# STATE OF NEW HAMPSHIRE
## INTER-DEPARTMENT COMMUNICATION

**DATE:** February 14, 2020

**FROM:** A.O. Andrew O'Sullivan
Wetlands Program Manager

**AT (OFFICE):** Department of Transportation
Bureau of Environment

**SUBJECT** Dredge & Fill Application
Derry-Londonderry, 13065
DES File #2018-03134

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

Forwarded herewith is the NH Department of Transportation's (NHDOT) response to NH Department of Environmental Service's (NHDES) Request for More Information (RFMI), and revised application package prepared by Fuss & O'Neill, Inc. for NHDOT for the subject Major impact project. This project is classified as Major per Env-Wt 303.02(c). The Towns of Derry and Londonderry, and the NHDOT, in cooperation with the Federal Highway Administration (FHWA), are proposing the construction of a new interchange with I-93 (known as Exit 4A) and other transportation improvements to reduce congestion and improve safety along NH Route 102.

The revised application package for this "Design Build" project includes plans that encompass the impacts anticipated for the base technical concept for the entire project. Because this project is "Design Build," it is possible that the successful team would propose an alternative technical concept which could include additional or reduced impacts to jurisdictional areas. As necessary, NHDOT will submit permit amendments from the "Design Build" team to account for any changes.

This application conservatively includes (recounts) all of the overlapping impacts that were permitted under the Salem-Manchester, 10418C (I-93 expansion) project (DES permit #2014-03446) for which mitigation was already paid by NHDOT on February 10, 2016. These overlapping impacts were not counted in the mitigation calculation for the subject project, which is detailed in the enclosed, revised application. In addition, the Trolley Car Stream designated as impact area S1 will be self-mitigating and those associated temporary impacts were not used in the mitigation calculation. The NHDOT estimates that the mitigation payment will be on the magnitude of $3.8 M when accounting for wetland impacts, watercourse impacts, secondary impacts, and vernal pool impacts. As this "Design Build" project progresses through design impacts will be likely be reduced. We anticipate that this mitigation total will be reduced. NHDOT will meet with NHDES's Mitigation Supervisor for agreement on a final mitigation payment amount.

**Responses to NHDES Jan 2019 Comments on the Exit 4A Conceptual Wetland Application**

**(Including 1-23-2019 NHDES Meeting with NHDOT)**

1. Application shows 216,962 sq. ft. (2632 linear feet) of impact to palustrine, riverine and Prime Wetland. (4.98 acres) Plan sheet 4 of 25 matches the total.

   *Yes, this included wetland, vernal pool and stream impact areas. Impact quantities have been revised due to some minor modifications to the design to address other comments and advance the stormwater management design. The impact areas are shown on permitting plan set Sheets 4 and 5, the revised wetland application form, and in Attachment A of the revised wetland application. The new total permanent impact area for palustrine wetlands, prime wetlands, vernal pools, perennial and intermittent streams is 244,186 square feet (5.61 acres). Temporary wetland and stream impacts have now also been quantified, and include a 5-ft wide erosion and sediment control zone at the project footprint edge, as well as temporarily impacted stream channel which will be relocated and restored. Temporary impacts total 43,103 sf (0.99 acres).*

2. Text response to the 20 questions, items 2 and 7f, state the impacts are to 4.34 acres including 1.15 acres of vernal pool habitat. 4.34 acres is 189051 sq. ft. and does not match the application.

   *Wetland and stream impacts were called out separately, to match the application form. Stream impacts were provided in linear feet so comparisons with other Alternatives could be made. Alternative B stream channels were not field delineated, so no width information was available for areal impact quantification. The areal impacts to wetlands and streams for Alternative A have been added to application narrative items 2 and 7f and updated on the application form.*

3. Response to Env-Wt 302.04(a)(13) does not address quantity of water.

   *The following statement has been added in the application narrative:*

   *The proposed project includes development of new roadway in undeveloped areas or areas with non-roadway current land use as well as redevelopment of existing roadway that would result in new impervious surface within Upper Beaver Brook watershed. Erosion and sedimentation control plans and stormwater plans (attached) were developed to insure that the quantity and quality of surface water moving through the project area is protected during construction and managed post-construction. The addition of new impervious roadway surfaces that contribute additional stormwater runoff to surface waters has the potential to add new TSS and nutrient loads to the watershed. The Project has approximately 1,717,000 square feet of redeveloped and newly developed pavement areas that require treatment. Of the 1,717,000 square feet, approximately 1,528,000 square feet or 89% of the impervious surface is proposed to be treated at 18 water quality treatment areas. Existing pavement that will be redeveloped by this project accounts for 827,700 square feet of the pavement requiring treatment. Currently, none of that pavement has treatment; therefore, implementation of the proposed stormwater treatment should provide a significant improvement in the water quality of the existing watershed. Considering the constraints of the project area and the proposed improvement to the existing condition, stormwater treatment has been provided to the maximum extent practicable. Please see the attached Stormwater Memo*

*(Attachment D), Section "4.11.2 Surface Waters and Water Quality – Environmental Consequences" in the FEIS, and the Water Quality Plans (attached to the application) for additional detail.*

4. Response to Env-Wt 302.04(a)(14), flooding to be completed during final design and does not address erosion or sedimentation.

   *A brief discussion of erosion and sedimentation control measures (below) has been added to the application narrative:*

   > *New stream crossing locations and extended crossing structures will be designed and constructed to meet NHDES stream crossing rules. Hydraulic analyses have been conducted for Shields Brook and Tributary E to aid design of the bridge crossings and to avoid raising base flood elevations. Excerpts from the two hydraulic reports are attached (Attachment C) and the full reports are available on request. All construction work will employ BMPs to minimize erosion and sedimentation, as shown on the Erosion and Sedimentation Control plans (attached to the permit application). In addition to short-term erosion and sedimentation controls such as straw bales and silt fence, permanent stormwater treatment features are being designed that will effectively attenuate stormwater volume and flow rates. These features include grassed swales and detention basins, as shown on the Water quality Plan, also attached to the permit application. Further details will be provided on final design plans by the Design-Build team.*

5. Response to Env-Wt 302.04(a)(15) reflects or redirects current in surface water not addressed. The response says it is not tidal water and that is not the question to be answered. Station 1055 reviewed.

   *A discussion of flow related stream alterations has been added to the application narrative as follows:*

   *While there are no direct impacts to ponds or lakes, and no redirection of wave energy, the Project will alter flow in several streams. Eight existing crossings will likely require culvert extensions or replacements; five intermittent streams will be shifted/relocated along the new connector road or to accommodate roads, ramps or sound walls. Alternatives to the skewed culvert currently shown for Shields Brook will be investigated during final design by the Design-Builder. Temporary disturbance areas and stream channel shifts will require temporary and permanent channel and bank stabilization, which will be detailed in final design, but are accounted for in the impact calculations. The prime wetland outlet crossing (Tributary E) on Tsienneto Road will require a bridge to meet stream rule standards. This upgrade would have the potential to drain the wetland, so final design by the Design-Builder will include a weir to maintain water elevations while accommodating storm flows. All crossings will be designed to pass the 100-year storm event. Table 3 Exit 4A Stream Impact Summary in Exhibit C below, includes additional stream impact information. Additional stream crossing/relocation details will be developed in final design by the Design-Builder. Please see FEIS Section "4.11 Surface Waters and Water Quality" for additional information on water resources.*

6. Prime Wetland impacts of 2,870 sq. ft. - requirements to be demonstrated in a subsequent submittal. The law requires the applicant to provide clear and convincing evidence there will be no

significant loss of value and the DES shall not issue a permit unless there is clear and convincing evidence there will be no significant loss of value. Need a detailed design, construction sequence and appropriate responses to rules Part Env-Wt 700. No prime wetland rules were responded to yet.

*The application has been updated with the current Prime Wetland impacts (which now include small impacts to Prime Wetland A-01 from a stormwater design element) and includes an assessment narrative addressing each of the sections of the rules at Env-Wt 703. Please see the revised wetland application narrative. A detailed design and construction sequence will be developed during final design by the Design-Builder.*

7. Draft design in April 2018 was a total of 3.43 acres. Please explain the additional 1.55 acres of impact.

   *There are several contributing factors to the increase in wetland impacts. The 3.43 quantity in April 2018 does not appear to have included stream channel impacts. The rest of the impact increase is associated with drainage features not previously designed, bridge design, delineation updates, and small additional impacts along the "gap" areas of Tsienneto Road that were identified as conceptual designs were completed. The total impact area is now as shown in the application form, Attachment A to the application, and Sheets 4 and 5 of the revised Wetland Plans. Temporary impacts have now also been quantified. Increases in impact quantities for the other Project Alternatives addressed in the FEIS would also be likely, had they been selected for further design.*

8. Stream crossing details to be in a subsequent submission is stated in the application and does not address Env-Wt 900. Around 9 crossings to be detailed.

   *Detailed design information on the (now) 13 stream crossing/relocation areas will be developed with final design by the Design-Build team. However, some additional information regarding the conceptual design for each stream crossing location have been added to Table 3 Exit 4A Stream Impact Summary in the revised wetland application narrative. The new impact quantities associated with the Base Technical Concept should accommodate the culvert/pipe replacements that may be necessary under the final design.*

9. ARM calculators seem to be based on other data (probably other preliminary estimates) and does not match the application information or the plans submitted. Bank impacts incorrectly reported.

   *While we believe that most of the data in the ARM fund calculators matched the impact information in the original permit application, we acknowledge that bank impacts were not correctly measured and reported. This error has been corrected, and all impact quantities entered into the ARM fund calculator were reviewed and updated to reflect other design modifications made in response to various comments and also discussions with the USACE and USEPA regarding impacts to vernal pools. The revised ARM fund calculations and a description of the impacts addressed are included in the revised application narrative.*

10. As required by Env-Wt 801.03(a), a clear understanding of what mitigation opportunities were reviewed or how the local communities provided input on local priorities needs to be summarized and information provided on the evaluation of permittee-responsible options. Explain date of meetings, comments or list reviewed, discussion of what was considered, DOT says SPIP is being

considered and this will come in prior to permit issuance. Town DPWs, Janusz Czyzowski and Mike Fowler have been contacted.

*We have included a mitigation package history summary in the wetland permit application narrative, documenting activities and meetings between 2012 and 2018, including local input. Meeting minutes are also attached. Please see the Exit 4A Mitigation History in the revised application narrative and Attachment E to the application.*

**PLANS**

11. Does "Previously impacted wetlands" mean previously permitted for impacts? Previously permitted thru 1-93 permit. D & I contracts discussed. May need to id the wetlands more clearly so not confusing or double counting them.

    *Almost all wetlands that intersect the I-93 design footprint have been removed from the Exit 4A permitting plans, including those in the median and within the I-93 toe of slope. Most of these have now been impacted by I-93 construction. The exception is approximately 1,000 feet of stream and adjacent wetlands between Trolley Car Lane and the west side of I-93 (Stream S1 and Wetland 14 on Sheets 6 and 7 in the revised wetland permitting plan set; and the red and orange impact areas on Attachment J to the permit application). Wetland fill and relocation of the stream channel to accommodate a sound wall was proposed and permitted by the I-93 Project (Contract 14463D and I, NHDES Permit 2014-03446), but the work did not take place. This work, (and some additional fill for ramp construction) is now part of the Exit 4A plans, and the impacts are tallied in the Exit 4A project. However, the 24,210 sf of wetland impacts quantified for the I-93 work in this location are excluded from the Exit 4A wetland ARM fund calculation, as mitigation for these impacts was included in the I-93 mitigation package. Please also note that impacts to Stream S1 are quantified as temporary on the Exit 4A wetland application form, as sufficient data has been collected to restore this stream after relocation (see Attachment B to the permit application). The S1 stream impacts are therefore also excluded from the stream ARM fund calculator.*

12. The plans need to include the Top of Bank location for perennial streams and impacts to bank areas need to be calculated, added to the impact summary, and mitigation adjusted to include these losses. In general, bank impacts are not identified in the application materials and overall stream resources seem to be incorrectly identified. Detailed where impacts to banks were not accounted for-Gino will send his marked up table. Potential of 2,500 linear feet of additional bank impacts. Reviewed station 52 - do not understand need for new flowline.

    *We acknowledge that bank impacts were not correctly measured and reported. The Ordinary High Water line for perennial streams corresponds to banks in these cases, and has been quantified and reported as bank impacts. Please see the revised permitting plan set. The widening of the road at Stream S2 (Shields Brook) requires an extended culvert, which is skewed to the road. This crossing will be reviewed further during final design by the Design-Builder with a goal of reducing the skew and the wetland/stream impacts, if possible.*

13. Stream and surface water bank impacts are not calculated correctly. Dale will scan and get these detailed comments to them. Overlap and discrepancies discussed developed from two plan sets

(I&D). D under construction currently. They will remove areas that have been filled and no longer exist.

Examples:

- Impact areas A and B show 36 and 301 linear feet of channel to be impacted. Add 70 and 600 linear feet of banks.
- Impact areas E and I include intermittent stream impacts that are not identified, add 260 and 125 linear feet of channel impacts.
- Impact area M, add 1,516 linear feet of bank impacts, channel was calculated at 758 linear ft.

*We have determined that the stream in Wetland 14 between Trolley Car Lane and the west side of I-93 (impact areas A, B, and CR, and now temporary impacts TA, TB, TL, TCE and TCF) is an intermittent stream. Previous Exit 4A materials, including the 2007 DEIS and the Normandeau 2010 stream relocation report had identified it as perennial, however, there are stream photos taken in 2010 and 2014 that clearly show a dry streambed, and a 2014 NHDOT stream crossing assessment report identifies this stream as intermittent. Based on field evidence, and for consistency with the I-93 stream crossing assessment report, we now classify this stream as intermittent. The areal and linear channel impacts have been re-measured and added correctly to the application form and plan set, including the stream as it passes through Wetland 14 (previously impact areas E and I, now impacts C, D, G, M, and N). As the stream is intermittent, the impacts do not include the bank measurements. The plan to relocate this stream included two stream assessments, one conducted by NHDOT and one conducted by Normandeau. As there are cross sections, sediment characterizations, and stream morphology notes (See Attachment B to the revised wetland permit application), stream simulation is attainable, and the stream relocation can be considered self-mitigating. Therefore, the stream impacts have been omitted from the revised ARM fund calculator, and placed in the "temporary impact" column on the wetland permit application form. Stream S70 is also intermittent, and therefore bank impacts are not tallied. Impact area L (previously M) S70 stream channel impacts, have been reduced from 758 linear feet to 70 linear feet.*

14. Consider building a taller wall instead of filling 60 feet away to build a berm to build a wall. See sheet 5 comment below.

    *The design of the sound wall and berm is consistent with the typical sound wall design for the I-93 Project, and will not be changed.*

15. Impact area BO says the bank impact is 32 linear feet. The impact area on the plan shows an additional 270 linear feet.

    *Impacts to this Tributary of Shields Brook north of the Connector Road have been eliminated through design revisions, and bank impacts associated with all perennial streams have been corrected. Impact Area BO now refers to a bank impact to Shields Brook south of the Connector Road. Please see the revised permitting plan set and application form impact table.*

16. On the opposite bank no calculation was provided and is about 240 linear feet. It is estimated the bank impacts at this crossing was underestimated by 510 linear feet.

*Bank impacts have been corrected and reduced through design refinement. Permanent impacts to the banks of Shields Brook now total 511 linear feet, and are labeled as impacts BL and BO on Sheet 16 of the revised permitting plan set. Revised bank impacts are also included in the application form and ARM fund calculations.*

17. Do not understand a OW line that seem to cross the stream (1053+25, 200 l) or the lettering "WOW"

    *This line is an overlapping OHW line, likely from several aerial photo wetland lines. Line types have been labeled for clarity, and those which are not relevant to the design or resource impacts were removed if possible.*

18. Locate the areas intended to treat runoff prior to discharge into jurisdictional areas. It would be helpful to have information on the drainage design. They can provide a general overview of proposed drainage. Current drainage areas, impervious pavement areas, direction of stormwater for treatment –will send drainage report.

    *Please see the conceptual stormwater design memo (Attachment D to the revised application). Water Quality plans have since been developed and are attached to the permit application. Additional details will be provided in final design by the Design-Builder.*

19. Overall there is a difference in the wetlands delineated for the 1-93 - 14633 D and 14633 I contracts when compared to the wetlands delineated under the Exit 4A design. Some wetlands are not shown, the limits of wetlands have changed and are shown either larger or smaller, and some wetlands are noted which did not exist under the previous contracts. Also some of the previously impacted wetlands are not shown leaving a large disconnection relative to new wetland and stream impacts and associated mitigation needs. For example, on sheet 5 in the application: Wetlands are not identified, but are noted in the 14633 D and 14633 I contract plans, sta 50+80 to 55+50; Wetlands are shown in the median but do not exist on 14633 D or 14633 I contract, sta 51+25 to sta 54; and on Sheet 7, Sta 70, wetlands appear to be delineated differently than noted in the 14633 I contract. It is suggested that a working session be held to go over both the 1-93 plan set and proposed impacts so there is agreement on impacts and mitigation totals.

    *Wetlands that intersect the I-93 design footprint have been removed from the Exit 4A permitting plans for clarity. We acknowledge that the field delineations completed for the I-93 Project and the Exit 4A Project are not identical. The Exit 4A wetland boundaries were delineated and GPS located by a Certified Wetland Scientist in 2016. The I-93 Project delineations and survey were completed at least 10 years previously, and the delineation methodology (and possibly site conditions) have changed in the interim. We stand by the more recent Exit 4A delineations. We would be happy to accompany NHDES on a field visit to verify wetland boundaries at an appropriate season. The US Army Corps of Engineers reviewed some wetland impact areas in the field on 9/25/19.*

20. On Sheet 5 in the application: Clarify why the proposal notes relocating the stream to the west for a second time. This stream is currently scheduled for 800 linear feet to be relocated to the west under the 14633 D contract, it appears this is proposal will relocate the stream to the west again and for a longer reach, Sta 56 to 61+50.

*Wetlands west of I-93 and east of Trolley Car Lane are associated with an un-named intermittent stream (S1), sometimes referred to as Wheeler Brook or Trolley Car Lane Brook. This stream flows south along the west side of I-93, then crosses diagonally under the highway through a culvert over 1,000 ft long and continues south to Wheeler Pond. The stream will be relocated up to approximately 50 feet to the west to accommodate both sound wall and ramp construction. A portion of Stream S1 was permitted for relocation under the I-93 project to accommodate sound walls, but the sound wall work and stream relocation/restoration has been deferred to the Exit 4A project. Impact calculations for Exit 4A include the portion of the work that was to be done by I-93. The sound walls, designed to match the sound wall design for the I-93 project, will be constructed on berms with a 2:1 slope. The berms are the minimum dimensions necessary to support the walls. The earthwork for ramps will have 2:1 slopes rather than the typical 4:1 slopes, to minimize wetland impacts.*

<u>Sheet 6</u>

21. Wetlands not shown but shown on 14633 D and 14633 I contract sta 58 to 63 west.

    *See response above regarding wetland delineations.*

22. Wetlands not shown as previously impacted completely sta 25 to sta 30.

    *These filled wetlands have been removed from the permitting plan set.*

23. Wetlands in median shown as existing, shown as wetland impacts on 14633 I contract, sta 22 to sta 23, and sta 26 to sta 28+50.

    *These filled wetlands have been removed from the permitting plan set.*

24. Where will pond 1670 outlet be directed to? Currently runs along toe of slope to culvert at sta 23. Will pond need to be re-engineered so as not to discharge to vernal pool, VP 3?

    *We do not believe that the pond 1670 will need to be redesigned. However, a berm has been added to prevent the pond discharge from entering Vernal Pool 3 (sheet 7 of the Permit Plan set). This has resulted in an increase in direct impacts (fill) to Vernal Pool 3.*

25. VP 4 currently flows under pond 1670 access road to a swale to the south, then to culvert at sta 23 along the toe of slope. Where will this be directed?

    *The Exit 4A ramp design will eliminate VP4 and a substantial portion of the pond 1670 access road. Currently, an intermittent stream carries flow from VP5 to VP4. This flow will be collected and flow towards VP3, however the details of this have not been designed, and will be addressed by the Design-Build team during final design by the Design-Builder. Sheet flow from the new access ramp is expected to drain to the forested land east of the highway.*

<u>Sheet 7</u>

26. Sta 71 to sta 73, wetlands not shown but shown on 14633 I contract plans located in new gore. Will these be impacted? Area has previously impacted wetlands identified.

    *No remaining wetlands were delineated in 2016 in this location.*

27. Note sheet 7 matches with sheet 10 to the east instead of sheet 6.

    *We have made the appropriate match line label correction to the plans. Sheet numbering has also changed.*

28. Sheet 8

    Sta 89+50, wetlands smaller than 14633 I contract. Additional wetland impacts not indicated.

    Sta 94, wetlands smaller than 14633 I contract. Additional wetland impacts not indicated.

    *Please see the response to comment 19 regarding wetland delineations, which applies to both Sheet 8 comments.*

29. Sheet 9

    Median, wetland shown as existing, previously impacted 14633 I contract.

    Sta 64+84, wetlands not shown as previously impacted.

    Wetlands to west slightly different than 14633 I contract.

    Wetland to west shown as previously impacted, not shown as wet on 14633 I contract

    Wetland 186 and 186A to west shown differently than 14633 I contract.

    *Please see the response to comment 19 regarding wetland delineations, which applies to all Sheet 9 comments.*

30. Sheet 11, move proposed driveway so as to not impact remaining portion of vernal pool. Reviewed concept for minimizing impacts. No future impacts for driveway off of access road as permit condition.

    *The driveway locations have been removed from the wetland plans. A note has been added to plan sheets 12 and 13 indicating that two points of access are granted on the north side and two points of access are granted on the south side of the Connector Road. These points of access shall be opposite each other forming four-way intersections. Specific access locations to be determined through the Town of Londonderry site plan approval process.*

31. Sheet 12, impact BG should be shaded as permanent impact.

    *The impact has increased, and the shading was modified for this location, now labeled as BF on Sheet 13. Note that this entire wetland (Wetland 64) and vernal pool (Vernal Pool 9) are shaded as permanently impacted, even though the cut slope only intersects the wetland at location BF. Potential secondary impacts (draining of the wetland due to the road cut) were conservatively applied to this wetland and included in the ARM fund calculations.*

32. Sheet 13 matches to sheet 12 instead of sheet 8.

    *We have made the appropriate match line label correction to the plans. Plan sheet numbering has changed.*

33. Sheet 14 there is no detail provided relative to the stream impact and no design for the alignment of the stream flow. The bank impacts are underestimated by about 510 linear feet. Shield Brook area.

    *The Stream S2 (Shields Brook) crossing now appears on Sheet 16. As previously mentioned, stream crossing details will be developed during final design by the Design-Builder, but preliminary structure designs for Shields Brook and Tributary E are included in the Type, Span, and Location Study (Attachment H). Shields Brook bank impacts have been re-measured and corrected on the design plans, application form and ARM fund calculator.*

34. Sheet 22 impact to vernal pool appears to be a probable outlet area for drainage where the impacts are likely to be more than the initial construction. Station 1139.

    *The vernal pool impact shown was based on the topography, and is not related to a drainage outlet. However, Fuss & O'Neill have been able to refine the design in this location to eliminate permanent fill impacts to this vernal pool (VP11), which is now shown on Sheet 25, although some temporary impacts will occur. The stormwater swale that was shown adjacent to the vernal pool has been eliminated from the design. A small impact to the wetland containing the vernal pool (Wetland 54) will occur from guard rail installation at the improved intersection of Tsienneto Road and Barkland Drive.*

35. Sheet 24 notes Prime Wetland, needs details, bank impacts missing upstream, about 140 linear feet and downstream about 160 linear feet. Pointed out local "dump" area - can it be cleaned up? Several local sites they are aware of - also location of a remnant pipe?

    *The prime wetland outlet stream channel and banks that will be affected by the Tsienneto Road crossing upgrade on Tsienneto Road have been measured and added to the stream impact quantities on the application form and plan set (now sheet 27). Permanent bank impacts were included in the ARM fund calculator. Upgradient of Tsienneto Road, the undersized culverts created a ponded condition within this shrub/emergent Prime wetland (identified as Wetland 62). Standing water will be maintained by the addition of a weir downstream of the new bridge. As noted in the meeting with NHDES, the local "dump" is privately owned, and the debris is also owned by the landowner; therefore restoration of this area cannot be included in the mitigation package.*

36. Mentioned vernal pool mitigation accounting needs to be reviewed according to Corps guidance (see Mark Kern's letter).

    *The mitigation plan, including vernal pool impact accounting, was discussed at the March 15, 2019 agency meeting and in follow up phone calls and emails. Based on the additional guidance from the USACE, the vernal pool impacts that must be entered into the ARM fund calculators have been revised. Please see the added vernal pool mitigation discussion and vernal pool ARM fund sheets in the revised wetland permit application narrative.*

37. Propose to change approval target date from 1-23-19 to mid-June.

    *We now anticipate an approval date of Mid-April 2020.*

NHDES-W-06-012

New Hampshire Department of Environmental Services

# WETLANDS PERMIT APPLICATION

## Water Division/ Wetlands Bureau
## Land Resources Management

Check the status of your application: www.des.nh.gov/onestop

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

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

**1. REVIEW TIME:** Indicate your Review Time below. To determine review time, refer to Guidance Document A for instructions.

☒ Standard Review (Minimum, Minor or Major Impact) ☐ Expedited Review (Minimum Impact only)

**2. MITIGATION REQUIREMENT:**

If mitigation is required, a Mitigation-Pre Application meeting must occur prior to submitting this Wetlands Permit Application. To determine if mitigation is required, please refer to the Determine if Mitigation is Required Frequently Asked Questions.

Mitigation Pre-Application Meeting Date: Month: **03** Day: **15** Year: **2019**

☐ N/A - Mitigation is not required

**3. PROJECT LOCATION:**

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

ADDRESS: **various** TOWN/CITY:

TAX MAP: BLOCK: LOT: UNIT:

USGS TOPO MAP WATERBODY NAME: **various - Shields Brook** ☐ NA STREAM WATERSHED SIZE: **Various** ☐ NA

LOCATION COORDINATES (If known): **71°19'17.952"W 42°53'55.785"N** ☒ Latitude/Longitude ☐ UTM ☐ State Plane

**4. PROJECT DESCRIPTION:**

Provide a brief description of the project outlining the scope of work. Attach additional sheets as needed to provide a detailed explanation of your project. DO NOT reply "See Attached" in the space provided below.

**The Towns of Derry and Londonderry, New Hampshire (the Towns), and the New Hampshire Department of Transportation (NHDOT), in cooperation with the Federal Highway Administration (FHWA) are proposing the construction of a new interchange with I-93 (known as Exit 4A) and other transportation improvements to reduce congestion and improve safety along Tsienneto Road and State Route 102 (NH 102)**

**5. SHORELINE FRONTAGE:**

☒ N/A This does not have shoreline frontage. SHORELINE FRONTAGE:

*Shoreline Frontage* is calculated by determining the average of the distances of the actual natural navigable shoreline frontage and a straight line drawn between the property lines, both of which are measured at the normal high water line (Env-Wt 101.89).

**6. RELATED NHDES LAND RESOURCES MANAGEMENT PERMIT APPLICATIONS ASSOCIATED WITH THIS PROJECT:**

Please indicate if any of the following permit applications are required and, if required, the status of the application.

To determine if other Land Resources Management Permits are required, refer to the Land Resources Management Webpage.

| Permit Type | Permit Required | File Number | Permit Application Status |
|---|---|---|---|
| Alteration of Terrain Permit Per RSA 485-A:17 | ☐ YES ☒ NO | ____ | ☐ APPROVED ☐ PENDING ☐ DENIED |
| Individual Sewerage Disposal per RSA 485-A:2 | ☐ YES ☒ NO | ____ | ☐ APPROVED ☐ PENDING ☐ DENIED |
| Subdivision Approval Per RSA 485-A | ☐ YES ☒ NO | ____ | ☐ APPROVED ☐ PENDING ☐ DENIED |
| Shoreland Permit Per RSA 483-B | ☒ YES ☐ NO | ____ | ☐ APPROVED ☐ PENDING ☐ DENIED |

**7. NATURAL HERITAGE BUREAU & DESIGNATED RIVERS:**

See the Instructions & Required Attachments document for instructions to complete a & b below.

a. Natural Heritage Bureau File ID: NHB **19** - **3453** .

b. ☐ This project is within a Designated River corridor. The project is within ¼ mile of: ____________ ; and date a copy of the application was sent to the Local River Management Advisory Committee: Month: __ Day: __ Year: ____

☒ N/A – This project is not within a Designated River corridor.

| **8. APPLICANT INFORMATION (Desired permit holder)** | | | |
|---|---|---|---|
| LAST NAME, FIRST NAME, M.I.: **Cota, Keith** | | | |
| TRUST / COMPANY NAME:**NHDOT** | MAILING ADDRESS: **7 Hazen Drive** | | |
| TOWN/CITY: **Concord** | | STATE: **NH** | ZIP CODE: **03302** |
| EMAIL or FAX: **Keith.Cota@dot.nh.gov** | PHONE: **(603) 271-1615** | | |
| ELECTRONIC COMMUNICATION: By initialing here: ________, I hereby authorize NHDES to communicate all matters relative to this application electronically. | | | |
| **9. PROPERTY OWNER INFORMATION (If different than applicant)** | | | |
| LAST NAME, FIRST NAME, M.I.: | | | |
| TRUST / COMPANY NAME: | MAILING ADDRESS: | | |
| TOWN/CITY: | | STATE: | ZIP CODE: |
| EMAIL or FAX: | PHONE: | | |
| ELECTRONIC COMMUNICATION: By initialing here ________, I hereby authorize NHDES to communicate all matters relative to this application electronically. | | | |
| **10. AUTHORIZED AGENT INFORMATION** | | | |
| LAST NAME, FIRST NAME, M.I.: **Carbonneau, Lee** | COMPANY NAME:**Normandeau Associates, Inc.** | | |
| MAILING ADDRESS: **25 Nashua Road** | | | |
| TOWN/CITY: **Bedford** | | STATE: **NH** | ZIP CODE: **03110** |
| EMAIL or FAX: **lcarbonneau@normandeau.com** | PHONE: **(603) 637-1150** | | |
| ELECTRONIC COMMUNICATION: By initialing here **LEC** , I hereby authorize NHDES to communicate all matters relative to this application electronically. | | | |

**11. PROPERTY OWNER SIGNATURE:**
See the Instructions & Required Attachments document for clarification of the below statements

By signing the application, I am certifying that:

1. I authorize the applicant and/or agent indicated on this form to act in my behalf in the processing of this application, and to furnish upon request, supplemental information in support of this permit application.
2. I have reviewed and submitted information & attachments outlined in the Instructions and Required Attachment document.
3. All abutters have been identified in accordance with RSA 482-A:3, I and Env-Wt 100-900.
4. I have read and provided the required information outlined in Env-Wt 302.04 for the applicable project type.
5. I have read and understand Env-Wt 302.03 and have chosen the least impacting alternative.
6. Any structure that I am proposing to repair/replace was either previously permitted by the Wetlands Bureau or would be considered grandfathered per Env-Wt 101.47.
7. I have submitted a Request for Project Review (RPR) Form (www.nh.gov/nhdhr/review) to the NH State Historic Preservation Officer (SHPO) at the NH Division of Historical Resources to identify the presence of historical/ archeological resources while coordinating with the lead federal agency for National Historic Preservation Act (NHPA) 106 compliance.
8. I authorize NHDES and the municipal conservation commission to inspect the site of the proposed project.
9. I have reviewed the information being submitted and that to the best of my knowledge the information is true and accurate.
10. I understand that the willful submission of falsified or misrepresented information to the NHDES is a criminal act, which may result in legal action.
11. I am aware that the work I am proposing may require additional state, local or federal permits which I am responsible for obtaining.
12. The mailing addresses I have provided are up to date and appropriate for receipt of NHDES correspondence. NHDES will not forward returned

| Keith A Cota | KEITH A. COTA | 02/11/2020 |
|---|---|---|
| Property Owner Signature | Print name legibly | Date |

# MUNICIPAL SIGNATURES

## 12. CONSERVATION COMMISSION SIGNATURE

The signature below certifies that the municipal conservation commission has reviewed this application, and:

1. Waives its right to intervene per RSA 482-A:11;
2. Believes that the application and submitted plans accurately represent the proposed project; and
3. Has no objection to permitting the proposed work.

| | | |
|---|---|---|
| ⇨ | Print name legibly | Date |

**DIRECTIONS FOR CONSERVATION COMMISSION**

1. Expedited review ONLY requires that the conservation commission's signature is obtained in the space above.

2. Expedited review requires the Conservation Commission signature be obtained **prior** to the submittal of the original application to the Town/City Clerk for signature.

3. The Conservation Commission may refuse to sign. If the Conservation Commission does not sign this statement for any reason, the application is not eligible for expedited review and the application will be reviewed in the standard review time frame.

