28	43,515.92
184.25	25.44	44,376.20
184.50	25.60	45,240.71
184.75	25.75	46,109.29
185.00	25.90	46,981.87
185.25	26.05	47,858.39
185.50	**26.20**	**48,738.80**

Q100 Flow

Hydrograph for Reach 5R: Section through bridge

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)
5.00	5,900.00	10,804	170.18	5,901.23
5.50	5,900.00	10,803	170.18	5,900.93
6.00	5,900.00	10,803	170.18	5,900.70
6.50	5,900.00	10,803	170.18	5,900.53
7.00	5,900.00	10,803	170.18	5,900.40
7.50	5,900.00	10,803	170.18	5,900.30
8.00	5,900.00	10,803	170.18	5,900.23
8.50	5,900.00	10,802	170.18	5,900.17
9.00	5,900.00	10,802	170.18	5,900.13
9.50	5,900.00	10,802	170.18	5,900.10
10.00	5,900.00	10,802	170.18	5,900.07
10.50	5,900.00	10,802	170.18	5,900.06
11.00	5,900.00	10,802	170.18	5,900.04
11.50	5,900.00	10,802	170.18	5,900.03
12.00	5,900.00	10,802	170.18	5,900.02
12.50	5,900.00	10,802	170.18	5,900.02
13.00	5,900.00	10,802	170.18	5,900.01
13.50	5,900.00	10,802	170.18	5,900.01
14.00	5,900.00	10,802	170.18	5,900.01
14.50	5,900.00	10,802	170.18	5,900.01
15.00	5,900.00	10,802	170.18	5,900.00
15.50	5,900.00	10,802	170.18	5,900.00
16.00	5,900.00	10,802	170.18	5,900.00
16.50	5,900.00	10,802	170.18	5,900.00
17.00	5,900.00	10,802	170.18	5,900.00
17.50	5,900.00	10,802	170.18	5,900.00
18.00	5,900.00	10,802	170.18	5,900.00
18.50	5,900.00	10,802	170.18	5,900.00
19.00	5,900.00	10,802	170.18	5,900.00
19.50	5,900.00	10,802	170.18	5,900.00
20.00	5,900.00	10,802	170.18	5,900.00

Q100 Flow

Stage-Discharge for Reach 5R: Section through bridge

Elevation (feet)	Velocity (ft/sec)	Discharge (cfs)
161.50	0.00	0.00
161.75	1.46	1.95
162.00	2.15	7.00
162.25	2.69	15.53
162.50	3.15	28.06
162.75	3.58	45.11
163.00	3.97	67.16
163.25	4.33	94.71
163.50	4.68	128.20
163.75	5.02	167.60
164.00	4.88	198.65
164.25	4.80	240.47
164.50	4.86	298.73
164.75	5.03	376.79
165.00	5.59	500.92
165.25	6.11	638.30
165.50	6.60	789.31
165.75	7.07	953.57
166.00	7.52	1,130.79
166.25	7.94	1,320.72
166.50	8.35	1,523.17
166.75	8.74	1,737.96
167.00	9.12	1,964.97
167.25	9.49	2,204.11
167.50	9.84	2,455.27
167.75	10.19	2,718.40
168.00	10.52	2,993.44
168.25	10.84	3,280.36
168.50	11.16	3,579.14
168.75	11.47	3,889.74
169.00	11.77	4,212.18
169.25	12.06	4,546.71
169.50	12.35	4,893.17
169.75	12.63	5,251.47
170.00	12.91	5,621.64
170.25	13.18	6,003.70
170.50	13.44	6,397.68
170.75	13.70	6,803.60
171.00	13.96	7,221.50
171.25	14.21	7,651.42
171.50	14.46	8,093.40
171.75	14.70	8,547.49
172.00	14.94	9,013.72
172.25	15.18	9,492.16
172.50	15.41	9,982.84
172.75	15.64	10,485.81
173.00	15.87	11,000.57
173.25	16.12	11,547.28
173.50	16.40	12,127.76
173.75	16.68	12,726.52
174.00	16.96	13,334.41
174.25	17.24	13,951.20
174.50	17.51	14,576.70
174.75	17.77	15,210.72
175.00	18.03	15,853.06
175.25	18.29	16,503.54
175.50	18.54	17,161.99
175.75	18.79	17,828.23
176.00	19.03	18,502.11
176.25	19.27	19,183.46
176.50	19.51	19,872.13
176.75	19.74	20,568.08
177.00	19.97	21,271.16
177.25	20.20	21,981.12
177.50	20.42	22,697.83
177.75	20.64	23,421.16
178.00	20.85	24,150.97
178.25	21.07	24,887.14
178.50	21.28	25,629.57
178.75	21.48	26,378.12
179.00	21.69	27,132.68
179.25	21.89	27,893.16
179.50	22.09	28,659.43
179.75	22.28	29,431.39
180.00	22.47	30,208.95
180.25	22.67	30,992.01
180.50	22.85	31,780.46
180.75	23.04	32,574.22
181.00	23.22	33,373.20
181.25	23.40	34,177.30
181.50	23.58	34,986.43
181.75	23.76	35,800.53
182.00	23.93	36,619.49
182.25	24.10	37,443.25
182.50	24.27	38,271.71
182.75	24.44	39,104.82
183.00	24.61	39,942.48
183.25	24.77	40,784.63
183.50	24.93	41,631.20
183.75	25.09	42,482.11
184.00	25.25	43,337.31
184.25	25.41	44,196.74
184.50	25.56	45,060.42
184.75	25.72	45,928.18
185.00	25.87	46,799.95
185.25	26.02	47,675.68
185.50	**26.17**	**48,555.30**

Q2.33 Flow

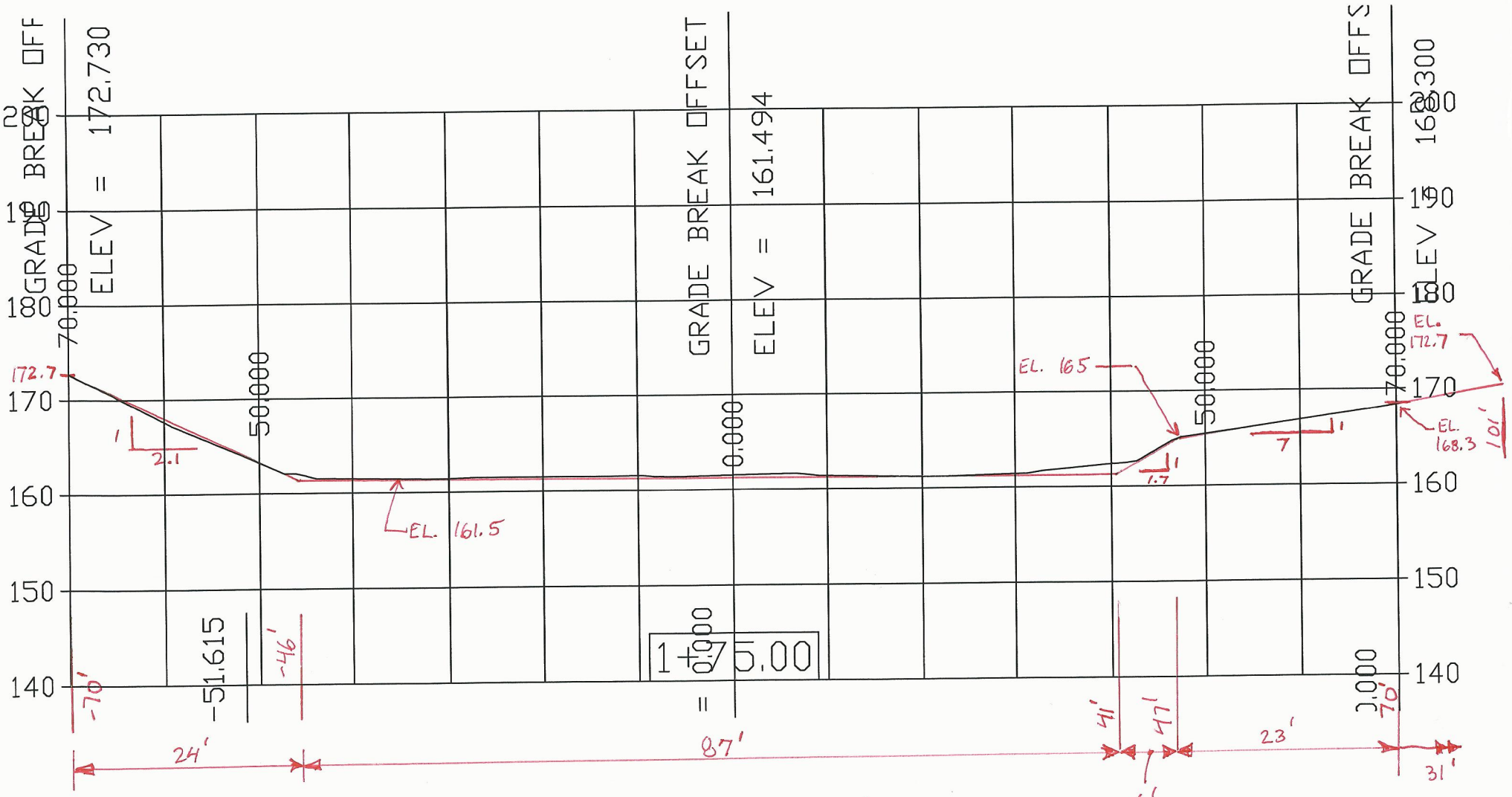
Hydrograph for Reach 8R: Section through bridge

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)
5.00	1,360.00	4,086	166.29	1,360.15
5.50	1,360.00	4,086	166.29	1,360.10
6.00	1,360.00	4,086	166.29	1,360.06
6.50	1,360.00	4,086	166.29	1,360.04
7.00	1,360.00	4,086	166.29	1,360.03
7.50	1,360.00	4,086	166.29	1,360.02
8.00	1,360.00	4,086	166.29	1,360.01
8.50	1,360.00	4,086	166.29	1,360.01
9.00	1,360.00	4,086	166.29	1,360.00
9.50	1,360.00	4,086	166.29	1,360.00
10.00	1,360.00	4,086	166.29	1,360.00
10.50	1,360.00	4,086	166.29	1,360.00
11.00	1,360.00	4,086	166.29	1,360.00
11.50	1,360.00	4,086	166.29	1,360.00
12.00	1,360.00	4,086	166.29	1,360.00
12.50	1,360.00	4,086	166.29	1,360.00
13.00	1,360.00	4,086	166.29	1,360.00
13.50	1,360.00	4,086	166.29	1,360.00
14.00	1,360.00	4,086	166.29	1,360.00
14.50	1,360.00	4,086	166.29	1,360.00
15.00	1,360.00	4,086	166.29	1,360.00
15.50	1,360.00	4,086	166.29	1,360.00
16.00	1,360.00	4,086	166.29	1,360.00
16.50	1,360.00	4,086	166.29	1,360.00
17.00	1,360.00	4,086	166.29	1,360.00
17.50	1,360.00	4,086	166.29	1,360.00
18.00	1,360.00	4,086	166.29	1,360.00
18.50	1,360.00	4,086	166.29	1,360.00
19.00	1,360.00	4,086	166.29	1,360.00
19.50	1,360.00	4,086	166.29	1,360.00
20.00	1,360.00	4,086	166.29	1,360.00

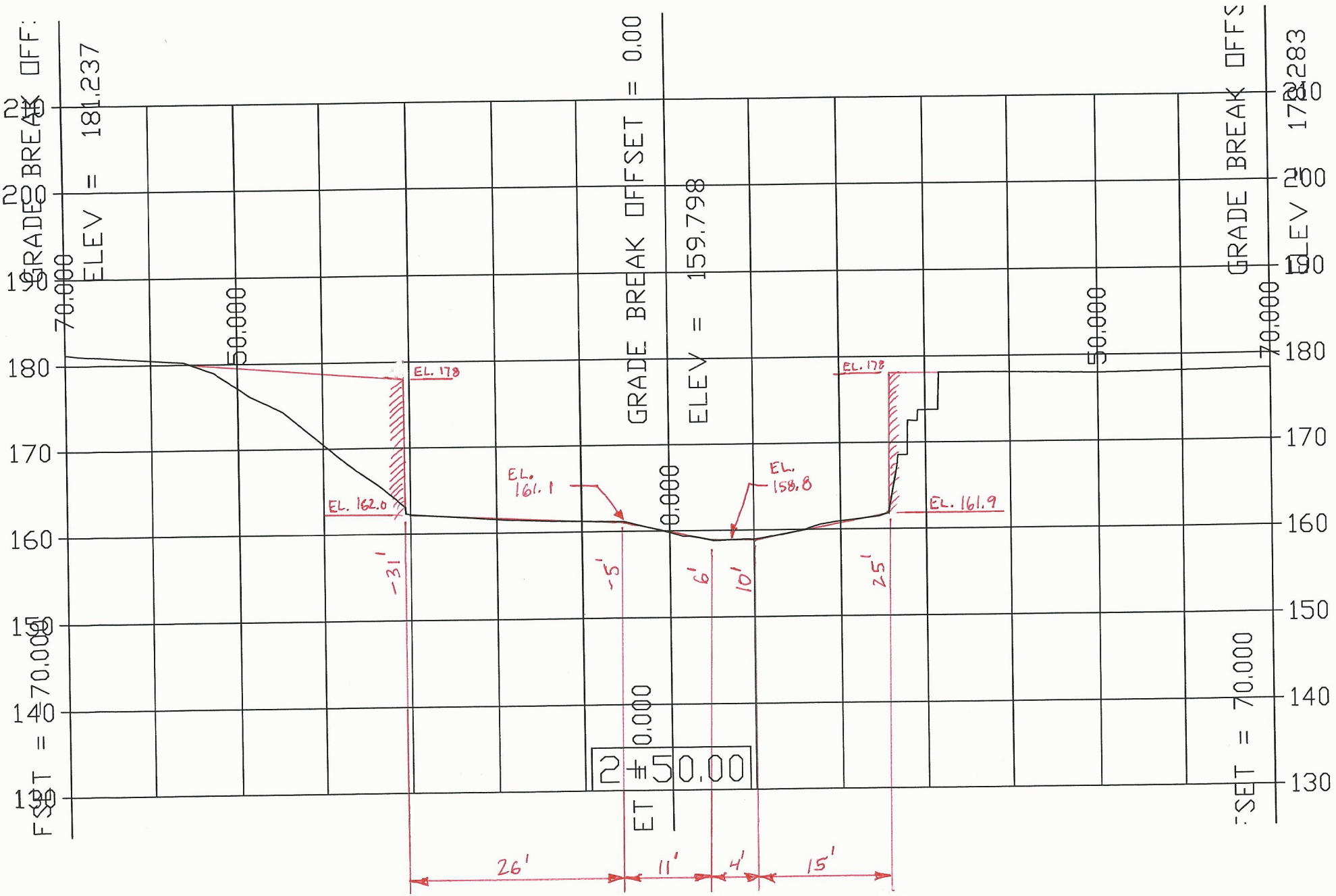
Q2.33 Flow

Stage-Discharge for Reach 8R: Section through bridge

Elevation (feet)	Velocity (ft/sec)	Discharge (cfs)
161.50	0.00	0.00
161.75	1.46	1.95
162.00	2.15	7.00
162.25	2.69	15.53
162.50	3.15	28.06
162.75	3.58	45.11
163.00	3.97	67.16
163.25	4.33	94.71
163.50	4.68	128.20
163.75	5.02	167.60
164.00	4.88	198.65
164.25	4.80	240.47
164.50	4.86	298.73
164.75	4.96	372.38
165.00	5.53	497.91
165.25	6.06	637.03
165.50	6.56	790.12
165.75	7.03	956.76
166.00	7.49	1,136.62
166.25	7.92	1,329.43
166.50	8.33	1,534.97
166.75	8.73	1,753.05
167.00	9.11	1,983.54
167.25	9.48	2,226.30
167.50	9.84	2,481.23
167.75	10.19	2,748.26
168.00	10.52	3,027.32
168.25	10.85	3,318.35
168.50	11.17	3,621.31
168.75	11.48	3,936.19
169.00	11.79	4,262.95
169.25	12.09	4,601.87
169.50	12.38	4,952.75
169.75	12.66	5,315.50
170.00	12.94	5,690.14
170.25	13.21	6,076.68
170.50	13.48	6,475.13
170.75	13.74	6,885.52
171.00	14.00	7,307.87
171.25	14.26	7,742.22
171.50	14.51	8,188.59
171.75	14.75	8,647.03
172.00	15.00	9,117.56
172.25	15.23	9,600.24
172.50	15.47	10,095.09
172.75	15.70	10,602.18
173.00	15.93	11,120.96
173.25	16.18	11,670.05
173.50	16.46	12,252.41
173.75	16.74	12,853.08
174.00	17.02	13,462.83
174.25	17.29	14,081.45
174.50	17.56	14,708.73
174.75	17.83	15,344.48
175.00	18.09	15,988.52
175.25	18.34	16,640.67
175.50	18.59	17,300.74
175.75	18.84	17,968.57
176.00	19.08	18,644.01
176.25	19.32	19,326.88
176.50	19.56	20,017.04
176.75	19.79	20,714.45
177.00	20.02	21,418.96
177.25	20.24	22,130.33
177.50	20.46	22,848.41
177.75	20.68	23,573.08
178.00	20.90	24,304.21
178.25	21.11	25,041.68
178.50	21.32	25,785.37
178.75	21.53	26,535.17
179.00	21.73	27,290.95
179.25	21.93	28,052.62
179.50	22.13	28,820.07
179.75	22.32	29,593.19
180.00	22.51	30,371.89
180.25	22.70	31,156.06
180.50	22.89	31,945.60
180.75	23.08	32,740.44
181.00	23.26	33,540.47
181.25	23.44	34,345.60
181.50	23.62	35,155.76
181.75	23.79	35,970.85
182.00	23.97	36,790.80
182.25	24.14	37,615.52
182.50	24.31	38,444.94
182.75	24.48	39,278.98
183.00	24.64	40,117.56
183.25	24.81	40,960.62
183.50	24.97	41,808.07
183.75	25.13	42,659.86
184.00	25.28	43,515.92
184.25	25.44	44,376.20
184.50	25.60	45,240.71
184.75	25.75	46,109.29
185.00	25.90	46,981.87
185.25	26.05	47,858.39
185.50	**26.20**	**48,738.80**