## 13. TOWN / CITY CLERK SIGNATURE

As required by Chapter 482-A:3 (amended 2014), I hereby certify that the applicant has filed four application forms, four detailed plans, and four USGS location maps with the town/city indicated below.

| | | | |
|---|---|---|---|
| ⇨ | Print name legibly | Town/City | Date |

**DIRECTIONS FOR TOWN/CITY CLERK:**

Per RSA 482-A:3,I

1. For applications where "Expedited Review" is checked on page 1, if the Conservation Commission signature is not present, NHDES will accept the permit application, but it will NOT receive the expedited review time.
2. IMMEDIATELY sign the original application form and four copies in the signature space provided above;
3. Return the signed original application form and attachments to the applicant so that the applicant may submit the application form and attachments to NHDES by mail or hand delivery.
4. IMMEDIATELY distribute a copy of the application with one complete set of attachments to each of the following bodies: the municipal Conservation Commission, the local governing body (Board of Selectmen or Town/City Council), and the Planning Board; and
5. Retain one copy of the application form and one complete set of attachments and make them reasonably accessible for public review.

**DIRECTIONS FOR APPLICANT:**

1. Submit the single, original permit application form bearing the signature of the Town/ City Clerk, additional materials, and the application fee to NHDES by mail or hand delivery.

**14. IMPACT AREA:**

For each jurisdictional area that will be/has been impacted, provide square feet and, if applicable, linear feet of impact.

***Permanent:*** *impacts that will remain after the project is complete.*

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

***Intermittent Streams:*** *linear footage distance of disturbance is measured along the thread of the channel.*

***Perennial Streams/ Rivers:*** *the total linear footage distance is calculated by summing the lengths of disturbance to the channel and each bank.*

| JURISDICTIONAL AREA | PERMANENT Sq. Ft. / Lin. Ft. | | TEMPORARY Sq. Ft. / Lin. Ft. | |
|---|---|---|---|---|
| Forested wetland | 161,605 | ☐ ATF | 13,721 | ☐ ATF |
| Scrub-shrub wetland | 852 | ☐ ATF | 63 | ☐ ATF |
| Emergent wetland | 8,655 | ☐ ATF | 2,495 | ☐ ATF |
| Wet meadow | | ☐ ATF | | ☐ ATF |
| Intermittent stream channel | 4,396 / 902 | ☐ ATF | 21,255 / 1,885 | ☐ ATF |
| Perennial Stream / River channel | 4,937 / 258 | ☐ ATF | 689 / 53 | ☐ ATF |
| Lake / Pond | / | ☐ ATF | / | ☐ ATF |
| Bank - Intermittent stream | / | ☐ ATF | / | ☐ ATF |
| Bank - Perennial stream / River | / 543 | ☐ ATF | / 115 | ☐ ATF |
| Bank - Lake / Pond | / | ☐ ATF | / | ☐ ATF |
| Tidal water | / | ☐ ATF | / | ☐ ATF |
| Salt marsh | | ☐ ATF | | ☐ ATF |
| Sand dune | | ☐ ATF | | ☐ ATF |
| Prime wetland | 2,126 | ☐ ATF | 1,560 | ☐ ATF |
| Prime wetland buffer | | ☐ ATF | | ☐ ATF |
| Undeveloped Tidal Buffer Zone (TBZ) | | ☐ ATF | | ☐ ATF |
| Previously-developed upland in TBZ | | ☐ ATF | | ☐ ATF |
| Docking - Lake / Pond | | ☐ ATF | | ☐ ATF |
| Docking - River | | ☐ ATF | | ☐ ATF |
| Docking - Tidal Water | | ☐ ATF | | ☐ ATF |
| Vernal Pool | 61,615 | ☐ ATF | 3,320 | ☐ ATF |
| **TOTAL** | 244,186 / 1,703 | | 43,103 / 2,053 | |

**15. APPLICATION FEE:** See the Instructions & Required Attachments document for further instruction

☐ Minimum Impact Fee: Flat fee of $ 200

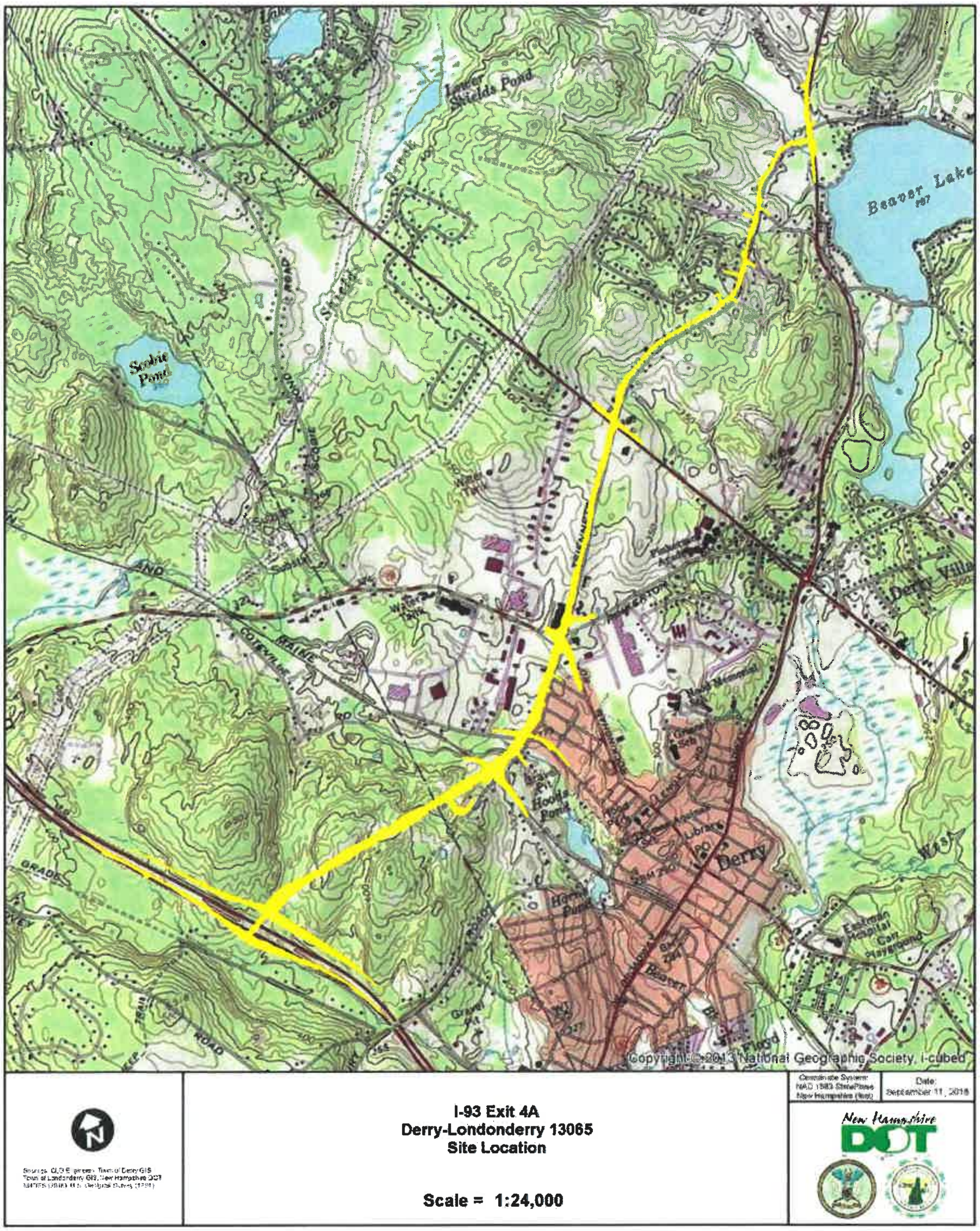
☒ Minor or Major Impact Fee: Calculate using the below table below

| | | | |
|---|---|---|---|
| Permanent and Temporary (non-docking) | **287,289** sq. ft. | X $0.20 = | $ **57,457.80** |
| Temporary (seasonal) docking structure: | sq. ft. | X $1.00 = | $ **0** |
| Permanent docking structure: | sq. ft. | X $2.00 = | $ **0** |
| **Projects proposing shoreline structures (including docks) add $200** | | = | $ **DOT paid 10K** |
| | | Total = | $ **2018 vouche** |

The Application Fee is the above calculated Total or $200, whichever is greater = $ **20,000+vouch**

# Table of Contents

## Location Map



# Exhibit A - Application Narrative

## 20 questions

| |
|---|
| **Env-Wt 302.04 Requirements for Application Evaluation - For any major or minor project, the applicant shall demonstrate by plan and example that the following factors have been considered in the project's design in assessing the impact of the proposed project to areas and environments under the department's jurisdiction.**<br>**Respond with statements demonstrating:** |
| 1. The need for the proposed impact. |
| The Towns of Derry and Londonderry, working with the Federal Highway Administration (FHWA) and the New Hampshire Department of Transportation (NHDOT) identified several factors demonstrating the need for transportation improvements within the study area, including traffic congestion in downtown Derry, economic vitality, and safety.<br><br>Please see Section "2.0 Purpose and Need" and "Appendix D – Interchange Justification Report" in the I-93 Exit 4A Final Environmental Impact Statement (FEIS) for additional detail. |
| **2. That the alternative proposed by the applicant is the one with the least impact to wetlands or surface waters on site.** |
| Alternatives A & B were the two build alternatives that met the Purpose and Need. One of the key reasons why Alternative A was selected versus Alternative B was related to their permanent wetland and stream impacts. Alternative A would have direct, permanent impacts to 5.39 acres of vegetated wetlands and vernal pools, and 1,703 linear feet of permanent stream channel and bank impacts (0.21 acres of streambed), while Alternative B would impact approximately 10 acres of vegetated wetlands and vernal pools, and impact 1,342 linear feet of stream (although this linear measurement for Alternative B does not include bank impacts for perennial streams). Impacts are summarized in the application form and Attachment A. Alternative B would have more stream impacts from new crossings on new alignment. Please see "4.12.2 Wetlands and Vernal Pools - Environmental Consequences and 4.14.2 Aquatic Life and Essential Fish Habitat – Environmental Consequences" in the FEIS for additional detail. A narrative describing wetland impact avoidance and minimization measures is also included as Exhibit F.<br>The ARM fund calculator for stream impacts includes all permanent impacts to streams and banks resulting from the Exit 4A project, but excludes the 1,719 linear ft. of impacts to an intermittent stream that parallels Trolley Car Lane, as the relocation and restoration of this stream is considered self-mitigating (see Attachment B). The ARM fund calculator for direct wetland impacts also excludes 24,210 sf of wetland impacts along I-93 in the Exit 4A area that were previously permitted and mitigated as part of the I-93 project (Contract 14463D and I, NHDES Permit 2014-03446), but not yet impacted (see Attachment J). |
| **3. The type and classification of the wetlands involved.** |
| The total permanent impact to vegetated wetlands is 5.39 acres. The majority of permanent impacts would occur in forested wetlands (5.12 acres), which includes 1.4 acres of permanent vernal pool impacts. There will also be 0.05 acres of permanent impact to two scrub-shrub/emergent prime |

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| wetlands; 0.20 acres of permanent impact to emergent wetlands; 0.02 acres of permanent impact to non-prime shrub wetland. There will be an additional 0.21 acres of permanent impact to perennial and intermittent stream channel. Temporary impacts include 0.49 acres of wetlands, and 0.50 acres of stream channel (including the relocated Trolley Car Lane stream). Temporary impacts by cover type are roughly proportional to the permanent impacts. The location of wetland and stream impacts are shown on the permitting plan sheets (attached). The wetland types are described in "4.12.1 Wetlands and Vernal Pools" in the FEIS, and wetland classifications are found in Exhibit E and Attachment A to this application. |
| **4. The relationship of the proposed wetlands to be impacted relative to nearby wetlands and surface waters.** |
| Wetlands proposed to be impacted are all in the Beaver Brook watershed. Please see FEIS sections "4.11 Surface Waters and Water Quality" and "4.12 Wetlands and Vernal Pools" for additional detail. |
| **5. The rarity of the wetland, surface water, sand dunes, or tidal buffer zone area.** |
| Wetlands proposed to be impacted are generally typical of wetlands in this part of New Hampshire, with forested wetlands (PFO1E) making up the majority of wetland impacts. There are 1.41 acres of vernal pools proposed to be permanently impacted, which provide habitat for vernal pool dwelling wildlife species. Please see "4.11 Surface Waters and Water Quality" and "4.12 Wetlands and Vernal Pools" in the FEIS for additional detail. |
| **6. The surface area of the wetlands that will be impacted.** |
| The proposed project would result in an estimated 5.39 acres of direct permanent vegetated wetland impact, including direct fill impacts to seven documented vernal pools, and anticipated loss of an additional vernal pool located adjacent to a road cut. There will be approximately 0.49 acres of direct temporary wetland impacts for construction assess/BMPs. There will be an additional 0.21 acres of permanent streambed impact and 0.50 acres of temporary streambed impact. As shown in Exhibit D – Mitigation, secondary impacts were also quantified and will be mitigated in accordance with federal guidance. "Wetlands and Vernal Pools 4.12.2 Environmental Consequences" in the FEIS has some additional detail. |
| **7. The impact on plants, fish and wildlife including, but not limited to:**<br>**a. Rare, special concern species;**<br>**b. State and federally listed threatened and endangered species;**<br>**c. Species at the extremities of their ranges;**<br>**d. Migratory fish and wildlife;**<br>**e. Exemplary natural communities identified by the DRED-NHB; and**<br>**f. Vernal pools.** |
| a. Based on records held by NHNHB two species of Special Concern, banded sunfish and redfin pickerel, have been found in Shields Brook, but not in the vicinity of the project crossing. Shields Brook will require a culvert extension, but stream connectivity will be maintained. See FEIS section |

"4.14.1 Aquatic Life and Essential Fish Habitat - Affected Environment". There are 23 Species of Greatest Conservation Need that could occur within the study area, based on their known habitat preferences and distribution within the state, but their locations are not tracked by NHNHB. See "Table 4.17-3. Species of Greatest Conservation Need that may be Present within the Project Area" in the FEIS.

b. The New Hampshire Natural Heritage Bureau indicated that there are recent records of state-threatened black racers in the vicinity of the project area (Attachment F). Proposed mitigation for potential impacts to black racers is discussed in "4.17.2 Threatened and Endangered Species – Environmental Consequences – Mitigation." No nearby records for any listed turtle species were found. No listed plants have been recorded or observed within the footprint of Alternative A, but the greatest opportunity for any undocumented populations of rare plants to be affected by the proposed Project, including the state-endangered Nuttall's reed grass (*Calamagrostis coarctata*), is along portions of the Project that cross or are aligned with transmission line ROW. See "4.17.2 Threatened and Endangered Species - Environmental Consequences" in the FEIS for more details. This habitat will be reviewed prior to construction. The project will implement reptile impact avoidance and minimization measures, including fencing and sweeps, during construction. Coordination with NHF&G continues.

The only federally listed species potentially present within the Project area is the threatened northern long-eared bat (NLEB; *Myotis septentrionalis*). This species is also state-listed as threatened. This tree-roosting bat uses forested habitats during its active season from April 15 – October 31. The Project has the potential to affect this species via tree clearing, which could reduce roosting habitat or cause direct mortality if an occupied roost tree is felled when bats are present. Therefore, a Presence/Absence survey compliant with USFWS' 2016 *Range-wide Indiana Bat Summer Survey Guidelines* (Guidelines) (USFWS, 2016), which are also applicable to summer survey for NLEB, was conducted, and this species was determined not to be present. Coordination with the USFWS for NLEB is included in Attachment I. Appendix M of the FEIS contains a full description of the survey and results.

c. Species at the extremity of their ranges are generally included in lists of Species of Special Concern or Species of Greatest Conservation Need. See "a." above.

d. The Project area is characterized by substantial development, but there is one large block of forest that will be fragmented by the Project. This could have an impact on several migratory forest-nesting birds (e.g., wood thrush, scarlet tanager, red-eyed vireo, and broad-winged hawk) that are sensitive to the fragmentation and edge effects that the road would create. The remaining forest area would have reduced habitat suitability for these species. Stream connectivity will be maintained and no impacts to the catadromous American eel is expected. See "4.16.2 Plant Communities and Wildlife – Environmental Consequences" and "4.14.1 Aquatic Life and Essential Fish Habitat - Affected Environment" in the FEIS for additional details.

e. The proposed Project will not directly affect exemplary natural communities.

f. The Project includes 1.41 permanent impacts to eight vernal pools, and an additional 0.076 acres of temporary impacts. Permanent, direct vernal pool impacts are included in the wetland ARM fund calculator, as these pools are also forested wetlands. It is expected that six vernal pools will cease to function as vernal pools due to this project. Following USACE mitigation recommendations, an additional ARM fund payment equivalent to 39,000 sf was calculated for each of the four medium value pools lost, and 65,000 sf for the loss of each of two high value pools (for a total of 286,000 sf of vernal pool function loss). In addition, the proposed project will either partially impact the pool or intersect the 750-ft federal buffer zone of 21 additional vernal pools, with potential secondary impacts. Following 2016 USACE guidance, these pools were re-evaluated to determine if post-construction value would drop due to landscape changes. Based on this assessment, three vernal pools will drop in value from high to medium or medium to low, and these were assigned a secondary impact equivalent of 26,000 sf per pool (for total secondary vernal pool impact of 78,000 sf). Please see the Table 1 and 2, below, and the ARM fund calculator sheets for Direct Wetland impacts, Vernal Pool Loss and Vernal Pool Secondary Impacts (Exhibit D).

**8. The impact of the proposed project on public commerce, navigation and recreation.**

In Derry, current constraints related to through-traffic are a concern for the accessibility of businesses downtown. In Londonderry, a large tract of undeveloped land on the east side of I-93 currently has poor highway access and is the subject of the Town's Woodmont Commons Planned Unit Development (PUD) Master Plan to attract regionally significant business opportunities.

Under the proposed Project, approximately 41.45 acres of new ROW would be required, and would include 14 residential acquisitions and 25 business displacements. In addition to compensation for property acquisition, relocation assistance would be provided to residential, non-profit, and business owners displaced by the Project in conformance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended. See "4.7.2 Socioeconomics - Environmental Consequences – Mitigation" in the FEIS for additional details. Implementation of the proposed project would provide direct Interstate access to commercial and industrial lands and be compatible with existing and future commercial and industrial uses. Please see "2.2.2 Economic Vitality" and "4.3.2 Land Use, Zoning, and Public Policy – Environmental Consequences" for additional detail.

The Project does not cross navigable waters.

There will be a very minor impact to Ryder Field in Derry which will not interfere with the recreational use of the property. See "7.4 Potential for Use and Impacts on Section 4(f) Resources" in the FEIS for additional details.

**9. The extent to which a project interferes with the aesthetic interests of the general public. For example, where an applicant proposes the construction of a retaining wall on the bank of a lake, the applicant shall be required to indicate the type of material to be used and the effect of the construction of the wall on the view of other users of the lake.**

The majority of the proposed Project corridor includes existing roads located in highly developed residential and commercial/industrial areas. Therefore, in most areas of the proposed project corridor, the existing traffic volumes, along with the type of development and its density, make for an environment that is not particularly sensitive from a visual perspective.

Between I-93 and North High Street, the proposed project corridor would be constructed in an undeveloped area of land. From a visual perspective, the area represents a visually pleasing landscape of woodlands and wetlands. However, there is a power line corridor with associated access roads within this area, with abundant evidence of past and ongoing illegal dumping activities, as well as all-terrain vehicle usage, which detracts from the overall visual experience.

Please see "4.6.2 Visual Resources – Environmental Consequences" in the FEIS for additional detail on aesthetic impacts of the proposed project.

**10. The extent to which a project interferes with or obstructs public rights of passage or access. For example, where the applicant proposes to construct a dock in a narrow channel, the applicant shall be required to document the extent to which the dock would block or interfere with the passage through this area.**

Under the proposed project, there would be a reduction in trips on east-west roadways including NH 102 and NH 28. The creation of a new parallel route to NH 102 would create a shift in traffic patterns through downtown Derry. The Project will not impact public access to, or passage along, public waters. In fact, the project includes a new underpass crossing at Folsom road that would accommodate a future rail-trail extension. Please see "4.2.2 Traffic and Transportation – Environmental Consequences" in the FEIS and permit plan sheet 16 for additional detail.

**11. The impact upon abutting owners pursuant to RSA 482-A:11, II. For example, if an applicant is proposing to rip-rap a stream, the applicant shall be required to document the effect of such work on upstream and downstream abutting properties.**

Landowners along the project route were afforded several opportunities to review and comment on the Project through public informational meetings and a formal Public Hearing held on December 5, 2018, and their comments have been considered and addressed to the greatest extent possible. The use of appropriate construction BMPs during construction will avoid and minimize impacts to abutting property owners. Design details for stream crossings, including scour stone and riprap have not yet been fully designed, but will be included in final design plans developed by the Design-Builder.

**12. The benefit of a project to the health, safety, and well being of the general public.**

Part of the purpose of the Project is to improve the safe and efficient movement of people, goods, and services between I-93 and the towns served by NH 102, specifically Derry and Londonderry, that are immediately adjacent to I-93 Exit 4; and to provide an alternative route to the Interstate system for traffic using NH 102 to and from the east, thus removing a large volume of through traffic from the heavily congested downtown Derry street network. Reducing traffic congestion on the Derry street network will improve safety by allowing more opportunities for vehicles to find gaps in traffic to make safer traffic turning movements into and across traffic. Reduced traffic will also make it safer for bicyclists and pedestrians to travel. Contiguous sidewalks are being provided throughout the project to improve safety and four- to five-foot wide shoulders are being provided for bicyclists. In addition, the profile (vertical alignment) of Tsienneto Road east of Scenic Drive is proposed to be revised to provide a less abrupt curvature to make it meet minimum AASHTO stopping sight distance standards. The intersection sight distance from Scenic Drive is also proposed to be improved to meet the posted speed standard.

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| **13. The impact of a proposed project on quantity or quality of surface and ground water. For example, where an applicant proposes to fill wetlands the applicant shall be required to document the impact of the proposed fill on the amount of drainage entering the site versus the amount of drainage exiting the site and the difference in the quality of water entering and exiting the site.** |
| The proposed project includes development of new roadway in undeveloped areas or areas with non-roadway current land use as well as redevelopment of existing roadway that would result in new impervious surface within Upper Beaver Brook watershed. Erosion and sedimentation control plans and stormwater plans (attached) were developed to insure that the quantity and quality of surface water moving through the project area is protected during construction and managed post-construction. The addition of new impervious roadway surfaces that contribute additional stormwater runoff to surface waters has the potential to add new TSS and nutrient loads to the watershed. The Project has approximately 1,717,000 square feet of redeveloped and newly developed pavement areas that require treatment. Of the 1,717,000 square feet, approximately 1,528,000 square feet or 89% of the impervious surface is proposed to be treated at 18 water quality treatment areas. Existing pavement that will be redeveloped by this project accounts for 827,700 square feet of the pavement requiring treatment. Currently, none of that pavement has treatment; therefore, implementation of the proposed stormwater treatment should provide a significant improvement in the water quality of the existing watershed. Considering the constraints of the project area and the proposed improvement to the existing condition, stormwater treatment has been provided to the maximum extent practicable. Please see the attached Stormwater Memo (Attachment D) and Section "4.11.2 Surface Waters and Water Quality – Environmental Consequences" in the FEIS for additional detail.<br><br>The proposed project footprint overlaps seven wellhead protection areas. However, several of these public wells are located near each other and therefore share largely overlapping WHPAs that occupy much of the same land area. Please see "4.13.2 Groundwater – Environmental Consequences" in the FEIS for additional detail. |
| **14. The potential of a proposed project to cause or increase flooding, erosion, or sedimentation.** |

The primary area of potential floodplain impact for the proposed project is on the floodplains of Shields Brook and Tributary E, the two perennial streams in the project area. The Project will place approximately 905 CY of fill below the 100-year flood elevation at these two streams. The proposed project would cross the Shields Brook floodplain near the existing Folsom Road/Madden Road crossing. Please see "4.15.2 Floodplains – Environmental Consequences" in the FEIS. New stream crossing locations and extended crossing structures will be designed and constructed to meet NHDES stream crossing rules. Hydraulic analyses have been conducted for Shields Brook and Tributary E to aid design of the bridge crossings and to avoid raising base flood elevations. Excerpts from the two hydraulic reports are attached (Attachment C) and the full reports are available on request. All construction work will employ BMPs to minimize erosion and sedimentation, as shown on the erosion and sedimentation control plans. In addition to short-term erosion and sedimentation controls such as straw bales and silt fence, permanent stormwater treatment features are being designed that will effectively attenuate stormwater volume and flow rates. These features include grassed swales and detention basins. Further details will be provided on final design plans developed by the Design-Builder.

**15. The extent to which a project that is located in surface waters reflects or redirects current or wave energy which might cause damage or hazards.**

While there are no direct impacts to ponds or lakes, and no redirection of wave energy, the Project will alter flow in several streams. Eight existing crossings will likely require culvert extensions or replacements; five intermittent streams will be shifted/relocated along the new connector road or to accommodate roads, ramps or sound walls. Alternatives to the skewed culvert currently shown for Shields Brook will be investigated during final design by the Design-Builder. Temporary disturbance areas and stream channel shifts will require temporary and permanent channel and bank stabilization, which will be detailed in final design, but are accounted for in the impact calculations. The prime wetland outlet crossing (Tributary E) on Tsienneto Road will require a bridge to meet stream rule standards. This upgrade would have the potential to drain the wetland, so final design by the Design-Builder will include a weir to maintain water elevations while accommodating storm flows. All crossings will be designed to pass the 100-year storm event. Table 3 Exit 4A Stream Impact Summary in Exhibit C below, includes additional stream impact information. Additional stream crossing/relocation details will be developed in final design by the Design-Builder. Please see FEIS Section "4.11 Surface Waters and Water Quality" for additional information on water resources.

**16. The cumulative impact that would result if all parties owning or abutting a portion of the affected wetland or wetland complex were also permitted alterations to the wetland proportional to the extent of their property rights. For example, an applicant who owns only a portion of a wetland shall document the applicant's percentage of ownership of that wetland and the percentage of that ownership that would be impacted.**

Cumulative effects (including direct impacts of the proposed project, indirect impacts attributable to the project, and actions by others) are documented in detail in Chapter 5 of the FEIS. Given the uncertainty associated with forecasting future land use changes, potential cumulative impacts to streams, wetlands and vernal pools are expressed as a range (minimum and maximum impacts). The Land Use Scenarios Technical Report provides the basis for the land development assumptions and

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| this report was provided for review to all the participating and cooperating agencies during the SDEIS process. |
| **17. The impact of the proposed project on the values and functions of the total wetland or wetland complex.** |
| Functions and values of affected wetlands were evaluated and are summarized in Exhibit E of this application. Additional information regarding the impacts to wetlands are discussed in "4.12.2 Wetlands and Vernal Pools – Environmental Consequences" in the FEIS. |
| **18. The impact upon the value of the sites included in the latest published edition of the National Register of Natural Landmarks, or sites eligible for such publication.** |
| Not applicable. No listed sites from the National Register of Natural Landmarks occur within Rockingham County, NH. |
| **19. The impact upon the value of areas named in acts of congress or presidential proclamations as national rivers, national wilderness areas, national lakeshores, and such areas as may be established under federal, state, or municipal laws for similar and related purposes such as estuarine and marine sanctuaries.** |
| No national rivers, wilderness areas, national lakeshores or other such sanctuary areas are within or adjacent to the study area. |
| **20. The degree to which a project redirects water from one watershed to another.** |
| All drainage from the project is currently within, and will remain within, the Upper Beaver Brook watershed (Level 12 Hydrologic Unit 010700061025). |
| **Additional Comments** |
| See below. |

## Prime Wetlands

The Town of Derry has designated Prime wetlands, two of which will be directly impacted by the Exit 4A project. The project currently proposes to permanently impact 1,561 square feet (previously 3,265 square feet) of wetlands at the outlet of Prime Wetland B-12 (also known as Wetland 62 on Wetland Plans) north of Tsienneto Road and west of the intersection with NH 102. There will also be temporary impacts of 1,228 sf at this location for construction purposes. The impacts result from the replacement of two side by side culverts on Stream S5 (also referred to as Tributary E) under Tsienneto Road. Under current conditions, the culverts are undersized and result in frequent flooding of the adjacent properties. An open stream crossing with a weir is proposed to maintain water elevations in the prime wetland while allowing additional flow capacity under Tsienneto Road. Improvements to Route 102, including replacement of two existing culverts, will result in an additional 410 sf of permanent impact and 232 sf of temporary impacts to Wetland 62 along the edge of the road.

The project will also permanently impact approximately 155 square feet of Prime Wetland A-01 (identified as Wetland 72 on Wetland Plans) south of Folsom Road and west of Franklin Street for the outlet of a stormwater treatment structure. There will be approximately 100 sf of temporary impacts at this location also, for installation of erosion and sedimentation controls.

In accordance with Env-Wt 703, Prime Wetlands Permit Process, the potential impacts of the project on prime wetlands have been evaluated and described below.

1) There will be no significant net loss of values set forth in RSA 482-A:1;

   RSA 482-A:1 identifies wetlands as valued sources of nutrients for finfish, crustacea, shellfish and wildlife of significant value; habitats and reproduction areas for plants, fish and wildlife of importance; sources of commerce, recreation and aesthetic enjoyment of the public; important for maintenance of adequate groundwater levels and absorption of flood waters and silt. Derry designated Prime Wetlands in 1986, noting that emergent wetland B-12 has a high percentage of vascular plants that filter and regulate the quantity and quality of water flowing to Beaver Lake; is undisturbed and natural, with nature trails; and is connected to other wetlands and waterbodies by streams. It further notes that a beaver dam helps to maintain a large area of open water that attracts wildlife. An improved road crossing of the outlet in a steeply-sided, forested area downstream of the marsh that is designed to meet stream rule standards without draining the marsh will have a negligible effect on wetland habitat values, filtering capabilities, and public access or enjoyment, but will reduce road and property flooding. The Prime Wetland Report indicates that B-12 is 10.1 acres, while the NWI map indicates it is 15.7 acres. Both likely underestimate jurisdictional wetland area. The permanent impact to the wetland is 1,971 sf, which is approximately 0.29 % of the NWI-mapped wetland area.

   Prime Wetland A-01 is a 5-acre emergent and scrub-shrub wetland adjacent to Hood Pond and otherwise surrounded by single and multi-family residences, just south of the channelized portion of Shields Brook. The 155 square feet of permanent impact is 0.07 % of the wetland area, and the stormwater that will be discharged will have been treated in accordance with water quality standards. The Prime Wetland Report notes that this wetland is a buffer between encroaching development and Hood Pond, a Town recreation area. It is hydrologically connected to other waterbodies (Horn Pond) by streams, and the sedges support food chain production. The report also states that a wide variety of wildflowers and many species of birds are present. It notes that Hood Pond was created by a stone dam above Horn Pond dating back to the mid 1800's. Trails are present in Hood Park on the east side of the Pond, but there appears to also be an old road along an easement through the proposed detention basin location on the northeast side of the pond. The basin will continue to buffer Hood Pond from residential development, but not as effectively as the natural habitat it will replace. However, the wetland's ability to provide the principal functions noted by Normandeau scientists, namely flood attenuation, sediment and nutrient retention, shoreline stabilization and wildlife habitat, will not be substantially altered.

2) The project is consistent with the purpose specified in RSA 482-A:1;

   The purpose of the wetland protection law as stated in RSA 482-A:1 is to protect the public good and welfare. Tsienneto Road crosses the outlet stream of the Prime Wetland B-12, and flooding has been a problem due to the undersized culverts. These undersized culverts serve as a dam, impounding flow that forms a small pond adjacent to the road. Approximately 50 feet upstream of the road is a stone wall that crosses the wetland and also impedes flow. Approximately 300 feet upstream of the road is the beaver dam, mentioned in the 1986 Prime wetland Report, which impounds surface water in the large marsh, to the benefit of wetland wildlife as noted in the Prime Wetland report. This crossing will maintain the public values of the marsh, as a weir will be constructed to avoid draining the marsh. The crossing will also protect public welfare by reducing flooding impacts and more safely accommodating traffic.

The treatment of stormwater is also in the public interest, and must be discharged back to surface water, as will occur at Prime Wetland A-01. The basin will be constructed in a previously cleared area adjacent to a multifamily development, but some tree cutting will also be required. This will result in a loss of some limited remaining natural habitat adjacent to the prime wetland.

(3) The project could not be relocated to avoid impacts on prime wetlands without either reducing the public value of the project, or negatively affecting the public health or safety;

The crossing at Prime Wetland B-12 has been designed to minimize wetland impacts while still reducing flooding, improving stream flow, aquatic organism passage, and improving traffic flow. As the road crossing is already present (and predates the designation of the wetland as Prime), the location is unavoidable.

There are limited opportunities but significant need for stormwater treatment in this highly developed project area, and every effort was made to find suitable, low impact solutions that minimize environmental impacts and maximize water quality goals at Prime Wetland A-01.

(4) The project's impacts on prime wetlands are the minimum practical without either reducing the public value of the project, or negatively affecting the public health or safety; and

The Tsienneto Road crossing location at Prime Wetland B-12 is unavoidable, and upgrades are necessary to accommodate a slightly wider road and to meet stream crossing rules. At this time, the impact area is part of the base technical concept design. However, impacts at this location will be reduced as much as possible during final design by the Design-Builder, if it can be accomplished without compromising the value of the project or public safety and health. Safety improvements that encroach slightly on this wetland where it abuts Route 102 are also the minimum necessary.

The 155 sf permanent impact to Prime Wetland A-01 is the minimum necessary for this stormwater infrastructure outfall. Safety fencing will keep the public out of the stormwater basin.

(5) The project incorporates appropriate and practicable compensatory mitigation for each of the wetland functions and values of RSA 482-A:1, and each of the functions and values ranked by the municipality, that are impacted by the project. The mitigation proposed shall be appropriate in terms of matching the proposed benefit given the relative harm of the project. The mitigation shall be practicable given the technology available at the time of this application.

The impacts to the functions and values of Prime Wetland B-12 are expected to be negligible, due to the location of the impacts at the outlet channel over 300 feet downstream of the marsh proper. However, the direct impact quantities as well as indirect "edge effect" impacts, as required by the USACE 2016 Mitigation Guidance document, have been included in the ARM fund calculation. In addition, a low-flow channel will be built into the weir structure to accommodate fish/aquatic organism passage and improve connectivity for aquatic organisms. Direct impacts to Prime Wetland A-01 for a stormwater outlet is also minimal, and included in ARM fund calculations for both direct impacts and edge effect impacts, following NHDES and USACE regulations and guidance.

## Vernal Pool impact and Mitigation Assessment

The assessment of vernal pool impacts in accordance with the 2016 USACE mitigation guidelines is summarized in Table 1. Details regarding the application of the guidance was provided to the project team in a meeting on March 15, 2019 (Attachment E).The analysis of the vernal pool value change was based on a GIS assessment of the post-construction land area quantities and classification within the 100-ft Vernal Pool Envelope and 750- ft Critical Terrestrial Habitat. The new quantities for each land classification were entered into the USACE habitat evaluation worksheet and the vernal pool quality re-evaluated and compared to the pre-construction evaluation (Table 2). Mitigation is proposed for all pools with loss of one or more value class.

**Table 1. Exit 4A Vernal Pool Impacts for Mitigation**

| VERNAL POOL ID | PLAN IMPACT CODE | DIRECT PERM IMPACT (SF) | SECONDARY IMPACT TYPE | VALUE CHANGE OR LOSS | IMPACT EQUIVALENT |
|---|---|---|---|---|---|
| VP2 | F | 7,236 | Permanent loss | M value loss | 39,000 |
| VP3 | J | 9,387 | Value drop | M to L drop | 26,000 |
| VP4 | P | 9,278 | Permanent loss | M value loss | 39,000 |
| VP6 | AO | 15,631 | Permanent Loss | M value loss | 39,000 |
| VP8 | AX | 10,722 | Permanent Loss | H value loss | 65,000 |
| VP9 | BC | 3,335 | Permanent Loss | H value loss | 65,000 |
| VP42 | AF | 5,415 | Permanent loss | M value loss | 39,000 |
| VP46 | AL | 611 | Value drop | H to M drop | 26,000 |
| VP64 | | (buffer only) | Value drop | H to M drop | 26,000 |
| **Perm Direct Impact Area:** | | **61,615** | **Secondary Impact Area:** | | **364,000** |

**Table 2. Exit 4A Vernal Pool Value Change[1] Post-Construction for Vernal Pools not Lost[2]. Highlighted Rows Indicate a Drop in Value.**

| VP ID | Current Landscape Score | Post-Const. Landscape Score | Score Change | Pool Score (unchanged) | Current VP Value[3] | Post-Const. VP Value[3] |
|---|---|---|---|---|---|---|
| PVP 87 | 10.61 | 4.77 | -5.84 | X | L | L |
| VP 03 | 18.30 | 14.74 | -3.55 | 16 | M | M[4] |
| VP 05 | 25.38 | 17.47 | -7.91 | 17 | M | M |
| VP 07 | 29.54 | 22.58 | -6.95 | 16 | M | M |
| VP 11 | 13.83 | 12.62 | -1.21 | 14 | M | M |
| VP 12 | 21.99 | 19.80 | -2.19 | 20 | M | M |
| VP 13 | 29.49 | 23.56 | -5.93 | 20 | M | M |
| VP 22 | 28.41 | 28.39 | -0.02 | 16 | M | M |
| VP 23 | 26.78 | 26.67 | -0.11 | 16 | M | M |
| VP 27 | 21.44 | 21.35 | -0.09 | 16 | M | M |
| VP 28 | 16.97 | 16.88 | -0.09 | 18 | M | M |
| VP 29 | 16.26 | 16.21 | -0.05 | 22 | M | M |
| VP 44 | 26.79 | 23.30 | -3.49 | 18 | M | M |
| VP 46 | 30.16 | 20.41 | -9.75 | 22 | H | M |
| VP 47 | 27.98 | 23.48 | -4.50 | 22 | H | H |
| VP 48 | 28.72 | 25.19 | -3.53 | 22 | H | H |
| VP 49 | 28.89 | 27.78 | -1.12 | 20 | M | M |
| VP 54 | 22.88 | 21.26 | -1.62 | 18 | M | M |
| VP 56 | 27.37 | 26.85 | -0.52 | 4 | L | L |
| VP 57 | 28.90 | 27.97 | -0.94 | 21 | H | H |
| VP 58 | 27.99 | 27.57 | -0.42 | 21 | H | H |
| VP 59 | 30.39 | 30.34 | -0.05 | 22 | H | H |
| VP 60 | 28.55 | 28.04 | -0.51 | 20 | M | M |
| VP 63 | 29.57 | 25.91 | -3.66 | 24 | H | H |
| VP 64 | 24.63 | 18.53 | -6.10 | 21 | H | M |

1 –Based on the USACE Vernal Pool Characterization Worksheets.
2 – Vernal Pools judged to be lost include 2, 4, 6, 8, 9 and 42, and are already included in mitigation calculations.
3 - Low value vernal pools have a landscape score of 11 or less or a pool score of 10 or less. Medium value vernal pools have a landscape score of 12 to 22 and a pool score of 11 to 20. High value vernal pools have a landscape score of 23 or more and a pool score of 21 or more. The lower of the two scores determines vernal pool value.
4 – Although not indicated by the post-construction worksheet, professional judgement was applied to determine that VP 3 would also likely drop in value.

# Exhibit B - NHDOT Bureau of Environment Conference Reports

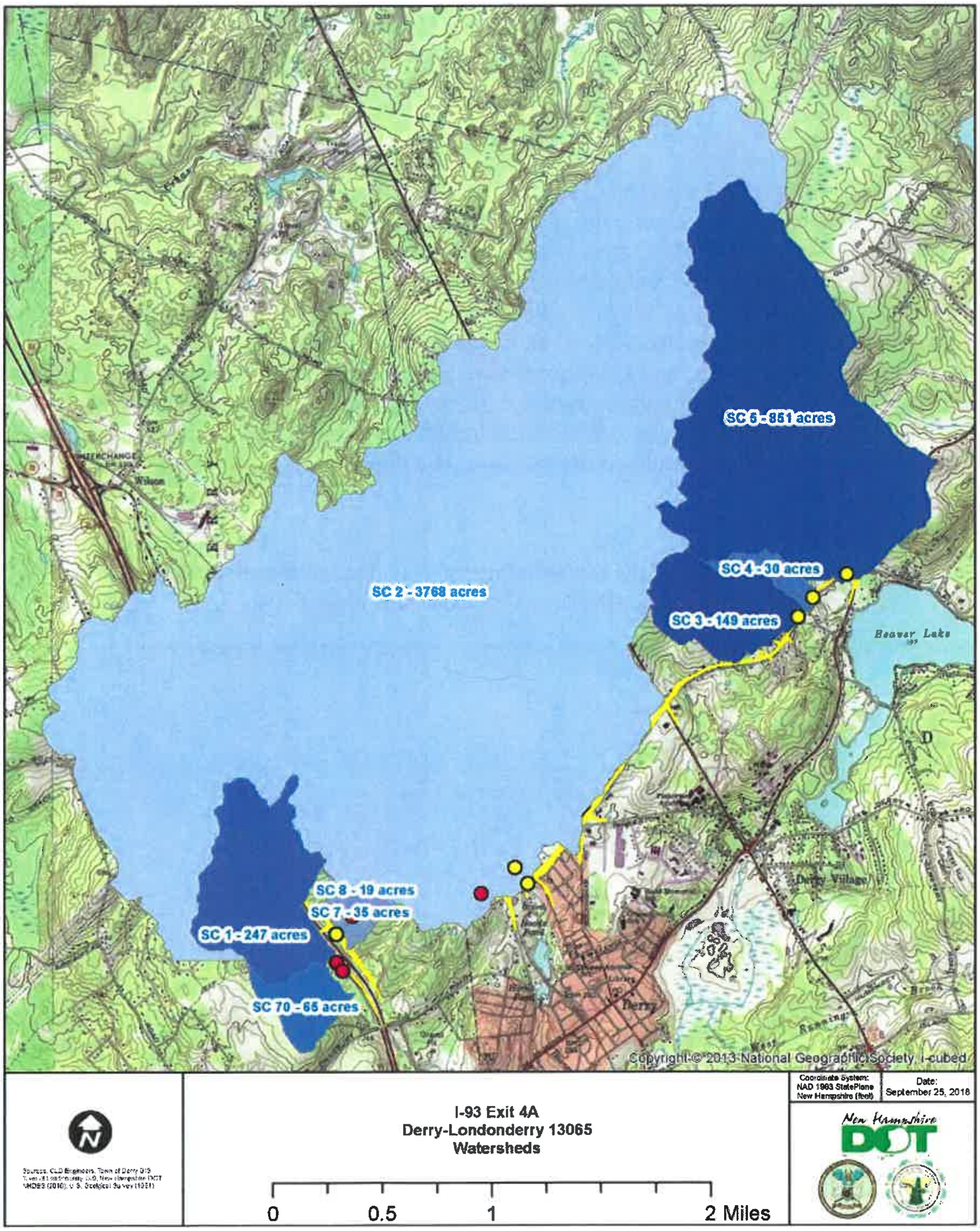
The project was reviewed on the following dates:

| | | | | | | |
|---|---|---|---|---|---|---|
| 5/28/1997 | 3/17/1999 | 6/16/1999 | 10/20/1999 | 11/17/1999 | 8/16/1999 | 9/20/2000 |
| 7/18/2001 | 8/17/2005 | 3/15/2006 | 5/16/2007 | 1/20/2016 | 2/17/2016 | 10/19/2016 |
| 4/18/2018 | 6/20/2018 | | | | | |

Minutes can be found at the link below under Derry-Londonderry 13065:

https://www.nh.gov/dot/org/projectdevelopment/environment/units/project-management/nracrmeetings.htm

## Exhibit C – Streams and Watershed Boundaries



## Env-Wt 900 Stream Crossing Requirements

As currently proposed, the project will incur impacts to 13 streams, two of which are perennial streams. Stream crossings and stream impacts are described in Section 4.14.2, "Aquatic Life and Essential Fish Habitat, Environmental Consequences" in the FEIS. Stream crossings are summarized in Table 3, below.

Hydraulic analyses have been completed for Shields Brook and Tributary E of Beaver Brook. The narrative portion of the hydraulic reports are attached (Attachment C). The full preliminary reports can be provided upon request. Stream surveys have also been completed for Shields Brook and Tributary E (Attachment G), and the assessment data is being incorporated into the stream crossing designs. The Type, Span and Location Studies for the Tributary E and Shields Brook crossings are also attached (Attachment H). Table 4 summarizes the improvements in hydraulic compatibility, geomorphic compatibility, and aquatic organism passage provided by the replacement of these existing, undersized culverts with new bridge spans. Currently, the stream and bank impacts associated with the crossing replacements are included in the ARM fund calculations. However, these crossings may be considered self-mitigating due to the substantial improvements in compatibility.

Final analyses and designs for the remaining stream crossings in the project area will be completed for the final design developed by the Design-Builder of the project.

**Table 3. Exit 4A Stream Permanent Impact Summary**

| Cross-ing | Flow Regime[a] Classification | Tier | Water-shed Size (Acres)[c] | Existing Crossing | Location | Activity Description | Linear Feet of Channel/ Bank Impact [d] | Relevant NHDES Stream Rule Criteria to be met |
|---|---|---|---|---|---|---|---|---|
| 1 | Intermittent[b] R4SB3 (Wheeler Pond Tributary) | 2 | 269 | No crossing; relocation proposed | New access ramp W of I-93 at southern Exit 4A interchange -71°20'56" 42°53'4" | Relocate stream channel to west for southbound off ramp construction. Use reference reach stream morphology data[e] (Attachment B) for stream simulation. | 1,719 *Self-Mitigating* | Env-Wt 904.05 Design Criteria for Tier 2 Stream Crossings |
| 2 | Perennial R3UB3 (Shields Brook) | 3 | 3,767 | 72" CMP | N. High St - between Ferland Drive and Franklin St -71°19'54 42°53'23" | Replace culvert with Bridge and extend; restore channels, banks and wetlands. Design-Build team to design stream simulation. | 247/511 | Env-Wt 904.05 Design Criteria for Tier 2 and Tier 3 Stream Crossings |
| 3 | Intermittent R4SB5 | 1 | 148 | 15" HDPE | Tsienneto Road - Approx. 200 ft west of Scenic Drive -71°18'26" 42°54'27" | Extend culvert to accommodate road widening. | 57 | Env-Wt 904.02 Tier 1 Stream Crossings |
| 4 | Intermittent R4SB5 | 1 | 30 | 15" unknown material culvert | Tsienneto Road - between Scenic Drive and Jeff Lane -71°18'21" 42°54'31" | Extend culvert to accommodate road widening. | 75 | Env-Wt 904.02 Tier 1 Stream Crossings |
| 5 | Perennial R3UB3 (Tributary E) | 3 | 850 | 30" and 36" CMPs | Tsienneto Road - 250 ft west of NH 102 -71°18'10 42°54'37 | Replace culverts with bridge; include weir to maintain marsh. Grade banks to direct flows and revegetate. Design-Build team to design stream simulation. | 11/32 | Env-Wt 904.05 Design Criteria for Tier 2 and Tier 3 Stream Crossings |

| Cross-ing | Flow Regime[a] Classification | Tier | Water-shed Size (Acres)[c] | Existing Crossing | Location | Activity Description | Linear Feet of Channel/ Bank Impact [d] | Relevant NHDES Stream Rule Criteria to be met |
|---|---|---|---|---|---|---|---|---|
| 7 | Intermittent R4SB5 | 1 | 35 | 24" RCP (two pipes, one under SB and one under NB) | New access ramp - E of I-93 at southern interchange -71°20'56 42°53'11 | Extend culvert under new I-93 northbound off-ramp, southbound on-ramp, and Connector Road. | 233 | Env-Wt 904.02 Tier 1 Stream Crossings |
| 8 | Intermittent R4SB5 | 1 | 19 | None | New Connector Road - 500 ft E of I-93 71°20'51" 42°53'15" | Construct new stream crossing/relocate stream for connector road. | 291 | Env-Wt 904.02 Tier 1 Stream Crossings |
| 9 | Ephemeral R4SB5 | 1 | 26 | None | 42°53'3", - 71° 20'44" | Stream relocation | 23 | Env-Wt 904.02 Tier 1 Stream Crossings |
| 11 | Ephemeral R4SB5 | 1 | Undeter-mined | None | New Connector Road- 300 ft N of Madden Road -71°20'9" 42°53'21" | Stream relocation. | 77 | Env-Wt 904.02 Tier 1 Stream Crossings |
| 70 | Intermittent R4SB5 | 1 | 65 | None | New access ramp W of I-93 at southern Exit 4A interchange -71°20'56" 42°53'4" | Stream relocation. | 70 | Env-Wt 904.02 Tier 1 Stream Crossings |
| 100 | Intermittent R4SB5 | 1 | 32 | 15" CMP | 42°54'32" 71°18'19" Station 1159 + 10 | Outfall pipe from closed system – to be removed | 22 | Env-Wt 904.02 Tier 1 Stream Crossings |
| 101 | Intermittent R4SB2 | 1 | 32 | 30" CMP | 42°54'10" -71°19'3" Station 1117 + 00 | Separate culvert and closed drainage, extend/replace culvert as needed | 13 | Env-Wt 904.02 Tier 1 Stream Crossings |
| 102 | Intermittent R4SB2 | 1 | 32 | 24" RCP | 42°54'43" -71°18'3" Rt 102 Station 421 + 10 | Extend culvert | 41 | Env-Wt 904.02 Tier 1 Stream Crossings |

a Flow regime based on observation and watershed size, except for Crossing 1 (see footnote B). In the absence of long term monitoring for streams in the project area, streams with watersheds smaller than 200 acres were assumed to be intermittent; larger than 200 acres were assumed to be perennial. Ephemeral stream met NHDES definition – unable to determine watershed size using Streamstats.

b Based on NHDOT observations in 2014 for the Stream Crossing Assessment report, the classification of this stream as intermittent for the I-93 project, and additional Normandeau photos of dry streambed in 2010, the Wheeler Pond tributary classification has been changed from perennial to intermittent.

c Watershed sizes based on Streamstats basin delineation: https://streamstats.usgs.gov/ss/.

d Linear disturbance quantities are for permanent impacts; additional temporary impacts are included in the application form.. Bank impacts for perennial streams only, both banks included.

e NHDOT Bureau of Environment Stream Crossing Assessment Report, 10/07/2014; and Normandeau Associates, Inc. Stream Relocation Assessment and Conceptual Restoration Plan November 2010.

**Table 4. Compatibility Assessment for Proposed Perennial Stream Crossings**

| Stream Name/ Tier/Rosgen | Crossing Structure | | Hydraulic Compatibility | | Geomorphic Compatibility | | Aquatic Organism Passage | |
|---|---|---|---|---|---|---|---|---|
| | Current | Proposed | Current | Proposed | Current | Proposed | Current | Proposed |
| Shields Brook<br>Tier 3<br>Rosgen C4 | 72" CMP in poor condition[1] | 52' Clear Span beam bridge (63' centerline)[2] | Undersized, floods at storms > 2-yr event[2] | Passes 100-yr flood[2] | Mostly incompatible[1] >7% slope[3] slight scour pool[3], 22° skew[2] | Compatible, banks spanned, 30° skew[2], natural substrate possible | Reduced[1] Affects wild eastern brook trout and redfin pickerel (SC) | AOP greatly enhanced: natural substrate, no constriction[2] |
| Tributary E<br>Tier 3<br>Rosgen C5/C6 | 30" and 36" CMP in good condition[1] | 40' Clear Span slab bridge (50' centerline)[2] | Floods at storms > 25-yr event[2] Culverts partially blocked w/debris[3] | Passes 100-year flood, but holds back $\leq$ 2-yr event[2] | Wetland, not assessed[1] 30° Skew[2] | Improved, bank re-established, skew reduced[2], natural substrate possible | No passage[1] Perched and blocked culverts[3] | AOP Improved: Bridge and low-flow weir will pass aquatic organisms[2] |

1 - Source- Aquatic Restoration Mapper (https://www.arcgis.com/apps/webappviewer/index.html?id=21173c9556be4c52bc20ea706e1c9f5a)
2 - Source - TSL Report (Application Attachment H)
3 - Source - Stream Survey Report (Application Attachment G)

# Exhibit D - Mitigation

Mitigation plans have not been finalized at this design stage. NHDOT is committing to working with the Towns of Londonderry and Derry to evaluate local stream crossing locations that would qualify for improvement funding as part of the Stream Passage Improvement Program (SPIP) agreement with NHDES to upgrade culverts within the Beaver Brook watershed. Additionally, a potential 35 acre preservation parcel in Derry (Sakr parcel) adjacent to Ballard Pond and Ballard State Forest suggested to the DOT by the Derry Conservation Commission is being evaluated.

Other than culvert improvements to be made through the SPIP and the potential preservation site in Derry, presently mitigation is proposed to be a payment to the Aquatic Resource Mitigation (ARM) fund. With the final determination of the applicability of culvert improvements and the preservation of the Sakr parcel site as mitigation, the in-lieu fee ARM payment would be reduced to reflect the values of these permittee-responsible mitigation efforts. Proposed mitigation for previous iterations of the Exit 4A project had incorporated elements of stream restoration, vernal pool creation, and land preservation. A summary of the history of mitigation package development follows.

## Exit 4A Mitigation history

The Project investigated several potential mitigation parcels suggested by both Derry and Londonderry in 2012. The parcels in Londonderry were first identified as priorities in a 2006 Open Space Task Force report. The Derry parcels were identified by the Derry Conservation Commission. Landowners were contacted and baseline documentation reports and maps were drafted for some of the most promising properties, including the Caras and Sawyer properties, and discussed with local, state and federal agencies, as described below. Meeting notes are in Attachment D.

**9/18/12** – A mitigation natural resource agency meeting was held with CLD, NAI, EPA, USACE, NHDES, Derry, and Londonderry. Proposed mitigation was for 3.48 acres of proposed wetland impact and impact to seven vernal pools – six direct, one by impacts of over 25% 250-foot critical habitat buffer. Mitigation included relocation of the stream east of Trolley Car Land along the Exit 4A southbound on-ramp and creation of riparian buffer, preservation of 125 acre Caras Property, and creation of five clusters of three vernal pools on the Caras Property. The developers identified a 30-acre parcel for protection and vernal pool creation. M. Kern indicated that he thought there should be more preservation than 125 acres for long term sustainability for the highway and that 30 acres was insufficient for the development. The project team planned to discuss additional mitigation approaches with the Developers and the Towns, and then revise the compensation packages and resubmit to the regulatory agencies. Mr. Roach suggests creating a Limited Access Highway and precluding development access to the interchange until mitigation costs for the development are recouped.

**12/11/12** – Natural resource agency meeting (at CLD): CLD, NAI, NWR, NHDOT, NHDES, USACE, USEPA, FHWA in attendance: The modified mitigation package discussed includes 134 acres of Caras parcels. M. Kern said the proposed mitigation would only mitigate half of the 7 vernal pool impacts. For guidance it was suggested that \$250K would compensate for one high quality VP. M. Kern stated that it would take at least \$1 million of an ILF payment to complete the package for the highway alone, but that the amount should be worked out with the Corps mitigation staff and other agencies. He further said mitigation for the Hyrax/Pillsbury development should include ILF payment, protecting a large area with many valuable vernal pools and VP creation in a large, sustainable area. If only ILF is offered, it would likely cost at least $5 million.

**2016** – Normandeau conducts field investigations on the Caras Parcel.

**2017** - The western Caras parcel (identified as Parcel 070 on Town of Derry Tax Map 020) was purchased by the Town of Derry on 7/19/2017 for groundwater protection. The Town of Derry purchases the Sawyer property at some time between 2012 and 2018.

**6/20/18** - Natural Resource Agency meeting at NHDOT - the proposed mitigation of ARM fund payment and SPIP was presented. No in-lieu fee calculations were presented at the meeting.

**6/26/18** – The stream relocation (east of Trolley Car Lane) should be included in the proposed mitigation package. The western Caras parcel (identified as Parcel 070 on Town of Derry Tax Map 020) was purchased by the Town of Derry on 7/19/2017 and it is unknown if the parcel could be used for wetland mitigation, or whether the other parcels are still available. Creation of vernal pools is not expected to be pursued as regulatory agencies have moved away from vernal pool creation. It is expected that mitigation will be primarily an in-lieu fee.

**7/2/18** - Steering Committee Meeting, NHDOT, Town of Derry, Town of Londonderry, F&O: F&O explain that in 2012, the Sawyer and Caras parcels in Derry were the best available mitigation options, but the towns have purchased these parcels for other purposes. DOT asked each Town to coordinate with their Conservation Commissions and get feedback from them if they have a prioritized listing on conservation parcels. NHDOT provided a list of culverts in the Beaver Brook watershed that have been identified for potential improvements as part of the SPIP and asked each Town to review the list and provide a prioritized list of culverts for consideration.

**3/15/19** – Mitigation meeting, NHDOT, Town of Derry, Town of Londonderry, F&O, Normandeau, USEPA, USACE, NHDES: After a recap of the project design and purpose by NHDOT, mitigation for stream impacts and vernal pools was discussed. NHDOT presented information on five culverts that DOT was assessing for possible mitigation under the Stream Passage Improvement Program (SPIP). Two were proposed by the Town of Derry, and three are on State roads. NHDES gave approval for continued evaluation of culverts for possible SPIP program. USACE and USEPA then provided guidance on calculating impacts to vernal pools for inclusion in the ARM fund as presented in the 2016 Mitigation Guidance document. The mitigation will address direct fill quantities, functional loss of pools that will be totally impacted, and value loss for pools partially or indirectly impacted. Overlapping wetland edge effect impacts can be eliminated. NHDES requested a follow-up meeting to discuss the results of the recalculation of impacts and mitigation. Additionally, a review of a potential preservation parcel in Derry adjacent to Ballard Pond and Ballard State Forest was recently suggested to the DOT by the Derry Conservation Commission was discussed. An evaluation of the property will be conducted in early spring 2019 by DOT in consultation with NHDES and USACE. If suitable the ARM fund payment will be adjusted based on the USACE preservation mitigation values.

## Exit 4A Proposed In-Lieu Fee Summary

The estimated total in-lieu fee for this project is **$3,769,086.39** as summarized in Table 5.

**Table 5. Exit 4A Proposed In-Lieu Fee Summary**

| Resource | Impact Quantity | In Lieu Fee Estimate | Assumptions |
|---|---|---|---|
| All Wetlands[1] | 210,643 sf (4.84 acres) | $1,061,965.82 | Includes direct impacts to wetlands/vernal pools in accordance with NHDES Rules Wt 800. |
| Secondary Impacts "Edge Effects" | 89,298 sf (2.05 acres) | $450,199.74 | Mitigation for secondary "Edge Effects" are calculated as recommended in the 2016 USACE Mitigation Guidance. |
| Vernal Pools Loss | 286,000 sf (6.57 acres) | $1,441,881.41 | Mitigation for functional loss of 4 medium and 2 high value vernal pools[2] based on ratios recommended in 2016 USACE Mitigation Guidance |
| Vernal Pools - Secondary | 78,000 sf (1.79 acres) | $393,240.38 | For partially or indirectly impacted vernal pools, modeled to drop in value[2] |
| Streams[3] | 1,703 lf | $421,799.04 | Impacts to channels of all streams and banks of perennial streams in accordance with NHDES Rules Wt 800. |
| **TOTAL** | | **$3,769,086.39** | |

1- 24,210 sf of wetland impacts permitted under the I-93 Project were subtracted as they have been previously mitigated.

2- See table in Attachment A, and also below in ARM fund calculations.

3- Stream S1 is considered self-mitigating, as there is sufficient data for stream simulation when the stream is relocated. Stream S1 has also been determined to be intermittent.

## Proposed Wetland Mitigation - Direct Impacts

Direct vegetated wetland impacts for the Exit 4A Project as currently proposed are listed in Table 6. Direct impacts are measured on project plans, and include the area of the wetland directly filled by footprint of the project; or, in the Case of Wetland 64 and Vernal Pool 9, may be drained; or, as in the case of Wetland 19 and Vernal Pool 42, will likely remain as a non-functional wetland remnant.

**Table 6. Proposed Direct Wetland Impacts**

| Cowardin | Impact (SF) | Impact (Acres) |
|---|---:|---:|
| PFO (forested) | 161,605 | 3.710 |
| Prime (PSS/EM and PSS) | 2,126 | 0.049 |
| PSS (scrub-shrub) | 852 | 0.020 |
| PEM (emergent) | 8,655 | 0.199 |
| Vernal Pools | 61,615 | 1.414 |
| **SubTotal** | **234,853** | **5.391** |
| Previously mitigated impacts (I-93) | -24,210 | 0.556 |
| **Total** | **210,643** | **4.835** |

## In-Lieu fee Estimated Payment for Direct Vegetated Wetland Impacts

Using the 2018 In-Lieu Fee Calculator, the in-lieu fee for direct wetland impacts, not counting streams but including vernal pools as forested wetlands, is estimated at $1,061,965.82.

**Table 7. In-Lieu Fee Calculation for Direct Wetland Impact**

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

| | | |
|---|---|---|
| **1** | **Convert square feet of impact to acres:** | |
| **INSERT SQ FT OF IMPACT** | Square feet of impact = | 210643.00 |
| | | 43560.00 |
| | Acres of impact = | 4.8357 |
| **2** | **Determine acreage of wetland construction:** | |
| | Forested wetlands: | 7.2535 |
| | Tidal wetlands: | 14.5071 |
| | All other areas: | 7.2535 |
| **3** | **Wetland construction cost:** | |
| | Forested wetlands: | $647,091.45 |
| | Tidal Wetlands: | $1,294,182.90 |
| | All other areas: | $647,091.45 |
| **4** | **Land acquisition cost (See land value table):** | |
| **INSERT LAND VALUE FROM TABLE WHICH APPEARS TO THE LEFT. (Insert the amount do not copy and paste.)** | Town land value: | 32795 |
| | Forested wetlands: | $237,880.07 |
| | Tidal wetlands: | $475,760.14 |
| | All other areas: | $237,880.07 |
| **5** | **Construction + land costs:** | |
| | Forested wetland: | $884,971.52 |
| | Tidal wetlands: | $1,769,943.04 |
| | All other areas: | $884,971.52 |
| **6** | **NHDES Administrative cost:** | |
| | Forested wetlands: | $176,994.30 |
| | Tidal wetlands: | $353,988.61 |
| | All other areas: | $176,994.30 |
| ************ | **TOTAL ARM PAYMENT************ | |
| | Forested wetlands: | $1,061,965.82 |
| | Tidal wetlands: | $2,123,931.65 |
| | All other areas: | **$1,061,965.82** |

## Secondary Impacts (Edge Effects)

The US Army Corps of Engineers 2016 Mitigation guidance also provides ratios for temporary fill, permanent conversion (forested to emergent) and secondary impact edge effects. The guidelines recommend that a portion of the standard amount of mitigation that would be required if a wetland were directly impacted should be added to the total if the project is within the "Impact Zone" of the project. The size of the Impact Zone varies by wetland type, and Impact Zones are broken into two types, depending on proximity to the project, with "High Level Impact Zone" being the closer portion, and requiring more mitigation than the rest of the impact zone. Impact zones were measured from the toe of slope or edge of cut. Since overlapping impact areas are not to be double counted, edge effects that overlap vernal pool secondary impact areas were subtracted.

Temporary fill and permanent conversion of wetland type are unlikely to be significant in this project. Secondary Impact Edge Effects are tabulated in Table 8. Secondary Impact Edge Effects were tabulated for areas of new alignment, road widening, and proposed stormwater treatment areas.

**Table 8. USACE Recommended Secondary Impact Edge Effects (from Table C2, Page 58 in 2016 USACE Guidance)**

| Wetland Type | Impact Zone[a] | Acreage in Impact Zone (30% Design) | % of Standard Amount | Acreage to be mitigated |
|---|---|---|---|---|
| Palustrine Emergent | 25 | 0.23 | 25% | 0.06 |
| | 75 | 0.50 | 10% | 0.05 |
| Scrub Shrub | 50 | 0.97 | 25% | 0.24 |
| | 100 | 2.46 | 10% | 0.25 |
| Forested | 50 | 2.77 | 25% | 0.69 |
| | 150 | 7.61 | 10% | 0.76 |
| | | | Total | 2.05[b] |

Notes – a USACE identifies "High level impact zones" and "remainder of impact zone" for emergent, scrub shrub, and forested wetlands. The amount of mitigation required is a percentage of what would be required for direct impacts.

b Secondary impact edge effects were refined after June 20, 2018 Natural Resource Agency meeting, again after the 3/15/19 meeting with state and federal wetland regulators, and after stormwater BMP design.

### In-Lieu fee Estimated Payment for Secondary Edge Effect Impacts

Secondary Impact Edge Effects add an estimated **$450,199.74** to the fee.

**Table 9. In-Lieu Fee Calculation Secondary Edge Effect Impacts**

| | | |
|---|---|---|
| **NHDES AQUATIC RESOURCE MITIGATION FUND<br>WETLAND PAYMENT CALCULATION<br>***INSERT AMOUNTS IN YELLOW CELLS***** | | |
| 1 | **Convert square feet of impact to acres:** | |
| INSERT SQ FT OF IMPACT | Square feet of impact = | 89298.00 |
| | | 43560.00 |
| | Acres of impact = | 2.0500 |
| 2 | **Determine acreage of wetland construction:** | |
| | Forested wetlands: | 3.0750 |
| | Tidal wetlands: | 6.1500 |
| | All other areas: | 3.0750 |
| 3 | **Wetland construction cost:** | |
| | Forested wetlands: | $274,321.83 |
| | Tidal Wetlands: | $548,643.65 |
| | All other areas: | $274,321.83 |
| 4 | **Land acquisition cost (See land value table):** | |
| INSERT LAND VALUE FROM TABLE WHICH APPEARS TO THE LEFT. (Insert the amount do not copy and paste.) | Town land value: | 32795 |
| | Forested wetlands: | $100,844.63 |
| | Tidal wetlands: | $201,689.25 |
| | All other areas: | $100,844.63 |
| 5 | **Construction + land costs:** | |
| | Forested wetland: | $375,166.45 |
| | Tidal wetlands: | $750,332.90 |
| | All other areas: | $375,166.45 |
| 6 | **NHDES Administrative cost:** | |
| | Forested wetlands: | $75,033.29 |
| | Tidal wetlands: | $150,066.58 |
| | All other areas: | $75,033.29 |
| ************ | **TOTAL ARM PAYMENT************* | |
| | Forested wetlands: | $450,199.74 |
| | Tidal wetlands: | $900,399.48 |
| | All other areas: | $450,199.74 |

## Vernal Pool Loss Mitigation

The 2016 USACE Mitigation Guidance provides recommendations for in-lieu payments based on the quality of vernal pools that will be eliminated. This applies to vernal pools that receive direct fill by the project and judged unlikely to function as vernal pools due to that fill, even if some wetland remains. This functional mitigation requirement is in addition to the direct fill mitigation previously calculated. Vernal pool quality is evaluated using the USACE's "Vernal Pool Characterization" form[1] that provides a scoring system for low, medium, and high quality vernal pools based on the characteristics of the vernal pool itself and of the surrounding landscape. For Exit 4A, the USACE scoring system in the Vernal Pool Characterization Form was applied to the six vernal pools that will be lost to the Project. There are four medium quality and two high quality vernal pools that will be substantially impacted and probably cease to function as vernal pools. These are VPs 2, 4, 6, 8, 9 and 42 on the plan set. Therefore, recommended mitigation under the USACE Guidance would be as provided in Table 10. The loss of VP9 is a conservative assessment, as this pool is not directly filled, but the adjacent road cut may alter the hydrology substantially.