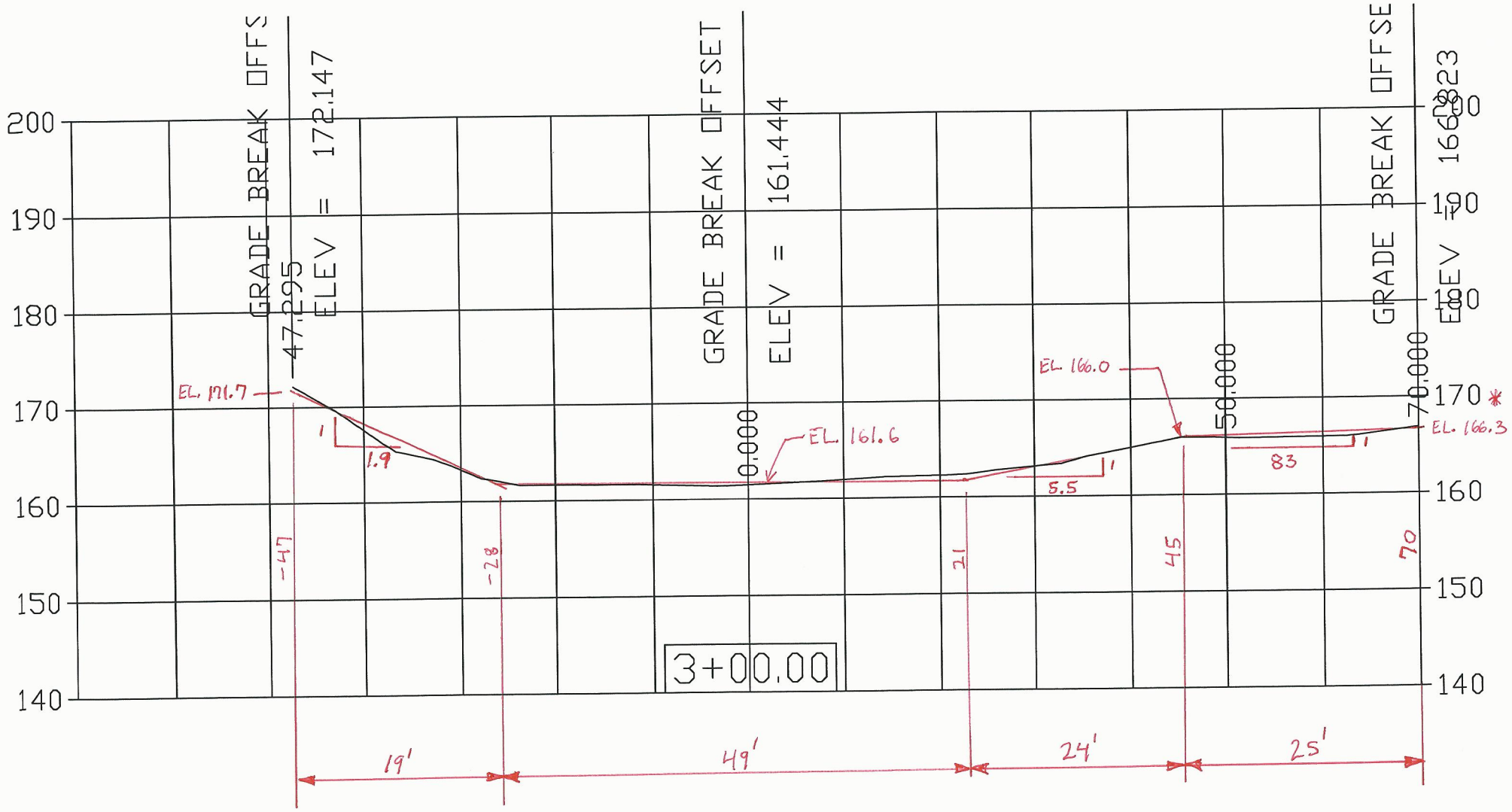


UPSTREAM SECTION

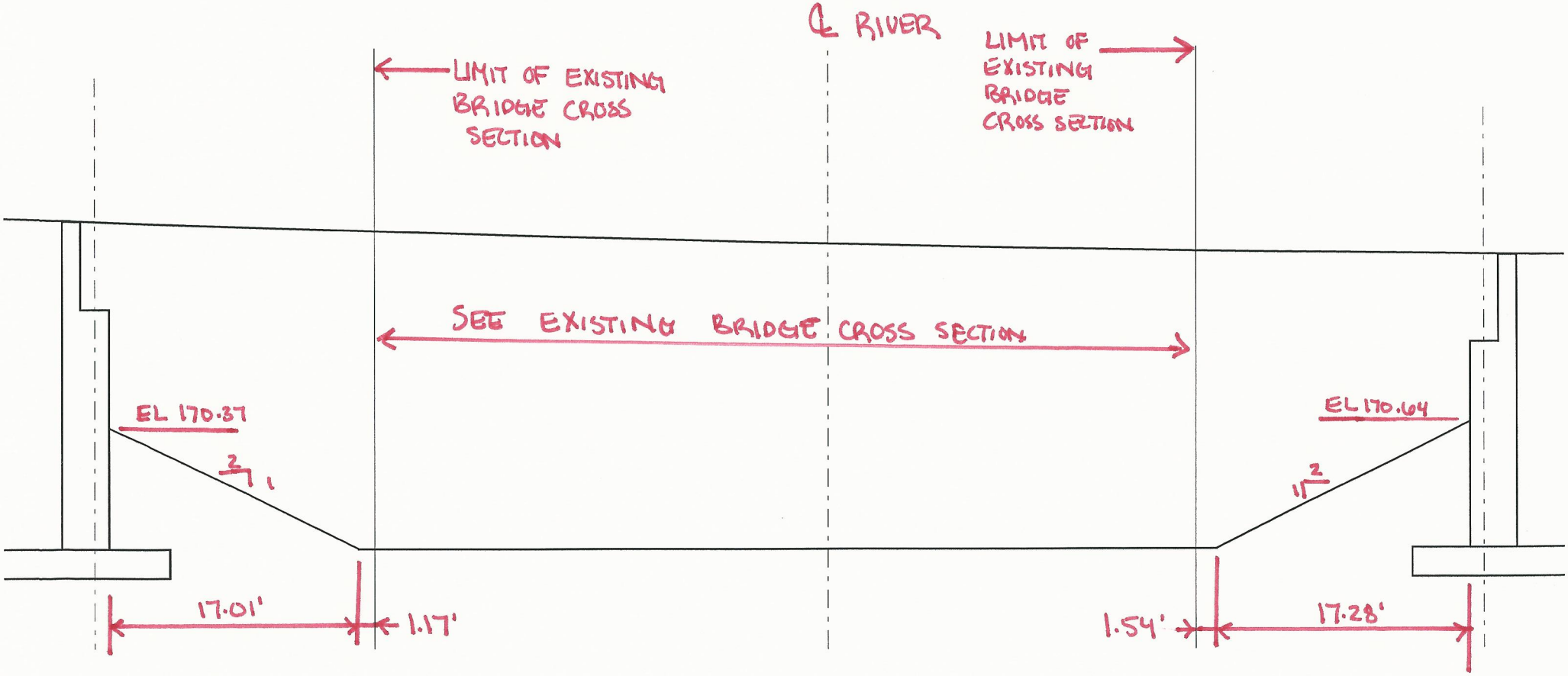


BRIDGE SECTION

	OFFSET FROM ℄	ELEV.
*	79'	168
	94'	170
	102'	172



DOWNSTREAM SECTION


℄ RIVER
LIMIT OF EXISTING BRIDGE CROSS SECTION
LIMIT OF EXISTING BRIDGE CROSS SECTION
SEE EXISTING BRIDGE CROSS SECTION
EL 170.37
3
1
EL 170.64
2
1
17.01'
1.17'
1.54'
17.28'

APPENDIX G

Individual Inventory From

INDIVIDUAL INVENTORY FORM

NHDHR INVENTORY # BRR0008

Name, Location, Ownership

1. Historic name: Seavey Bridge
2. District or area: n/a
3. Street & number: Green Hill Road over Isinglass River
4. City or town: Barrington
5. County: Strafford
6. Current owner: Town of Barrington

Function or Use

7. Current use(s): Municipal highway bridge, Barrington 109/162
8. Historic use(s): Town bridge at same location

Architectural Information

9. Style: I-beam stringer w/ concrete deck, 1 span
10. Architect/builder: NH Dept. Public Works & Highways
11. Source: NHDOT Records
12. Construction date: 1955
13. Source: NHDOT Records
14. Alterations, with dates: wood guardrails replaced with steel W-type, date unknown
15. Moved? no ☒ yes ☐ date:

Exterior Features

16. Foundation: Concrete and stone
17. Cladding: n/a
18. Roof material: n/a
19. Chimney material: n/a
20. Type of roof: n/a
21. Chimney location: n/a
22. Number of stories: n/a
23. Entry location: n/a
24. Windows: n/a

Replacement? no ☐ yes ☐ date:

Site Features

25. Setting: Rural local road
26. Outbuildings: n/a
27. Landscape features: River

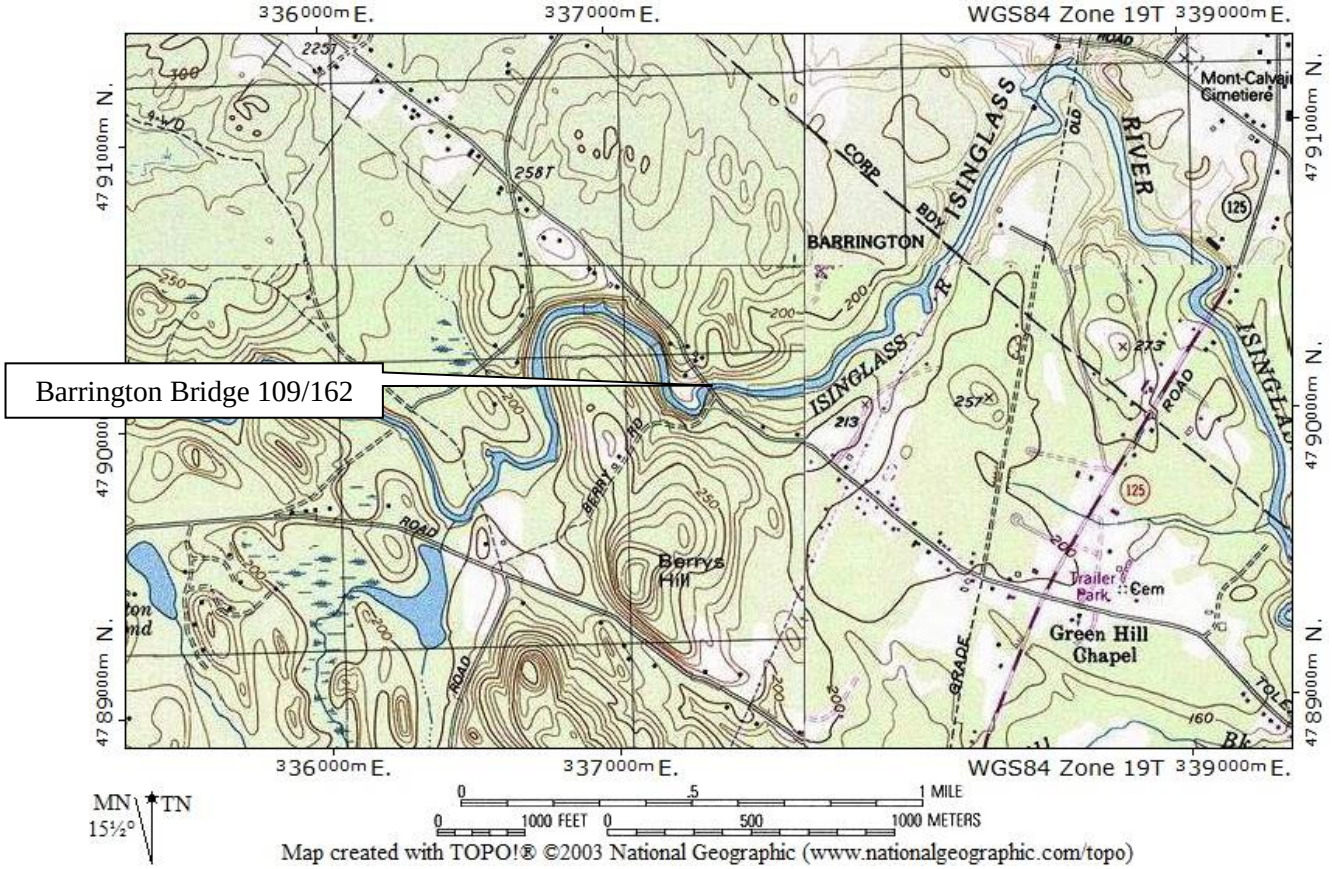
35. Photo # 1 Direction: NE
36. Date: 22 December 2014
37. Reference (file name or frame #): BRR0008_001

28. Acreage: less than 1 ac.
29. Tax map/parcel #: n/a
30. Map reference: UTM 19.337333.4790118
31. USGS quad and scale: Barrington NH 7.5 minute 1995

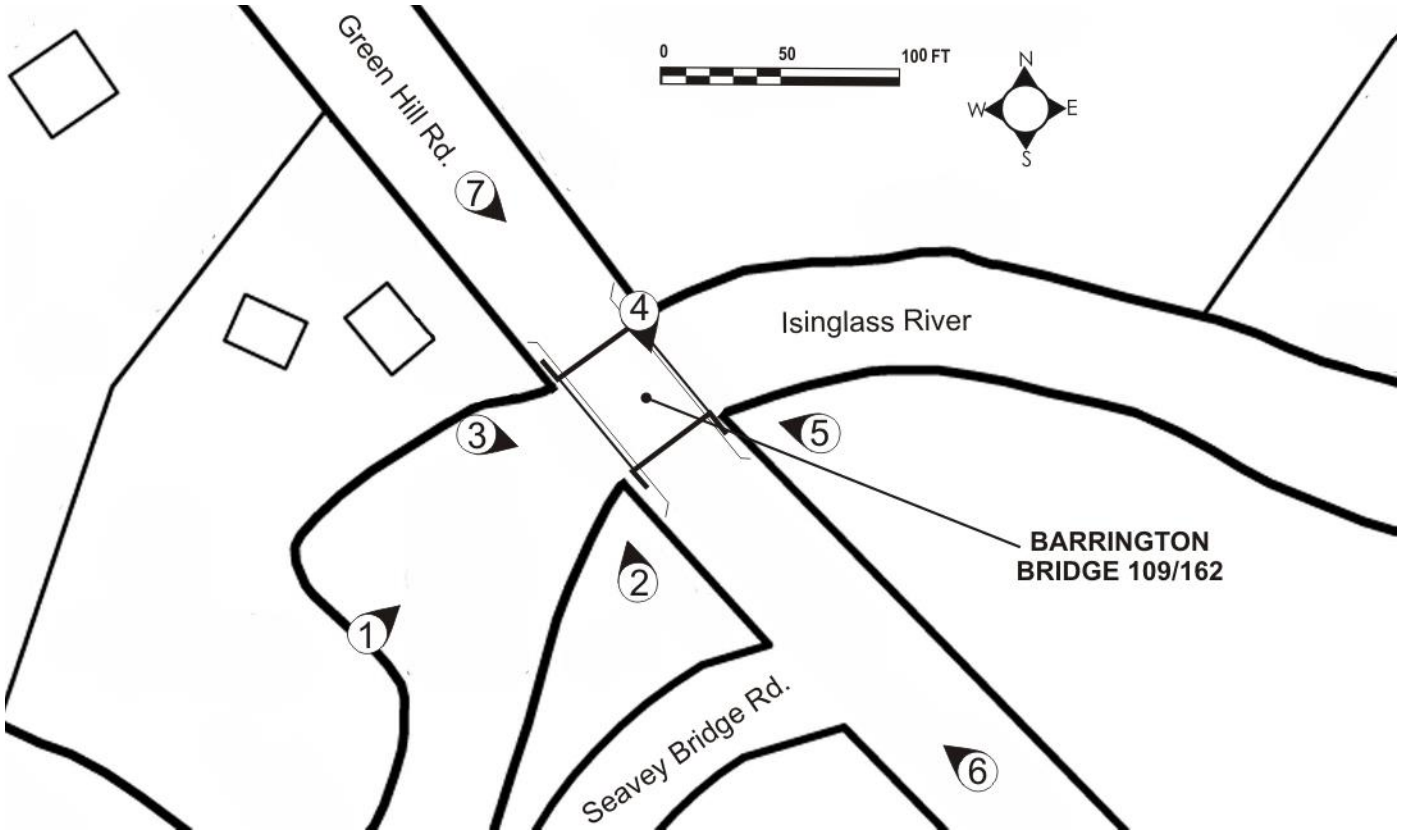
Form prepared by

32. Name: Richard M. Casella
33. Organization: Historic Documentation Company, Inc.
34. Date of Survey: Field: 12/22/2014 Report: 01/28/2015