### In-Lieu Fee Estimated Payment for Vernal Pool Loss

The 2016 USACE Guidance recommends a vernal pool functional loss mitigation ratio of 1:1 (low quality): 1:3 (medium quality): 1:5 (high quality). These ratios are applied as a 13,000 factor per pool for in-lieu fee calculations. This factor is based on an equivalent cost of preserving one vernal pool. Following this guidance, a factor of 13,000 is applied to the ARM fund calculator for each low value vernal pool, 39,000 for each medium value pool, and 65,000 for each high value pool. Using this guidance, the total factor applied for mitigation of lost vernal pool function for four medium and two high value pools would be 286,000. This is the square foot area entered into the ARM fund calculator for vernal pool loss.

**Table 10. USACE Recommended In- Lieu Fee Multiplier for Vernal Pool Loss (from USACE 2016 Mitigation Guidance, Page 95)**

| Vernal Pool Characterization | Recommended ratio for preservation | Number of lost vernal pools | USACE impact multiplier required per pool | Number of lost vernal pools x USACE multiplier |
|---|---|---|---|---|
| High | 1:5 | 2 | 65,000 | 130,000 |
| Medium | 1:3 | 4 | 39,000 | 156,000 |
| Low | 1:1 | 0 | 13,000 | 0 |
| | **TOTAL** | | | **286,000** |

In addition to the in-lieu fee payment for 1.41 acres of vernal pool fill included in the wetland ARM fund calculation, the additional estimated payment for vernal pools loss is **$1,441,881.41** as detailed in Table 11.

[1]http://www.nae.usace.army.mil/Portals/74/docs/regulatory/StateGeneralPermits/NEGP/VPCharacterizationFormDRAFT.pdf

**Table 11. In-Lieu Fee Calculation for Vernal Pool Loss**

| | | |
|---|---|---|
| **NHDES AQUATIC RESOURCE MITIGATION FUND<br>WETLAND PAYMENT CALCULATION<br>***INSERT AMOUNTS IN YELLOW CELLS***** | | |
| 1 | **Convert square feet of impact to acres:** | |
| **INSERT SQ FT OF IMPACT** | Square feet of impact = | 286000.00 |
| | | 43560.00 |
| | Acres of impact = | 6.5657 |
| 2 | **Determine acreage of wetland construction:** | |
| | Forested wetlands: | 9.8485 |
| | Tidal wetlands: | 19.6970 |
| | All other areas: | 9.8485 |
| 3 | **Wetland construction cost:** | |
| | Forested wetlands: | $878,586.78 |
| | Tidal Wetlands: | $1,757,173.56 |
| | All other areas: | $878,586.78 |
| 4 | **Land acquisition cost (See land value table):** | |
| **INSERT LAND VALUE FROM TABLE WHICH APPEARS TO THE LEFT. (Insert the amount do not copy and paste.)** | Town land value: | 32795 |
| | Forested wetlands: | $322,981.06 |
| | Tidal wetlands: | $645,962.12 |
| | All other areas: | $322,981.06 |
| 5 | **Construction + land costs:** | |
| | Forested wetland: | $1,201,567.84 |
| | Tidal wetlands: | $2,403,135.68 |
| | All other areas: | $1,201,567.84 |
| 6 | **NHDES Administrative cost:** | |
| | Forested wetlands: | $240,313.57 |
| | Tidal wetlands: | $480,627.14 |
| | All other areas: | $240,313.57 |
| ************ | **TOTAL ARM PAYMENT*********** | |
| | Forested wetlands: | $1,441,881.41 |
| | Tidal wetlands: | $2,883,762.82 |
| | All other areas: | $1,441,881.41 |

## Vernal Pool Secondary (indirect) Impact Mitigation

The 2016 USACE Mitigation Guidance also provides recommendations for additional in-lieu fee payments for vernal pools that will be partially impacted or that will have impacts to their Critical Terrestrial Habitat (a 750 ft. buffer around each pool) that would reduce their vernal pool value. Value loss is determined by scoring the landscape portion of the USACE "Vernal Pool Characterization" form[2] and identifying any pools whose combined current landscape plus pool value drops from high to medium, high to low, or medium to low under the built condition. Based on our GIS analysis and USACE review of the project footprint impacts to vernal pools and their critical terrestrial habitat, three vernal pools will be affected sufficiently to drop in value due to project impacts, but will likely continue to function as vernal pools in the near term. Vernal pools 3 and 46 have direct pool impacts, and pool 64 will have impacts to the critical terrestrial habitat that results in a drop in value. Therefore, recommended mitigation under the USACE Guidance would be as provided in Table 12 and described below.

### In-Lieu Fee Estimated Payment for Vernal Pool Secondary (Indirect) Impacts

The 2016 USACE Guidance recommends that if the total value score under the built condition drops the vernal pool value below the existing condition, then this loss in value is to be included in the ARM fund calculator. The vernal pool area factors described in the vernal pool loss section above are to be used in the ARM fund calculator for each loss of value. For example, if a high value VP (value of 65,000) drops to a medium value VP (value of 39,000) the loss value of 26,000 is entered in the ARM fund calculator (65,000 – 39,000 = 26,000). Low value vernal pools do not need to be evaluated. Using this guidance, the total area to be mitigated for secondary impacts to the three vernal pools that have been evaluated to have dropped one value level would be 3 X 26,000 or 78,000 sf (1.79 acres). This estimated payment is **$393,240.38** as shown in Table 12.

**Table 12. In-Lieu-Fee Calculation for Vernal Pool Secondary Impacts**

| NHDES AQUATIC RESOURCE MITIGATION FUND<br>WETLAND PAYMENT CALCULATION<br>***INSERT AMOUNTS IN YELLOW CELLS*** | | | |
|---|---|---|---|
| 1 | **Convert square feet of impact to acres:** | | |
| **INSERT SQ FT OF IMPACT** | Square feet of impact = | | 78000.00 |
| | | | 43560.00 |
| | Acres of impact = | | 1.7906 |
| | | | |
| 2 | **Determine acreage of wetland construction:** | | |
| | Forested wetlands: | | 2.6860 |
| | Tidal wetlands: | | 5.3719 |

[2]http://www.nae.usace.army.mil/Portals/74/docs/regulatory/StateGeneralPermits/NEGP/VPCharacterizationFormDRAFT.pdf

| | | | |
|---|---|---|---|
| | All other areas: | | 2.6860 |
| 3 | **Wetland construction cost:** | | |
| | Forested wetlands: | | $239,614.58 |
| | Tidal Wetlands: | | $479,229.15 |
| | All other areas: | | $239,614.58 |
| 4 | **Land acquisition cost (See land value table):** | | |
| **INSERT LAND VALUE FROM TABLE WHICH APPEARS TO THE LEFT. (Insert the amount do not copy and paste.)** | Town land value: | | 32795 |
| | Forested wetlands: | | $88,085.74 |
| | Tidal wetlands: | | $176,171.49 |
| | All other areas: | | $88,085.74 |
| 5 | **Construction + land costs:** | | |
| | Forested wetland: | | $327,700.32 |
| | Tidal wetlands: | | $655,400.64 |
| | All other areas: | | $327,700.32 |
| 6 | **NHDES Administrative cost:** | | |
| | Forested wetlands: | | $65,540.06 |
| | Tidal wetlands: | | $131,080.13 |
| | All other areas: | | $65,540.06 |
| ************ | **TOTAL ARM PAYMENT*********** | | |
| | Forested wetlands: | | $393,240.38 |
| | Tidal wetlands: | | $786,480.77 |
| | All other areas: | | $393,240.38 |

## Stream Mitigation

### NHDES Stream Mitigation

Linear feet of stream and bank impacts are provided in the wetland application. Approximately 803 linear feet of impact to Stream S1, the Trolley Car Lane stream west of I-93, was already permitted for the I-93 Project (Contracts 14463D and I, NHDES Permit 2014-03446), although the construction and stream relocation/restoration was not completed. As sufficient information has been collected to insure stream simulation when stream S1 is relocated and restored for the Exit 4A project, the 1,719 linear feet of impact is assumed to be self-mitigating and is not included in the calculation. All other stream impacts are included in the in-lieu fee calculation. Stream mitigation ARM fund contribution may be further reduced by the costs associated with stream culvert replacement(s) project(s) that are determined to qualify for the Stream Passage Improvement Program (SPIP). These evaluations are to be conducted by DOT in consultation with DES to determine the appropriate stream crossing(s) to mitigate. The estimated ARM fund payment for stream mitigation is **$421,799.04** as shown in Table 13.

**Table 13. In-Lieu Fee Calculation for Stream Impacts**

| NHDES AQUATIC RESOURCE MITIGATION FUND STREAM PAYMENT CALCULATION | | |
|---|---|---|
| | | |
| INSERT LINEAR FEET OF IMPACT on BOTH BANKS AND CHANNEL | Right Bank | 271.00 |
| | Left Bank | 272.0000 |
| | Channel | 1160.0000 |
| | | |
| | TOTAL IMPACT | 1703.0000 |
| | | |
| | Stream Impact Cost: | $351,499.20 |
| | | |
| | NHDES Administrative cost: | |
| | | $70,299.84 |
| ********* | TOTAL ARM FUND STREAM PAYMENT******** | |
| | | $421,799.04 |

# Exhibit E - Wetland Functions/Values and Photographs

Wetlands proposed to be impacted by Alternative A were reviewed to determine what functions and values the wetland currently provides that may be affected by construction of the project. The Highway Methodology Workbook Supplement (USACE, 1999) recognizes up to 13 different functions and values, including:

1. Groundwater recharge/discharge; GW
2. Floodflow Alteration; FA
3. Fish and Shellfish habitat; FS
4. Sediment/toxicant retention; SR
5. Nutrient removal/retention/transformation; NR
6. Production Export; PE
7. Sediment/shoreline stabilization; SS
8. Wildlife habitat; WH
9. Recreation; RE
10. Education/scientific value; ED
11. Uniqueness/Heritage; UH
12. Visual Quality/aesthetics; VQ and
13. Endangered Species; ES

Results of the impact review follow. In accordance with Highway Methodology practices, functions are either assigned a P, for Primary Function provided by the wetland, an X for function provided by the wetland, or left blank to indicate that the function is not provided by the wetland.

**Table E1. Permanent Impacts to Wetland Functions and Values for Exit 4A Selected Alternative (Bold font indicates Prime Wetland)**

| Alternative A (Selected Alternative) Permanent Impacts to Wetland Functions and Values | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wetland ID | Total Wetland Acres | Square Feet Impact | Cowardin Class | GW | FA | FS | SR | NR | PE | SS | WH | RE | ED | UH | VQ | ES |
| 11 | 3.38 | 7,106 | PFO | X | X | - | X | X | X | - | X | - | - | - | - | - |
| 13 | 0.06 | 1,820 | PFO | X | - | - | - | - | - | - | - | - | - | - | - | - |
| 14 | 3.46 | 95,325 | PFO | X | P | X | P | X | X | X | P | - | - | - | X | - |
| 15[1] | 0.27 | 12,942 | PFO | X | X | - | X | X | X | - | P | - | - | - | - | - |
| 16[1] | 0.46 | 25,687 | PFO | X | X | - | X | X | X | - | P | - | - | - | - | - |
| 17 | 0.30 | 3,523 | PFO | X | X | - | X | X | X | - | P | - | - | - | - | - |
| 18 | 0.02 | 659 | PEM | X | - | - | - | - | - | - | X | - | - | - | - | - |
| 19[1] | 0.22 | 15,043 | PFO | X | X | - | X | X | X | - | P | - | - | - | - | - |
| 20 | 0.03 | 1,505 | PFO | X | X | - | X | X | X | - | P | - | - | - | - | - |
| 21 | 0.06 | 361 | PFO | X | - | - | - | - | - | - | X | - | - | - | - | - |
| 22[1] | 0.61 | 827 | PFO | X | X | - | X | X | X | - | P | - | - | - | - | - |
| 24[1] | 0.11 | 19,119 | PFO | X | X | - | P | X | X | - | X | - | - | - | - | - |
| 35[1] | 0.10 | 12,866 | PFO | X | - | - | - | - | - | - | P | - | - | - | - | - |
| 39 | 0.19 | 4,379 | PEM | X | - | - | X | - | - | - | X | - | - | - | - | - |
| 40 | 0.02 | 852 | PSS | X | - | - | X | - | - | - | - | - | - | - | - | - |
| 41 | 0.95 | 7,077 | PFO | X | P | X | P | X | P | X | P | - | - | - | - | - |
| 46 | 0.18 | 2,561 | PFO | X | P | X | P | X | P | X | P | - | - | - | X | - |
| 49 | 1.15 | 3,025 | PFO | X | - | X | X | X | - | - | P | - | - | - | - | - |

| Alternative A (Selected Alternative) Permanent Impacts to Wetland Functions and Values | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wetland ID | Total Wetland Acres | Square Feet Impact | Cowardin Class | GW | FA | FS | SR | NR | PE | SS | WH | RE | ED | UH | VQ | ES |
| 54 | 0.12 | 62 | PEM | X | - | - | - | - | X | - | P | - | - | - | - | - |
| 56 | 0.31 | 615 | PEM | X | X | - | P | - | X | - | X | - | - | - | - | - |
| 59 | 2.91 | 2,481 | PFO | P | X | X | P | X | X | P | X | X | X | X | X | - |
| 61 | 0.01 | 582 | PFO | X | P | - | X | X | X | - | - | - | X | - | - | - |
| **62** | **17.79** | **1,971** | **PSS/EM** | **X** | **P** | **X** | **X** | **X** | **P** | **X** | **P** | **X** | **-** | **-** | **X** | **-** |
| 64[1] | 0.12 | 5,036 | PFO | X | - | - | X | - | - | - | P | - | - | - | - | - |
| 66 | 0.36 | 692 | PFO | X | - | - | P | X | X | - | X | - | - | - | - | - |
| 67 | 0.31 | 1,483 | PFO | X | X | - | X | - | - | - | X | - | - | - | - | - |
| **72** | **13.82** | **155** | **PSS** | **X** | **P** | **X** | **P** | **P** | **X** | **P** | **P** | **X** | **-** | **-** | **X** | **-** |
| 73 | 10.13 | 2,850 | PEM | X | X | - | P | X | X | X | X | - | - | - | X | - |
| 80 | 3.15 | 1,875 | PFO | X | P | - | X | X | - | P | X | X | - | - | - | - |
| 86 | 0.01 | 552 | PFO | X | - | - | - | - | - | - | - | - | - | - | - | - |
| 90 | 0.04 | 1,148 | PFO | X | - | - | S | - | - | - | - | - | - | - | - | - |
| 100 | 0.01 | 311 | PFO | X | - | - | - | - | - | - | - | - | - | - | - | - |
| 102 | 0.02 | 90 | PEM | X | - | - | P | - | - | - | - | - | - | - | - | - |

1 – Vernal Pool impacts are included in wetland impact quantities.

**Photo 1. Facing west-northwest from Wetland 14,
south of Project boundary crossing with Stream Crossing 1 (5/21/2018)**

**Photo 2. Facing southwest from northern boundary of Wetland 14 (5/21/2018).
Riprap from recent construction on I-93.**

**Photo 3. Facing northwest from Stream Crossing 1 crossing with western Project boundary, within Wetland 14 (5/21/2018)**

**Photo 4. Facing east-southeast from western Project boundary crossing with Wetland 14 (5/21/2018)**

**Photo 5. Facing north near southern end of Wetland 15 towards Vernal Pool 2 (5/21/2018). Erosion controls from recent construction for I-93.**

**Photo 6. Facing southeast from northwest boundary of Wetland 15, towards Vernal Pool 2 (5/21/2018) Sideslopes of recently widened I-93 to right in photo.**

**Photo 7. Facing north-northwest from southern boundary of Wetland 16, towards Vernal Pool 03 (5/21/2018). Erosion controls from recent I-93 construction.**

**Photo 8. Facing north-northeast from northern boundary of Wetland 16, towards Vernal Pool 4 (5/21/2018)**

**Photo 9. Facing east-northeast to Wetland 16, near southern boundary of Vernal Pool 4 (5/21/2018). Erosion controls from recent I-93 construction.**

**Photo 10. Facing north-northeast of Wetland 17 and Stream Crossing 7 (5/21/2018)**

**Photo 11. Facing southwest from northeastern boundary of Wetland 17 and Stream 7 (5/21/2018)**

**Photo 12. Facing east-southeast from eastern boundary of Wetland 19, towards Vernal Pool 42, south of Wetland 18 (5/21/2018)**

**Photo 13. Facing northeast from western boundary of Wetland 19, towards Vernal Pool 42 (5/21/2018)**

**Photo 14. Facing northwest from eastern boundary of Wetland 20 (5/21/2018)**

**Photo 15. Facing east-northeast between wetlands 20 and 22 along Stream 8 (5/21/2018)**

**Photo 16. Facing northeast from junction of Stream 8 and Wetland 22 at Project boundary crossing/southern boundary of Vernal Pool 46 (5/21/2018)**

**Photo 17. Facing north-northeast from southern boundary of Wetland 24, toward Vernal Pool 06 (5/21/2018)**

**Photo 18. Facing west from eastern boundary of Wetland 24, toward Vernal Pool 06 (5/21/2018)**

**Photo 19. Facing north from Wetland 35 to Vernal Pool 08 from southwest Project boundary crossing (5/21/2018)**

**Photo 20. Facing southwest from Wetland 35 to Vernal Pool 08 from eastern pool/wetland boundary (5/21/2018)**

**Photo 21. Facing south-southwest from northeast boundary of Wetland 39 (5/24/2018)**

**Photo 22. Facing northeast from southwest boundary of Wetland 40, near Stream 11 (5/24/2018)**

**Photo 23. Facing northwest to Wetland 41 and Stream 2, north of North High Street (5/15/2018)**

**Photo 24. Facing southeast toward Stream 2 at road crossing, south of North High Street (5/15/2018)**

**Photo 25. Facing south to Wetland 41 from Franklin Street Extension (5/21/2018)**

**Photo 26. Facing southeast towards Wetland 46 from Folsom Road (5/15/2018)**

**Photo 27. Facing northwest from Tsienneto Road toward Wetland 49 (5/15/2018)**

**Photo 28. Facing northwest from Tsienneto Road toward Wetland 54/Vernal Pool 11 (5/15/2018)**

**Photo 29. Wetland 11 facing north from wetland plot(10/25/2019)**

**Photo 30. Wetland 13 facing north from wetland plot (10/25/2019)**

**Photo 31. Facing southeast from Tsienneto Road toward Stream Crossing 4 (5/15/2018)**


Photo 32. Facing northwest from Tsienneto Road toward Wetland 56 (5/15/2018)


Photo 33. Facing southeast from Tsienneto Road toward Wetland 59 (5/15/2018)

**Photo 34. Facing north from Tsienneto Road toward Prime Wetland 62 (previously called Wetland 59) and Stream Crossing 5 (5/15/2018)**

**Photo 35. Facing south from Tsienneto Road toward Wetland 59 and Stream Crossing 5 (5/15/2018)**

**Photo 36. Facing southeast from Chester Road (NH Route 102) towards Wetland 59 and Stream Crossing 6 into Beaver Lake (5/15/2018)**

**Photo 37. Facing northwest from Chester Road (NH Route 102) towards Stream Crossing 6 (5/15/2018)**

**Photo 38 Wetland 60, north of Tsienneto Road, view north (7/27/2018)**

**Photo 39 Wetland 61, south of Tsienneto Road, view south (7/27/2018)**

Photo 40 Wetland 18 view north (10/25/2019)

Photo 41 Wetland 21 from army corps plot, view west (10/15/2019)

**Photo 42 Wetland 59 from Tsienneto Road view southeast (10/24/2019)**

**Photo 43 Wetland 61 from Tsienneto Road view southeast (10/24/2019)**

Photo 44 Wetland 64 view west (10/15/2019)

Photo 45 Wetland 66 at wetland plot (10/25/2019)

**Photo 46 Wetland 67 at wetland plot (10/25/2019)**

**Photo 47 Wetland 100 at wetland plot (1/16/2020)**

Photo 48 Wetland 72 at wetland plot (10/14/2019)

Photo 49 Wetland 80 near Tsienneto Rd facing east (10/12/2019)

**Photo 50 Wetland 80 near proposed stormwater outlet facing east (10/12/2019)**

**Photo 51 Wetland 102 at wetland plot (12/17/2019)**

**Photo 52 Stream crossing 100 facing south (12/16/2020)**

**Photo 53 Stream crossing 101 facing northeast towards Tsienneto Road (12/16/2020)**

Photo 54 Wetland 73 north side facing south (10/14/2019)

Photo 55 Wetland 90 facing northwest (10/15/2019)

Photo 56 Wetland 86 north side facing southeast (10/14/2019)

Photo 57 Wetland 87 west edge facing northeast (10/14/2019)

Photo 58. Stream crossing 102 from Route 102 facing east (12/16/2019)

# Exhibit F - Wetland Impact Avoidance and Minimization

Avoiding and minimizing impacts to wetland resources has been an important consideration throughout Exit 4A project development, from the identification of alternatives through the design of the base technical concept. Specific efforts are described below. Wetland impact avoidance and minimization efforts will continue as the Design/Build team undertakes final design. For purposes of this narrative, wetland resources include wetlands, streams, and vernal pools.

## Alternatives Analysis and Selection

Documentation of wetland resource impact avoidance and minimization efforts during alternatives analysis and selection are described in the FEIS. Several excerpts from the FEIS are included here.

Early in Project planning, a number of conceptual corridors for a new interchange location and connecting roadways were identified. And each corridor was evaluated based on engineering, environmental, cultural, topographic, and socioeconomic constraints. As noted in the 2007 DEIS, a 300-foot-corridor width was used to represent the potential physical characteristics associated with a new location alternative and for the initial screening of alternatives from an environmental impact standpoint. This width was based on the likely required cross-section of the proposed roadway needed to serve projected traffic volumes, as well as the design criteria outlined in the 2007 DEIS. These preliminary design criteria used to develop potential highway alternatives, as well as upgrade options for existing highways, are based on American Association of State Highway and Transportation Officials (AASHTO) policy and the NHDOT Highway Design Manual. Conceptual corridor alternatives considered during the screening process for the 2007 DEIS include (1) upgrade existing roadways, (2) new I-93 interchange/connector road options, and (3) combinations of 1 and 2.

Two iterative stages of conceptual corridor screening were outlined in the 2007 DEIS and are summarized in this FEIS. Five alternatives remained after the screening process was completed (referred to as alternatives A, B, C, D and F) and these alternatives are described in ES2.3. (*From ES.2.1 Conceptual Corridors, page ES-7*).

Alternative A was selected as the preferred alternative based on the results of engineering, environmental, and socioeconomic studies (see Table ES-1 and Chapter 4). Advantages of the preferred alternative compared to the other Build Alternatives include lowest cost, including transmission line relocations; least acreage for ROW acquisitions; lowest wetland impacts of the alternatives that meet the purpose and need; and no impact on Wildlife Action Plan (WAP) highest ranked habitat.

The No Build Alternative and Alternative F do not meet the purpose and need of the Project. Even with the upgrades to the existing roadway under Alternative F, traffic in downtown Derry would increase 16 percent compared to the No Build Alternative. Additionally, Alternative F would not contribute to economic development. Although Alternative D would result in a modest decrease in traffic in downtown Derry (11 percent), it would not contribute to economic development. Alternative C would decrease the downtown Derry traffic the most (22 percent reduction); however, it would not contribute to economic development. It is the most costly of the Build Alternatives

($42,260,000). Although Alternatives A and B both satisfy the traffic and economic development needs of the Project, Alternative A more closely follows existing roads than Alternative B, and Alternative A has considerably less impact on wetlands, wildlife habitat, and parks and recreational lands than Alternative B. For example, Alternative A would impact 4.77 acres of wetlands[3], and Alternative B would impact 10.0 acres of wetlands. Alternative A would impact 0.02 acre of Rider Fields, and Alternative B would impact 1.31 acres of Rider Fields. (*From FEIS Section ES 2.3 Description of and Rationale for the Preferred Alternative, Page ES-13*)

Alternative F (NH 102 upgrade) would not meet the transportation need for the project because it would increase traffic through downtown Derry and this point has been clarified in Section 3.7.2 of the FEIS. Alternative A and B are considered to have the same potential for induced development as discussed in Chapter 5. Alternative A does not have the greatest impacts to the aquatic environment. In terms of direct impacts, the impacts of Alternative B and C are greater than Alternative A. Wetland edge effect impacts, though not measured for Alternatives B and C, would also be greater than for Alternative A, as these impacts extend out from direct wetland impacts, which are greater for Alternatives B and C. Alternative B impacts a greater number of vernal pool envelopes and critical terrestrial habitat than Alternative A, although direct vernal pool fill may be less. Alternative C has less direct and secondary vernal pool impacts that either Alternative A or B. In terms of indirect and cumulative impacts, of the alternatives that meet the purpose and need, Alternatives A and B could result in a similar potential for induced growth related impacts; however, Alternative B is anticipated to result in greater cumulative impacts to aquatic resources. (*from FEIS Appendix M: Response F4*).

**Alternative A Base Technical Concept Design**

Trolley Car Lane/Wetlands West of I-93 (Plan Sheets 6-8)

Wetlands west of I-93 and east of Trolley Car Lane are associated with an un-named intermittent stream (S1), sometimes referred to as Wheeler Brook or Trolley Car Lane Brook. This stream flows south along the west side of I-93, then crosses diagonally under the highway through a culvert over 1,000 ft long and continues south to Wheeler Pond. The stream will be relocated up to approximately 50 feet to the west to accommodate both sound wall and ramp construction. A portion of Stream S1 permitted for relocation as part of the I-93 project to accommodate sound walls, but the sound wall work and stream relocation/restoration has been deferred to the Exit 4A project. Impact calculations for Exit 4A include the portion of the work that was to be done by I-93. The sound walls, designed to match the sound wall design for the I-93 project, will be constructed on berms with a 2:1 slope. The berms are the minimum dimensions necessary to support the walls. The earthwork for ramps will have 2:1 slopes rather than the typical 4:1 slopes, to minimize wetland impacts. Along the toe of slope for most of the project area, a 5-foot wide temporary disturbance zone will accommodate the installation of erosion and sedimentation (E&S) control Best

[3] Permanent impacts to vegetated wetlands for Alternative A are now 5.39 acres based on advances to the Base Technical Concept since completion of the FEIS.

Management Practices (BMPs). Wetlands temporarily impacted by E&S BMPs will be restored to pre-construction grades and seeded with an appropriate wetland seed mix.

Normandeau wetland scientists delineated wetland boundaries (Wetland 14) along Stream S1 and a tributary (S70), and conducted stream surveys to document channel morphology, bankfull width, and substrate composition in sufficient detail to re-establish stream habitat. The stream survey and restoration reports for Stream S1 by Normandeau and by NHDOT are attached (Permit Attachment B). Relocation and restoration of this stream is considered self-mitigating. This intermittent stream will be relocated during low flow conditions to the extent possible, and care will be taken to maintain flow and minimize downstream aquatic impacts. Streambanks and temporarily disturbed wetlands will be stabilized with native wetland/riparian vegetation, and stream channel substrates will match the material currently in the streambed. Further information regarding stream impacts and mitigation are included in Exhibit C and Attachment B of the application. The Design-Build contractors are expected to submit additional construction and stream restoration details.

<u>Wetlands Northwest of Trolley Car Lane (Plan Sheets 9 and 10)</u>

Construction of the I-93 southbound off-ramp to Exit 4A will impact wetlands 11, 13, and 66. While this ramp is initially going to be single lane, traffic projections associated with a full buildout of the currently undeveloped property around the Connector Road indicate that widening to two lanes will be necessary in the future. Therefore the design accommodates a two-lane ramp, resulting in impacts to the edges of these three wetlands. Ramp slopes are 2:1, the maximum vegetated slope consistent with standard highway design.

<u>Wetlands and Vernal Pools on the Eastern Edge of I-93 (Plan Sheets 6-10)</u>

The I-93 northbound off-ramp to Exit 4A and stormwater collection and treatment features require fill in Wetlands 15, 16, and 17; Stream S7; and Vernal Pools 2, 3, and 4. Drainage will be directed along the ramp slope, away from the vernal pools, and under the highway via new swales and extensions of existing drainage pipes. The added fill is expected to reduce the value of Vernal Pools 2 and 3, and eliminate Vernal Pool 4. Impacts calculated for mitigation purposes include direct wetland, stream and vernal pool fill impacts, and indirect (edge effect) impacts. Vernal pool loss and secondary (indirect) impacts that reduce vernal pool value are also included in the mitigation impact calculations. Many of these resource areas were also incrementally impacted by the recent I-93 construction. The Exit 4A on-ramp to I-93 North will also require fill in Wetland 67 for ramp construction, and temporary disturbance in Wetland 9, for installation of erosion and sedimentation controls. As on the west side, the eastern ramp slopes are 2:1 to minimize wetland impacts and temporary impacts for E&S BMPs will be restored.

<u>Connector Road Wetlands and Vernal Pools (Plan Sheets 11-15)</u>

The Connector Road crosses mostly undeveloped land with rolling topography, as well as two electric transmission line easements. The selection of this project route (Alternative A) and connection point to I-93 is discussed in the FEIS. The western end of the Connector Road will be constructed on fill, as it is elevated over I-93. The eastern end of the Connector Road near Madden Road and Folsom Road is partially within a disturbed gravel mining and industrial area, and the highly variable topography will require both cuts and fills for the road. Wetland 64 and associated Vernal Pool 9 were located in close proximity to a proposed road cut for the Madden Road intersection, which could result in secondary hydrologic impacts (draining of the wetland). Maximizing slopes to avoid direct impacts will not necessarily avoid secondary impacts. The permit plans therefore show a total impact to Wetland 64 and VP 9, even though only a portion of these areas will be directly filled or excavated by the Project. These impacts are included in the mitigation total and ARM fund calculations. Previously, only secondary edge and vernal pool buffer impacts were included in the mitigation package. The Design-Build team will be directed to minimize secondary impacts to Wetland 64 and VP 9 if possible.

The middle portion of this four-lane Connector Road will be located primarily in a cut. Where the Connector Road overlaps with the Eversource transmission easement, several transmission structures will need to be relocated. This will be addressed in final design by the Design-Builder. There will be significant impacts to Wetlands 18, 19, 20, 24 and 35 and Vernal Pools 42, 6, and 8, and impacts to the edges of several other wetlands will occur. Wetland 19 and Vernal Pool 42 will not be completely filled, but the remnant left after construction will likely have minimal function and was therefore considered a total impact. Given the quantity and distribution of vernal pools in this block of land, total avoidance of resource impacts and habitat fragmentation was not possible. Fill slopes in the vicinity of wetlands have been minimized where possible, but the Connector Road width must also accommodate guardrails. As one of the project purposes is to provide access for the future development of this undeveloped land, additional resource impacts are likely, as discussed in Section 5.4 of the FEIS.

Both Derry and Londonderry, and therefore the Exit 4A Project area, are included in the MS4 General Permit program. Because both towns have discharges that impact an impaired AU for which a TMDL has been prepared (i.e., Beaver Brook), both are required to meet additional requirements of the MS4 permitting program. Compliance with the NH Alteration of Terrain program and a 401 Water Quality Certificate are also required. Locating stormwater basins and treatment swales is challenging in urban locations. Two of the stormwater basins for the project will be located along the Connector Road, one at each end. These have been sited to avoid and minimize permanent wetland impacts to the extent practicable. The outlet of the basin at the western end of the Connector Road was redirected to avoid discharging to Vernal Pool 5. The stormwater basin located north of the Connector Road, just west of the proposed intersection with Madden Road was placed between the existing Eversource transmission line easement and Wetland 35, Vernal Pool 8, and Wetland 90. This basin grading was revised and refined to minimize the impacts to these wetlands to the extent practicable and impacts to Wetland 35 and Vernal Pool 8 were reduced significantly during design.

Shields Brook (Plan Sheets 15 and 16)

The Folsom Road crossing structure over Shields Brook will be replaced. This crossing was designed to meet the 2.2 times bankfull width requirements of the NHDES stream rules to minimize flooding potential at the crossing location and greatly improve aquatic organism passage and hydraulic and geomorphic compatibility. This crossing has a skew, and the Design-Build contractors may propose an alternate design. The stream morphology survey and an excerpt of the hydraulic study are attached (Permit Attachments G and C, respectively). Impacts have been significantly reduced from the October 2018 permit application based on hydraulic studies and crossing design development.

This crossing could be considered self-mitigating, but at this time, impacts to the channel and banks for bridge construction are included in the stream ARM fund estimate. Details supporting the design of this crossing are included in Exhibit C and Attachments C and H.

Several stormwater features will discharge treated stormwater to Shields Brook. One of these will have an outlet into Wetland #72 (Derry Prime Wetland A-01) with permanent impacts of approximately 155 sf. As runoff from existing impervious road surfaces in this part of Derry is not currently treated, these structures should improve water quality in the stream/wetland system. The stormwater BMPs have been located to minimize wetland impacts. Protection of Prime Wetland functions and values is addressed in the NHDES Wetland Application Narrative.

Tsienneto Road Wetland and Streams (Plan Sheets 18-27)

Tsienneto Road will be widened slightly, and a drainage catchment system added to treat runoff from existing and additional impervious surfaces. There are small impacts to wetlands and intermittent streams along this roadway. The contractor will determine which culverts and other drainage pipes need replacement, but temporary and permanent impacts have been included for all pipes that connect to jurisdictional resources in the event that replacement is required.

The crossing of Tributary E (Sheet 27) will be modified from the undersized 30-inch diameter corrugated metal pipe (CMP) and a 36-inch diameter CMP to a 40-foot clear-span structure (actually 50-feet on centerline, due to an existing skew). Wetland 62 on the upstream side of the Tributary E crossing is a prime wetland (Derry Prime Wetland B-12). An assessment of the effects of the Project on prime wetland functions and values is included in the permit application narrative. The new crossing includes a downstream weir to prevent the prime wetland marsh from draining at normal flows when the culverts are replaced with a bridge span. The weir will pass the 2-year storm and greater with reduced flooding, and a low-flow channel will accommodate passage of fish and other aquatic organisms. An excerpt from the hydraulic analysis is attached (Permit Attachment C). Stream surveys have also been completed for Tributary E (Attachment G), and the assessment data was incorporated into the stream crossing design. The Type, Span and Location Study for the Tributary E crossing is also attached (Attachment H). The crossing design may be self-mitigating, but impacts have been included in the ARM fund calculations at this time.

Route 102 Wetlands and Streams (Sheets 27 and 28).

The project includes improvements to the intersection of Tsienneto Road and Route 102 (Chester Road), including the addition of turning lanes, which will require widening of the paved roadway. A portion of the Route 102 improvements on Sheet 26 lies within the Protected Shoreland of Beaver Lake, and therefore a Shoreland Permit Application will be submitted for this Project. Tributary E flows under Route 102 at the edge of the project area, and into Beaver Lake. The possible replacement of the culvert which carries Tributary E under Route 102 is being evaluated under the Stream Passage Improvement Program (SPIP), but is not part of the Exit 4A project design.

To the east of the Tsienneto Road intersection (Sheet 28), turning lanes and stormwater treatment swales will be added, and minor improvements to the intersections of residential roads will also take place to tie in to the improved Route 102. Minor impacts to the edge of Derry Prime Wetland B-14 (Wetland 62) would occur along the edge of Route 102 for culvert replacements and road widening.

## Construction Impact Avoidance and Minimization Measures

NHDOT has committed to the following impact avoidance and minimization efforts during construction, as stated in several sections of the FEIS. Further impact avoidance and minimization methods will be identified during final design by the Design-Builder.

- For protection of wildlife, sweeps and fencing of construction areas and material storage areas will be conducted to insure that snakes and turtles and their nests are not crushed by construction activities.
- Only wildlife-friendly erosion control materials will be deployed during construction activities.
- Project will develop and implement a sedimentation and erosion control program. This sedimentation and erosion control plan (as part of the Stormwater Pollution Prevention Plan) will be consistent with the National Pollutant Discharge Elimination System, the NHDES' AoT permitting requirements, and the 2017 Construction General Permit.
- Temporary erosion and sediment controls will be installed as necessary during construction. Proper maintenance of erosion control devices such as silt socks and silt fences will be an integral part of the Project so as to ensure their adequate installation and use.
- Erosion control measures and construction schedules will require that areas stripped of vegetation be stabilized as soon as practicable after exposure to prevent soil loss by wind and water.
- Vegetation removal and vegetation disturbance in riparian areas will be minimized, and extend no further than 5 feet beyond the project footprint in wetland areas for E&S controls. Where practical, efforts will be made to maintain a buffer strip of vegetation near streams.
- Where appropriate, upslope drainage will be diverted around work areas.
- Stream work will be timed to avoid impacts to breeding fish and wildlife, and high flows.
- BMPs for fertilizer application during construction will also be followed.
- Mechanisms to avoid and control chemical leaks and spills from the construction equipment will be instituted.
- Temporary impact areas will be restored to natural grades with clean, appropriate surficial material (if needed, including stream gravel, topsoil, etc.) and seeded with native seed appropriate for the location.
- Disturbed areas will be monitored for soil stability, and erosion control materials removed once stabilization is achieved.
- Minor road adjustments to limit stream and wetland crossings will continue to be evaluated for the Project to further minimize impacts.

# Attachment A

## Wetland Impact Summary

| | A | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Exit 4A - WETLAND IMPACT SUMMARY February 5, 2020 | | | | | | | | |
| 2 | WETLAND | WETLAND | LOCATION | | | | | TOWN | COMMENTS |
| 3 | NUMBER | CLASSIFICATION | | PERMANENT WETLAND | BANK | CHANNEL | TEMPORARY IMPACTS | | |
| 4 | | | | | | | | | |
| 5 | | | | SF | LF | LF | SF | | |
| 6 | PERMANENT IMPACTS | | | | | | | | |
| 7 | Emergent Wetlands | | | SF | | | | | |
| 8 | 73 | PEM1/PSS1E | BQ | 2850 | | | | D | |
| 9 | 18 | PEM1E | AG | 659 | | | | L | |
| 10 | 102 | PEM1E | BT | 90 | | | | D | |
| 11 | 54 | PEM1E | BX | 62 | | | | D | |
| 12 | 56 | PEM1E | CJ | 615 | | | | D | |
| 13 | 39 | PEM1F | BG | 4379 | | | | D | |
| 14 | | | Total | 8655 | | | | | |
| 15 | Forested Wetlands | | | | | | | | |
| 16 | 19 | PF01E | CQ | 497 | | | | L | |
| 17 | 81 | PFO | BW | 273 | | | | D | |
| 18 | 14 | PFO1/2E | C | 21575 | | | | L | |
| 19 | 14 | PFO1/2E | D | 13598 | | | | L | |
| 20 | 14 | PFO1/2E | G | 6278 | | | | L | |
| 21 | 14 | PFO1/2E | M | 16866 | | | | L | |
| 22 | 14 | PFO1/2E | N | 37008 | | | | L | |
| 23 | 15 | PFO1E | E | 4382 | | | | L | |
| 24 | 15 | PFO1E | H | 1324 | | | | L | |
| 25 | 16 | PFO1E | I | 2336 | | | | L | |
| 26 | 16 | PFO1E | K | 507 | | | | L | |
| 27 | 16 | PFO1E | O | 199 | | | | L | |
| 28 | 16 | PFO1E | Q | 2061 | | | | L | |
| 29 | 16 | PFO1E | R | 1919 | | | | L | |
| 30 | 17 | PFO1E | T | 39 | | | | L | |
| 31 | 17 | PFO1E | V | 3484 | | | | L | |
| 32 | 13 | PFO1E | X | 1820 | | | | L | |
| 33 | 66 | PFO1E | Y | 692 | | | | L | |
| 34 | 11 | PFO1E | Z | 909 | | | | L | |
| 35 | 11 | PFO1E | AA | 3312 | | | | L | |
| 36 | 67 | PFO1E | AB | 1483 | | | | L | |
| 37 | 11 | PFO1E | AC | 366 | | | | L | |
| 38 | 11 | PFO1E | AD | 2519 | | | | L | |
| 39 | 19 | PFO1E | AE | 9131 | | | | L | |
| 40 | 20 | PFO1E | AI | 273 | | | | L | |
| 41 | 20 | PFO1E | AJ | 1232 | | | | L | |
| 42 | 21 | PFO1E | AK | 361 | | | | L | |
| 43 | 22 | PFO1E | AM | 216 | | | | L | |
| 44 | 24 | PFO1E | AN | 167 | | | | L | |
| 45 | 24 | PFO1E | AP | 5 | | | | L | |
| 46 | 24 | PFO1E | AQ | 452 | | | | L | |
| 47 | 24 | PFO1E | AR | 98 | | | | L | |
| 48 | 24 | PFO1E | AS | 2598 | | | | L | |
| 49 | 24 | PFO1E | AT | 168 | | | | L | |
| 50 | 90 | PFO1E | AU | 1148 | | | | L | |
| 51 | 35 | PFO1E | AV | 136 | | | | L | |
| 52 | 35 | PFO1E | AW | 1155 | | | | L | |
| 53 | 35 | PFO1E | AY | 21 | | | | L | |
| 54 | 35 | PFO1E | AZ | 301 | | | | L | |
| 55 | 35 | PFO1E | BA | 5 | | | | L | |
| 56 | 35 | PFO1E | BB | 526 | | | | L | |
| 57 | 64 | PFO1E | BD | 180 | | | | L/D | |
| 58 | 64 | PFO1E | BE | 382 | | | | L/D | |
| 59 | 64 | PFO1E | BF | 1139 | | | | L/D | |
| 60 | 86 | PFO1E | BJ | 552 | | | | D | |
| 61 | 41 | PFO1E | BM | 176 | | | | D | |
| 62 | 41 | PFO1E | BN | 6901 | | | | D | |
| 63 | 46 | PFO1E | BP | 2561 | | | | D | |
| 64 | 49 | PFO1E | BR | 3025 | | | | D | |
| 65 | 100 | PFO1E | BS | 311 | | | | D | |
| 66 | 61 | PFO1E | BV | 582 | | | | D | |
| 67 | 59 | PFO1E | CI | 815 | | | | D | |
| 68 | 59 | PFO1E | CL | 1666 | | | | D | |
| 69 | 80 | PFO1E/PEM1E | CC | 941 | | | | D | |
| 70 | 80 | PFO1E/PEM1E | CD | 81 | | | | D | |
| 71 | 80 | PFO1E/PEM1E | CE | 215 | | | | D | |
| 72 | 80 | PFO1E/PEM1E | CF | 598 | | | | D | |
| 73 | 80 | PFO1E/PEM1E | CG | 40 | | | | D | |
| 74 | | | Total | 161605 | | | | | |

| | A | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Exit 4A - WETLAND IMPACT SUMMARY February 5, 2020 | | | | | | | | |
| 2 | WETLAND | WETLAND | LOCATION | | | | | TOWN | COMMENTS |
| 3 | NUMBER | CLASSIFICATION | | | | | | | |
| 4 | | | | PERMANENT WETLAND | BANK | CHANNEL | TEMPORARY IMPACTS | | |
| 5 | | | | SF | LF | LF | SF | | |
| 75 | **Shrub Wetlands** | | | | | | | | |
| 76 | 62 | PSS/PEM1E | CK | 1389 | | | | D | Prime Wetland |
| 77 | 62 | PSS/PEM1E | CM | 172 | | | | D | Prime Wetland |
| 78 | 62 | PSS/PEM1E | CO | 410 | | | | D | Prime Wetland |
| 79 | 72 | PSS1/PEM1/PFO1B | BK | 155 | | | | D | Prime Wetland |
| 80 | 40 | PSS1E | BI | 852 | | | | D | |
| 81 | | | **Total** | **2978** | | | | | |
| 82 | **Streams** | | | **SF** | **Bank LF** | **Channel LF** | **Temp. SF** | | |
| 83 | S2 | R3UB3 | BL | 4048 | 404 | 202 | | D | Perennial - Shields Brook |
| 84 | S2 | R3UB3 | BO | 780 | 107 | 45 | | D | Perennial - Shields Brook |
| 85 | S5 | R3UB3 | CN | 109 | 32 | 11 | | D | Perennial - Tributary E |
| 86 | S101 | R4SB2 | BU | 54 | | 13 | | D | Intermittent |
| 87 | S102 | R4SB2 | CP | 212 | | 41 | | D | Intermittent |
| 88 | S70 | R4SB5 | L | 187 | | 70 | | L | Intermittent |
| 89 | S9 | R4SB5 | S | 48 | | 23 | | L | Intermittent |
| 90 | S7 | R4SB5 | U | 884 | | 117 | | L | Intermittent |
| 91 | S7 | R4SB5 | W | 738 | | 116 | | L | Intermittent |
| 92 | S8 | R4SB5 | AH | 1232 | | 291 | | L | Intermittent |
| 93 | S11 | R4SB5 | BH | 77 | | 77 | | D | Intermittent |
| 94 | S3 | R4SB5 | BY | 159 | | 24 | | D | Intermittent |
| 95 | S3 | R4SB5 | BZ | 265 | | 33 | | D | Intermittent |
| 96 | S4 | R4SB5 | CA | 219 | | 46 | | D | Intermittent |
| 97 | S4 | R4SB5 | CB | 196 | | 29 | | D | Intermittent |
| 98 | S100 | R4SB6 | CH | 125 | | 22 | | D | Intermittent |
| 99 | S1 | R4UB3 | A | 0 | | 44 | 336 | L | Intermittent self-mitigating |
| 100 | S1 | R4UB3 | B | 0 | | 1638 | 19364 | L | Intermittent self-mitigating |
| 101 | S1 | R4UB3 | CR | 0 | 0 | 37 | 694 | L | Intermittent self-mitigating |
| 102 | | | **Total** | **9333** | **543** | **2879** | 20394 | | |
| 103 | **Vernal Pools** | | | **Direct Impact** | **Loss/Secondary Impact** | | | | |
| 104 | VP2 | VP | F | 7236 | Perm. Loss | 39,000 | M Value Loss | L | |
| 105 | VP3 | VP | J | 9387 | Value Drop | 26,000 | M to L drop | L | |
| 106 | VP4 | VP | P | 9278 | Perm. Loss | 39,000 | M Value Loss | L | |
| 107 | VP42 | VP | AF | 5415 | Perm. Loss | 39,000 | M Value Loss | L | |
| 108 | VP46 | VP | AL | 611 | Value Drop | 26,000 | H to M drop | L | |
| 109 | VP6 | VP | AO | 15631 | Perm. Loss | 39,000 | M Value Loss | L | |
| 110 | VP8 | VP | AX | 10722 | Perm. Loss | 65,000 | H Value Loss | L | |
| 111 | VP9 | VP | BC | 3335 | Perm. Loss | 65,000 | H Value Loss | L/D | |
| 112 | VP64 | VP | Buffer Only | 0 | Value Drop | 26,000 | H to M drop | L | |
| 113 | | | **Total** | **61615** | | **364,000** | | | |
| 114 | | | | | | | | | |

| | A | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Exit 4A - WETLAND IMPACT SUMMARY February 5, 2020 | | | | | | | | |
| 2 | WETLAND | WETLAND | LOCATION | | | | | TOWN | COMMENTS |
| 3 | NUMBER | CLASSIFICATION | | PERMANENT WETLAND | BANK | CHANNEL | TEMPORARY IMPACTS | | |
| 4 | | | | | | | | | |
| 5 | | | | SF | LF | LF | SF | | |
| 115 | TEMPORARY IMPACTS | | | | | | | | |
| 116 | Emergent Wetlands | | | | | | Temp. SF | | |
| 117 | 73 | PEM1/PSS1E | TBA | | | | 1281 | D | |
| 118 | 83 | PEM1E | TBB | | | | 100 | D | |
| 119 | 102 | PEM1E | TBD | | | | 53 | D | |
| 120 | 54 | PEM1E | TBH | | | | 162 | D | |
| 121 | 56 | PEM1E | TBT | | | | 112 | D | |
| 122 | 54 | PEM1E | TCC | | | | 27 | D | |
| 123 | 39 | PEM1F | TAP | | | | 356 | D | |
| 124 | 81 | PEM1H/PUB5H | TBF | | | | 144 | D | |
| 125 | 81 | PEM1H/PUB5H | TBG | | | | 260 | D | |
| 126 | | | | | | Total | 2495 | | |
| 127 | Forested Wetlands | | | | | | Temp. SF | | |
| 128 | 9 | PFO1 | TS | | | | 77 | L | |
| 129 | 9 | PFO1 | TT | | | | 52 | L | |
| 130 | 103 | PFO1 | TBI | | | | 9 | D | |
| 131 | 14 | PFO1/2E | TC | | | | 1261 | L | |
| 132 | 14 | PFO1/2E | TH | | | | 593 | L | |
| 133 | 14 | PFO1/2E | TJ | | | | 1239 | L | |
| 134 | 14 | PFO1/2E | TK | | | | 1072 | L | |
| 135 | 14 | PFO1/2E | TM | | | | 1267 | L | |
| 136 | 15 | PFO1E | TD | | | | 290 | L | |
| 137 | 15 | PFO1E | TE | | | | 145 | L | |
| 138 | 15 | PFO1E | TG | | | | 50 | L | |
| 139 | 66 | PFO1E | TO | | | | 271 | L | |
| 140 | 11 | PFO1E | TP | | | | 457 | L | |
| 141 | 11 | PFO1E | TQ | | | | 703 | L | |
| 142 | 67 | PFO1E | TR | | | | 691 | L | |
| 143 | 11 | PFO1E | TU | | | | 1206 | L | |
| 144 | 21 | PFO1E | TZ | | | | 177 | L | |
| 145 | 22 | PFO1E | TAB | | | | 38 | L | |
| 146 | 24 | PFO1E | TAD | | | | 79 | L | |
| 147 | 24 | PFO1E | TAE | | | | 32 | L | |
| 148 | 24 | PFO1E | TAG | | | | 7 | L | |
| 149 | 90 | PFO1E | TAH | | | | 105 | L | |
| 150 | 35 | PFO1E | TAI | | | | 76 | L | |
| 151 | 35 | PFO1E | TAL | | | | 90 | L | |
| 152 | 35 | PFO1E | TAM | | | | 7 | L | |
| 153 | 35 | PFO1E | TAO | | | | 38 | L | |
| 154 | 41 | PFO1E | TAT | | | | 150 | D | |
| 155 | 41 | PFO1E | TAV | | | | 160 | D | |
| 156 | 46 | PFO1E | TAZ | | | | 646 | D | |
| 157 | 49 | PFO1E | TBC | | | | 459 | D | |
| 158 | 60 | PFO1E | TBE | | | | 54 | D | |
| 159 | 59 | PFO1E | TBS | | | | 176 | D | |
| 160 | 59 | PFO1E | TBV | | | | 92 | D | |
| 161 | 59 | PFO1E | TBW | | | | 94 | D | |
| 162 | 59 | PFO1E | TBY | | | | 482 | D | |
| 163 | 80 | PFO1E/PEM1E | TBN | | | | 420 | D | |
| 164 | 80 | PFO1E/PEM1E | TBO | | | | 561 | D | |
| 165 | 80 | PFO1E/PEM1E | TBP | | | | 213 | D | |
| 166 | 80 | PFO1E/PEM1E | TBQ | | | | 130 | D | |
| 167 | 80 | PFO1E/PEM1E | TBR | | | | 52 | D | |
| 168 | | | | | | Total | 13721 | | |
| 169 | Shrub Wetlands | | | | | | Temp. SF | | |
| 170 | 62 | PSS/PEM1E | TBU | | | | 1228 | D | Prime Wetland |
| 171 | 62 | PSS/PEM1E | TCA | | | | 73 | D | Prime Wetland |
| 172 | 62 | PSS/PEM1E | TCB | | | | 159 | D | Prime Wetland |
| 173 | 72 | PSS1/PEM1/PFO1B | TAR | | | | 100 | D | Prime Wetland |
| 174 | 85 | PSS1E | TAY | | | | 63 | D | |
| 175 | | | | | | Total | 1623 | | |
| 176 | Streams | | | SF | Bank LF | Channel LF | Temp. SF | | |
| 177 | S2 | R3UB3 | TAQ | | 32 | 20 | 129 | D | Perennial - Shields Brook |
| 178 | S2 | R3UB3 | TAS | | 10 | 5 | 85 | D | Perennial - Shields Brook |
| 179 | S2 | R3UB3 | TAU | | 10 | 5 | 154 | D | Perennial - Shields Brook |
| 180 | S2 | R3UB3 | TAW | | 10 | 5 | 77 | D | Perennial - Shields Brook |
| 181 | S2 | R3UB3 | TAX | | 10 | 5 | 87 | D | Perennial - Shields Brook |
| 182 | S5 | R3UB3 | TBX | | 25 | 5 | 135 | D | Perennial - Tributary E |
| 183 | S5 | R3UB3 | TBZ | | 18 | 8 | 22 | D | Perennial - Tributary E |

| | A | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Exit 4A - WETLAND IMPACT SUMMARY February 5, 2020 | | | | | | | | |
| 2 | WETLAND | WETLAND | LOCATION | | | | | TOWN | COMMENTS |
| 3 | NUMBER | CLASSIFICATION | | PERMANENT WETLAND | BANK | CHANNEL | TEMPORARY IMPACTS | | |
| 4 | | | | | | | | | |
| 5 | | | | SF | LF | LF | SF | | |
| 184 | S9 | R4SB5 | TN | | | 5 | 16 | L | Intermittent |
| 185 | S3 | R4SB5 | TBJ | | | 5 | 19 | D | Intermittent |
| 186 | S3 | R4SB5 | TBK | | | 5 | 34 | D | Intermittent |
| 187 | S4 | R4SB5 | TBL | | | 5 | 33 | D | Intermittent |
| 188 | S4 | R4SB5 | TBM | | | 5 | 15 | D | Intermittent |
| 189 | S1 | R4UB3 | TA | | | 5 | 42 | L | Intermittent |
| 190 | S1 | R4UB3 | TB | | | 5 | 150 | L | Intermittent |
| 191 | S1 | R4UB3 | TL | | | 5 | 68 | L | Intermittent |
| 192 | S1 | R4UB3 | TCE | | | 5 | 114 | L | Intermittent |
| 193 | S1 | R4UB3 | TCF | | 0 | 121 | 370 | L | Intermittent |
| 194 | | | | Totals | 115 | 219 | 1550 | | |
| 195 | Vernal Pools | | | | | | Temp. SF | | |
| 196 | VP2 | VP | TF | | | | 606 | L | |
| 197 | VP3 | VP | TI | | | | 810 | L | |
| 198 | VP46 | VP | TAA | | | | 68 | L | |
| 199 | VP6 | VP | TAC | | | | 126 | L | |
| 200 | VP6 | VP | TAF | | | | 378 | L | |
| 201 | VP8 | VP | TAJ | | | | 15 | L | |
| 202 | VP8 | VP | TAK | | | | 611 | L | |
| 203 | VP8 | VP | TAN | | | | 619 | L | |
| 204 | VP11 | VP | TCD | | | | 87 | D | |
| 205 | | | | | | Total | 3320 | | |

| | | | | | |
|---|---|---|---|---|---|
| 206 | | | | | |
| 207 | **Impact Summary** | **Permanent** | | **Temporary** | |
| 208 | **Resource Type** | **Square Feet** | **Acres** | **Square Feet** | **Acres** |
| 209 | PFO (no VPs) | 161,605 | 3.710 | 13,721 | 0.315 |
| 210 | PSS (no Prime) | 852 | 0.020 | 63 | 0.001 |
| 211 | PEM | 8,655 | 0.199 | 2,495 | 0.057 |
| 212 | Prime | 2,126 | 0.049 | 1,560 | 0.036 |
| 213 | Vernal Pools | 61,615 | 1.414 | 3,320 | 0.076 |
| 214 | **Veg. Wetland Total** | **234,853** | **5.391** | **21,159** | **0.486** |
| 215 | | | | | |
| 216 | Per. Streams | 4,937 | 0.113 | 689 | 0.016 |
| 217 | Int. Streams | 4,396 | 0.101 | 861 | 0.020 |
| 218 | Self Mitigating | - | | 20394 | 0.468 |
| 219 | **Stream Total** | **9,333** | **0.214** | **21,944** | **0.504** |
| 220 | | | | | |
| 221 | **Resource Total** | **244,186** | **5.606** | **43,103** | **0.990** |
| 222 | | | | | |
| 223 | **Perm+Temp** | **287,289** | **6.595** | | |
| 224 | | | | | |
| 225 | | | | | |
| 226 | | | | | |
| 227 | **Streams - Linear Ft** | **Permanent** | | **Temporary** | |
| 228 | **Streams** | **Channel LF** | **Banks LF** | **Channel LF** | **Banks LF** |
| 229 | Perennial | 258 | 543 | 53 | 115 |
| 230 | Intermittent | 902 | N/A | 166 | N/A |
| 231 | Self Mit (no ARM) | 0 | N/A | 1719 | N/A |
| 232 | **total LF impacts** | **1,160** | **543** | **1938** | **115** |
| 233 | | | | | |
| 234 | **Total T/P channel** | **3,098** | | | |
| 235 | **Total T/P bank** | **658** | | | |

# Attachment B

## Stream Restoration - Simulation Data
## Trolley Car Lane stream

# Bureau of Environment
# Stream Crossing Assessment Report

**Project:** I-93 Northern Segment (Stream Relocation Sta 43662+00 to 43670+00 SB "Trolley Car Lane")

**Date assessment completed: 10/07/2014**
**Assessment completed by:** Matt Urban and Marc Laurin

The Department is proposing to impact 2,368 linear feet of intermittent stream (R4SB3,5,6) as part of the Salem-Manchester I-93 widening project. The stream is located between Sta43662+00 and 43670+00 SB), in the Town of Londonderry. The Bureau of Environment has reviewed this segment of stream to collect stream characteristic data that can be used to simulate the natural stream channel when the stream is relocated to the west of its current alignment as a result of the proposed slope widening in this area. Due to the man-made influences along this segment of stream, such as straightened segments, and berms creating unnatural entrenchment ratios, it is difficult to accurately classify this stream.

Bankfull Width at Section 1: 10'
Max Channel Depth at Section 1: 1.5
100% Rip-Rap Stone (no surface water)

Bankfull Width at Section 2: 8'
Max Channel Depth at Section 2: 2.0
100% Rip-Rap Stone (no surface water)

Bankfull Width at Section 3: 12'
Max Channel Depth at Section 3: 1.2
100% Muck/Organics with standing water

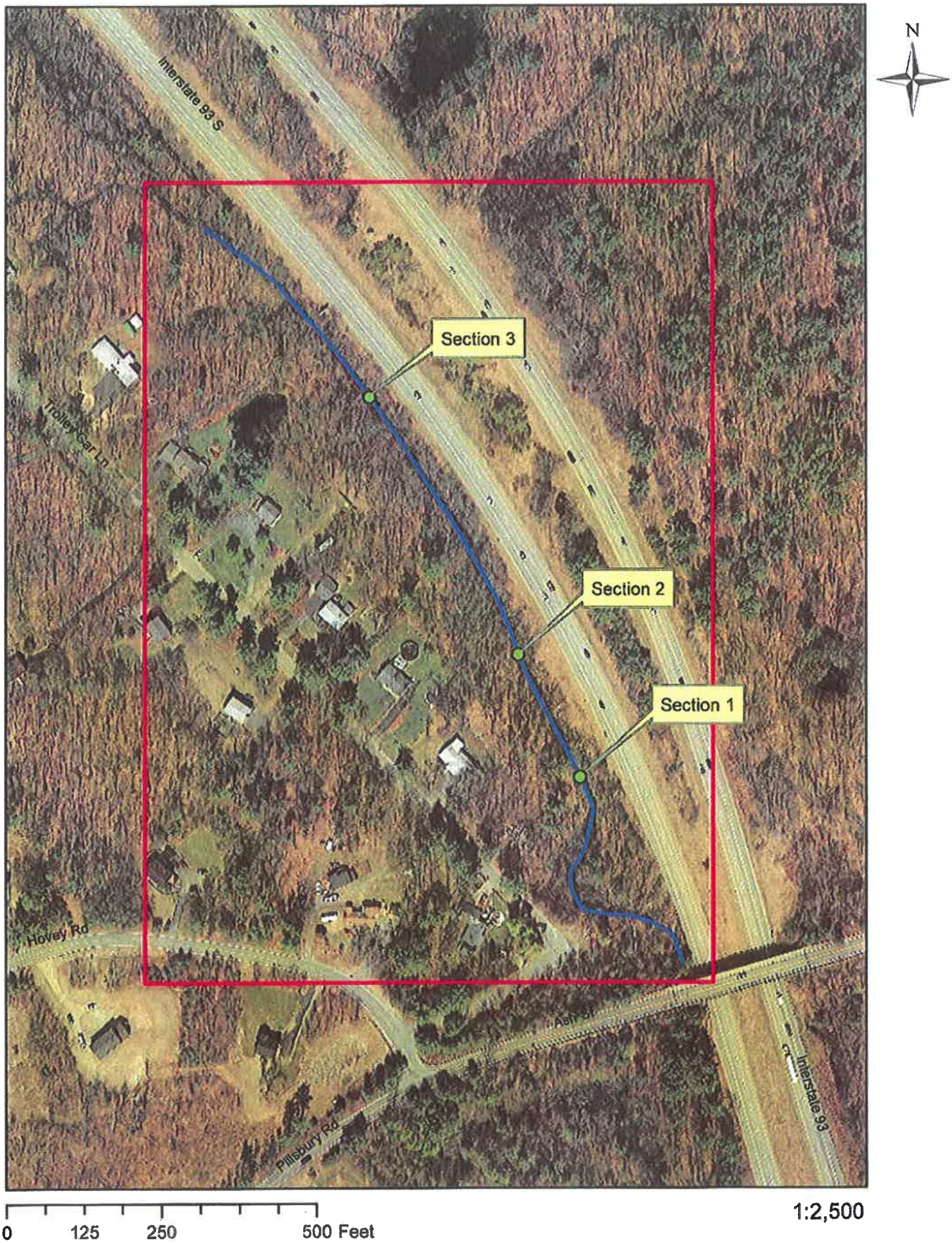
Slope between sections: approx. 1.5 -2 %

Dominant Surrounding Vegetation: Red Maple, Dogwood, White Birch, Fern

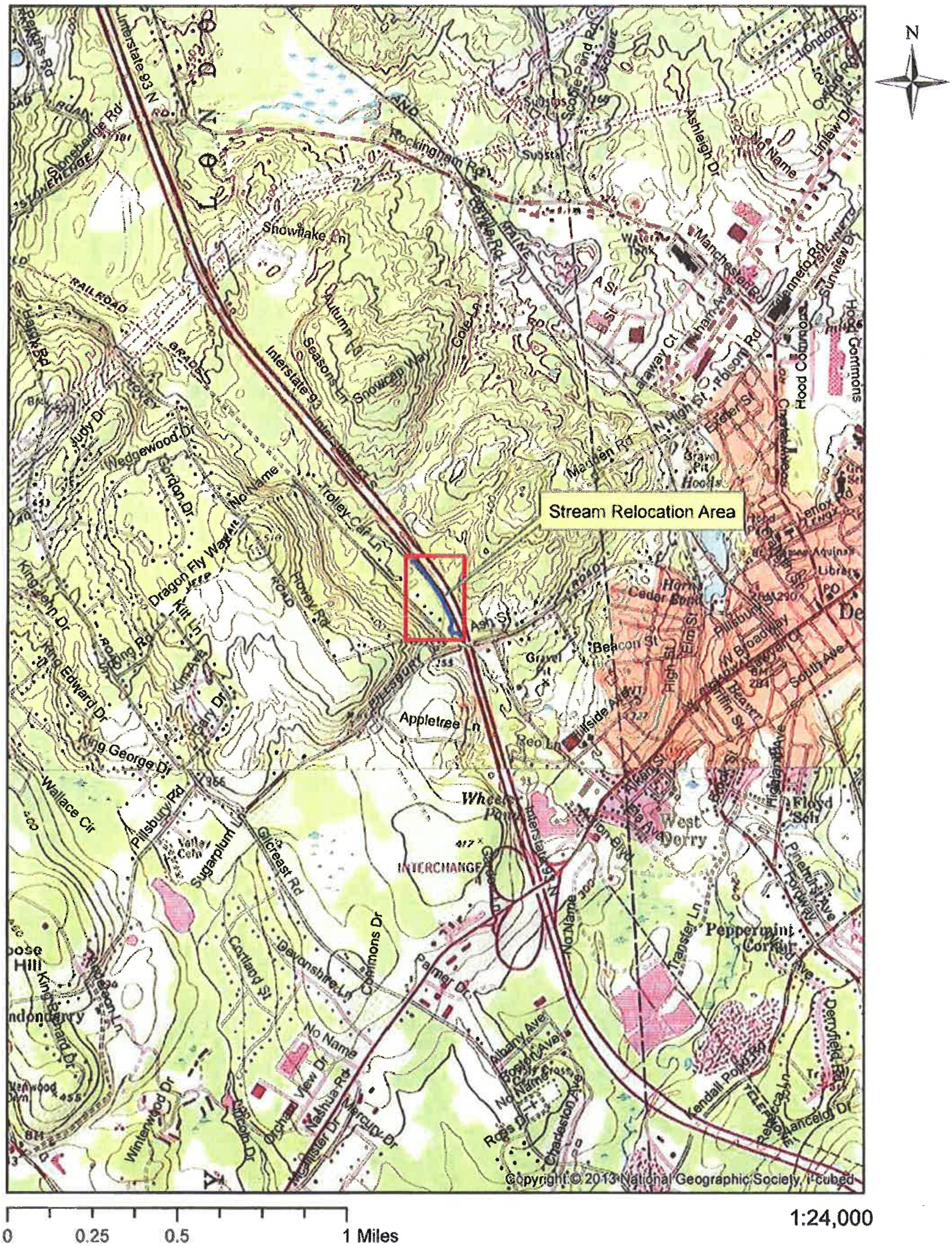
**<u>Recommended Cross Section for Relocated Segment of Stream Based on Averaged Data from Sections 1 thru 3.</u>**