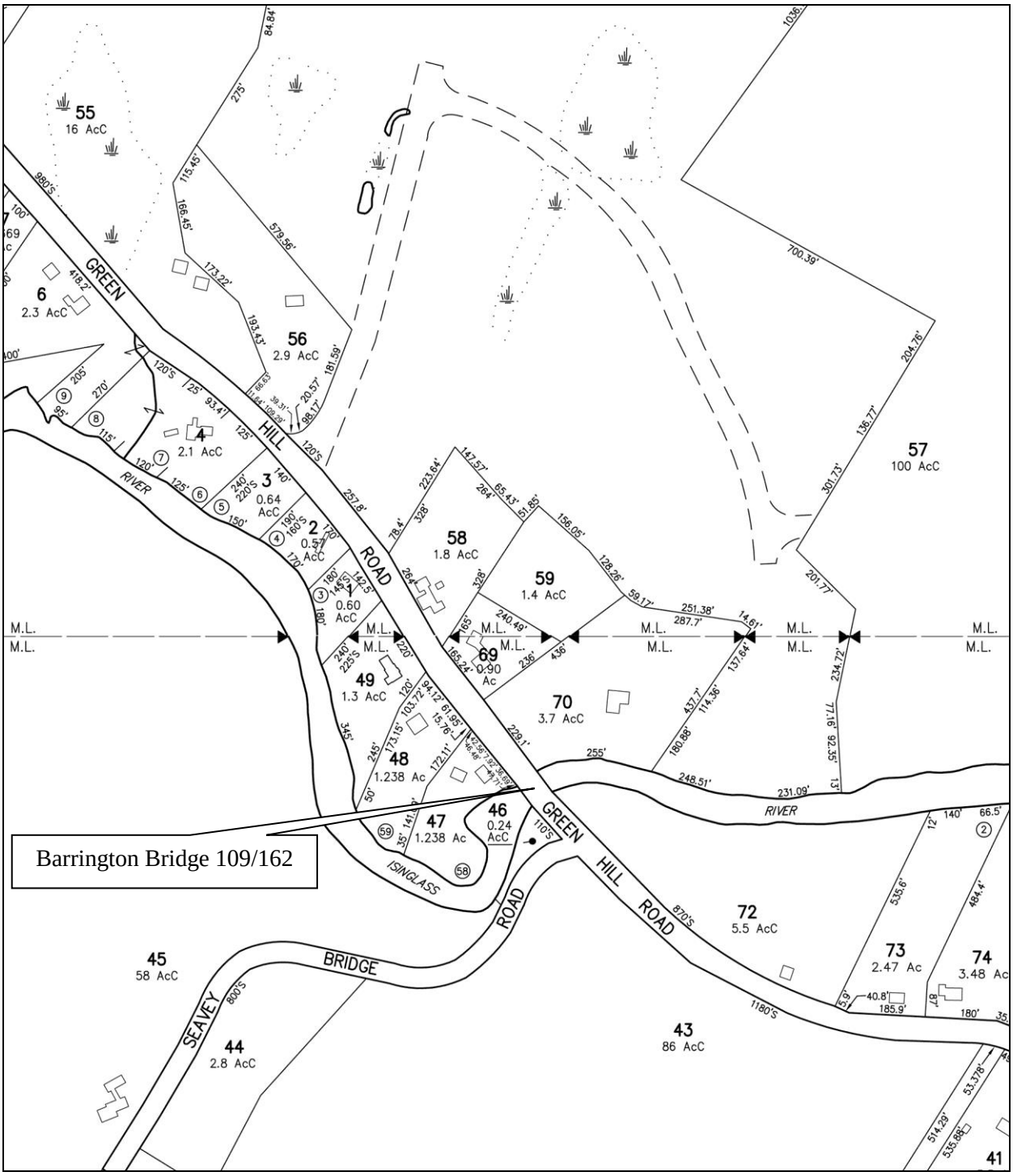
39. LOCATION MAP: USGS Quad: Barrington, NH 1995



40A. SITE SKETCH & KEY TO PHOTOS:



40B. TAX PARCEL PROPERTY MAP
(Source: http://www.barrington.nh.gov/Pages/BarringtonNH_Assessor/Taxmaps



41. Historical Background and Role in the Town or City's Development:

Barrington Bridge 109/162 carrying Green Hill Road over the Isinglass River was built in 1954-55 to replace an existing two-span wood stringer bridge known as Seavey Bridge, the original date of construction of which was not determined. The 1856 map shows the road crossing the river and three people by the name Seavey resided in the vicinity of the bridge (Figure 1). The 1892 map shows only a "J.C. Seavey" residing just north of bridge (Figure 2). No further information on the Seavey family was obtained. The NH Highway Department (NHHD) project card noted that Seavey Bridge consisted of one 32' and one 34' wood beam spans. The original bridge plans for the new bridge depict a stone pier in the middle of the river "to be removed" with the note "timber stringers in the existing structure to be salvaged to the Town of Barrington" (see Figure 5). A cursory search of the Town Reports and the histories of Barrington did not find any further information on the earlier wood stringer Seavey Bridge, however the Town Annual Report for 1955 provided the following detailed report on the new Seavey Bridge project:

REPORT ON THE SEAVEY BRIDGE

Estimated cost of Bridge was $22,000 later more soundings were taken which raised the state estimate to around $24,000.

The Town and State shares equaly up to $30,000, the State's share being not over $15,000.

No State workmen were available to build the bridge. and it was decided at a meeting with state officials to build by private contract.

The bids were opened Dec. 30, 1954. The lowest bidder was King and Jones Co. with a bid of $32,946.50.

Bids were much higher then estimated and all bids were rejected. It is hoped that some way will be found to either lower the cost of building, or that the bridge could be built later with state workmen.

THE STATE OF NEW HAMPSHIRE
DEPARTMENT OF PUBLIC WORKS
AND HIGHWAY

Project No. T-2787

Bids opened December 30, 1954 for construction of approximately 66 ft. Reinforced Concrete Slab Bridge on I-Beams with Approaches on the Town Road, near the Rochester Town Line, connecting N. H. Rt. 125 with U. S. Rt. 202, and about 1 mile west of the junction of N. H. 125 in the Town of Barrington, New Hampshire.

A. King & Jones Construction Co., 68 Mascoma St., Lebanon, N. H. $32,946.50

B. Charter Oak Construction Co., Inc., 525 Main St., Hartford, Conn. $33,062.50

C. Iafolla Construction Co., Inc., Peverly Hill Road, Portsmouth, N. H. $33,461.00

D. Harvey Construction Co., Inc., 450 Valley St., Manchester, N. H. $34,214.50

E. E. D. Swett, Inc., Winchester, N. H. $35,295.50

F. Daniels Construction Co., 3 Main St., W. Lebanon, N. H. $35,571.50

G. Curtis A. Mooney, Green St., Bristol, N. H. $40,853.00

H. Landers & Griffin Inc., 800 Islington St., Portsmouth, N. H. $45,489.05

We hereby certify that we have examined the town officers' accounts and find them properly vouched and correctly cast.

IRENE CALEF,
BERTHA ROSS,
Auditors

Jan. 18, 1954

The 1956 Town Report did not complete the story other than to note $8,000 paid to the Treasurer of New Hampshire for part payment of Seavey Bridge project. A NHHD Bridge Card was completed for Barrington Bridge 109/162 (no date on card) noting that the total cost of the project was $34,771.00 and that the bridge was ultimately built by the highway department forces. The state project number was T-2787; a total of 16 sheets of drawings were prepared for the bridge and regrading/realignment of the approaches (NHDOT File No. 3-4-4-2). The current bridge inspection report notes the bridge as "not rebuilt;" plans show that wood guardrails on the existing steel posts preceded the present steel W-type guardrails (date of installation unknown) evidently the only alteration made to the structure.

42. Applicable NHDHR Historic Contexts: 84. Automobile highways and culture, 1900-present.

43. Architectural Description and Comparative Evaluation:

Barrington 109/162 is a single span steel I-beam stringer bridge with a reinforced concrete deck that carries Green Hill Road over Isinglass River in Barrington, NH. The bridge is located about 1.25 miles northwest of the intersection of Green Hill Road with NH 125. The area surrounding the bridge is wooded and moderately developed with residences, none of which exhibit characteristics indicative of historical importance.

The bridge has a span of 62.0' and a total length of 66.0 feet. The deck height above the river is approximately 18 feet. The superstructure consists of three lines of steel wide flange stringers, 36" deep and weighing 194 pounds per linear foot. The stringers are spaced 7.0' on centers, tied with four lines of 12"x20# channel diaphragms and carried on rocker expansion bearings. The stringers carry a reinforced concrete deck 6.5" thick, with a curb width of 18.0' and overall width of 19.8 feet. The slab is topped with an asphalt wearing course. Concrete curbs, 8" high by 16" wide are cast monolithic with the deck. Bridge railings consist of one line of steel W-type guardrail bolted to 6" steel H-posts anchored in the curb. Original plans show the posts to be original, but the railing originally consisted of one line of 6"x8" treated timber rail.

The spans rest on reinforced concrete and stone abutments. Plans (see Figure 5) show the preexisting stone pier and stone north abutment removed. Note the preexisting north abutment and pier were both skewed relative to the south abutment. The new north concrete abutment is shown constructed in a new location closer to and in alignment with the south abutment. The existing stone south abutment is shown encased in concrete. The flanking stream-bank slopes are shown graded and armored with heavy riprap. The existing conditions however, differ from the plans: the riprap was not placed and stone from the pier and abutments was evidently salvaged and used in the construction of the abutments. It appears that the stone was used to build abutments on which reinforced concrete bridge seats were then cast. The stone was laid in Portland cement mortar joints indicative of mid-20th century granite masonry. This deviation from the original plans was probably a cost savings measure undertaken by the highway department who ultimately constructed the bridge after contractor bids exceeded the construction budget (as noted in Historical Background section above).

Bridge Technology & Comparative Discussion

The history of the steel stringer bridge and its application in New Hampshire has been studied extensively through the preparation of many NHDHR Individual Inventory Forms, HAER, and NH Historic Property Documentations. The reader is referred to those reports filed at NHDHR for photographs and comparative discussion of other examples. Reference is given to the sample of Individual Inventory Forms shown in Table 1 below, all of which resulted in a finding of Not Eligible for the National Register by the NHDHR Determination of Eligibility Committee.

TABLE 1: Examples of New Hampshire I-Beam Stringer Bridges (IB-C) Inventoried & Found Not Eligible

NH Bridge #.	*DHR Form # - Date*	*Bridge Date*	*No. of IB Spans*	*Max Span Length*	*Abutment Type*
New Boston 064/056	NWB0008 - 2008	1940	1	60.0'	-
Newbury 138/072	NBR0007 - 2009	1929	1	38.0"	1 conc; 1 stone with conc. cap
Canaan 123/126	CAN0017 - 2009	1930	1	60.0'	-
Lee 063/045	LEE0007 - 2009	1935	1	33.0'	-
Bradford 098/114	BRA0017 – 2009	1950	1	17.0'	conc.
Winchester 133/163	WIN0021 - 2010	1940/1982	1	24.0'	conc.
Canaan 178/141	CAN0018 – 2010	1950	1	40.0'	-
Sunapee 094/100)	SUN0008 - 2011	1919	1	23.0'	stone with conc. caps
Sandwich 203/138	SWH0010 – 2011	1953	1	42.0'	-
Ossipee 152/268	OSS0029 - 2012	1950	1	58.0'	conc. on pilings
Antrim 184/071	ANT0009 – 2012	1946	1	70.0'	-
Lebanon 066/059	LEB0018 - 2013;	1953	2	31.5'	conc.
Lebanon 192/128	LEB0019 - 2013	1938	1	60.0'	1 conc; 1 stone with conc. cap
Tamworth 150/106	TAM0021 - 2014	1955	1	71.0'	conc. pier & abutments
Stewartstown 121/114	STE0037 - 2014	1940	1	38.0'	stone, conc. encased

44. National or State Register Criteria Statement of Significance:

Barrington Bridge 109/162 is not associated with events important to the broad patterns of our history. It was built in 1955 to replace the preceding timber stringer bridge of unknown age. The bridge crossing dates to the first half of the 19th century but the current bridge lacks characteristics that can be associated with the original crossing, with earlier bridges at the site[1] or with activities in the area important to the local history. The bridge is therefore not eligible for the National Register under Criteria A.

Barrington 109/162 consists of a single simple 62' I-beam stringer span with concrete deck carried on concrete and stone masonry abutments. It is of standardized design and does not possess important architectural or engineering characteristics of its type, period, or method of construction. It does not differ technologically in any important way from the hundreds of other examples of the type in NH. The bridge type is of a bridge type exempt from NHPA Section 106 review pursuant to the Advisory Council on Historic Preservation Program Comment for Common Post-1945 Concrete and Steel Bridges. The bridge was designed and built by the NHHD (Dept. of Public Works and Highways at that time). Plans indicate Robert J. Prowse and Harold E. Langley collaborated on the design. The two were noted engineers in the history of the NHHD, both ultimately serving as (chief) Bridge Engineer for the department. In addition to notable bridge designs for which Langley and Prowse were individually responsible, they also collaborated during the 1950s on several atypical continuous beam bridge designs of note.[2] As a simple bridge that followed standard specifications and details, Barrington Bridge 109/162 does not possess important design characteristics that would make it an important example of the work for which Langley and Prowse were noted for. The bridge is therefore not eligible for the National Register under Criteria C.

45. Period of Significance: N/A

46. Statement of Integrity: The property retains integrity of location, setting, association, feeling, design, materials and workmanship. The removal of the original wood guardrail and replacement with steel guardrail slightly diminished the integrity of the original design and materials.

47. Boundary Discussion: The boundary of the property is defined by the physical limits of the bridge and its abutments.

48. Bibliography and/or References: Also see footnote & caption citations.

Chase, J. *Map of Rockingham County New Hampshire*. Philadelphia: Smith & Coffin, 1857.

Hurd, D. H. *Town and County Atlas of the State of New Hampshire.* Philadelphia: D. H. Hurd & Co. 1892.

NHDOT Bridge Card, Inspection Files and Plan Files. Filed at NHDOT, Bridge Design, Concord.

Wiggin, Morton H. *A History of Barrington, NH 1966.* Copyright Joan Wiggin.

Surveyor's Evaluation:

NR listed:	individual	_____	NR eligible:		NR Criteria:	A	____
	within district	_____	individual	____		B	_____
			within district	____		C	_____
Integrity:	yes	__X__	not eligible	_X___		D	_____
	no	__ __	more info needed	____		E	_____

[1] The apparent random reuse of stone from the earlier bridge to construct the abutments does not constitute a historical association of importance; the integrity of the original masonry work has been lost.
[2] See "Ossipee Bridge 137/297, NH 16 & 25 over Bearcamp River" NHDHR Inventory # OSS0030, 2012. Filed at NHDHR, Concord.

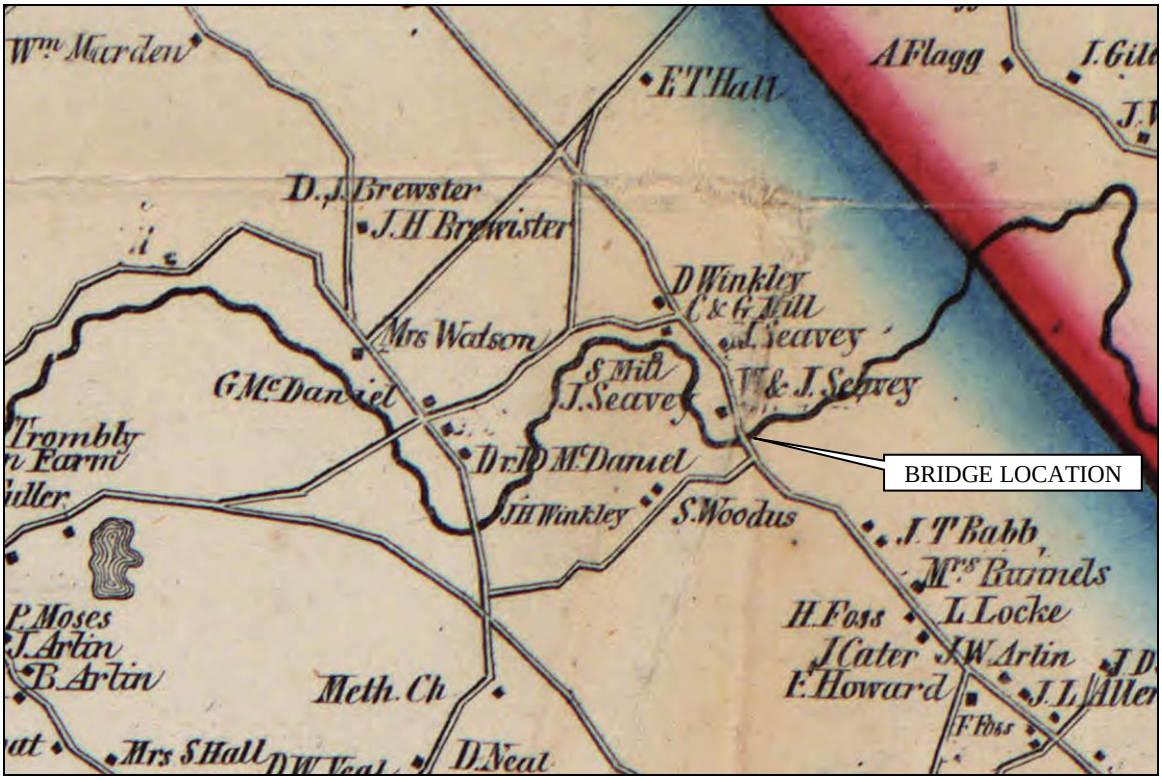


FIGURE 1: Chase 1856 Map, showing three Seavey's in vicinity of bridge.

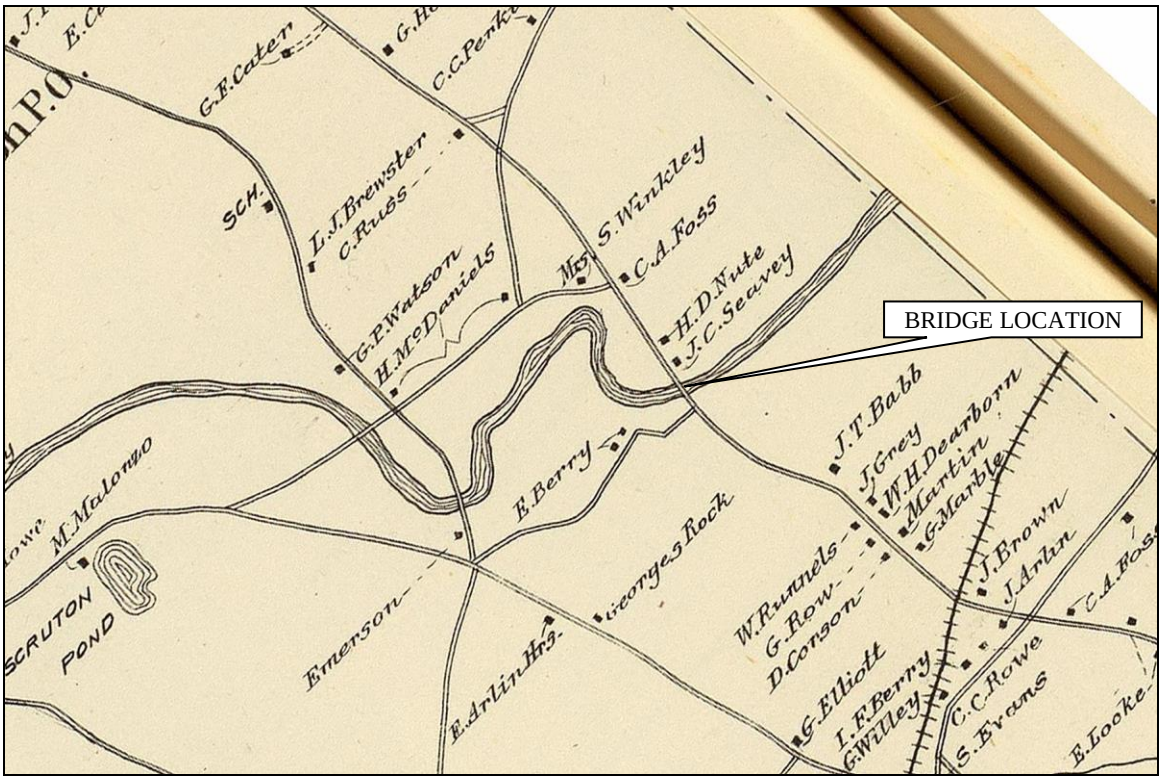


FIGURE 2: Hurd 1892 Map showing "J.C. Seavey" residing north of bridge.

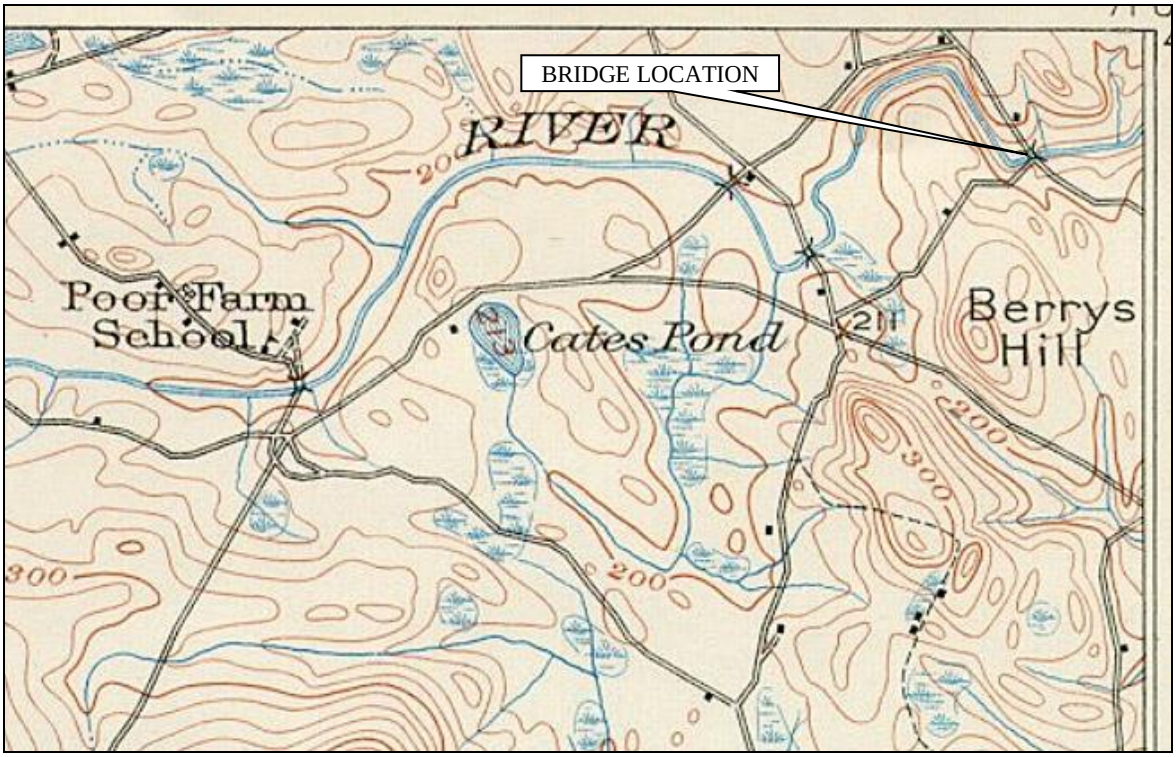


FIGURE 3: Topographical Map, 1919, showing conditions (Source: USGS Mt. Pawtuckaway NH Quadrangle, 1919).

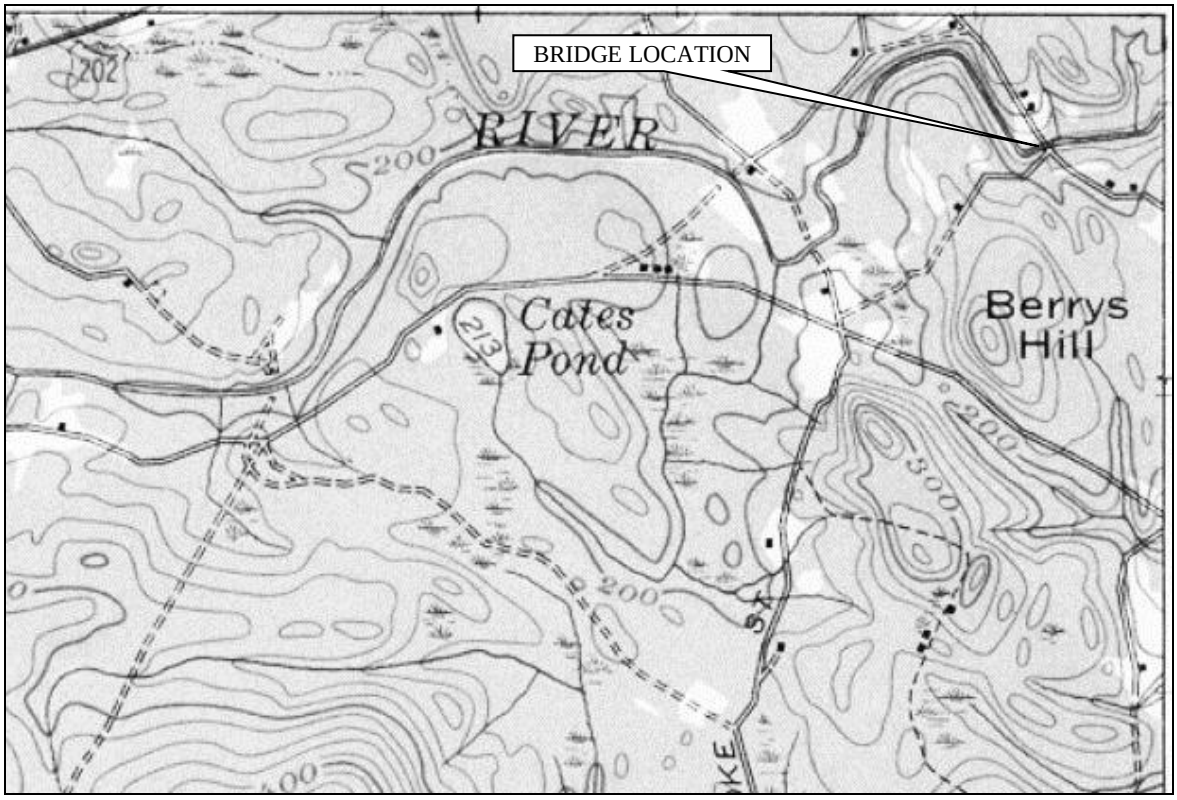


FIGURE 4: Topographical Map, 1957, showing conditions (Source: USGS Mt. Pawtuckaway NH Quadrangle, 1957).

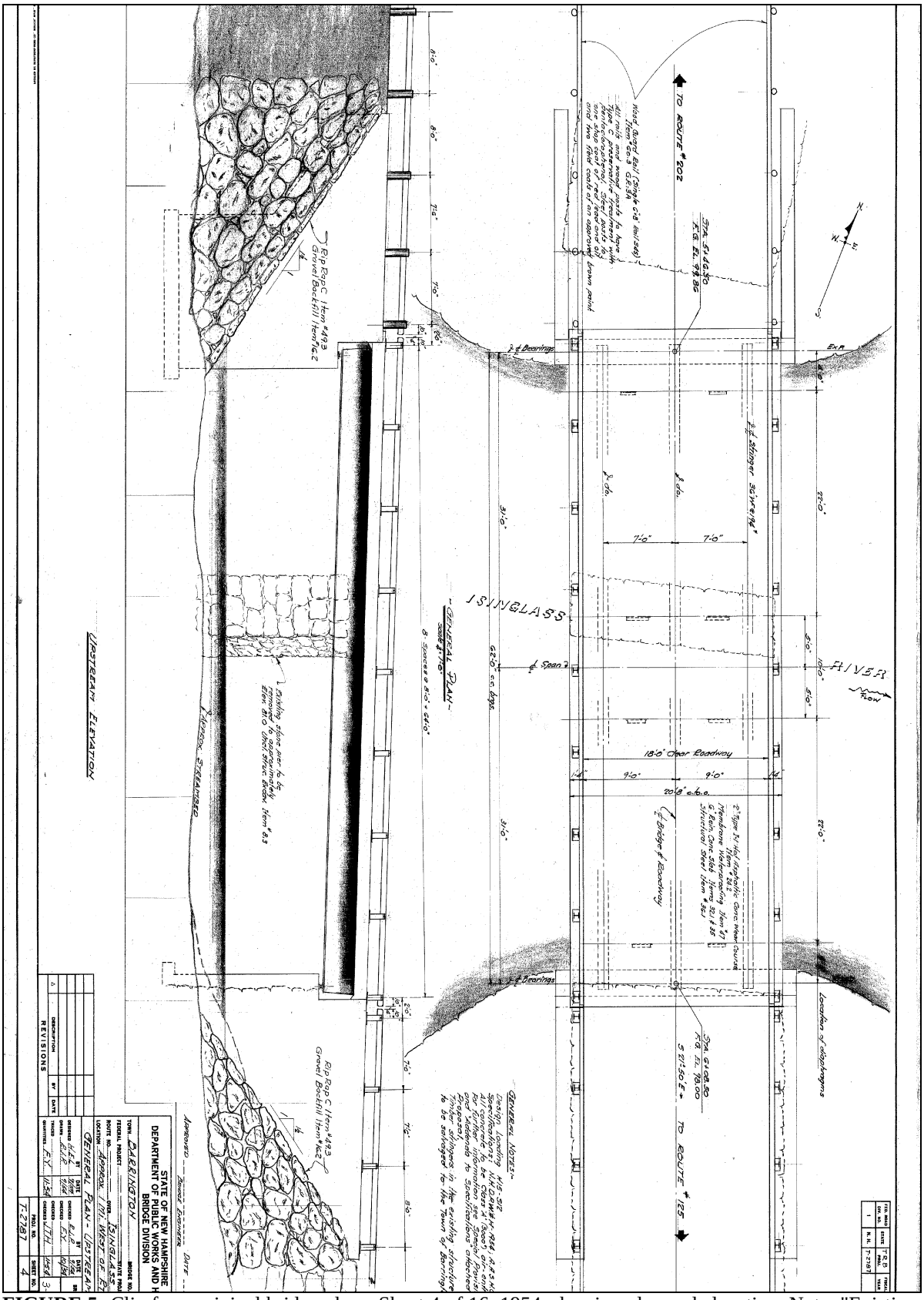


FIGURE 5: Clip from original bridge plans, Sheet 4 of 16, 1954, showing plan and elevation. Note: "Existing stone pier to be removed" from two span wood stringer bridge being replaced, stone apparently reused to face abutments; rip rap as shown not placed (Source: NHDOT Bridge Plan File No. 3-4-4-2).