**Bankfull Width at Relocation: 10'**
**Max Channel Depth at Relocation: 1.6**
**Muck/Organics**

# Cross Sections for Stream Relocation (Tolley Car Lane)

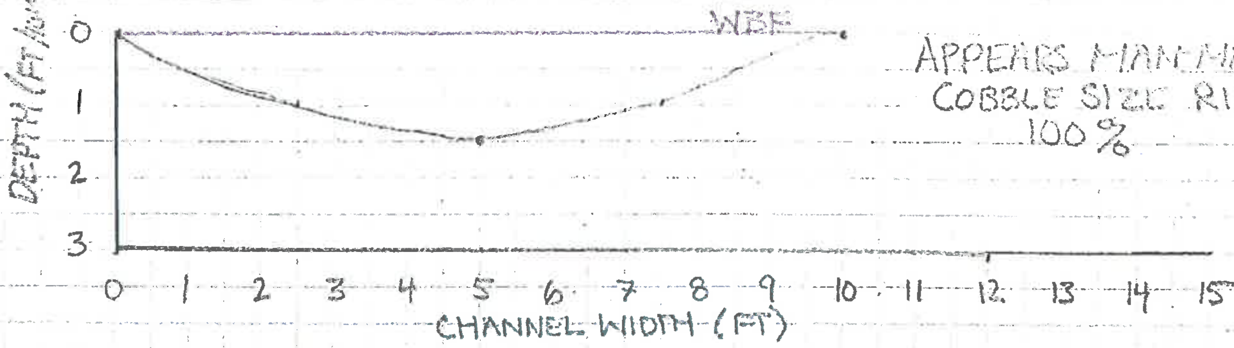


# Cross Sections for Stream Relocation (Tolley Car Lane)



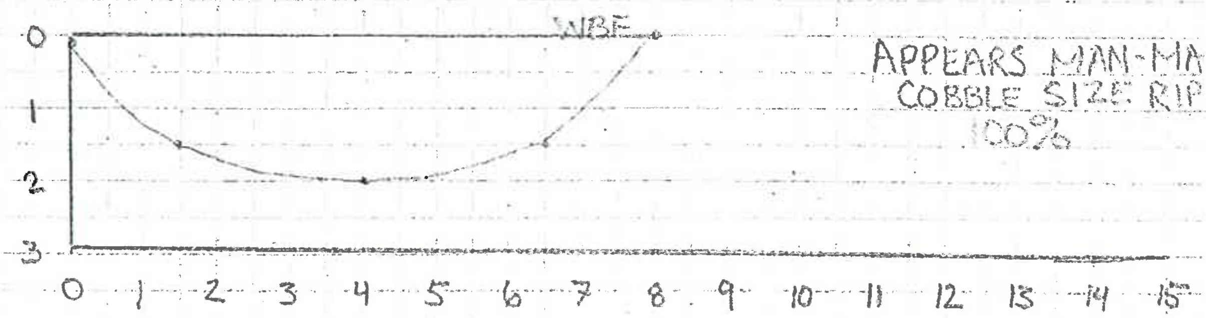

1:24,000

SECTION # 1



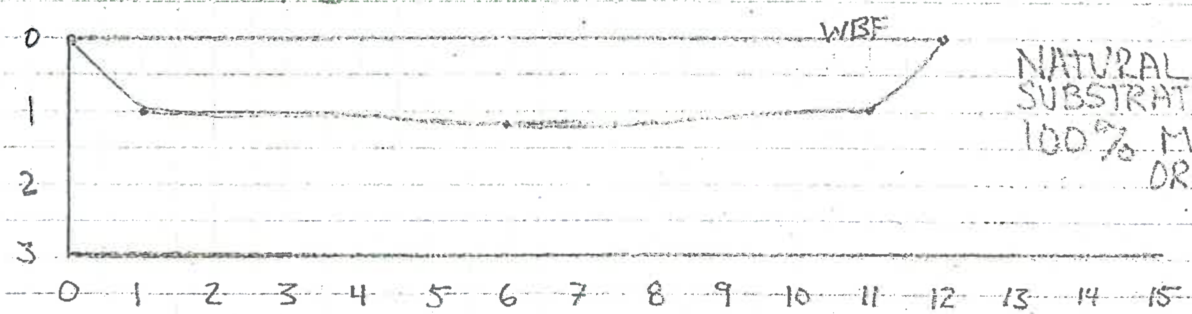

APPEARS MAN-MADE
COBBLE SIZE RIP-RAP
100%

SECTION # 2



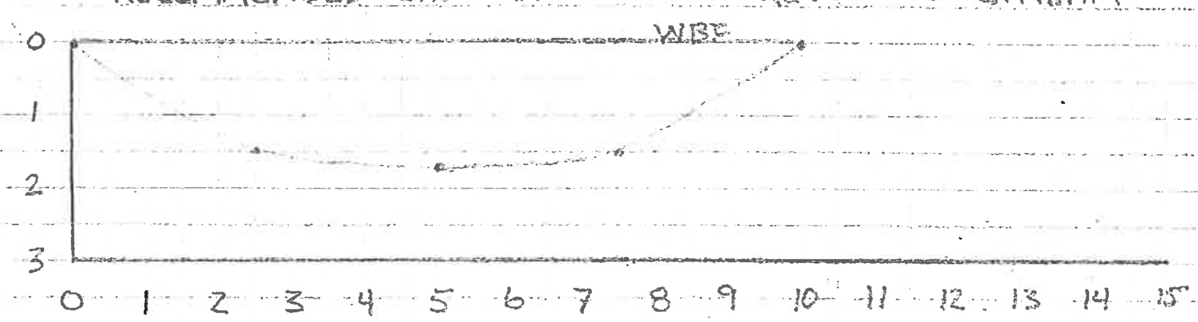

APPEARS MAN-MADE
COBBLE SIZE RIP-RAP
100%

SECTION # 3




NATURAL
SUBSTRATE
100% MUCK/
ORGANICS

RECOMMENDED CROSS SECTION FOR RELOCATED STREAM



SECTION #1 10/7/14

SECTION #3 10/7/14

SECTION #2 10/7/14

FHWA-NH-EIS-07-01-F

# I-93 Exit 4A Interchange Study
# Derry-Londonderry
# Final Environmental Impact Statement
# Stream Relocation Assessment and Conceptual Restoration Plan

**Prepared for**

**Town of Derry**
**14 Manning Street**
**Derry, NH 03038**

**Town of Londonderry**
**268 B Mammoth Road**
**Londonderry, NH 03053**

**U.S. Department of Transportation**
**Federal Highway Administration**
**Lead Agency**

**November 2010**

FHWA-NH-EIS-07-01-F

# I-93 Exit 4A Interchange Study
# Derry-Londonderry
# Final Environmental Impact Statement
# Stream Relocation Assessment and Conceptual Restoration Plan

*Prepared for*
**TOWN of DERRY**
**TOWN OF LONDONDERRY**
**US DEPARTMENT OF TRANSPORTATION**
**FEDERAL HIGHWAY ADMINISTRATION**

*Prepared by*
**NORMANDEAU ASSOCIATES, INC.**
**25 Nashua Road**
**Bedford, NH 03110**

**R-21429.000**

**November 2010**

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# DERRY-LONDONDERRY
# FINAL ENVIRONMENTAL IMPACT STATEMENT
# STREAM RELOCATION ASSESSMENT AND CONCEPTUAL RESTORATION PLAN

## 1.0 Introduction

The construction of Alternatives A and B for the Exit 4A interchange will result in impacts to the drainages located within the footprint of the area of disturbance. The Draft Environmental Impact Statement (DEIS; FHWA 2007) noted that along the east side of Interstate I-93 an estimated 900 feet of intermittent stream channel would need to be relocated along with 1,450 feet of perennial stream channel located along the west side of the highway.

In the comments received from the U.S. Environmental Protection Agency (EPA) on the DEIS it was noted that "no details were provided in the DEIS that describe how these relocated streams would be rebuilt or restored" (USEPA 2007). In comments received from the New Hampshire Department of Environmental Services (DES; DES 2007) it was noted that "the DEIS discusses physical impacts to streams, particularly a 1,450 foot relocation of a perennial stream and a 900-foot relocation of an intermittent stream under Alternative A" and goes on to state that "the relocated stream segments will need to be designed in such a way that mimics natural conditions to the maximum extent possible and in accordance with DES Wetland Bureau regulations".

In response to these concerns, an assessment of the relocated was performed and a conceptual restoration plan was developed. Section 2 details the assessment of the existing drainages in the footprint of proposed Exit 4A. This includes an initial field reconnaissance of the streams along the east and west sides of Interstate I-93 in the Exit 4A footprint. This was followed by a more detailed field survey of selected portions of the west side drainage to obtain the geomorphic information needed to classify the stream segments, included as Section 3. Section 4 details the aquatic habitat assessment that was conducted for the west side stream. Section 5 provides a preliminary conceptual design for the relocated channel.

## 2.0 Field Reconnaissance

A field reconnaissance was performed along the east and west sides of Interstate I-93 from the Ash Street/Pillsbury Road overpass to the location of the proposed Alternative A and B Exit 4A interchange on November 19 and 23, 2009. The objectives of the field reconnaissance were to document the location of any stream channels and culvert crossings along both sides of the highway and to initially characterize the streams located within the footprint of the proposed Exit 4A interchange. Notable features were photo documented and their location georeferenced using a handheld Garmin GPS receiver.

## 2.1 East Side

Four stream crossings were documented along the east side of Interstate I-93 between the overpass to the proposed Alternative A and B location of the Exit 4A interchange. Two of these are located within the footprint of the proposed interchange and are associated with the drainages that will be impacted by the proposed project. The first of these is located approximately midway between the overpass and the proposed interchange (point ES-4, Figure 2-1). Flow from this wetland/vernal pool complex (B-11a/VP-3) discharges into a 2 foot inside diameter circular concrete culvert that directs this runoff under the highway to the stream on its west side. This wetland/vernal pool complex is also connected to another wetland/vernal pool complex (B-11a/VP-4) approximately 500 feet to the northwest by a constructed channel at the base of the I-93 embankment. The outlet (point ES-7, Figure 2-1) from the upper wetland/vernal pool complex (B-11a/VP-4) is well defined consisting of a parabolic channel; 5-6 feet wide and 1-2 feet deep (Figure 2-2), with bed material consisting of organic material, silt and sand.

Downstream (point ES-6, Figure 2-1), the channel becomes more u-shaped in cross-section and its width decreases to 4 feet and the channel is about one foot deep (Figure 2-3). Before discharging into the lower wetland/vernal pool complex (B-11a/VP-3) the stream channel becomes indistinct. At the time of the field reconnaissance, there was no flow in the channel and the channel bed was covered by leaf material. The channel bed generally consists of compacted fine grain (sand and silt) native material. Limited bank scour was observed in one area, but overall the channel appeared stable.

The second stream crossing on the east side of Interstate I-93 and in the footprint of the proposed Alternative A and B of the Exit 4A interchange is located approximately 300 feet northwest of wetland/vernal pool complex B-11a/VP-4 (point ES-8, Figure 2-1). This is where the east branch of the unnamed tributary to Wheeler Pond flows into a 3 foot inside diameter circular concrete culvert, which directs it southwest under the highway. The construction of the Alternative A and B Exit 4A interchange would result in the placement of fill material in this area and the existing culvert would need to be extended to a point approximately 150 feet upstream.

## 2.2 West Side

An unnamed tributary of Wheeler Pond flows between Interstate I-93 and Trolley Car Lane from the location of the Alternative A and B Exit 4A interchange to the Ash Street/Pillsbury Road overpass (Figure 2-1). At the overpass, it flows into a circular concrete culvert, which conveys the stream under the highway to the southeast towards Wheeler Pond. Along this stream length four culvert outlets were documented. Only one of these was located in the footprint of the proposed Alternative A and B Exit 4A interchange. This is the culvert that conveys the east branch tributary under the highway. The east branch tributary then flows through wetland complex A-14 (Figure 2-1) and joins the west side stream channel (Figure 2-5). Based on the proposed Alternative A and B Exit 4A interchange plan, approximately 400 feet of this channel will be rerouted into a culvert under fill material placed in the wetland complex for the construction of the exit ramp.

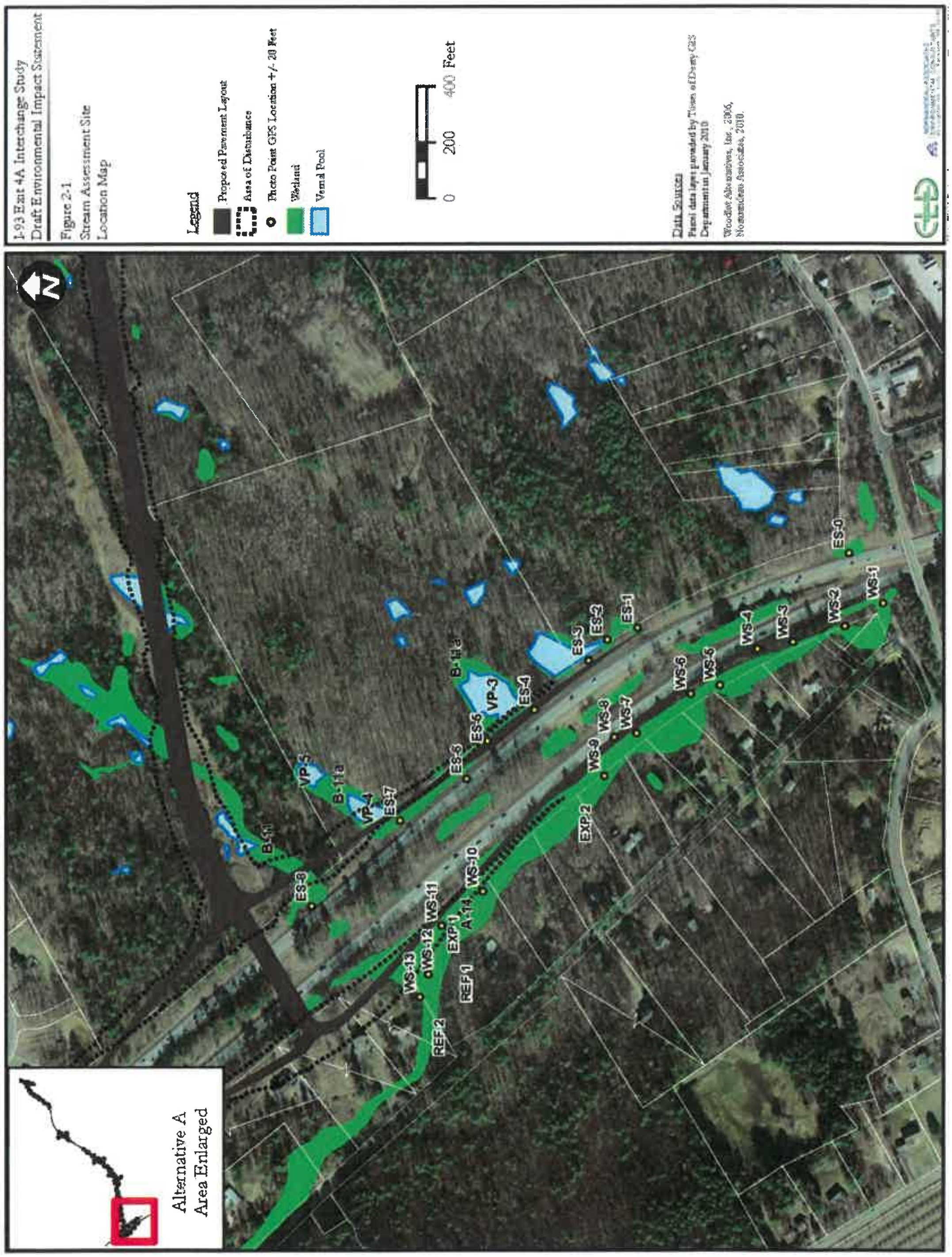


Figure 2-1. Stream Assessment Site Location Map.

Figure 2-2. Outlet channel from wetland/vernal pool complex B-11a/VP-4 at point ES-7. Ruler for scale is 8 inches long. Photograph taken on November 23, 2009.

Figure 2-3. East side channel at point ES-6 looking downstream towards wetland /vernal pool complex B-11a/VP-3. Ruler for scale is 8 inches long. Photograph taken on November 23, 2009.

Figure 2-4. East side channel at point ES-5 looking upstream from wetland /vernal pool complex B-11a/VP-3. Ruler for scale is 8 inches long. Photograph taken on November 23, 2009.

Figure 2-5. East branch tributary looking upstream from its confluence with the west side stream at point WS-11 in wetland complex A-14. Photograph taken on November 19, 2009.

Upstream of its confluence with the east branch (point WS-11), the channel of the west side stream transitions from a higher gradient, higher velocity, riffle and pool dominated stream (upstream of point WS-13, Figure 2-6) to a lower gradient, lower velocity stream (downstream of point WS-13, Figure 2-7) that flows through the wetland complex. Through the wetland complex the channel is primarily u-shaped with its width ranging from 4 to 8 feet and its depth ranging from 1 to 1.5 feet. The channel bed consists of fine sand and silt material.

Figure 2-6. West side stream looking upstream at point WS-13. Photograph taken on November 19, 2009.

Figure 2-7. West side stream looking downstream at point WS-13. Photograph taken on November 19, 2009.

Downstream of its confluence with the east branch, the gradient of the main channel increases and several interconnected side channels parallel the main channel. The channel substrate also coarsens to sand and gravel and riffles and pool features become more evident.

# 3.0 Geomorphic Field Assessment

## 3.1 East Side

A geomorphic field assessment of the intermittent channels along the east side of Interstate I-93 within the footprint of the proposed Alternative A and B Exit 4A interchange was not performed. This decision was based on their original design as drainage ditches to convey runoff from the highway and between the two wetland complexes, their ephemeral or intermittent nature, the lack of any significant aquatic habitat and the planned construction of a new detention basin in this area. The design of the new detention basin will incorporate the design of the new drainages.

## 3.2 West Side

A geomorphic field assessment of two reaches of the tributary to Wheeler Pond located on the west side of Interstate I-93 was performed on December 2 and 4, 2009, with an additional field survey at a third reach of the stream performed on July 22, 2010. The objectives of the geomorphic field assessments were to document the existing condition of the selected stream segments, classify them by channel type and obtain information on the morphology for the development of a conceptual design for the relocation of a portion of the stream channel. The methods used during the field assessment are detailed in the Quality Assurance Project Plan (Normandeau 2010) developed for this study.

The three reaches that were classified included a 220 foot section in the northwestern portion of wetland complex A-14 (upstream and downstream of point WS-12, Figure 2-1), a 39 foot section (near point WS-10, Figure 2-1) and a 90 foot section near the end of the natural stream channel (upstream of point WS-9, Figure 2-1). A Level II stream type delineation (Rosgen 1996) was performed to characterize reaches of the stream above, within and below the area to be impacted by the construction of the proposed exit. The morphological information collected from the middle reach was also used in the development of a conceptual design of the relocated channel.

In brief, the stream type delineation included: flagging of bankfull stage, survey of the longitudinal profile, survey of a representative cross-section and a pebble count. The information collected during the field delineation was used to determine their morphological characteristics for stream type classification:

- Bankfull width
- Mean depth
- Bankfull cross-sectional area
- Width to depth ratio
- Maximum depth
- Width of flood prone area
- Entrenchment ratio

- D50 particle size
- Water surface slope
- Channel sinuosity

The results of the field delineation for the three reaches surveyed on the west side stream are summarized in Table 3-1.

### 3.2.1 Upper Reach

The upper reach of the main stream in wetland complex A-14 is relatively straight with a low gradient (Table 3-1 and Figures 3-1 and 3-2). The channel has few features such as riffles and pools and in cross-section is u-shaped (Figures 3-3 and 3-4). Based on a pebble count, the median size of the channel material is silt and fine sand. No gravel or cobble sized particles were measured during the pebble count.

**Table 3-1. Morphological characteristics of the upper, middle and lower reaches of the west stream in wetland complex A-14.**

| | Upper | Middle | Lower | Delineative Criteria | |
|---|---|---|---|---|---|
| **Morphological Characteristic** | **Reach** | **Reach** | **Reach** | **B Type** | **E Type** |
| Bankfull Width (ft) | 5 | 6.4 | 10.8 | | |
| Mean Depth (ft) | 1.05 | 0.69 | 0.59 | | |
| Bankfull Cross-Section Area (sq. ft) | 5.25 | 4.4 | 6.42 | | |
| Width/Depth Ratio | 4.8 | 9.3 | 18.3 | >12 | <12 |
| Maximum Depth (ft) | 1.4 | 0.89 | 0.96 | | |
| Width of the Flood Prone Area (ft) | 150* | 25.1 | 21.7 | | |
| Entrenchment Ratio | 30* | 3.9 | 2.01 | 1.4 - 2.2 | >2.2 |
| Channel Materials (D50 in mm) | 0.0625 | 0.0625 | 2.5 | | |
| Water Surface Slope | 0.005 | Dry | 0.015 | .02 - .039 | <.02 |
| Channel Sinuosity | 1 | 1.05 | 1.04 | 1 - 1.2 | >1.5 |
| **Stream Type** | **E5** | **E6** | **B4** | | |

Delineative criteria from Rosgen (1996). Values with * are estimated.

The bankfull width and depth measured at the cross-section were 5 feet and 1.05 feet, with a width to depth ratio of 4.8. The maximum bankfull depth was 1.4 feet. The width of the flood prone area could not be measured directly due to the large width of the wetland complex in this area and may exceed 150 feet. As a result, the entrenchment ratio could not be directly calculated. Considering that the width of the flood prone area is greater than 150 feet and bankfull width was measured as 5 feet, the estimated entrenchment ratio has an estimated value of 30. When the values for the morphological characteristics for the upper reach are compared to Rosgen's (1996) delineative criteria for the major stream types, the upper reach of the perennial stream can be classified as an E5 type stream (Table 3-1). These types of streams are characteristically found in alluvial valleys with extensive floodplains and wetlands (Rosgen 1996).

Figure 3-1. Upper reach of the west side stream looking upstream at cross-section. Orange flagging notes bankfull stage and location of survey location for longitudinal profile. Length of stadia rod is 4.8 feet. Photograph taken on December 2, 2009.

Figure 3-2. Upper reach of west side stream looking downstream from cross-section. Orange flagging notes bankfull stage and location of survey location for longitudinal profile. Photograph taken on December 2, 2009.

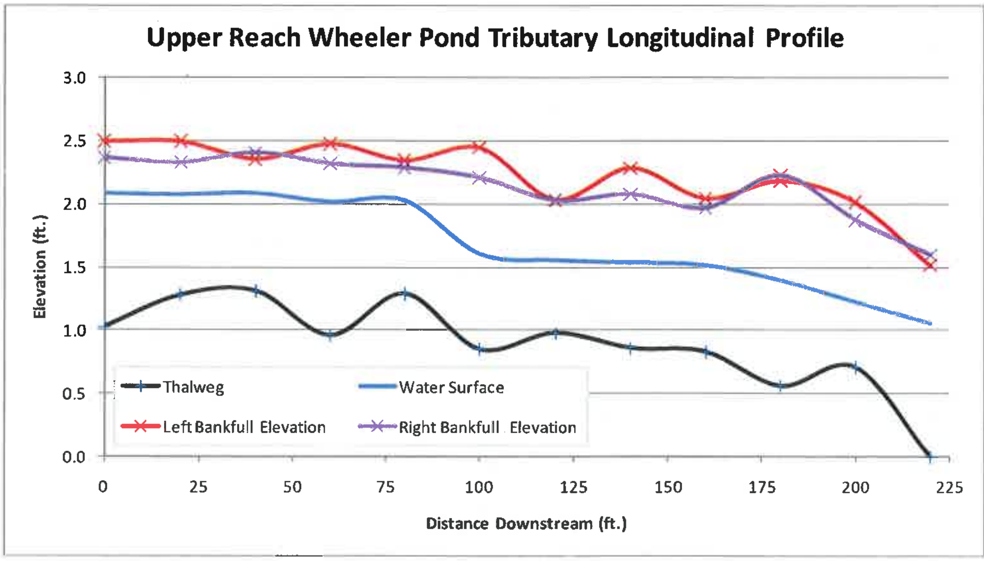


Figure 3-3. Longitudinal profile of the upper reach of the west side stream based on survey performed on December 2, 2009.

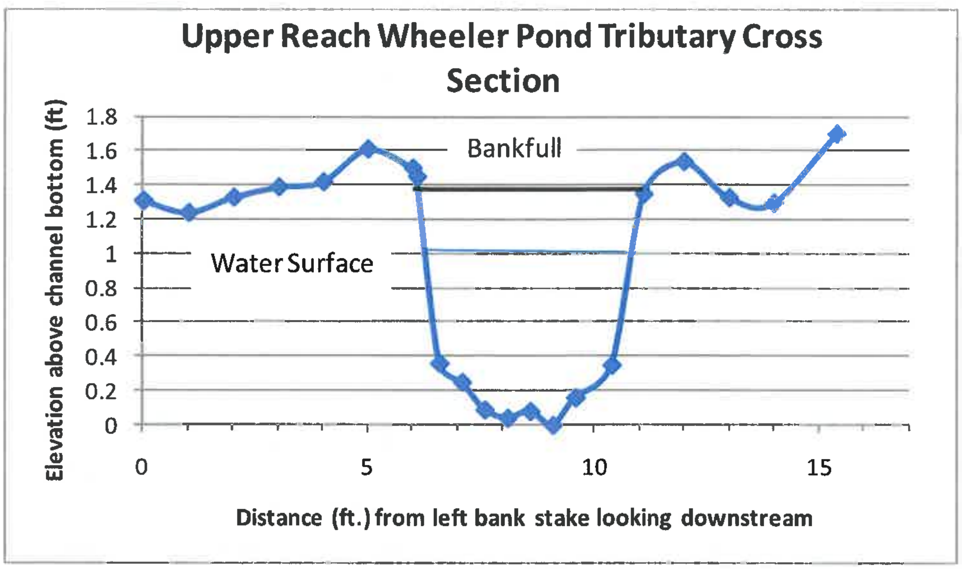


Figure 3-4. Cross-section of the upper reach of the west side stream based on survey performed on December 2, 2009. Cross-section located at station 0+60 on the longitudinal profile.

### 3.2.2 Middle Reach

The middle reach of the west side stream in wetland complex A-14 is located just below the confluence of the main channel with an overflow channel near the end of the large wetland area. The channel immediately downstream of the confluence is slightly sinuous with a low gradient

(Table 3- 1 and Figures 3-5 and 3-6). This channel is transitional between the wetland controlled reach above it and the upland controlled reach downstream. The channel has riffles and pools and is u-shaped to parabolic shaped in cross-section (Figures 3-7 and 3-8). Based on a pebble count, the median size of the channel material is silt and clay, but coarser sized (gravel and cobble) particles were measured in the riffles.

Figure 3-5. Middle reach of west side stream looking upstream towards riffle cross-section. Left photo taken June 4, 2010 and right photo taken on July 22, 2010. Orange flagging notes bankfull stage.

Figure 3-6. Middle reach of west side stream looking downstream from cross-section. Scale of ruler on rock is 8 inches. Photograph taken on June 4, 2010.

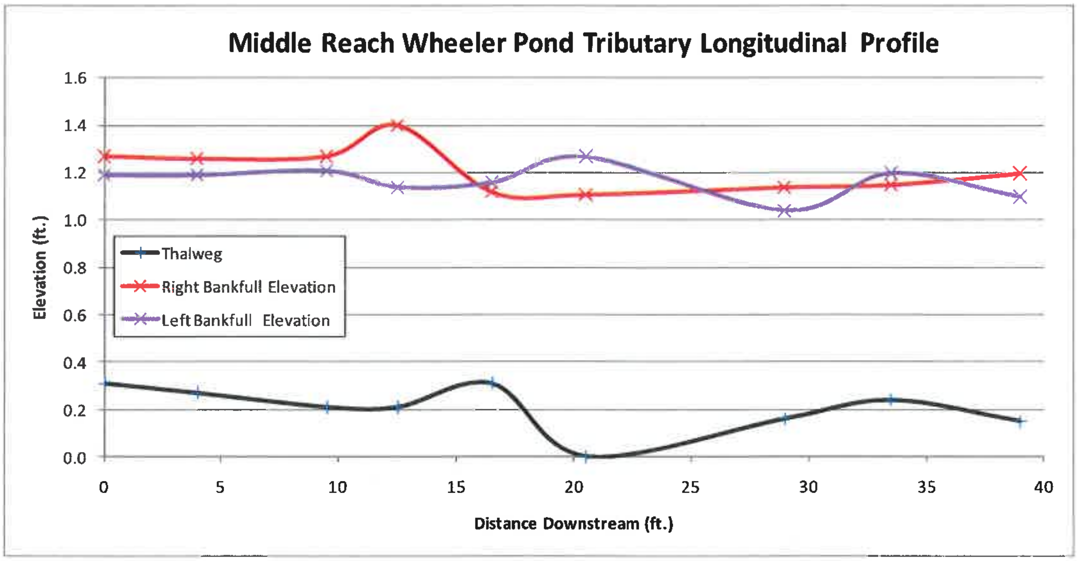


Figure 3-7. Longitudinal profile of the middle reach of the west side stream based on survey performed on July 22, 2010.

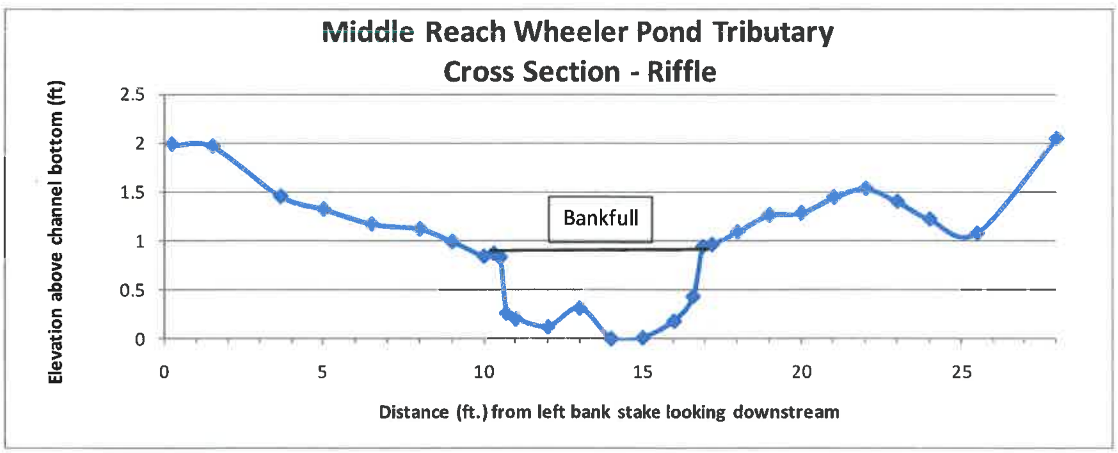


Figure 3-8. Cross-section of the middle reach of the west side stream based on survey performed on July 22, 2010. Cross-section located at station 0+00 on the longitudinal profile.

The bankfull width and depth measured at the riffle cross-section were 6.4 feet and 0.69 feet, with a width to depth ratio of 9.3. This value is higher than that measured in the upper reach and reflects the channel getting wider and shallower. The maximum bankfull depth was 0.89 feet. Based on this value, the width of the flood prone area is 25.1 feet and the entrenchment ratio is 3.9. When the values for the morphological characteristics for the middle reach are compared to Rosgen's (1996) delineative criteria for the major stream types, this portion of the stream can be classified as an E6 stream type (Table 3-1) and is transitional in nature between the upper and lower reaches.

### 3.2.3 Lower Reach

The lower reach of the west side stream in wetland complex A-14 is sinuous with a slightly higher gradient than that of the two reaches surveyed upstream (Table 3-1 and Figures 3-9 and 3-10).

Figure 3-9. Lower reach of west side stream looking upstream from cross-section. Orange flagging notes bankfull stage and location of survey location for longitudinal profile. Length of stadia rod is 4.8 feet. Photograph taken on December 4, 2009.

Figure 3-10. Lower reach of west side stream looking downstream towards cross-section. Orange flagging notes bankfull stage and location of survey location for longitudinal profile. Length of stadia rod is 4.8 feet. Photograph taken on December 4, 2009.