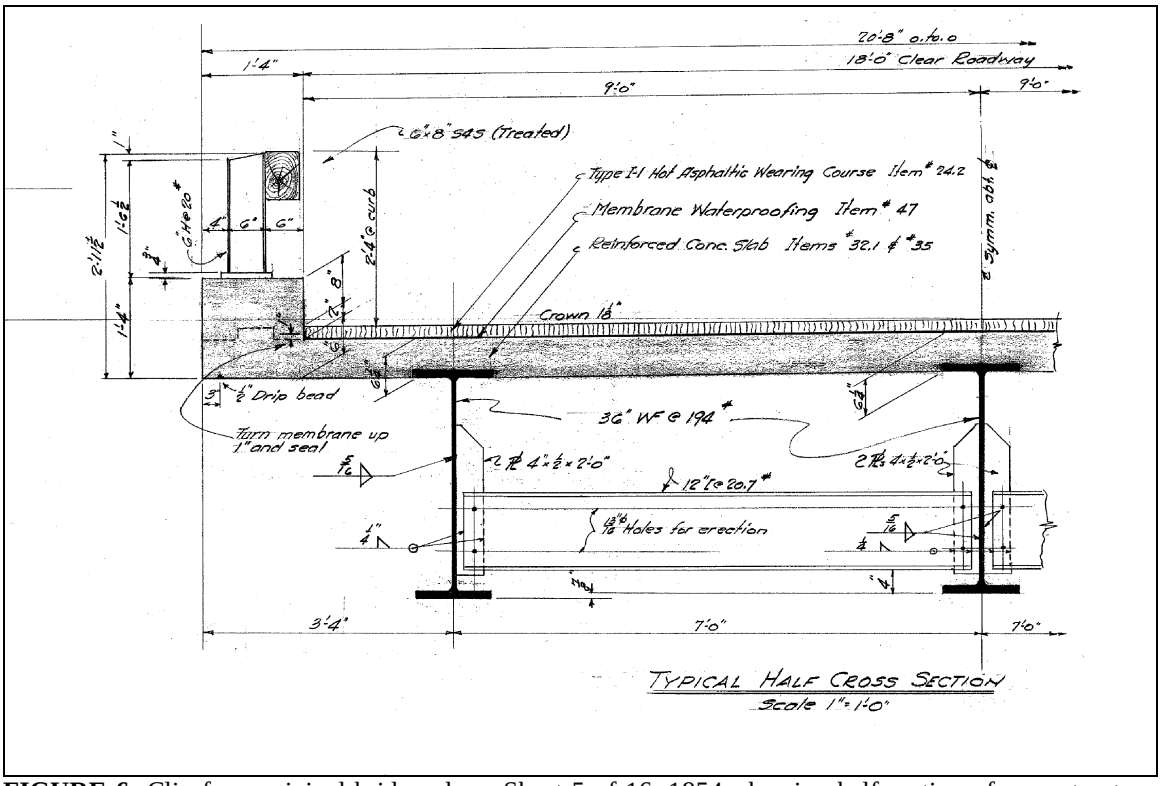


FIGURE 6: Clip from original bridge plans, Sheet 5 of 16, 1954, showing half section of superstructure (Source: NHDOT Bridge Plan File No. 3-4-4-2).

Date photos taken: 22 December 2014

Photo :#	2	Description: Oblique view of upstream side showing concrete abutments cast on existing stone abutments.

Reference (file name or frame #): BRR0008_002 Direction: N

Date photos taken: 22 December 2014

Photo :#	3	Description: North abutment.

Reference (file name or frame #): BRR0008_003 Direction: E

Date photos taken: 22 December 2014

Photo :#	4	Description: South abutment and underside of deck showing three deck stringers.

Reference (file name or frame #): BRR0008_004 Direction: S

Date photos taken: 22 December 2014

Photo :#	5	Description: Railing, deck and south abutment, downstream side (east)

Reference (file name or frame #): BRR0008_005 Direction: W

Date photos taken: 22 December 2014

Photo :#	6	Description: Bridge approach and roadway view from south

Reference (file name or frame #): BRR0008_006 Direction: NW

Date photos taken: 22 December 2014

Photo :#	7	Description: Bridge approach and roadway view from north

Reference (file name or frame #): BRR0008_007 Direction: SE

PHOTO KEY IS LOCATED ON PAGE_2__

I, the undersigned, confirm that the photos in this inventory form have not been digitally manipulated and that they conform to the standards set forth in the NHDHR Photo Policy. These photos were printed at the following commercial printer OR were printed using the following printer, ink, and paper: CVS, Fall River, MA.
(Color photos must be professionally printed.)
The negatives or digital files are housed at/with: _Historic Documentation Company, Inc., 490 Water St., Portsmouth, RI 02871

SIGNED:

FOR STATE REGISTER LISTING ONLY!
If this inventory form is being submitted for consideration of New Hampshire State Register listing, have you included:

____ a photo CD with digital images included in the nomination (does not apply if film photography was used)

____ the State Register Contact Information sheet

APPENDIX H

Greenhill Rd / Isinglass River Bridge Closure: Traffic Re-routing and Travel Times

Greenhill Rd / Isinglass River Bridge Closure: Traffic Re-routing and Travel Times

Details

SRPC staff visually compared routes that looked fairly direct then tested each in Google Maps to determine the four with the quickest travel times per Google's algorithms.

Notes:

- Resident routes were mapped as if travelers were heading for the Greenhill Rd. intersection with either US-202 or NH-125, from immediately adjacent to the bridge site on either the south or north bank (respectively) of the river.
- Emergency routes were similarly mapped to a point adjacent to the bridge site.
- Berry Rd. was not used in any analyses because A) Google does not recognize it as connecting Greenhill Rd. and Scruton Pond Rd. and B) aerial imagery shows much of the length to be a narrow, unimproved dirt track not suitable for through traffic.

Resident Route A: South of the Isinglass to the US-202 / Greenhill Rd. intersection

Original Route: Greenhill Rd.	*1.7 miles, 3 min.*
Route A: Greenhill Rd. to NH-125 N to Flagg Rd. to Hansonville Rd to Greenhill Rd.	5.4 miles, 11 min.
Route B: Greenhill Rd. to NH-125 N to Gear Rd. to Dry Hill Rd. to US-202 W	5.9 miles, 11min.
Route C: Greenhill Rd. to NH-125 S to Scruton Pond Rd. to US-202 E	7.1 miles, 13 min.
Route D: Greenhill Rd. to NH-125 S to NH-9 W to NH-126 N to US-202 E	9.7 miles, 15 min

Resident Route B: North of the Isinglass to the NH-125 / Greenhill Rd. intersection

Original Route: Greenhill Rd.	*0.9 miles, 2 min.*
Route A: Greenhill Rd. to Hansonville Rd. to Flagg Rd. to NH-125 S	4.2 miles, 8 min.
Route B: Greenhill Rd. to Hansonville Rd. to Gear Rd. to NH-125 S	4.8 miles, 9 min.
Route C: Greenhill Rd. to US-202 W to Scruton Pond Rd. to NH-125 N	7.9 miles, 15 min.
Route D: Greenhill Rd. to US-202 W to NH-126 S to NH-9 E to NH-125 N	10.5 miles, 16 min.

Barrington Public Safety Complex to South of the Isinglass

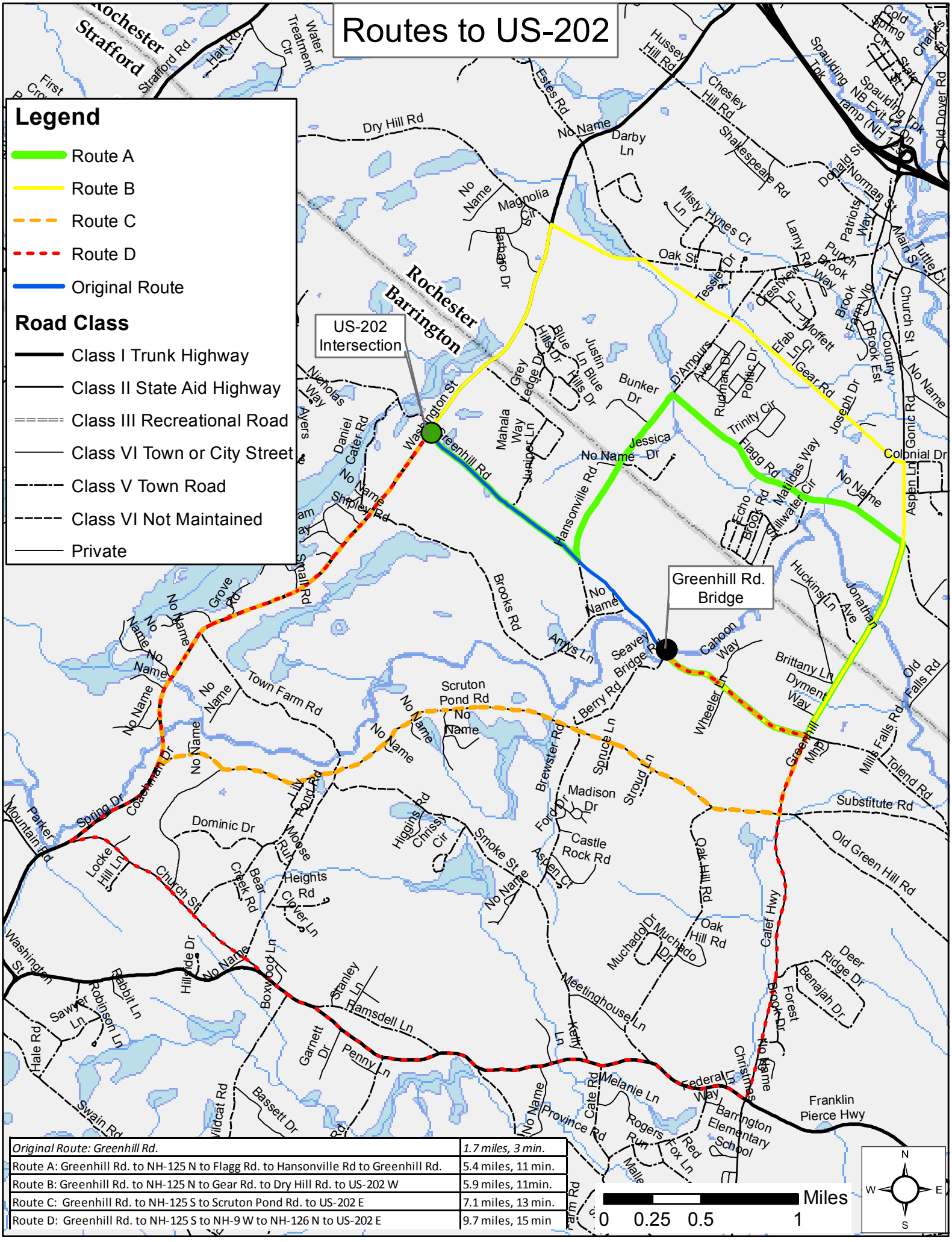
Original Route: NH-9 E to NH-125 N to Greenhill Rd.	3.7 miles, 6 min.
Not impacted by bridge closure	

Barrington Public Safety Complex to North of the Isinglass

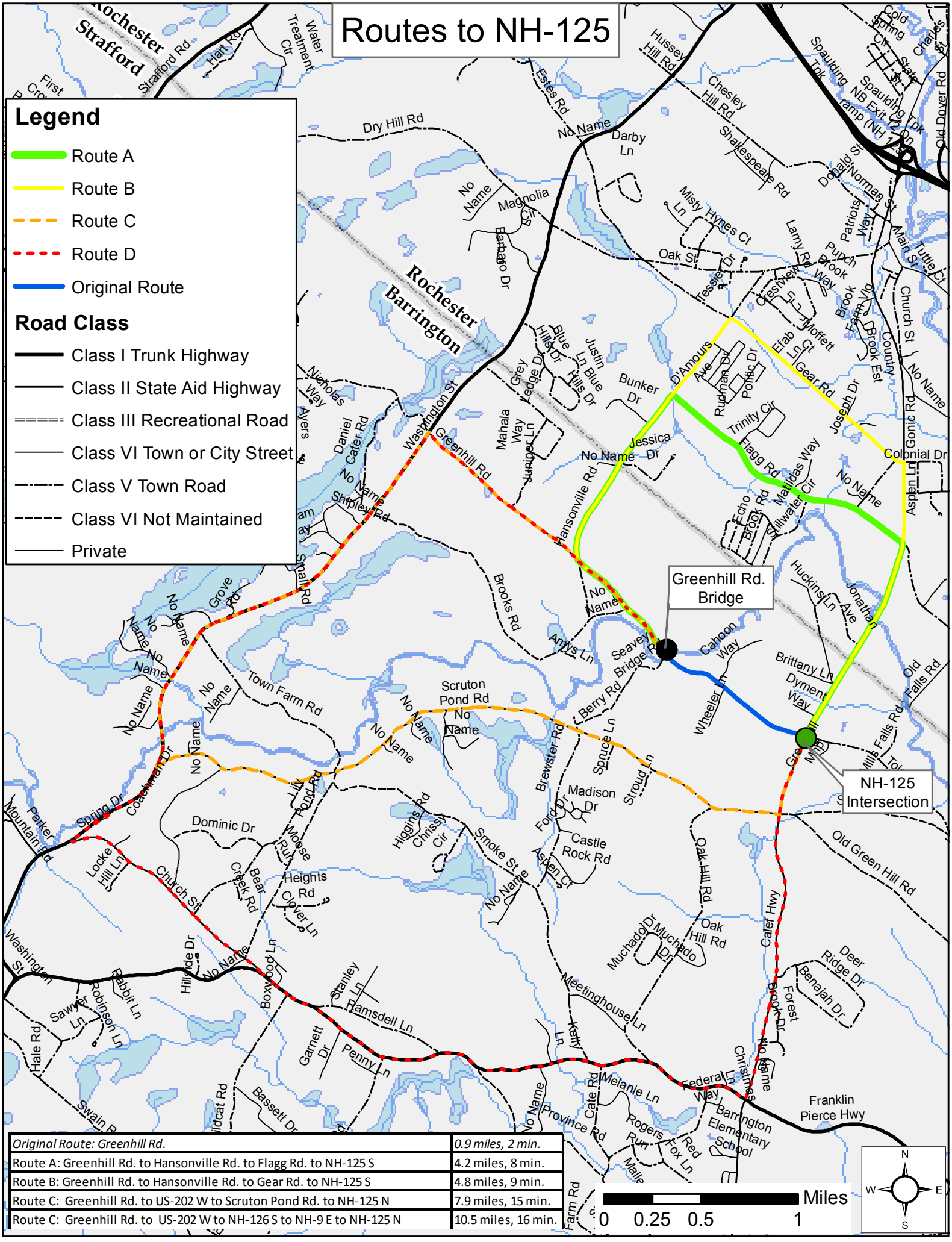
Original Route: NH-9 E to NH-125 N to Greenhill Rd.	3.7 miles, 6 min.
Route A: NH-9 E to NH-125 N to Flagg Rd. to Hansonville Rd. to Greenhill Rd.	7.0 miles, 12 min.
Route B: NH-9 W to NH-126 to US-202 to Greenhill Rd.	7.7 miles, 12 min.
Route C: NH-9 E to NH-125 N to Gear Rd. to Hansonville Rd. to Greenhill Rd.	7.6 miles, 13 min.
Route D: Smoke St. to Scruton Pond Rd. to US-202 E to Greenhill Rd.	7.2 miles, 14 min.

Rochester Gonic Fire Station to North of the Isinglass

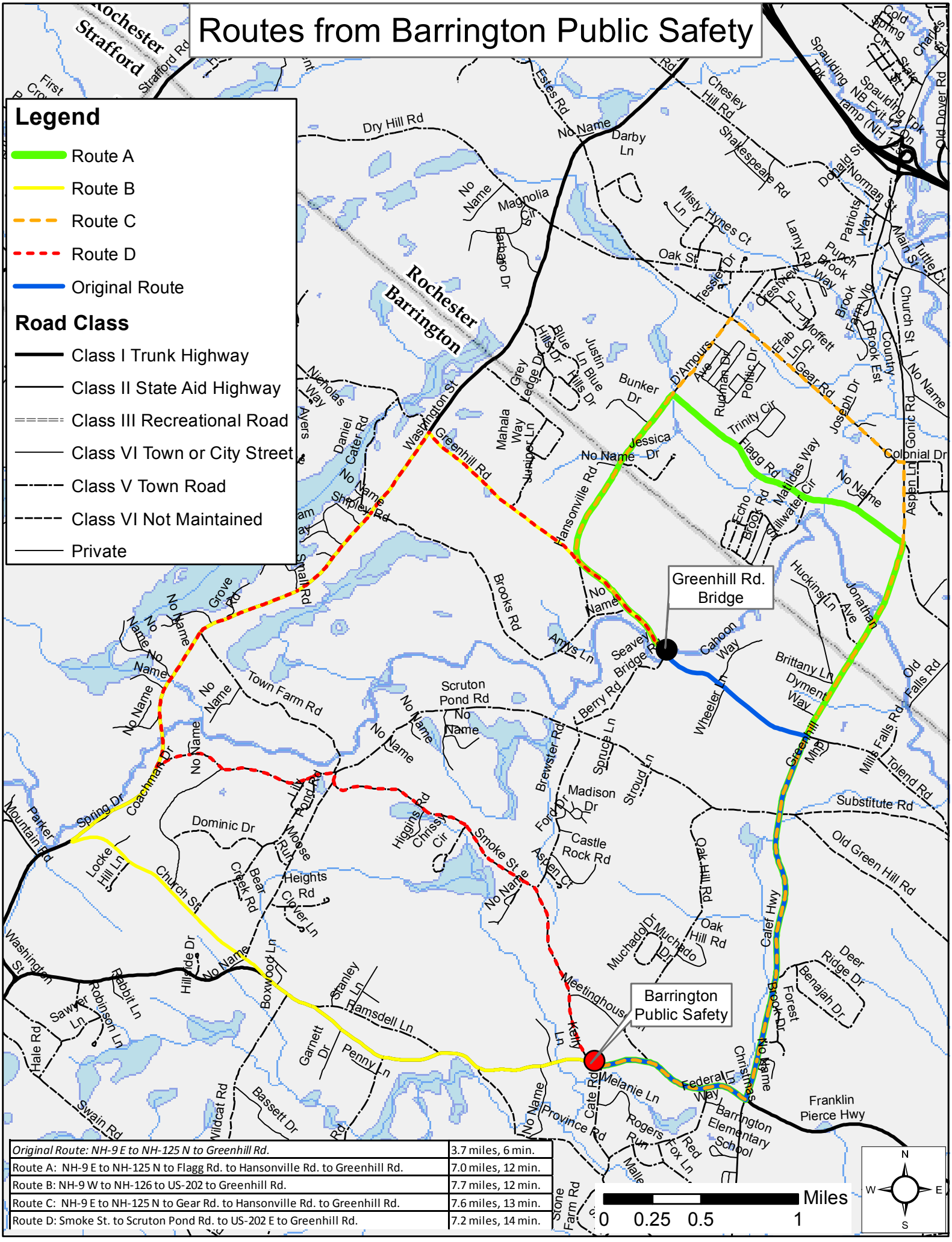
Original Route: NH-125 N to Greenhill Rd.	3.7 miles, 6 min.
Route A: NH-125 S to Oak St. to Hansonville Rd. to Greenhill Rd.	3.1 miles, 7 min.
Route B: NH-125 S to Oak St. to Dry Hill Rd to US-202 W to Greenhill Rd.	4.8 miles, 8 min.
Route C: NH-125 S to Gear Rd. to Hansonville Rd. to Greenhill Rd.	4.5 miles, 9 min.
Route D: Grove St. / Chesley Hill Rd. to US-202 W to Greenhill Rd.	5.3 miles, 10 min.



Original Route: Greenhill Rd.	*1.7 miles, 3 min.*
Route A: Greenhill Rd. to NH-125 N to Flagg Rd. to Hansonville Rd to Greenhill Rd.	5.4 miles, 11 min.
Route B: Greenhill Rd. to NH-125 N to Gear Rd. to Dry Hill Rd. to US-202 W	5.9 miles, 11min.
Route C: Greenhill Rd. to NH-125 S to Scruton Pond Rd. to US-202 E	7.1 miles, 13 min.
Route D: Greenhill Rd. to NH-125 S to NH-9 W to NH-126 N to US-202 E	9.7 miles, 15 min

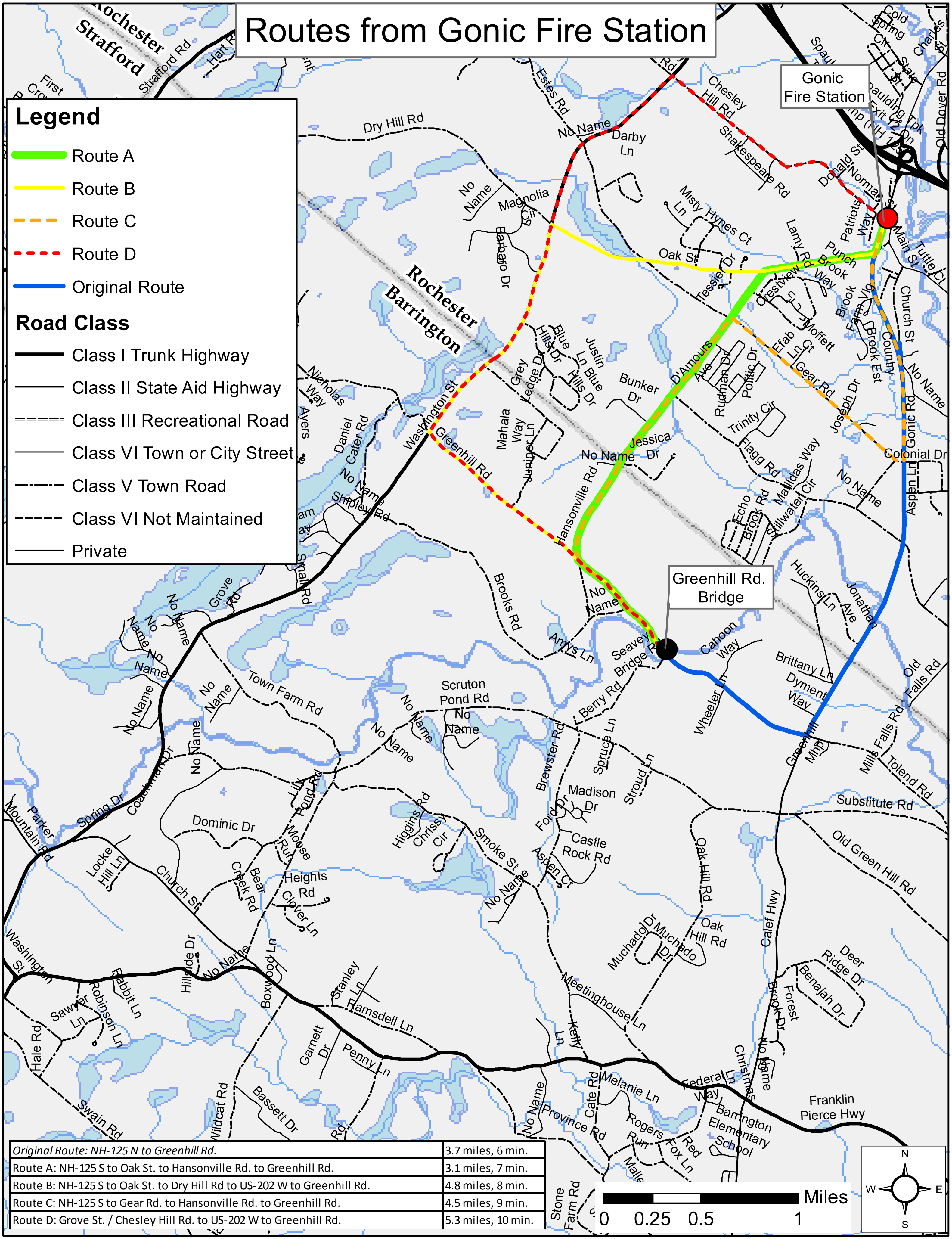


Original Route: Greenhill Rd.	*0.9 miles, 2 min.*
Route A: Greenhill Rd. to Hansonville Rd. to Flagg Rd. to NH-125 S	4.2 miles, 8 min.
Route B: Greenhill Rd. to Hansonville Rd. to Gear Rd. to NH-125 S	4.8 miles, 9 min.
Route C: Greenhill Rd. to US-202 W to Scruton Pond Rd. to NH-125 N	7.9 miles, 15 min.
Route C: Greenhill Rd. to US-202 W to NH-126 S to NH-9 E to NH-125 N	10.5 miles, 16 min.



Original Route: NH-9 E to NH-125 N to Greenhill Rd.	3.7 miles, 6 min.
Route A: NH-9 E to NH-125 N to Flagg Rd. to Hansonville Rd. to Greenhill Rd.	7.0 miles, 12 min.
Route B: NH-9 W to NH-126 to US-202 to Greenhill Rd.	7.7 miles, 12 min.
Route C: NH-9 E to NH-125 N to Gear Rd. to Hansonville Rd. to Greenhill Rd.	7.6 miles, 13 min.
Route D: Smoke St. to Scruton Pond Rd. to US-202 E to Greenhill Rd.	7.2 miles, 14 min.

Routes from Gonic Fire Station



Original Route: NH-125 N to Greenhill Rd.	3.7 miles, 6 min.
Route A: NH-125 S to Oak St. to Hansonville Rd. to Greenhill Rd.	3.1 miles, 7 min.
Route B: NH-125 S to Oak St. to Dry Hill Rd to US-202 W to Greenhill Rd.	4.8 miles, 8 min.
Route C: NH-125 S to Gear Rd. to Hansonville Rd. to Greenhill Rd.	4.5 miles, 9 min.
Route D: Grove St. / Chesley Hill Rd. to US-202 W to Greenhill Rd.	5.3 miles, 10 min.

APPENDIX I

Wetlands Report

TES Environmental Consultants, LLC

WETLANDS STUDY

GREEN HILL ROAD OVER THE ISINGLASS RIVER
BARRINGTON, NEW HAMPSHIRE

Prepared for:

Sandford Surveying and Engineering, Inc.
597 New Boston Road
Bedford, NH 03110

Prepared by:

TES Environmental Consultants, L.L.C.
1494 Route 3A, Unit 1
Bow, NH 03304

April 10, 2015

INTRODUCTION

TES Environmental Consultants, L.L.C. (TES) has prepared this report to document the physical and biological characteristics of the wetlands in the vicinity of the bridge (NHDOT Bridge No. 109/162) on Green Hill Road at the crossing of the Isinglass River in Barrington, New Hampshire. These observations are provided in support of the Survey Scope of Services related to the proposed replacement of the bridge.

On-site investigations were performed by TES on May 8, 2014 to delineate and flag the boundaries of wetland resources, and to characterize the wetland habitats present at the site in order to classify the wetlands in accordance with the U.S Fish and Wildlife Service's Wetlands and Deepwater Habitats Classification system (Cowardin et al., 1979). The wetland delineation was performed according to the standards of the Corps of Engineers Wetland Delineation Manual and the Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Northcentral and Northeast Region, Version 2.0, January 2012, US Army Corps of Engineers.

Follow-up reviews of existing published information from the sources listed below were then performed, and a wetlands functions and values assessment was performed in accordance with the U.S. Army Corps of Engineers Highway Methodology Supplement (USACE New England District 1999).

The following existing information sources were reviewed for the subject site:

- USGS Barrington – NH Quadrangle topographic map
- US Army Corps of Engineers The Highway Methodology Workbook – Supplement
- Aerial photographs from Google Earth and other sources
- USDA-NRCS Soil Survey of Strafford County, New Hampshire (via Web Soil Survey)
- National Wetlands Inventory map
- NH Natural Heritage Program Datacheck Program
- Isinglass River Local Advisory Committee web site

SITE CHARACTERIZATION

The Green Hill Road bridge (NHDOT Bridge No. 109/162 – see Figures 1 and 2) over the Isinglass River in Barrington is a steel-girder span supported by stone-block abutments on the north and south sides of the crossing. Berry Road (aka Seavey Bridge Road), a local gravel-surfaced road, extends westward from Green Hill Road approximately 200 feet south of the bridge. Residential development exists on both sides of Green Hill Road to the north of the bridge, and relatively undisturbed forest extends along both sides of Green Hill Road for over 500 feet to the south of the bridge.

The Isinglass River at the bridge is a free-flowing perennial stream approximately 60 feet wide, narrowing slightly downstream of the bridge and widening to the upstream side, where a "cove"

exists outside of the River channel on the north side (Figure 3). The River averaged approximately 1-2 feet in depth on the May 8 site visit, which was below bank-full level but of typical or slightly below expected flow level for mid-Spring. The River has steep, wooded banks to the north and south on both the upstream and downstream sides of the bridge, which drop to much lower banks on the south side of the River approximately 100 feet to the southeast of the bridge (Figure 4). The forest along the northeast side of the bridge is a fringe less than 50 feet wide adjacent to a house and barn to the north. Footpaths extend along the southern shores of the River east and west of the bridge.

A forested wetland drainageway extends roughly north to south on both sides of Green Hill Road approximately 400 feet south of the bridge, passing through a culvert under the road (Figure 5). A similar forested wetland drainageway contributes to the River from the north approximately 100 feet to the east of the bridge (Figure 6). Both of these wetlands were delineated on May 8, 2014, as were the banks of the Isinglass River extending from 250 feet upstream of Green Hill Road to 150 feet downstream from the bridge. Two shallow ditches along Berry Road within 100 feet of Green Hill Road were found to not qualify as wetlands subject to state and federal jurisdiction, since it does not qualify as a watercourse under New Hampshire wetlands rules (Env Wt 101.107) and is not contiguous to another wetland or surface water.

The U.S. Fish and Wildlife Service classification (per Cowardin et al., 1979) of each of these wetlands is presented below.

- Isinglass River: Riverine, Upper Perennial, Unconsolidated Bottom, Cobble-Gravel, Permanently Flooded (R3UB1H)
- Forested wetland both sides of Green Hill Road 400 feet south of Isinglass River bridge: Palustrine, Forested, Broad-leaved Deciduous, Seasonally Flooded (PFO1C)
- Forested wetland north of Isinglass River approximately 10 feet east of Green Hill Road bridge: Palustrine, Forested, Broad-leaved Deciduous, Seasonally Flooded (PFO1C)

Wetlands

Wetland resources at the Green Hill Road bridge site at the Isinglass River were delineated and flagged in the field as described above, and subsequently located by field survey for accurate depiction on site plans. River Bank formed the majority of the resource boundaries along the River, except for the forested swamp that contributes to the River from the north, approximately 100 feet east of the bridge. Forested swamp was also located within the survey area approximately 400 feet south of the bridge, extending from south of Green Hill Road through a culvert to the north side, and eventually contributing to the Isinglass River several hundred feet east of the bridge.

Forests along the banks of the Isinglass River are a mix of deciduous and evergreen tree species, including red oak (*Quercus rubra*), white ash (*Fraxinus americana*), shagbark hickory (*Carya ovata*), white pine (*Pinus strobus*), and eastern hemlock (*Tsuga canadensis*). Shrub and ground cover are well-established in most areas along the river banks, although foot traffic along the southern side of the river west of the bridge has worn away vegetation to bare soil in places.

The freshwater wetland 400 feet south of the bridge has a canopy of mostly red maple (*Acer rubrum*) and green ash (*Fraxinus pensylvanica*) and ground cover of Canada mayflower (*Maianthemum canadense*) and twisted stalk (*Streptopus roseus*). The forested drainage that contributes to the Isinglass River approximately 100 feet east of the bridge has similar vegetation, as well as skunk cabbage (*Symplocarpus foetidus*), false hellebore (*Veratrum viride*), and sedges (*Carex* spp.).

The Isinglass River is a "Designated River" in accordance with RSA 483, The Rivers Management & Protection Act, and is therefore managed and protected for its outstanding natural and cultural resources.

No portions of any of the wetland resources in the vicinity of the Green Hill Road bridge over the Isinglass River consist of vernal pools.

Invasive Plant Species

The vicinity of the Green Hill Road bridge over the Isinglass River was investigated for the presence of invasive plants identified in the New Hampshire Department of Transportation (NHDOT) Best Management Practices for Roadside Invasive Plants. No invasive plants identified in that publication were observed along Green Hill Road or along the banks of the River.

WETLAND FUNCTIONAL ASSESSMENT METHODOLOGY

Wetland functions and their significance were evaluated using the US Army Corps Highway Methodology guidelines. The following is a list of the 14 wetland functions and values with a brief description of each.

1. **(1&2) Groundwater recharge/discharge:** This function considers the potential for a wetland to serve as a groundwater recharge and/or discharge area. Recharge should relate to the potential for the wetland to contribute water to an aquifer. Discharge should relate to the potential for the wetland to serve as an area where ground water can be discharged to the surface.
2. **Floodflow Alteration:** This function considers the effectiveness of the wetland in reducing flood damage by attenuation of floodwaters for prolonged periods following precipitation events.
3. **Fish and Shellfish Habitat:** This function considers the effectiveness of seasonal or permanent water bodies associated with the wetland in question for fish and shell fish habitat.
4. **Sediment/Toxicant/Pathogen Retention:** This function reduces or prevents degradation of water quality. It relates to the effectiveness of the wetland as a trap for sediments, toxicants or pathogens.

5. **Nutrient Removal/Retention/Transformation:** This function relates to the effectiveness of the wetland to prevent adverse effects of excess nutrients entering aquifers or surface waters such as ponds, lakes, streams, rivers or estuaries.
6. **Production Export:** This function relates to the effectiveness of the wetland to produce food or usable products for humans or other living organisms.
7. **Sediment/Shoreline Stabilization:** This function relates to the effectiveness of a wetland to stabilize stream banks and shorelines against erosion.
8. **Wildlife Habitat:** This function considers the effectiveness of the wetland to provide habitat for various types and populations of animals typically associated with wetlands and the wetland edge. Both resident and or migrating species must be considered.
9. **Recreation:** This value considers the effectiveness of the wetland and associated watercourses to provide recreational opportunities such as canoeing, boating, fishing, hunting and other active or passive recreational activities. Consumptive opportunities consume or diminish the plants, animals or other resources that are intrinsic to the wetland, whereas non-consumptive opportunities do not.
10. **Educational/Scientific Value:** This value considers the effectiveness of the wetland as a site for an "outdoor classroom" or as a location for scientific study or research.
11. **Uniqueness/Heritage:** This value relates to the effectiveness of the wetland or its associated water bodies to produce certain special values. Special values may include such things as archeological sites, unusual aesthetic quality, historical events, or unique plants, animals, or geological features.
12. **Visual Quality/Aesthetics:** This value relates to the visual and aesthetic qualities of the wetland.
13. **Threatened or Endangered Species Habitat:** This value relates to the effectiveness of the wetland or associated water bodies to support threatened or endangered species.