This channel is upland controlled and formed in glacial till. It also appears to be the end of the original stream channel, with the remaining portion of the stream having been either relocated or impacted during the construction of Interstate I-93. The channel in this reach consists of riffles and pools and is u-shaped to parabolic shaped in cross-section (Figures 3-11 and 3-12). Based on a pebble count, the median size of the channel material is very fine gravel, with cobble sized clasts concentrated in the riffles.

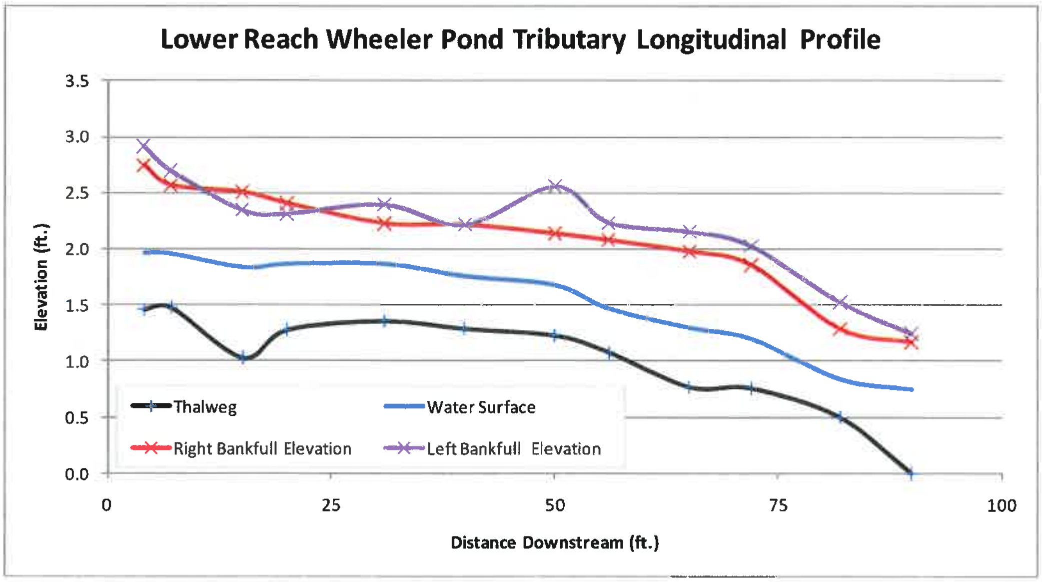


Figure 3-11. Longitudinal profile of the lower reach of west side stream based on survey performed on December 4, 2009.

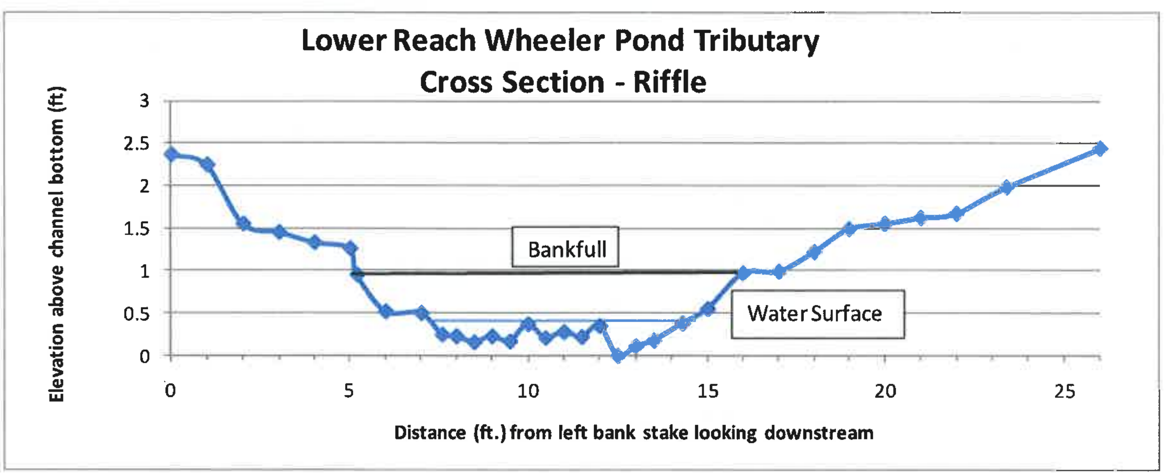


Figure 3-12. Cross-section of the lower reach of west side stream based on survey performed on December 4, 2009. Cross-section located at station 0+40 on the longitudinal profile.

The bankfull width and depth measured at the riffle cross-section were 10.8 feet and 0.59 feet, with a width to depth ratio of 18.3. The maximum bankfull depth was 0.96 feet. Based on this value, the width of the flood prone area is 21.7 feet and the entrenchment ratio is 2.01. When the values for the morphological characteristics for the lower reach are compared to Rosgen's (1996) delineative criteria for the major stream types, this portion of the stream can be classified as a B4 stream type (Table 3-1).

The transition from the E type channel of the upper and middle reaches, to the B type stream in the lower reach reflects the transition from a lower gradient wetland controlled channel (upper and middle reaches) to a higher gradient upland controlled channel. This transition is reflected in the increase in the width to depth ratio (channel getting wider and shallower) and the decrease in the entrenchment ratio.

# 4.0 Aquatic Habitat Assessment

## 4.1 Baseline Data

Baseline physical habitat data and benthic macroinvertebrate data were collected from four sampling stations along the west side stream, two experimental stations from reaches where stream habitat may be relocated or altered during construction and from two reference stations in reaches not expected to be affected by the construction of Exit 4A.

At each sampling station, the physical habitat of the stream was evaluated using the habitat assessment matrix developed for the Rapid Bioassessment Protocols (RBPs) in Barbour et al. (1999). The RBP habitat assessment matrix provides separate assessment metrics for low and high gradient streams; stream habitat in the Exit 4A study area was evaluated using both high gradient (Stations EXP2 and REF2) and low gradient (Stations EXP1 and REF 1) assessment metrics. Ten metrics were scored on a numerical scale of 0 to 20 (lowest to highest quality respectively) for each sampling reach. The metric scores were summed at a station to provide a numerical habitat score for that station; scores increased as habitat quality increased. Total scores can range from 0 to 200, therefore, in general, scores 150 to 200 would indicate excellent habitat quality, scores 100 to 149 would indicate good habitat quality, scores 50 to 99 would indicate fair habitat quality, and scores 0 to 49 would indicate poor habitat quality.

Benthic macroinvertebrate sampling followed procedures provided in NH Department of Environmental Services Biomonitoring Protocols (NHDES 2004) and EPA's RBP (Barbour et al.1999) Multihabitat Approach sampling procedure. Benthic macroinvertebrate samples were collected from two experimental stations and from two reference stations during December 2009 using a 595µm mesh dip net. Approximately 3 meters$^2$ of substrate was sampled from each location. High gradient habitat from reference station REF2 and experimental station EXP2 was sampled by holding the dip net perpendicular to the flow and utilizing a kicking-motion of the foot to agitate the substrate and dislodge organisms. Low gradient habitat from reference station REF1 and experimental station EXP1 were sampled by using the dip net to jab into the bank and substrate to dislodge organisms.

## 4.2 Laboratory Analysis

In the laboratory, fixed-count subsampling procedures described in Barbour et al. (1999) was followed. Each sample was evenly distributed in a gridded white enamel pan. Randomly selected grids were individually sorted until a minimum of 200 organisms was removed from each sample. Once sorting was initiated in a grid, all animals were removed from that grid. Therefore in some cases, more than 200 organisms may have been identified from a sample. Organisms removed during the sorting process were identified to the genus and species taxonomic level, except for damaged organisms and organisms where larval development was insufficient to allow for genus and species identification.

## 4.3 Biological Metrics

Benthic data were analyzed using seven biological metrics (parameters) to assess the data. These metrics integrate population community and functional feeding group characteristics to produce a single evaluation of biotic integrity. The seven metrics used in this evaluation are described in sections 4.3.1 to 4.3.7.

### 4.3.1 Taxa Richness

Taxa richness is the number of distinct taxa (types of organisms) in a sample. For example, if two genera of mayfly, one genus of caddisfly, and five genera of midges were found in a sample, regardless of the number of individuals in each group, the taxa richness of the sample would be 8. The number of distinct taxa was determined using the following counting rules:

- Higher level taxonomic identifications (e.g., Phylum, Class, Order, Family) were not counted as a separate taxon if lower taxonomic levels (i.e., genus or species) were found in that sample.
- Higher level taxonomic identifications (e.g., Phylum, Class, Order, Family) were not counted toward taxa richness unless they were the only representative.
- Pupae were ignored in all calculations.

### 4.3.2 Biotic Index

The biotic index is a ranking based on literature-reported values of the relative sensitivity of a taxon to organic pollution stress caused primarily by the presence of oxygen-demanding substances in the water. This index was developed by Hilsenhoff (1982) to summarize the tolerances of benthic macroinvertebrates at the generic taxonomic level. Values range from 0 (sensitive) to 10 (tolerant), therefore lower values indicate less impaired conditions. This metric was calculated by multiplying the mean number of individuals of a taxon by its assigned tolerance value, which were provided by Bode (1988) and Bode et al. (1995). All of these products were summed, and divided by the total number of individuals of each taxon that was assigned a tolerance value.

Where: "n" is the number of individuals of the "i"th taxon;

"a" is the biotic index value of that taxon;

N is the total number of individuals in the sample assigned a Biotic Index Value

### 4.3.4 Ratio of Scrapers to Filtering Collectors

Scrapers are benthic macroinvertebrates that feed on algae and bacteria growing on the substrate (periphyton). Filtering collectors feed on fine particulate material that is suspended in the water. The predominance of either functional feeding group reflects an abundance of their food source, and the two feeding groups are usually compared as a ratio. The more this ratio differs from a value of 1.0, the greater the imbalance in the proportion of these two food resources. A low ratio indicates either a relatively high abundance of particulate food or a low abundance of periphyton, whereas a high ratio indicates either a high abundance of periphyton or a low abundance of particulate material. A high ratio may also indicate the presence of toxicants adsorbed onto fine organic particulate material that has become available as food for filtering collectors.

### 4.3.5 EPT Richness Index

Three groups of benthic insects are considered particularly sensitive to pollution, and the number of distinct taxa among them generally increases with increasing water quality. These groups (orders), Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) are collectively referred to as the EPT taxa. The EPT Index is calculated by counting the number of EPT taxa represented in each sample, similar to calculating taxa richness. Low values for this metric indicate potentially stressful conditions.

### 4.3.6 Percent Contribution of the Dominant Taxon

The percent contribution of the most abundant taxon to the total number of organisms found in a sample is a measure of balance in the benthic community. If the dominant taxon accounts for a large percentage of the individuals present, it is an indication of stress because the community is dominated by one taxon, whereas unstressed communities typically exhibit a more evenly balanced abundance among several taxa.

### 4.3.7 Community Loss Index

The community loss index measures the loss of benthic taxa in samples from an experimental station compared to those found at the reference station, and is calculated as follows:

Where: a= number of taxa common to both samples

c= total number of taxa present at the experimental station

d= total number of taxa present at the reference station

The value of this index can range from 0 to infinity, and increases as the test station becomes increasingly dissimilar to the reference station.

## 4.4 Data Analysis

Benthic data collected from the west side stream during 2010 provide baseline information on benthic community composition. These baseline data will be used as reference data during post-construction benthic sampling comparisons. Benthic macroinvertebrate reference stations (REF 1 and REF2) were also established in 2010 and will be used for comparison with post-construction benthic studies to document changes in the benthic community over time at the same location.

Benthic data between reference and experimental stations were evaluated using procedures and scoring criteria described in EPA's Rapid Bioassessment Protocols III (Plafkin et al. 1989). Each metric was given a score based on its percent comparability to reference data. For comparisons against experimental Stations EXP1 and EXP2 values of metrics from Stations REF1 and REF2 were used as reference data, respectively.

**Table 4-1. Biological Scoring Criteria**

| | Biological Scoring Criteria | | | |
|---|---|---|---|---|
| Metric | 6 | 4 | 2 | 0 |
| 1. Taxa Richness (exp./ref.*100) | >80% | 60-80% | 40-60% | <40% |
| 2. Hilsenhoff Biotic Index (ref./exp.*100) | >85% | 70-85% | 50-70% | <50% |
| 3. Scraper to Filterer Abundance Ratio (exp./ref.*100) | >50% | 35-50% | 20-35% | <20% |
| 4. EPT Richness (exp./ref.*100) | >90% | 80-90% | 70-80% | <70% |
| 5. Percent Contribution of the Dominant Taxon (actual value) | <20% | 20-30% | 30-40% | >40% |
| 6. Community Loss Index (actual value) | <0.5 | 0.5-1.5 | 1.5-4.0 | >4.0 |

Metric scores for each experimental station were totaled and compared to the total metric score for the reference data. Reference data total scores used for comparison against experimental data automatically received an optimal score of 6 for each metric, except for percent contribution of the dominant taxon, which would be less than optimal if a single taxon composed greater than 20 percent of the benthic community at that station (Plafkin et al. 1989). The percent comparison between the total scores for each station provides a Biological Condition category, based on criteria provided in Table 4-2.

## 4.5 Results

The west side stream was assessed on 15 Dec 2009. Physical habitat and benthic macroinvertebrate data were collected at two low-gradient stations (REF 1, EXP 1) and at two high-gradient stations (REF 2, EXP 2), sampling stations are shown in Figure 4-1.

Experimental Station EXP 1 was located in low gradient habitat on the eastern branch of the west side stream reach adjacent to I-93 in the segment proposed for relocation. This station had fair habitat for supporting macroinvertebrates and the RBP habitat score was 72 (Table 4-3). The substrate was comprised of 90 percent mud and 10 percent sand; dissolved oxygen concentration was 10.3 mg/l, pH was 7.5, and specific conductance was 175.2 µS/cm. Station EXP 1 was 0.4 ft deep and had a current velocity of 0.2 ft per second (fps). This station had the lowest values for dissolved oxygen and specific conductance of any station (Table 4-3).

Station REF 1 was located on the west branch of the west side stream and was the low gradient reference station. Station REF 1, had a slightly higher habitat value (75) than Station EXP 1 but was still considered fair habitat based on RBP habitat assessment criteria (Table 4-3). RBP habitat assessment criteria also indicated that Stations REF1 and EXP1 had comparable habitat to support similar benthic communities. At Station REF1 the substrate was comprised of 75 percent sand and

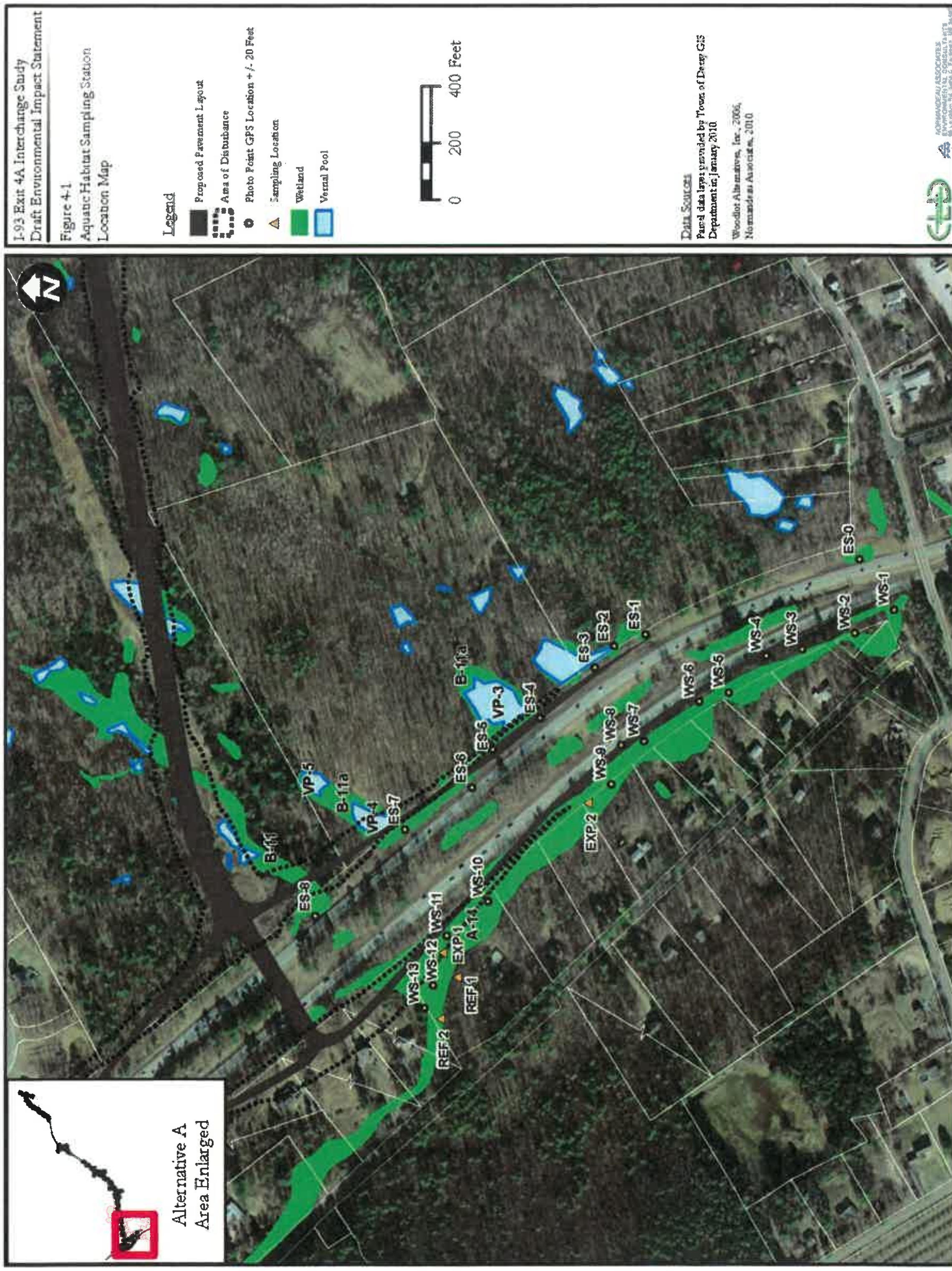


Figure 4-1. Aquatic Habitat Sampling Station Location Map.

25 percent mud, depth was 0.8 ft and velocity was 0.4 fps, dissolved oxygen concentration was 13.1 mg/l (the highest value found at any station), pH was 7.5, and specific conductance was 331.2 µS/cm.

Experimental Station EXP 2 was located immediately downstream of a chain link fence that crosses the stream, approximately 100 feet upstream of the culvert that crosses under Route I-93. This station received a habitat score of 144 (Table 4-4), based on RBP habitat criteria, and is considered good habitat for supporting aquatic biota. The substrate was comprised of 20 percent boulder, 50 percent cobble, 20 percent gravel, and 10 percent sand (Table 4-4). Depth was 0.4 ft and velocity was 1.1 fps. Dissolved oxygen concentration was 10.6 mg/l, pH was 7.2 standard units, and specific conductance was 324.4 µS/cm.

**Table 4-2. Biological Condition**

| BIOASSESSMENT | | |
|---|---|---|
| % Comparison to Ref. Score | Biological Condition Category | Attributes |
| >83% | Nonimpaired | Comparable to the best situation to be expected within an ecoregion. Balanced trophic structure. Optimum community structure (composition and dominance) for stream size and habitat quality. |
| 54-79% | Slightly Impaired | Community structure less than expected. Composition (species richness) lower than expected due to the loss of some intolerant forms. Percent contribution of tolerant forms increases. |
| 21-50% | Moderately Impaired | Fewer species due to loss of most intolerant forms. Reduction in EPT index. |
| <17% | Severely Impaired | Few species present. If high densities of organisms, then dominated by one or two taxa. |

Reference Station REF 2 was located upstream of all other stations in a high gradient reach adjacent to a house. This station had excellent habitat for supporting macroinvertebrates, the RBP habitat score was 152 (Table 4-4), and RBP habitat assessment criteria indicated that Stations EXP2 and REF2 had comparable habitat to support similar benthic communities. The substrate was comprised of 10 percent boulder, 60 percent cobble, 10 percent gravel, and 20 percent sand (Table 4-4). Depth was 0.5 ft and velocity was 1.1 fps. Dissolved oxygen concentration was 11.4 mg/l, pH was 7.2 standard units, and specific conductance was 327.9 µS/cm (Table 4-4).

Low gradient Stations EXP 1 and REF 1 had benthic communities that were typical of the habitat where they were collected and the metric values found at the low gradient stations were consistent with what is normally found in low gradient habitats. Both stations had benthic communities that were numerically dominated by the midge *Micropsectra* sp., which comprised 49.3 percent and 63.2 percent of the benthic community at Stations EXP 1 and REF 1, respectively (Table 4-5). Both

**Table 4-3. Habitat assessment values and physical characteristics of the Low Gradient benthic macroinvertebrate sampling stations in December 2009.**

| Habitat Assessment | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Station | Lat | Long | Substrate/Cover | Pool Substrate | Pool Variability | Substrate Deposition | Channel Flow | Channel Alteration | Bank Stabilty |
| Ref 1 | 42.88497 | 71.35023 | 5 | 6 | 0 | 6 | 17 | 13 | 6 |
| Exp 1 | 42.88511 | 71.34991 | 6 | 8 | 0 | 5 | 17 | 11 | 6 |
| | Veg Protection | Riparian Veg Width | Total Score | Percent Compared to Reference Station | Habitat Value | | | | |
| Ref 1 | 6 | 8 | 10 | 78 | --- | | | | |
| Exp 1 | 6 | 8 | 5 | 72 | 92 | | | | |
| | | | | | | | | | |
| Water Quality | | | | | | | | | |
| | Substrate % Sand | Substrate & Mud | Temp | DO | Specific Conductance | pH | Depth | Velocity | |
| | | | (°C) | (mg/l) | (µmhos/cm) | (std. units) | (ft) | (fps) | |
| Ref 1 | 75 | 25 | 3.0 | 13.1 | 331.2 | 7.5 | 0.8 | 0.4 | |
| Exp 1 | 10 | 90 | 3.3 | 10.3 | 175.2 | 7.5 | 0.4 | 0.2 | |

**Table 4-4. Habitat assessment values and physical characteristics of the High Gradient benthic macroinvertebrate sampling stations in December 2009.**

| Habitat Assessment | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Station** | **Lat** | **Long** | **Substrate/Cover** | **Embeddedness** | **Velocity/Depth Regime** | **Substrate Deposition** | **Channel Flow** | **Channel Alteration** | **Bank Stabilty** | **Riffle Freg.** |
| Ref 2 | 42.88513 | 71.35078 | 19 | 17 | 8 | 19 | 18 | 18 | 14 | 11 |
| Exp 2 | 42.88371 | 71.34795 | 19 | 17 | 8 | 19 | 18 | 18 | 13 | 11 |
| | **Veg Protection** | **Riparian Veg Width** | **Total Score** | **Percent Compared to Reference Station** | **Habitat Value** | | | | | |
| Ref 2 | 14 | 14 | 123 | --- | excellent | | | | | |
| Exp 2 | 14 | 9 | 117 | 95 | good | | | | | |
| | | | | | | | | | | |
| **Water Quality** | | | | | | | | | | |
| | **Substrate %** | | | | **Temp** | **DO** | **Specific Conductance** | **pH** | **Depth** | **Velocity** |
| | Boulder | Cobble | Gravel | Sand | (°C) | (mg/l) | (µmhos/cm) | (std. units) | (ft) | (fps) |
| Ref 2 | 10 | 60 | 10 | 20 | 3.4 | 11.4 | 327.9 | 7.2 | 0.5 | 1.1 |
| Exp 2 | 20 | 50 | 20 | 10 | 3.9 | 10.6 | 324.4 | 7.2 | 0.4 | 1.1 |

**Table 4-5. Benthic Macroinvertebrate Abundance Data from Dip Net Samples Collected.**

| Group/Taxon | | Station | | | |
|---|---|---|---|---|---|
| | | **Ref 1** | **Exp 1** | **Ref 2** | **Exp 2** |
| **Oligochaeta** | *Stylodrilus heringianus* | 2 | . | 4 | 48 |
| | *Limnodrilus* sp. | . | 2 | . | . |
| **Mollusca** | *Pisidium* sp. | . | 60 | 1 | . |
| **Isopoda** | Caecidotea sp. | . | 5 | . | . |
| **Collembola** | *Collembola* | . | . | . | 1 |
| **Ephemeroptera** | *Leptophlebiidae* | . | . | . | 1 |
| | *Paraleptophlebia* sp. | . | . | 1 | . |
| **Plecoptera** | *Capniidae* | . | . | . | 1 |
| | *Allocapnia* sp. | 3 | . | 3 | . |
| | *Leuctra* sp. | . | . | . | 1 |
| | *Ostrocerca* sp. | . | . | 6 | 10 |
| | *Chloroperlidae* | . | . | 1 | 1 |
| **Coleoptera** | *Oulimnius latiusculus* | . | . | . | 2 |
| | *Oulimnius* sp. | . | . | 2 | . |
| **Megaloptera** | *Sialis* sp. | . | 4 | 1 | . |
| **Trichoptera** | *Glossosoma* sp. | . | . | . | 1 |
| | *Rhyacophila* sp. | . | . | 1 | 6 |
| | *Chimarra aterrima* | . | . | 1 | . |
| | *Diplectrona* | . | . | 2 | 10 |
| | *Hydropsyche* sp. | . | . | . | 4 |
| | *Ptilostomis* sp. | 1 | . | . | . |
| | *Limnephilidae* | . | 1 | . | . |
| | *Limnephilus* sp. | . | . | 1 | . |
| | *Pycnopsyche* sp. | . | . | 1 | . |
| | *Neophylax* sp. | . | . | 3 | . |
| **Diptera** | *Pseudolimnophila* sp. | . | . | 1 | . |
| | *Dicranota* sp. | 4 | . | . | 5 |
| | *Chelifera* sp. | . | . | 1 | . |
| | *Chrysops* sp. | 1 | . | . | . |
| | *Bittacomorphella* sp. | . | 1 | . | . |
| | *Palpomyia* gr. | 2 | . | . | . |
| | *Ceratopogon* sp. | . | . | 1 | 1 |
| | *Prosimulium* sp. | . | . | 51 | 49 |
| | Stegopterna sp. | 3 | . | 70 | 31 |
| | *Microtendipes pedellus* gr. | 1 | . | . | . |
| | *Orthocladius* sp. | . | . | . | 3 |
| | *Zavrelimyia* sp. | . | 7 | . | . |
| | *Zavrelia* sp. | . | 4 | . | . |
| | *Thienemanniella* sp. | . | . | 2 | . |
| | *Thienemannimyia* gr. | 12 | 12 | . | 2 |
| | *Larsia* sp. | 19 | . | . | . |
| | *Tvetenia* sp. | . | . | 2 | 1 |
| | *Phaenopsectra* sp. | . | 4 | . | . |

(continued)

**Table 4-5. (Continued)**

| Group/Taxon | | Station | | | |
|---|---|---|---|---|---|
| | | Ref 1 | Exp 1 | Ref 2 | Exp 2 |
| Diptera | *Orthocladiinae* | . | 2 | 2 | . |
| | *Diplocladius* sp. | 4 | . | 2 | 3 |
| | *Chaetocladius* sp. | 11 | . | 5 | . |
| | *Parachaetocladius* sp. | . | . | . | 5 |
| | *Parametriocnemus* sp. | . | 1 | . | . |
| | *Trissopelopia ogemawi* | . | . | 2 | . |
| | *Apsectrotanypus johnsoni* | . | 2 | . | . |
| | *Micropsectra* sp. | 127 | 104 | 37 | 9 |
| | *Chironomini* | 1 | . | 1 | . |
| | *Heterotrissocladius* sp. | 4 | . | . | . |
| | *Chironominae* | . | 2 | . | . |
| | *Brillia parva* | 6 | . | 2 | 3 |

stations had low values for Taxa Richness and EPT Index and somewhat high values for Biotic Index and Percent Dominant Taxon (Table 4-5). These data reflect metric values typically associated with benthic communities found in low gradient habitats. Community Loss Index, which estimates the loss of benthic taxa between the experimental station (EXP 1) and the reference station (REF 1) was 0.93.

High gradient Stations EXP 2 and REF 2 also had benthic communities that were typical of the habitat where they were collected. The benthic communities at both stations were numerically dominated by Simuliidae (black flies); *Prosimulium* sp. comprised 24.8 percent of the benthic community at experimental Station EXP 2 and *Stegopterna* sp. comprised 33.8 percent of the benthic community at reference Station REF 2, (Table 4-6). Other metric values were also consistent with the higher habitat quality associated with high gradient habitat conditions. At both high gradient stations Taxa Richness values were above 20, Biotic Index values were below 5.0, EPT Index values were 9 and 10 at EXP 2 and REF 2, respectively, and Community Loss Index between the experimental station (EXP 2) and the reference station (REF 2) was 0.70.

## 4.6 Discussion

Benthic macroinvertebrate communities in the west side stream near Exit 4A were representative of typical benthic communities from the habitats where they were collected. Communities from low-gradient habitat stations (EXP 1, REF 1) had communities that were dominated by Chironomidae (non-biting midges). Low-gradient habitats are often numerically dominated by Chironomidae and Oligochaeta (segmented worms), and also support communities that have low EPT index values, high Biotic Index values, and low Taxa Richness values, compared to high-gradient habitats. These benthic communities do not necessarily indicate impaired conditions, they simply support organisms that can survive in low gradients with soft substrate and low dissolved oxygen. Low gradient habitats often have benthic communities with low diversity and high numbers of tolerant organisms, which can survive in shifting substrates, low flow, low dissolved oxygen, and often, elevated summer temperatures.

The high gradient benthic communities in the Exit 4A streams (EXP 2, REF 2) also supported representative of benthic communities commonly found in high gradient habitats. High gradient habitats support a greater number of macroinvertebrate taxa than low gradient habitats, which results in a more diverse community of pollution intolerant taxa, therefore these communities usually have higher values for EPT Index and Taxa Richness and lower values for Biotic Index and Percent Dominant Taxon. The Scraper/Filterer ratio is also higher in non impaired habitats because the substrate is coarse (i.e., boulders and cobble), and provides a more suitable medium for periphyton growth, which is consumed by scrapers.

# 5.0 Preliminary Conceptual Design

## 5.1 East Side

The channel along the east side of Interstate I-93 and within the footprint of the Alternative A and B Exit 4A interchange connects two wetland/vernal pool complexes, which then discharges into a concrete culvert that directs the runoff to the unnamed tributary to Wheeler Pond on the west side of the highway. Based on the physical characteristics of this channel (located at the base of the highway embankment, its straight channel and its parabolic cross-sectional form) it appears to have been designed as a drainage ditch between the two wetland complexes as part of the original construction of the highway.

The construction of the proposed interchange will require that this channel and short sections of constructed ditch along the base of the embankment be relocated. Based on their original design as drainage ditches, their ephemeral/intermittent nature and lack of aquatic habitat along with the planned construction of a new detention basin adjacent to the new exit ramp and between the two wetland complexes the design of the relocated channels will be the responsibility of the design engineer. The design should be based on standard engineering practices used in the design of drainage ditches along with the best management practices for stormwater management.

## 5.2 West Side

The DEIS (FHWA 2007) indicates that 1,450 feet of perennial stream along the west side of Interstate I-93 will require relocation. Based upon a review of the conceptual design information available for the Exit 4A project, it appears that the amount of perennial stream requiring relocation within the project footprint in wetland complex A-14 is significantly less than this. The construction of the proposed southbound entrance ramp will directly impact approximately 400 to 450 feet of the east branch tributary and approximately 300 to 350 feet of the main channel of the west side tributary of Wheeler Pond. It is assumed that the east branch tributary will be rerouted into a culvert and buried under fill placed during the construction of the southbound ramp of Exit 4A. It is also assumed that the culvert will, in general follow the course of the existing channel and discharge into the main channel of the west side stream near their present confluence.

Approximately 300 to 350 feet of the west side stream, from about its confluence with the east branch tributary (point WS-11) to just below the area where the middle reach of the stream was assessed (point WS-10) will need to be relocated due to planned emplacement

**Table 4-6. Biological metric scores and biological conditions of streams assessed, December 2009.**

| | REF 1 | | EXP 1 | | REF 2 | | EXP 2 | |
|---|---|---|---|---|---|---|---|---|
| **METRIC** | **VALUE** | **SCORE** | **VALUE** | **SCORE** | **VALUE** | **SCORE** | **VALUE** | **SCORE** |
| Taxa Richness | 16 | 6 | 15 | 6 | 28 | 6 | 23 | 6 |
| Biotic Index | 7.05 | 6 | 6.43 | 6 | 4.92 | 6 | 4.34 | 6 |
| Scraper/Filterer Ratio | 0.25 | 6 | 0 | 0 | 0.14 | 6 | 0.29 | 6 |
| EPT Index | 1 | 6 | 2 | 6 | 10 | 6 | 9 | 6 |
| Percent Dominant Taxon | 49.29 | 0 | 63.18 | 0 | 33.82 | 2 | 24.75 | 4 |
| Community Loss Index | 0.93 | 6 | 0.93 | 4 | 0.7 | 6 | 0.7 | 4 |
| **Total Score: Index of Biotic Integrity** | | 30 | | 22 | | 32 | | 32 |
| **Percent Similarity to the Reference Score** | | | | 73 | | | | 100 |
| **BIOLOGICAL CONDITION** | **SLIGHT IMPAIRMENT** | | | | **NON-IMPAIRMENT** | | | |

of fill in the existing channel during the construction of the southbound exit ramp. The existing channel will be reconstructed south west and parallel to the base of the new ramp. The planform, channel geometry, and channel features will have the characteristics of an E type stream. Both the upper and middle reaches of the west side stream were delineated as having the characteristics of an E type stream. Since the middle reach of the stream is located downstream of the confluence of both the east branch tributary and the main channel of the west side stream and is within the section of the stream to be relocated, its planform and channel geometry should be a reasonable reference reach for the design of the relocated channel.