Wetland Functions and Values

The wetland system associated with the Isinglass River consists primarily of the River itself, and the forested drainageway tributaries described previously. The River is a relatively undisturbed habitat with high water quality and ample recreational opportunities. The New Hampshire Fish and Game Department stocks trout in the River, and ample evidence of fishing activity was observed along the banks on May 8, 2014. In general, the Isinglass is a high quality waterway that rates high for several wetland functions and values, as described in more detail in the following sections.

Moderate and High-Rated Functions and Values:

Groundwater recharge/discharge. This function considers the potential for a wetland to serve as a groundwater recharge and/or discharge area. Recharge should relate to the potential for the wetland to contribute water to an aquifer. Discharge should relate to the potential for the wetland to serve as an area where ground water can be discharged to the surface. The Isinglass River in the vicinity of the Green Hill Road bridge is situated within an area that is shown on the USDA-NRCS soils mapping for Strafford County as Hollis-Charleton rocky fine sandy loam (HdC), a complex of glacial till soils and soils having bedrock near the surface. Such soils are

typically associated more with groundwater discharge than recharge, indicating that this area is not an aquifer. However, the potential for downstream water use by municipalities or private users is high due to the apparent high quality of surface water in the River, and therefore the Isinglass in this vicinity is rated moderate to high for these functions.

Fish and Shellfish Habitat. This function considers the effectiveness of seasonal or permanent water bodies or waterways associated with the subject wetland for fish and shellfish habitat. The Isinglass River is a perennial stream known to be habitat for trout, which require cool, high-quality water, as it is stocked with trout by the New Hampshire Fish and Game Department. Other species of fish also inhabit the River, and no obstructions to fish passage exist downgradient from the bridge to the Cocheco River in Rochester, or upstream to the outlet of Bow Lake in Northwood. Therefore, the potential for this section of the river to function as fish habitat is high.

Production Export. This function relates to the effectiveness of the wetland to produce food or usable products for humans or other living organisms. The section of the Isinglass River in the vicinity of the Green Hill Road bridge does not itself produce high levels of organic detritus supportive of downgradient ecosystems, but it conveys some remnants of vegetation from its large watershed, which has significant organic production potential. This production is conveyed downstream eventually to Cocheco River in Rochester, and from there to the Piscataqua River in Dover. As a result of this potentially important role in production export, this resource was rated as moderate to high in regards to this function.

Wildlife Habitat. This function considers the effectiveness of the wetland to provide habitat for various types and populations of animals (both resident and or migratory) typically associated with wetlands and the wetland edge. The Isinglass River, a perennial stream with high water quality and light disturbance along the majority of its length, provides significant habitat and a movement corridor for a wide variety of wildlife, including waterfowl and other birds, aquatic and terrestrial mammals, reptiles and amphibians. Therefore, the River rates high for the wildlife habitat function.

Recreation. This value considers the effectiveness of the wetland and associated watercourses to provide recreational opportunities such as canoeing, boating, fishing, hunting and other active or passive recreational activities. Public access to the Isinglass River is available at the Green Hill Road bridge, with off-road parking on both sides of the road to the south of the bridge. Footpaths along the southern shore of the River extend both east and west of the bridge, and connect to additional trails to the west. Evidence of frequent fishing activity (footpaths, fishing debris) is present near the bridge, and launching of canoes and kayaks is possible at the site. Passive recreation such as bird watching and other observation of nature is also possible at the site. For all these reasons, the Isinglass River at the Green Hill Road bridge is considered to rate highly for recreation.

Educational/Scientific Value. This value considers the effectiveness of a wetland as a site for an "outdoor classroom" or as a location for scientific study or research. Visual accessibility at the bridge is excellent, and there are educational opportunities related to nature present at the

site, especially given the availability of off-road parking. Therefore, the Isinglass River at the Green Hill Road bridge is considered to rate highly for this value.

Uniqueness/Heritage: This value relates to the effectiveness of the wetland or its associated water bodies to produce certain special values. Special values may include such things as archeological sites, unusual aesthetic quality, historical events, or unique plants, animals, or geological features. The Isinglass River at the Green Hill Road bridge is a prominent feature of the natural landscape, and the vistas provided are of a small but relatively undisturbed perennial stream surrounded by forest. Although no noteworthy historical or archeological significance such as old mills, dams, or related structures is known to be associated with this site, the views of the River and largely undeveloped surroundings are somewhat unusual within a generally well-developed region in the state, and contribute to the moderate rating determined for this value.

Visual Quality/Aesthetics. This value relates to the visual and aesthetic qualities of the wetland. For reasons of good visual access to attractive views of a nearly undisturbed perennial stream surrounded mostly by forest habitat, the Isinglass River at the Green Hill Road bridge is rated high for visual quality and aesthetics.

Threatened or Endangered Species Habitat. This value relates to the effectiveness of the wetland or associated water bodies to support threatened or endangered species. The New Hampshire Natural Heritage Program's Datacheck web program was accessed to check for known occurrences of rare or endangered species of animals or plants, or exemplary natural communities in the vicinity of the Green Hill Road bridge over the Isinglass River. The result of this search, which identifies all such known rare species or habitats within one mile from a given location, indicated the potential for the existence of such resources in the vicinity (see attached printout from the datacheck). This outcome does not indicate that a project will impact such rare species or habitats, but that they are nearby, and an evaluation of potential project impacts would need to be further evaluated. As a result of this outcome and the parameters of the Highway Methodology, this function is evaluated as high for this vicinity.

Low-Rated Functions and Values:

Floodflow Alteration. This function considers the effectiveness of the wetland in reducing flood damage by attenuation of floodwaters for prolonged periods following precipitation events. The Isinglass River and associated wetlands in the vicinity of the Green Hill Road bridge have little ability to mitigate floodwaters due to the continuous gradient of the River and the lack of low-lying areas capable of retaining surface waters and preventing property damage. As a result the River and associated wetlands in this location have a low rating for floodflow alteration.

Sediment/Toxicant/Pathogen Retention. This function reduces or prevents degradation of water quality. It relates to the effectiveness of the wetland as a trap for sediments, toxicants or pathogens. The Isinglass River in this location has little ability to retain sediment, toxicants and pathogens since it has a continuous grade, and stream flow is high enough to prevent settling of fine sediment and associated contaminants. In addition, there are no wetlands along the banks of

the River capable of receiving flow from the River and retaining sediment and contaminants. Therefore, the Isinglass River rates low for this function.

Nutrient Removal/Retention/Transformation. This function relates to the effectiveness of the wetland to prevent adverse effects of excess nutrients entering aquifers or surface waters such as ponds, lakes, streams, rivers or estuaries. As with sediment /toxicant/pathogen retention, the Isinglass River in this location has little ability to remove, retain and transform nutrients due to its continuous grade, stream flow rates, and lack of wetlands at or just above stream flow levels. Therefore this wetland complex is considered to have a low ability for nutrient removal/ retention/transformation.

Sediment/Shoreline Stabilization. This function relates to the effectiveness of a wetland to stabilize stream banks and shorelines against erosion. In general, this function is intended to reflect the importance of a wetland in protecting the banks of a water body or waterway. The Isinglass River in this location has upland banks rather than wetlands, and therefore this wetland function is absent.

SCALE 1:24000

0 1000 2000

YARDS

FIGURE 1
Green Hill Road Bridge over the Isinglass River, Upstream Side,
View East from Northwest River Bank (5/8/2014)

FIGURE 2
Green Hill Road Bridge over the Isinglass River, Downstream Side,
View West from Southeast River Bank (5/8/2014)

1494 Route 3A, Unit 1 Bow, NH 03304 Phone 856-8925
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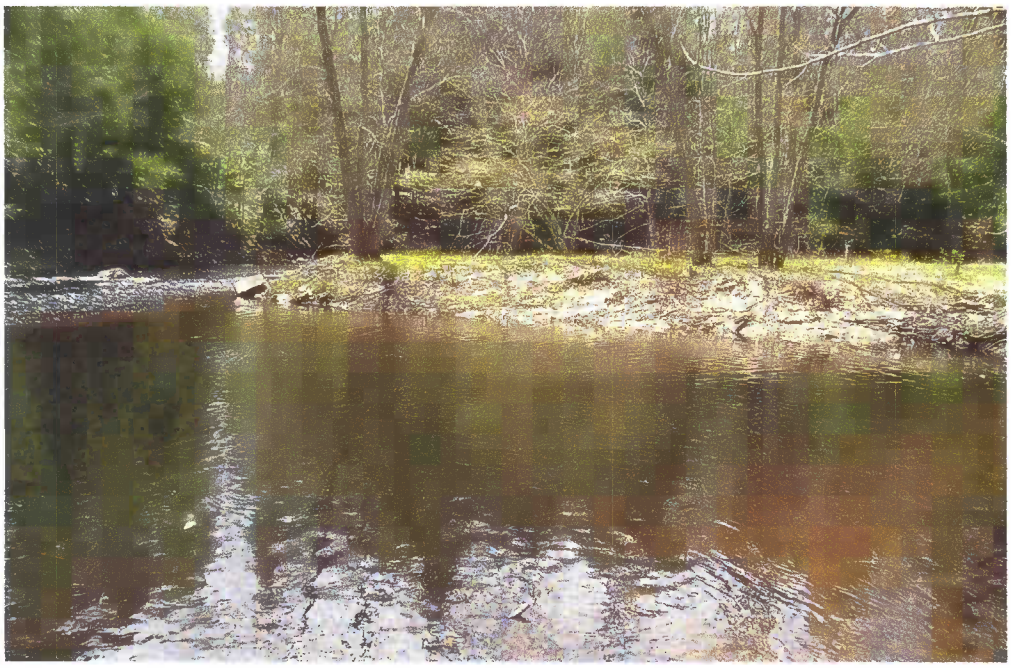

FIGURE 3
Shallow Cove Outside Isinglass River Channel Northwest of Green Hill Road Bridge (5/8/2014)

FIGURE 4
Lower Bank (to Left) along Isinglass River to the Southeast of the Green Hill Road Bridge, and Steep Opposite Bank (to Right) (5/8/2014)

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FIGURE 5
Outlet from Forested Drainageway to Culvert under Green Hill Road, Approximately 400 feet South of Isinglass River Bridge (5/8/2014)

FIGURE 6
Outlet from Forested Drainageway Towards North Bank of Isinglass River, Approximately 100 feet East of Green Hill Road Bridge (5/8/2014)

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Wetland Function-Value Evaluation Form

Total area of wetland Indefinite Human made? No Is wetland part of a wildlife corridor? Yes or a "habitat island"? No

Adjacent land use Forest, residential Distance to nearest roadway or other development 0 feet

Dominant wetland systems present Riverine Contiguous undeveloped buffer zone present No

Is the wetland a separate hydraulic system? No If not, where does the wetland lie in the drainage basin? Upper perennial

How many tributaries contribute to the wetland? 20+/- Wildlife & vegetation diversity/abundance (see attached list)

Wetland I.D. Isinglass River

Latitude 43.24618 Longitude -71.00382

Prepared by: TES Date 4/10/15

Wetland Impact:
Type TBD Area TBD

Evaluation based on:
Office ✓ Field ✓

Corps manual wetland delineation completed? Y ✓ N

Function/Value	Occurence Y	Occurence N	Rationale (Reference #)*	Principal Function(s)/Value(s)	Comments
Groundwater Recharge/Discharge	✓		1,2,5,6,7,11,12	✓	Discharge expected; high water quality; soils do not support recharge.
Floodflow Alteration		✓	13		Stream gradient, lack of flood storage areas.
Fish and Shellfish Habitat	✓		1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17	✓	Perennial stream, high water quality, forested bank, trout stocked.
Sediment/Toxicant Retention		✓	1,6,8,9,10		High stream flow, unvegetated channel, no fine/organic soils.
Nutrient Removal		✓	2,4		High stream flow, unvegetated channel, no fine/organic soils.
Production Export	✓		1,3,4,5,6,10		Export of production from large watershed, not from wetland vegetation.
Sediment/Shoreline Stabilization		✓	1,2,3,6,8,9,14		Upland, rather than wetland, vegetation form river bank.
Wildlife Habitat	✓		1,2,3,6,8,12,17,19	✓	River provides habitat and wildlife corridor; high water quality.
Recreation	✓		2,4,5,6,7,8,9,10,11,12	✓	Active and passive recreational use facilitated and occurring.
Educational Scientific Value	✓		1,2,5,8,11	✓	Off-road parking, accessible, nature study/outdoor class potential.
Uniqueness/Heritage	✓		3,7,11,13,14,16,17,18,22,27,30	✓	Unusually undisturbed river and corridor in highly developed region.
Visual Quality/Aesthetics	✓		2,3,6,8,9,11,12	✓	Visually appealing stream/forest setting; accessible.
ES Endangered Species Habitat	✓		1	✓	NH NHP Datacheck indicates potential habitat or exemplary natural community in vicinity.
Other					

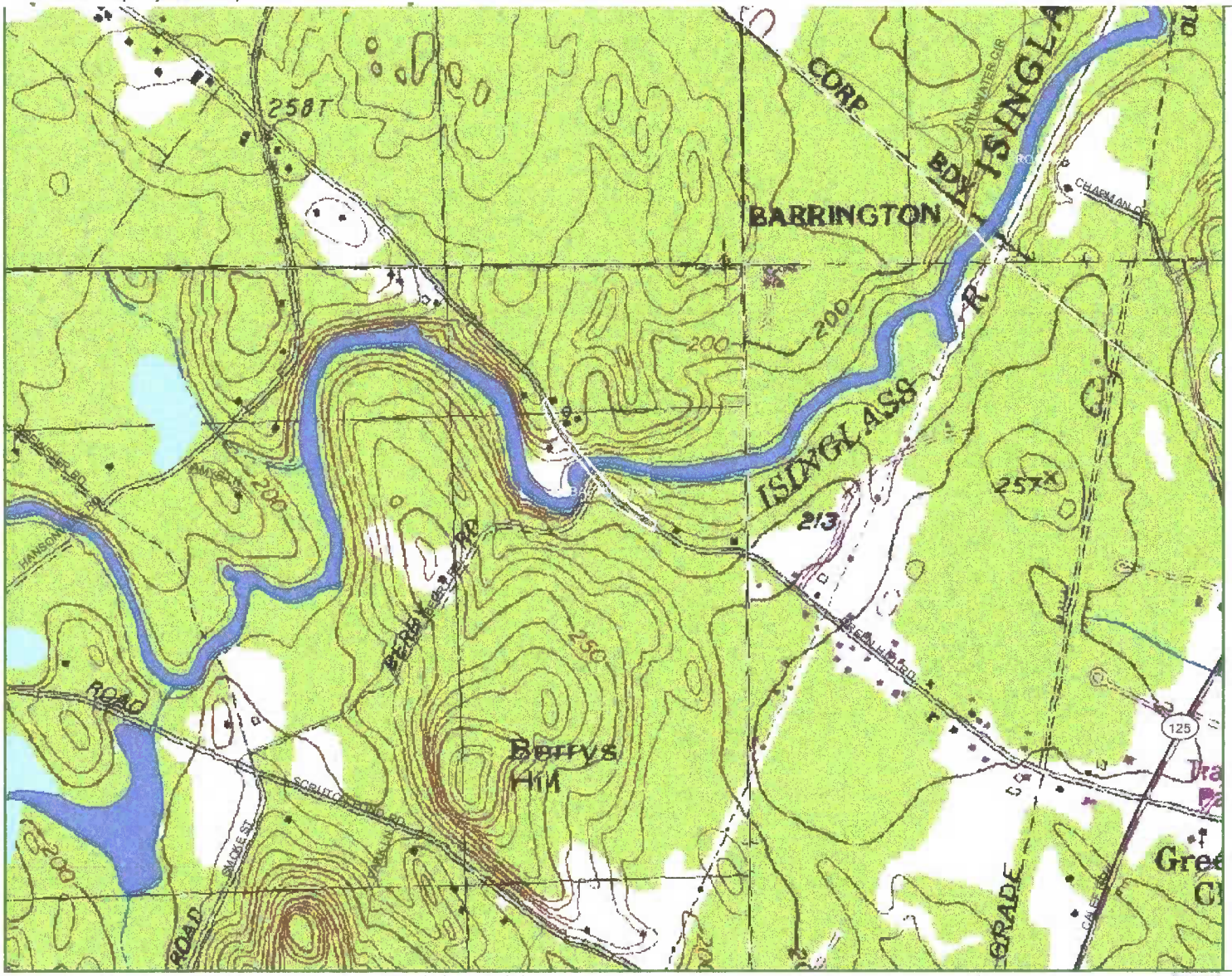
Notes:

* Refer to back up list of numbered considerations.

NHB DataCheck Tool: Map Project

Natural Heritage Bureau

On Click: Map Project Boundary



Map X: Map Y: Map Scale = 1:10,373

Quit

Map Project Boundary

Mapped area: 1.48 acres
Reported tract area: 1.5 acres

DataCheck Results: POTENTIAL IMPACTS

There are NHB records in the vicinity of the area you drew that may be affected by this project.

To obtain an official letter to include in your permit application or funding request, please click on "Continue" below to provide additional information about the project.

Continue Remap Cancel

APPENDIX J

Glossary

GLOSSARY

The following glossary is provided to assist the reader with this report. Not all terms provided herein have necessarily been used in the context of the report.

AASHTO: American Association of State Highway & Transportation Officials

Abutment: The outermost end supports on a bridge, which carry the load from deck to ground.

Annual Average Daily Traffic (AADT): The total volume passing a point or segment of a highway facility in both directions for one year, divided by the number of days in the year.

Approach: The part of the bridge that carries traffic from the land to the main parts of the bridge.

Approach Span: The span or spans connecting the abutment with the main span or spans.

Beam: A rigid, usually horizontal, member whose primary function is to carry a transverse load, i.e., a load that causes bending.

Beam Bridge: A bridge built of beams, either classified as a short-span or long-span beam bridge, whose ends rest on piers or abutments.

Bearing: A device at the ends of beams that is placed on top of a pier or abutment. The ends of the beam rest on the bearing.

Bedrock: The solid rock layer beneath sand, silt or clay.

Box Girder Bridge: A box girder bridge is a bridge where the main beams comprise girders in the shape of a hollow box. The box girder normally comprises either prestressed concrete, structural steel, or a composite of steel and reinforced concrete. The box is typically rectangular or trapezoidal in cross-section. Box girder bridges are commonly used for highway flyovers and for modern elevated structures of light rail transport. Although normally the box girder bridge is a form of beam bridge, box girders may also be used on cable-stayed bridges and other forms.

Bridge Condition Ratings: Through periodic safety inspections, data is collected on the condition of the primary components of a structure. Condition ratings, based on a scale of 0-9, are collected for the following components of a bridge. A condition rating of 4 or less on one of the following item classifies a bridge as structurally deficient.

Camber: A positive, upward curve built into a beam or truss that compensates for some of the vertical load and anticipated deflection.

Cantilever: A projecting beam or member supported only on one end.

Cast-in-Place: Concrete poured within formwork on site to create a structural element in its final position.

Cofferdam: A watertight temporary structure used in bridge building to keep water away from an area that has been pumped dry. It is used to create a dry section of a water body, allowing construction of bridge foundations unimpeded by water.

Compression: The stress resulting from a pushing force on a member, which tends to shorten it (the opposite of tension).

Compression Member: An engineering term that describes a timber or other truss member that is subjected to squeezing or pushing. Also see tension member.

Condition Ratings: According to the National Bridge Inspection Standards (NBIS), condition ratings are used to describe an existing bridge or culvert compared with its condition if it were new. The ratings are based on the materials, physical condition of the deck (riding surface), the superstructure (supports immediately beneath the driving surface), and the substructures (foundation and supporting posts and piers). General condition ratings range from 0 (failed condition) to 9 (excellent).

Continuous Span Beam Bridge: A simple bridge made by linking one beam bridge to another; some of the longest bridges in the world are continuous span beam bridges.

Crown: On road surfaces, where the center is the highest point and the surface slopes downward in opposite directions, assisting in drainage. Also a point at the top of an arch.

Concrete: A mixture of stone, sand, cement, and water that hardens into a stone like substance.

Dead Load: The weight of a structure itself, including the weight of fixtures or equipment permanently attached to it.

Deck: The roadway portion of a bridge, including shoulders. Most bridge decks are constructed as reinforced concrete slabs, but timber decks are still seen in rural areas and open-grid steel decks are used in some movable bridge designs.

Deck Bridge: A bridge in which the supporting members are all beneath the roadway.

Deck Plate Girder: A plate girder bridge is a bridge supported by two or more plate girders. The plate girders are typically I-beams made up from separate structural steel plates (rather than rolled as a single cross-section), which are welded (or occasionally bolted or riveted) together to form the vertical web and horizontal flanges of the beam. In some cases, the plate girders may be formed in a Z-shape rather than I-shape.

Deflection: The displacement of a structural member or system under load.

Diaphragm: Bracing that spans between the main beams or girders of a bridge or viaduct and assists in the distribution of loads.

Diversion Channel: A bypass created to divert water around a structure so that construction can take place.

Environmental Impact Statement (EIS): A comprehensive study of potential social, economic and environmental impacts related to a federally-assisted project. Projects for which an EIS is required are defined in the National Environmental Policy Act of 1969, as amended.

Expansion Joints: Metal framework around a narrow opening, which allows for the change in length of the bridge due to temperature change.

Fascia: The visible, exterior face of a structure, usually superstructure. Examples are the exterior beam of a structure may be called the fascia beam.

Fatigue: Cause of structural deficiencies, usually due to repetitive loading over time.

Fill: Earth, stone or other material used to raise the ground level, form an embankment or fill the inside of an abutment, pier or closed spandrel.

Fixed-span Bridge: A bridge without a movable, or draw, span.

Flanges: The upper and lower parts of an "I" shaped beam or girder.

Floor Beam: Horizontal members that are placed transversely to the major beams, girders or trusses; used to support the deck.

Footing: The bottom portion of an abutment or pier, which is usually wider than the stem of the abutment or pier transmit bridge loads to the ground.

Forms: Temporary structures or molds made of wood, metal, or plastic used when placing concrete to ensure that it is shaped to its desired final form.

Formwork: A total system of support for freshly placed concrete, including the mold and all supporting members, hardware, and necessary bracing. Formwork must be strong enough to support the considerable weight and pressure of wet concrete without bending or breaking.

Fracture-Critical: A fracture-critical bridge is one that does not contain redundant supporting elements. This means that if those key supports fail, the bridge would be in danger of collapse. This *does not* mean the bridge is inherently unsafe, only that there is a lack of redundancy in its design.

Full-Depth Replacement of Concrete Deck: A technique used to restore the structural integrity and rideability of distressed concrete pavement. It involves removing the deteriorated concrete down to the base, repairing the base, and refilling the excavated area with new concrete. Full-depth replacement is a particularly effective technique for pavement repairs near joints and cracks. By removing and replacing isolated areas of deterioration, pavement can be restored close to its original condition.

Functionally Obsolete: A functionally obsolete bridge is one that was built to standards that are not used today. These bridges are not automatically rated as structurally deficient, nor are they inherently unsafe. Functionally obsolete bridges are those that do not have adequate lane widths, shoulder widths, or vertical clearances to serve current traffic demand, or those that may be occasionally flooded.

Girder: A large beam of steel, iron, reinforced concrete, or timber used to support concentrated loads at isolated points along its length.

Girder Bridge: A girder bridge is perhaps the most common and most basic bridge. The cross section of the girder takes the shape of the capital letter "I". The vertical plate in the middle is known as the *web*, and the top and bottom plates are referred to as *flanges*. A box girder is much the same as an I-beam girder except it takes the shape of a box. The typical box girder has two webs and two flanges. However, in some cases there are more than two webs, creating a multiple chamber box girder. Other examples of simple girders include pi girders, named for their likeness to the mathematical symbol for pi, and T shaped girders.

Gross Vehicle Weight (GVW): Refers to the total curb weight of the vehicle and payload. Expresses the maximum continuous load for vehicles traversing a bridge.

Guardrail: Structural barrier which is meant to keep vehicular traffic from leaving the roadway in the event of an accident. Guardrail may be steel beam with steel or wooden posts, concrete barriers or numerous other types.

Haunch: The enlarged part of a beam near its supported ends that results in increased strength; visible as the curved or angled bottom edge of a beam.

Haunched Girder: Typical slab-on-beam bridges have space between the bottom of the slab and the top of the top flanges of beams. This space, referred to as the fillet or haunch, typically consists of unreinforced concrete that increases the dead load of the section but is not normally considered to add strength.

Invert: Bottom elevation of a pipe or culvert.

Knee Brace: Additional support connecting the deck with the main beam that keeps the beam from buckling outward. Commonly made from plates and angles.

Lateral Bracing: Members used to stabilize a structure by introducing diagonal connections.

Live Load: The moving load on a structure, including the weight of people, cars, and equipment, but not including wind load.

Load: Weight distribution throughout a structure; loads caused by wind, earthquakes and gravity affect how weight is distributed throughout a structure.

Load Posted: Any bridge or structure restricted to carrying loads less than the legal load limit. Load posting a bridge is required by National Bridge Inspection Standards when a bridge is not capable of safely carrying a legal load.

Main Beam: A beam supporting the spans and bearing directly onto a column or wall.

Main Span: The longest span in a multi-span bridge and located between the bridge's main piers or towers (supports). Bridges typically compared using main-span lengths, which do not account for the length of the entire bridge or its approaches.

Masonry: Construction of stone and mortar. Concrete masonry involves the use of concrete masonry units, commonly, but incorrectly, referred to as “Cinder Blocks”.

Member: Any individual angle, beam, plate or other single component, which is a part of the overall bridge structure.

National Environmental Policy Act of 1969 (NEPA): Legislation requiring that any project using federal funding or requiring federal approval (including transportation projects) examine the effects of alternative choices on the environment before a decision is made.

NHDOT: New Hampshire Department of Transportation

Pack Rust: Pack rust is a thick build-up of corrosion product that tends to develop between the surfaces of closely joined, unprotected metal objects, such as built-up bridge members in trusses. Pack rust is known to create tremendous prying force between the built-up sections which can eventually fracture bolts or rivets.

Parapet: A low wall along the outside edge of a bridge deck used to protect vehicles and pedestrians

Pile: A structural element that is driven vertically into the ground to support a bridge. Pilings, or groups of piles, are used as a base on which to build abutments or piers.

Pile Bent: A row of driven or placed piles with a pile cap to hold them in their correct positions.

Pile Driver: A machine that repeatedly drops a heavy weight on top of a pile until the pile reaches solid soil or rock or cannot be pushed down any farther.

Pile-Supported Bridge: Pile-supported structures are supported by timber piling at regular intervals (typically 10 to 15 feet on center). A pile-supported structure can be built to any length and virtually any height.

Plate Girder: A steel beam fabricated by welding, bolting, or riveting together metal sections in the form of an "I" shape that is designed to give strength without great weight.

Pointing: A repair of stone abutments, which consists of putting mortar into joints between the stones.

Pre-Cast Girder: Girder is fabricated off-site Portland cement using reinforcing steel and post -tensioning cables. These girders are shipped to the construction site by truck and hoisted into place by cranes.

Prestressed Concrete: Concrete which contains steel cables, wires, etc. under tension. Used to lend greater strength to a structure.

Q_{50}- 50-Year storm event, an event that has a 2% chance of being exceeded in any one year.

Railing: A fence-like construction built at the outermost edge of the roadway or the sidewalk portion of a bridge to protect pedestrians and vehicles.

Range of Stress: The algebraic difference between the minimum and maximum stresses in a member.

Reaction: The resistance of a support against the pressure of a loaded member.

Redundancy: A structural condition where there are more elements of support than are necessary for stability.

Redundant Member: A member in a bridge that renders it a statically indeterminate structure; the structure would be stable without the redundant member whose primary purpose is to reduce the stresses carried by the determinate structure.

Reinforced Concrete: Concrete that has been hardened onto embedded metal, usually steel, in the form of rods, bars, or mesh. The tensile strength of steel and the compression strength of concrete render a member capable of sustaining heavy stresses of all kinds over considerable spans.

Reinforcing Steel: Steel rods, which are placed in concrete to give it additional strength.

Reinforcement: Adding strength or bearing capacity to a structural member. Examples include the placing of metal rebar into forms before pouring concrete or attaching gusset plates at the intersection of multiple members of a truss.

Revet: The process of covering an embankment with stones.

Revetment: A facing of masonry or stones to protect an embankment from erosion.

Rigger: An individual who erects and maintains scaffolding or other inspection access equipment.

Rigid: Ability to resist deformation when subjected to a load.

Rigidity: The measure of a structure's ability not to change shape when subjected to a load.

Rip Rap: Gabions, stones, blocks of concrete or other protective covering material of like nature deposited upon river and stream beds and banks, lake, tidal or other shores to prevent erosion and scour by water flow, wave or other movement .

Rust Scale: The brown flaky material seen on the surface of steel, which is caused by corrosion.

Scour: The erosion of submerged piers and abutments or the soil beneath them from fast-flowing water.

Section Loss: The amount of an original member which has been lost due to heavy rust scale or rot and has reduced its strength because of that loss.

Shear: The sliding of one layer of a material relative to another layer.

Simple Span: A span in which the effective length is the same as the length of the spanning structure. The spanning superstructure extends from one vertical support, abutment or pier to another without crossing over an intermediate support or creating a cantilever.

Skew: When the superstructure is not perpendicular to the substructure, a skew angle is created. The skew angle is the acute angle between the alignment of the superstructure and the alignment of the substructure.

Spalling: Areas of concrete where the surface has been affected by salt or other factors and has begun to break away.

Span: The distance a bridge extends between two supports.

Specifications: A document that explains all material and construction requirements of the bridge structure to be constructed, usually used by engineers or architects in the planning stages of construction.

Splice Plate: A plate that joins two girders. Commonly riveted or bolted.

Steel Stringers: Load-carrying beams in the bridges superstructure that rest on abutments and other intermediate supports.

Stiff: Ability to resist deformation.

Stiffener: On plate girders, structural steel shapes, such as an angle, are attached to the web to add intermediate strength.

Stringers: Members that run in the same direction as the traffic and which are underneath the riding surface and provide support for the riding surface.

Stirrups: Vertical reinforcement in a concrete beam.

Substructure: The substructure consists of all parts that support the superstructure. The main components are:

- Abutments or end-bents
- Piers or interior bents
- Footings
- Piling

Superstructure: The superstructure consists of the components that actually span the obstacle the bridge is intended to cross. It includes:

- Bridge deck,
- Structural members (steel girders, concrete beams, etc.)
- Parapets, handrails, sidewalk, lighting and drainage features

Tension: The stress resulting from a pulling force on a member, which tends to extend it (the opposite of compression).

Tension Member: Any timber or rod of a truss that is subjected to pull or stretch.

Torsion: An action that twists a material.

U-Bolt: A bar bent in the shape of the letter "U" and fitted with threads and nuts at its ends.

Ultimate Strength: The highest stress that a material can withstand before breaking.

Ultrasonic Testing: Nondestructive testing of a material's integrity using sound waves.

Underpass: The lowest feature of a grade separated crossing.

Uniform Load: A constant load across a member.

Unit Stress: The stress per unit of surface or cross-sectional area.

Uplift: A negative reaction or a force tending to lift a beam, truss, pile, or any other bridge element upwards.

Upstream Face: The side of a bridge that is against the water.

Vertical Curve: A sag or crest in the profile of a roadway.

Wash: Slope in the top of the abutment beam seat to drain water away from the bearings.

Waterway: The available width for the passage of water beneath a bridge.

Wearing Surface: The topmost layer of material applied upon a roadway to receive the traffic loads and to resist the resulting disintegrating action; also known as wearing course.

Web: The center vertical part of an "I" shaped beam or girder.

Web Plate: The plate forming the web element of a plate girder, built-up beam or column.

Web Stiffener: A small member welded to a beam web to prevent buckling of the web.

Weephole: A hole in a concrete retaining wall to provide drainage of the water in the retained soil.

Weld: A joint between pieces of metal at faces that have been made plastic by heat or pressure.

Welded Bridge Structure: A structure whose metal elements are connected by welds.

Welded Joint: A joint in which the assembled elements and members are united through fusion of metal.

Wheel Load: The load carried by and transmitted to the supporting structure by one wheel of a traffic vehicle, a movable bridge or other motive equipment or device.

Wingwalls: A retaining wall that is a part of an abutment and used to keep the fill from falling into the stream.

Working Stress: The unit stress in a member under service or design load.

X-Bracing: A form of additional supports for the piling of a bridge. The timbers are placed in a "criss-cross" pattern joining the supporting piling.

Yield: Permanent deformation that a metal piece takes when it is stressed beyond the elastic limit.

Yield Stress: The stress at which noticeable, suddenly increased deformation occurs under slowly increasing load.

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