A major issue with the proposed construction of the new entrance ramp in Wetland Complex A-14 is the significant reduction in the wetland area, which provides temporary storage during flood events resulting in lower peak flows and flow velocities. Also, the placement of the east branch tributary into a culvert that will bypass the former wetland area and directly discharge into the perennial stream may also contribute to increased peak flows and flow velocities. As a result, the stability of the existing channels in and downstream of Wetland Complex A-14 cannot be ensured post-construction.

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# Attachment C

## Hydraulic Reports - Excerpts

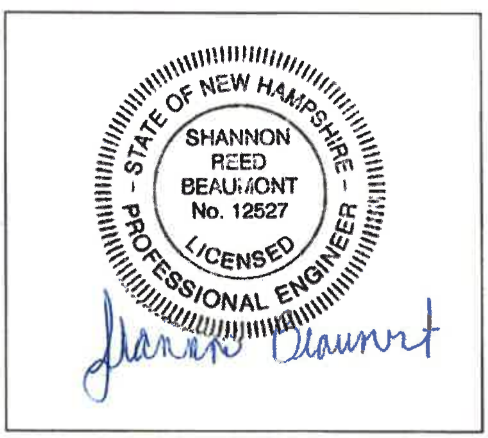
# HYDROLOGIC AND HYDRAULIC REPORT

## FOLSOM ROAD/NORTH HIGH STREET OVER SHIELDS BROOK
## DERRY, NEW HAMPSHIRE

***Submitted to:***
**NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION**

**NOVEMBER 2018**

FUSS & O'NEILL




***Prepared by: Shannon Beaumont, P.E.***

***Checked by: Anna Giraldi, P.E.***

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**FOLSOM ROAD/NORTH HIGH STREET OVER SHIELDS BROOK**

# HYDROLOGIC AND HYDRAULIC REPORT

**NOVEMBER 2018**

## EXECUTIVE SUMMARY

The existing 6-foot diameter corrugated metal pipe is located in Derry, Rockingham County, New Hampshire on Folsom Road/North High Street over Shields Brook. The culvert is being replaced as part of the Exit 4A Interchange Project that will turn the existing local road into a 4-lane Connector Road with additional left/right turn lanes and a 5-foot sidewalk, and will raise the profile at the Shields Brook crossing 7 to 8 feet. The culvert is also undersized and causing a restriction in flow. The culvert is in a suburban location. The brook's drainage basin consists of mostly forested areas with only approximately 8.5 percent storage. The upstream channel is sinuous with a shallow channel slope.

View looking at upstream invert

View looking at downstream invert

A Stream Crossing Assessment Report has not yet been completed, however, a delineated bankfull width of 22 feet was determined, resulting in a design clear span of 28.5 feet. The results of the proposed model specify a 28.5-foot clear span by 4.7-foot rise structure with channel banks extending through the proposed structure and a minimum opening area of 126 sq. feet.

Existing and proposed hydraulic models were created utilizing HEC-RAS. The results of the existing hydraulic model show that the existing culvert passes up to the 2-year design flood event without overtopping. The proposed 28.5-foot clear span buried structure meets freeboard requirements for the 100-year design flood event.

The 28.5-foot clear span buried structure meets both NHDOT requirements (hydraulic and freeboard) and NHDES requirements (bankfull width and channel banks through the structure). Scour analyses were not performed, but riprap sizing calculations were completed. This structure will require 2-feet of NHDOT Riprap, Class III across the entire width of the waterway, and any streambed material utilized based on NHDES Stream Crossing requirements shall incorporate Class III Riprap for scour protection. The riprap should extend from the face of each abutment (or along the faces of the wingwalls) at least 25 feet to protect the downstream roadway embankment, and should extend up the embankments at least to the 100-year flood event elevation at the bridge. The top of the material should be flush with the existing channel grade.

## 1. INTRODUCTION

As part of the Exit 4A project, a Connector Road will be built along the length of the existing Folsom Road/North High Street. This work will involve the replacement of the existing 6-foot diameter corrugated metal pipe at the future Connector Road's crossing with Shields Brook.

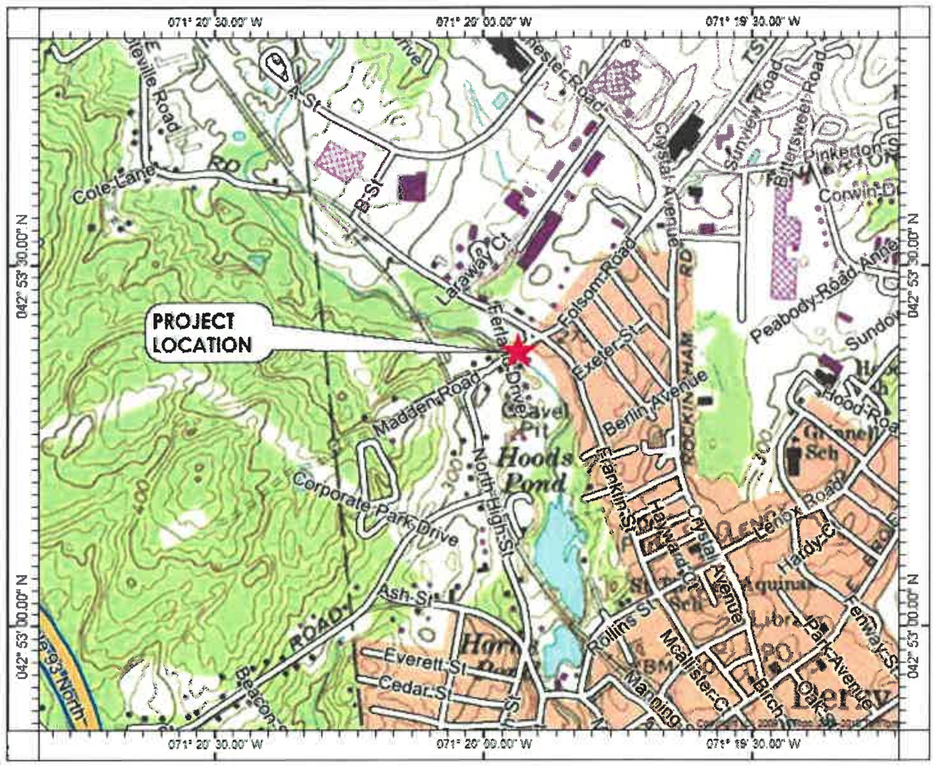
### 1.1 Background

The existing culvert is 6-feet in diameter and provides a total waterway opening of approximately 28 square feet. The culvert is undersized and constricts the channel. The Future Connector Road is expected to significantly widen the road from 2 lanes to 4 lanes with a 5-foot sidewalk, and includes a 18-foot island/left turn lane and an 11-foot right turn lane at the project location. The profile will also be raised at the crossing location 7 to 8 feet. Additional photos can be found in Appendix A.

Downstream Invert

1.2 Site Location

The culvert is located on Folsom Road/North High Street over Shields Brook in the Town of Derry, Rockingham County, New Hampshire. See Location Map.




Location Map

## 2. DESIGN CRITERIA

The Hydrologic and Hydraulic Study was completed in accordance with the NHDOT Bridge Design Manual dated January 2015 with current revisions (Reference 1).

2.1 Design Frequency and Freeboard

Folsom Road is a paved road in Derry, not far from downtown Derry. This road would currently be considered a Highway Tier 5 local road. However, after the Connector Road is built, it will be considered a Highway Tier 2 road, or statewide corridor also considered a principal arterial road. Per the NHDOT Bridge Design Manual Table 2.7.4-1 Design Frequencies, for a Tier 2 road, the 100-year event is the design flood, and the 500-year event is the check flood. A new bridge must be designed for the "Design Flood" with the specified freeboard requirements. The bridge must also be checked against the "Check Flood" for high flow damage and is considered an extreme limit state.

2.2 Proposed Bridge Requirements

The proposed bridge substructures must be designed for the 100-year design flood event scour potential, and checked against the 500-year check flood event scour potential. Scour countermeasures and channel protection must be designed to protect against scour for the design flood. However, an evaluation of the replacement structure type and corresponding scour analysis are outside the scope of this report. Therefore, the scour potential at this crossing and scour countermeasures and channel protection have not be designed and will not be discussed as part of this report.

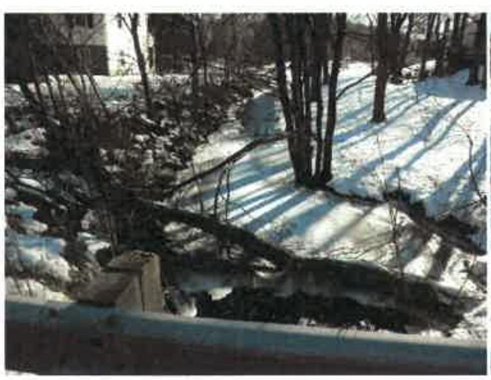
## 3. HYDROLOGY

### 3.1 Drainage Basin Description

The FEMA Flood Insurance Rate Maps (FIRMs) for the project location indicate that the project location is located in Zone AE, a detailed study area with base flood elevations determined. Therefore, the FEMA Flood Insurance Study (FIS) provides drainage areas and flow values for the Folsom Road/North High Street Crossing. See Appendix C for FEMA FIS Information. The site is currently in a wooded suburban area approximately 1000 feet downstream of a dam that meters the flow. The basin consists of mostly forested areas with some urban drainage and 8.5 percent storage area. The channel slope is at less than 1 percent. The total contributing drainage area is 5.9 square miles (about 3770 acres). The maximum elevation at the upper limit of the main channel is approximately 494 feet with an elevation at the Folsom Road/North High Street Crossing of approximately 270 feet resulting in a 224-foot drop in elevation (Reference 2). See Appendix B for the Watershed Area Map.

### 3.2 River Channel and Floodplain

The river channel upstream is shallow and sinuous and extends from the dam upstream to the crossing through what appears to be a wetland area lined with trees and brush. The immediate downstream channel extends between a parking lot and residential back yards. The channel is narrow and appears to have been straightened to accommodate previous development. Once past the parking lot, the channel opens back up and is lined with trees before feeding into Hoods Pond. The outlet of Hoods pond is a dam.



Downstream Reach

Upstream Reach

A full stream assessment has not been performed at this location. However, the delineated bankfull width (BFW) is 22 feet, and the calculated bankfull width is approximately 37 feet using the regional hydraulic curve. The discrepancy between the two BFWs is likely due to the dam upstream not being taken into account by the regional hydraulic curve. A structure size of 28.5 feet (based on the delineated bankfull width) is recommended to meet stream crossing requirements of 1.2 times BFW plus 2 feet.

It should be noted that due to the proposed raise in roadway profile and roadway widening, some stream alignment will be required. A tributary converges with Shields Brook just upstream of the existing invert. The proposed culvert will extend past the convergence location, requiring the tributary to be realigned to converge upstream of the proposed invert.

### 3.3 Flood History

Observations from the Town indicate that overtopping has occurred at/near the crossing in the past. The Town indicated that this overtopping occurred due to a constriction downstream. However, an evaluation of the existing channel did not reveal a constriction.

### 3.4 Hydrologic Study Approach

NHDOT Bridge Design Manual (Reference 1) methodologies indicate that for an ungauged site such as this one, one of the two preferred analysis methods for determining runoff rates/volumes; USGS StreamStats for NH (Reference 4) or the Natural Resources Conservation Service (NRCS) (SCS) Unit Hydrograph Method; should be chosen for analysis. Two of the accepted check methods; Flood Insurance Studies, Runoff Estimates for Small Rural Watersheds and Development of a Sound Method (Reference 5), the New England Hill and Lowlands (NEHL) and Adirondack White Mountains (AWM) Method (Reference 6), and the Index Flood Method; should be chosen to confirm the accuracy of the chosen analysis method.

Based on site conditions with respect to drainage area size and storage area, the USGS StreamStats for NH was chosen for the analysis method. Since the project is located in a FEMA Detailed Study Area, the Flood Insurance Study (FIS) was utilized as a check method. The Runoff Estimates for Small Rural Watersheds and Development of a Sound Method was chosen as the other check method for this project.

Fuss and O'Neill established the following design flow rates based on the USGS StreamStats for NH analysis method:

| Recurrence Interval in Years | Flow Rate in Cubic Feet per Second (CFS) | |
|---|---|---|
| Q2 | 134 | |
| Q10 | 292 | |
| Q25 | 390 | |
| Q50 | 472 | |
| Q100 | 571 | Design Flood |
| Q500 | 815 | Check Flood |

The design flow rates from the FEMA FIS were within the allowable prediction error of the design flow rate from the USGS StreamStats. The design flow rate from the

Runoff Estimates for Small Rural Watersheds and Development of a Sound Method (FHWA 5-Parameter Method) was within the allowable prediction error of the design flow rate from the USGS StreamStats method for Q100, but was slightly greater than the allowable prediction error for Q50. The FHWA 7-Parameter Method however resulted in design flow rates that slightly exceeded the allowable prediction error for all of the design flow rates for the StreamStats method. The standard error of estimate for the 7-Parameter Method is 83% and uses outdated information. As one of the check methods falls entirely within the allowable prediction error, and the other two either fall within or are only slightly outside the allowable prediction error, the USGS StreamStats for NH method is considered acceptable. See Appendix D for Hydrologic Discharge Calculations.

## 4. RIVER HYDRAULIC ANALYSIS

### 4.1 General Hydraulic Model Approach

The Corp of Engineers Hydrologic Engineer Center's (HEC's) HEC-RAS River Analysis System was utilized to develop the existing and proposed hydraulic models for this project. The river modeling software GeoHECRAS was utilized to help develop the models (Reference 9). This program completely supports HEC-RAS within a 2D and 3D GIS environment. The surface model was developed from survey (Reference 8) and LIDAR provided by the Town of Derry. The surfaces were imported into the GeoHECRAS program and merged to create a single terrain surface. Cross sections were cut within the program to allow a seamless transition from the surface model obtained from Survey to the development of the cross sections for the hydraulic model.

The HEC-RAS program utilizes a Step-Backwater Analysis method. The program calculates energy losses through the bridge as a result of friction and either contraction or expansion losses. For this project, the culvert module was utilized.

The upstream and downstream boundary conditions were based on the normal depth slope developed from USGS maps and survey.

HEC-RAS channel sections Station 1.444 and Station 1.373, the upstream approach station and downstream exit station of the bridge, represent natural unconstricted channel conditions. HEC-RAS channel sections Station 1.397, Station 1.406, and Station 1.410 were chosen to represent the immediate downstream exit location, structure location, and the immediate upstream entrance location, respectively. See the Cross Section Location Plan in Appendix E. These stations were chosen to coordinate with the stations utilized in the FEMA FIS model. Characteristic Manning's roughness coefficients of 0.045 for the channel, 0.09 for the upstream overbank areas in wooded and shrubbery areas, and 0.06 for the downstream overbanks areas consisting of lawns and suburban backyards. Contraction and expansion coefficients of 0.1 and 0.3, respectively, were used everywhere but in the cross sections immediately upstream and downstream of the existing bridge. Contraction and expansion coefficients of 0.6 and 0.8, respectively, were used at these locations to model the constriction caused by the culvert. Ineffective flow areas were used to model the "dead storage zones" upstream and downstream of the bridge crossing. These areas do not contribute to the conveyance characteristics of the channel. Only the open area underneath the structure contributes to the conveyance computations. The model was run utilizing a subcritical flow regime.

## 4.2 Existing Bridge

### 4.2.1 Hydraulic Modeling Approach

The existing structure consists of a 6-foot diameter corrugated metal pipe that is skewed to the road. LIDAR provided by the Town of Derry was utilized to develop the roadway profile. The invert elevations of the existing pipes were obtained from the survey and input into HEC-RAS utilizing culvert design methodology. The structure is skewed approximately 22 degrees.

### 4.2.2 Hydraulic Performance of Existing Bridge

The results of the existing bridge model indicate that Folsom Road/North High Street is overtopped for all storms greater than the 2-year event. The overtopping does not occur at the culvert however, as the low point of the road is on the east side of the crossing near the intersection of Folsom Road/North High Street with Franklin Street Extension.

A second flow scenario was developed utilizing the FEMA flows as reported in the FIS to compare to the FEMA FIRM. The results indicate small increases from the FEMA model at the upstream approach section ranging from as high as 8" for the Q10 flood event to as low as 0.12" for the Q50 flood event. However, the FEMA FIS and FIRM both indicate all flows gothrough the culvert with no roadway overtopping. This appears to be an oversight in the FEMA model as it is unlikely the roadway elevations at the crossing locations have decreased significantly since the FEMA model was developed.

The Town of Derry has indicated the road has overtopped at this location in the past, which corresponds with the existing HEC-RAS model.

The existing FEMA HEC-2 model input was obtained and evaluated to compare to the HEC-RAS model developed for this project. However, the development of a duplicate effective model as required for a LOMR application is outside the scope of this project. The FEMA HEC-2 input data is included in Appendix C of this report along with HEC-2 Input Descriptions.

See Appendix F for the existing structure hydraulic model and output.

## 4.3 Proposed Bridge

### 4.3.1 Alternative Selection

As noted previously, a stream assessment has not been completed for this project. For the purposes of this hydraulic model, a 28.5-foot clear span buried structure was evaluated due to the profile raise and large skew of the proposed structure, however, a final structure type has not yet been determined. As 28.5 feet is pushing the limits of what can be obtained for a buried structure, it may be possible to obtain an Alternate Design from the NHDES and decrease the span while still meeting hydraulic requirements, but that is outside the scope of this project. The structure length was approximated based on the proposed roadway width. It was assumed channel banks would be incorporated inside the structure,

Just upstream of the crossing is the confluence of Shields Brook with a secondary stream. Stream realignment will be required to ensure the proposed structure spans a single stream rather than increasing the span to accommodate both channels. Based on the layout, it appears the secondary stream will be the most likely channel to realign.

#### 4.3.2 Proposed Bridge Geometry

Based on the discussions in Section 4.3.1, the proposed structure was modeled in HEC-RAS as a 28.5-foot clear span with 10-foot rise buried 2 feet, and 132-feet long with 2H:1V channel sloped through the structure. The actual minimum required structure rise and area are discussed in Section 4.3.4 below. The proposed structure is aligned with the river and skewed to the road approximately 45 degrees.

#### 4.3.3 Hydraulic Modeling Approach

For the proposed model, the culvert module was also utilized. The existing model was copied, and the proposed bridge section (Section 1.408) and immediate upstream and downstream channel cross sections (Stations 1.428 and 1.397) were revised to show the revised spans and culvert length. See the Cross Section Location Plan in Appendix E. The layout of the structure was also adjusted to represent a 45-degree skew with the roadway crossing, however, as the culvert was aligned with the stream channel, the skew function was not utilized. It was assumed that channel banks would be incorporated through the structure, so internal cross sections were utilized to incorporate 2H:1V channel slopes through the length of the structure.

The models were run using the subcritical flow regime. A rise of 10 feet buried 2 feet was assumed initially. This rise provides more than the required capacity for hydraulic requirements, but was sufficient to provide unrestricted flow for the purpose of determining the minimum low chord elevation for the proposed structure.

In addition, the expansion and contraction coefficients were reduced from 0.6 and 0.8 for the existing model to 0.3 and 0.5 for the proposed models since the proposed structure substantially decreases the constriction at the Shields Brook crossing.

#### 4.3.4 Hydraulic Performance of Proposed Conditions

The water profile of the proposed bridge model for the design flood is significantly lower than the existing model. See Figure 1. Based on a visual inspection of the water surface profile, the 100-year design flow passes through the proposed alternative without overtopping the road.

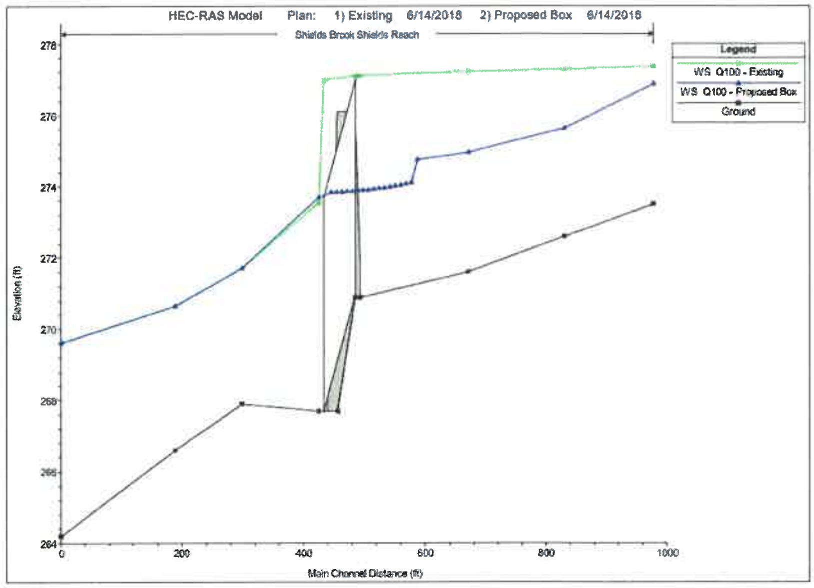



**FIGURE 1. – 100-YEAR EVENT WATER SURFACE PROFILE**

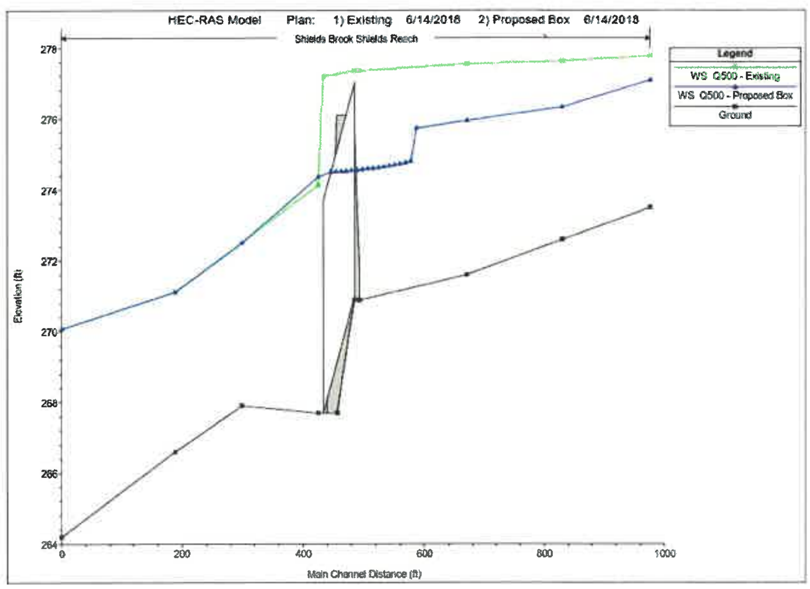



**FIGURE 2. – 500-YEAR EVENT WATER SURFACE PROFILE**

See Table 1 for a Summary of the Water Surface Elevations at the upstream section (HEC-RAS Station 1.444) for the existing model compared to the proposed model.

| **HEC-RAS Station 1.444** | 100-Year Design Flood Event (ft.) | 500-Year Check Flood Event (ft.) |
|---|---|---|
| Existing Bridge Model | 277.22 | 277.54 |
| 28.5-Foot Span Buried | 274.97 | 275.96 |
| Difference | -2.25 | -1.58 |

**TABLE 1. – SUMMARY OF WATER SURFACE ELEVATIONS**

Per the NHDOT Bridge Design Manual, the freeboard at the upstream face of the bridge shall be the greater of the hydraulic flow depth measured at the immediate upstream section (Station 1.428) or the flow depth measured at the uncontracted upstream section (Station 1.444) applied at the upstream face of the bridge (Station 1.408 Br U) plus 1 foot. Based on the results of the 28.5-foot clear span buried structure, the hydraulic flow depths at HEC-RAS Station 1.428 and 1.444 are 3.7 feet and 2.73 feet, respectively. The hydraulic flow depth at Station 1.428 therefore controls, resulting in a minimum low chord elevation of 275.46 feet at the upstream face of the bridge. The resulting minimum structure rise is therefore 4.70 feet, resulting in a minimum required opening area of 126 square feet. See Appendix F for freeboard and opening area calculations.

See Table 2 for a comparison of the velocities between existing and proposed structures at the upstream bridge section (HEC-RAS Station 1.406 Br U existing, and 1.408 Br U proposed) where velocities are the greatest according to the model results. The decrease in velocity from existing to proposed as shown in the table will result in decreased scour potential.

| **HEC-RAS Station 1.406 BR D, Exist. And 1.408 BR D, Prop.** | 100-Year Design Flood Event (fps) | 500-Year Check Flood Event (fps) |
|---|---|---|
| Existing Bridge Model | 10.17 | 10.47 |
| 28.5-Foot Span Buried | 5.99 | 7.07 |
| Difference | -4.18 | -3.40 |

**TABLE 2. – SUMMARY OF VELOCITIES**

See Appendix F for the proposed structure hydraulic model input and output.

## 5. STABILITY AND SCOUR ASSESSMENT

### 5.1 Channel Description

As discussed in Section 3.2, the river channel upstream is shallow and sinuous and extends from the dam upstream to the crossing through what appears to be a wetland area lined with trees and brush. The immediate downstream channel extends between a parking lot and residential backyards. The channel is narrow and appears to have been straightened to accommodate previous development. Once past the parking lot, the channel opens back up and is lined with trees before feeding into Hoods Pond. The outlet of Hoods pond is a dam.

A full stream assessment has not been performed at this location, however, a concern in designing stream crossing structures for what appears to be a sinuous channel is channel stability and lateral extension. Channel stability and lateral movement is highly dependent on the adjacent stability of the natural stream bank. If existing stream bank stability is impacted, this channel type can quickly become unstable. To compensate for possible channel instability and wider bankfull flows, larger crossing structures and/or flood plain drainage structures should be considered.

As a stream assessment has not been completed and the channel materials such as the D50 have not been determined, channel stability and scour assessment have not been further evaluated at this time. If a closed-bottom buried structure is the chosen proposed structure type, a scour assessment may not be required.

### 5.2 Foundation and Countermeasure Recommendations

#### 5.2.1 Scour Countermeasures

The proposed structure should be designed to be stable with minimal damage should that scour occur during the 100-year design flood event. The structure should be designed to be stable during the 500-year check flood event, even if extensive damage occurs, to prevent potential loss of life.

Riprap is typically used as a scour countermeasure to protect the substructure. Riprap sizing calculations were performed (See Appendix G) to determine the required riprap for the design and check flood events based on the maximum velocity and depth within the contracted section of the bridge for each event. These equations were based on the HEC-23, Design Guideline 14 – Sizing Rock Riprap at Abutments (Reference 10). For the 28.5-foot clear span buried structure, the resulting D50 of the riprap was calculated to be 0.66 feet for the 100-year design flood event and 0.95 feet for 500-year check flood event. This D50 corresponds to NHDOT Riprap, Class III (Reference 1) for both design flood events.

Both abutment walls should have this riprap extending from the toe of the abutment into the bridge waterway approximately 10 feet for the 100-year design flood event. However, the 500-year check event requires 11 feet. It is recommended that the larger 11-foot value is used to ensure stability during the 500-year flood event. This would result in essentially the entire width of the channel being stabilized by riprap. The riprap thickness for Class III Riprap should be at least 2-feet deep.

The riprap should extend from the face of each abutment wall back along each downstream roadway approach embankment (or along the faces of the wingwalls) at least 25 feet to protect the downstream roadway approach embankment, and should extend up the embankments at least to the 100-year design flood event elevation at the bridge. The top of the riprap (or simulated streambed material if it is placed on top of or mixed in with the riprap) should be flush with the existing channel grade.

#### 5.2.2 Channel Protection

The potential contraction scour depths in the channel have not been calculated, however, it is likely channel protection will be required. As the existing structure is being replaced, NHDES Stream Crossing rules will require streambed material through the new structure. It is recommended based on the stone sizing calculations that the Class III Riprap extend across the full width of the channel inside the proposed structure. Therefore, any streambed material specified for the channel should incorporate the Class III Riprap for scour protection.

## 6. CONCLUSIONS AND RECOMMENDATIONS

### 6.1.1 Conclusions

The existing structure is undersized and only passes up to the 2-year flood event without overtopping the road. The proposed replacement structure is a 28.5-foot clear span buried structure with channel banks which meets hydraulic requirements.

### 6.1.2 Recommendations

The 28.5-foot clear span buried structure results in decreased proposed velocities as compared to existing, which results in decreased scour potential. The larger span also meets bankfull width requirements and decreases the potential for structure instability due to channel lateral migration. It accommodates all hydraulic requirements for the future safety of the crossing for vehicles and pedestrians. A smaller span structure could be utilized and still meet hydraulic requirements in order to meet the project budget and accommodate site constraints if an alternative design is obtained as part of the NHDES permitting process.

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# HYDROLOGIC AND HYDRAULIC REPORT

## TSIENNETO ROAD OVER TRIBUTARY E
## DERRY, NEW HAMPSHIRE

***Submitted to:***
**NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION**

**NOVEMBER 2018**

FUSS & O'NEILL

STATE OF NEW HAMPSHIRE
SHANNON REED BEAUMONT No. 12527
LICENSED PROFESSIONAL ENGINEER

Shannon Beaumont

***Prepared by: Shannon Beaumont, P.E.***

***Checked by: Ethan Carrier***

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**TSIENNETO ROAD OVER TRIBUTARY E**

**HYDROLOGIC AND HYDRAULIC REPORT**

**NOVEMBER 2018**

## EXECUTIVE SUMMARY

The existing 30-inch and 36-in diameter corrugated metal pipes (CMPs) are located in Derry, Rockingham County, New Hampshire on Tsienneto Road over Tributary E. The pipes are being replaced as part of the Exit 4A Interchange Project. The existing road at the project location will increase in width to accommodate a 5-foot sidewalk, but will remain a 2-lane local road similar to existing. The culverts are undersized and perched causing a restriction in flow. This restriction appears to have led to the creation of an upstream wetland that has been designated by the Town as a "Prime" wetland. The tributary's drainage basin consists of mostly forested areas with only approximately 1.3 percent storage. The upstream channel is shallow within the wetland, but steepens upstream of the wetland.

View looking at upstream invert

View looking at downstream invert

A Stream Crossing Assessment Report has not yet been completed, however, a delineated bankfull width of 32 feet was determined, resulting in a design clear span of 40 feet. The results of the proposed model specify a 40-foot span by 4.6-foot rise structure with channel banks extending through the proposed structure and a minimum opening area of 160 sq. feet. The structure type has not been determined.

Existing and proposed hydraulic models were created utilizing SMS 2D Modeling Program. The results of the existing hydraulic model show that the existing culvert passes up to the 25-year design flood event without overtopping. The proposed 40-foot clear span structure meets freeboard requirements for the 50-year design flood event and accommodates the 100-year check flood event without overtopping. Downstream of the Tsienneto Road crossing is the Route 102 crossing, which is an undersized 36-inch reinforced concrete pipe (RCP). This structure is overtopped above the 2-year design flood. The proposed hydraulic model indicated that this structure sees additional flow for the 2-year flood event due to the increased structure opening at Tsienneto Road, but does not appear to be negatively affected by the larger flood events.

The 40-foot clear span structure meets both NHDOT requirements (hydraulic and freeboard) and NHDES requirements (bankfull width and channel banks through the structure). Scour analyses were not performed, but riprap sizing calculations were completed. This structure will require 2-feet of NHDOT Riprap, Class III extending 9 feet into the channel from each abutment, and any streambed material utilized based on NHDES Stream Crossing requirements shall incorporate Class III Riprap for scour protection. The riprap should extend from the face of each abutment (or along the faces of the wingwalls) at least 25 feet to protect the downstream roadway embankment, and should extend up the embankments at least to the 100-year flood event elevation at the bridge. The top of the material should be flush with the existing channel grade.

# 1. INTRODUCTION

As part of the Exit 4A project, Tsienneto Road will be improved at the crossing location. The limits of the project extend just past the crossing to the intersection of Tsienneto Road with Route 102. This work will involve the replacement of the existing 30-inch and 36-inch diameter CMPs at Tsienneto Road's crossing with Tributary E. Although the replacement of the Route 102 structure downstream is not being evaluated in this report, the existing structure is included in the model to evaluate the impact the Tsienneto Road replacement structure will have on flooding downstream at the Route 102 crossing.

## 1.1 Background

The existing crossing consists of a 30-inch diameter CMP and a 36-inch diameter CMP and provides a total waterway opening of approximately 12 square feet. The culverts are undersized, which has resulted in the culverts being perched due to scour that has developed at the culvert inlets. The Exit 4A project is expected to maintain the existing 2-lane road, but increase the shoulders and add a 5-foot sidewalk at the crossing location. The profile will also be raised approximately 2 feet at the crossing to improve the vertical alignment of the road. Additional photos can be found in Appendix A.

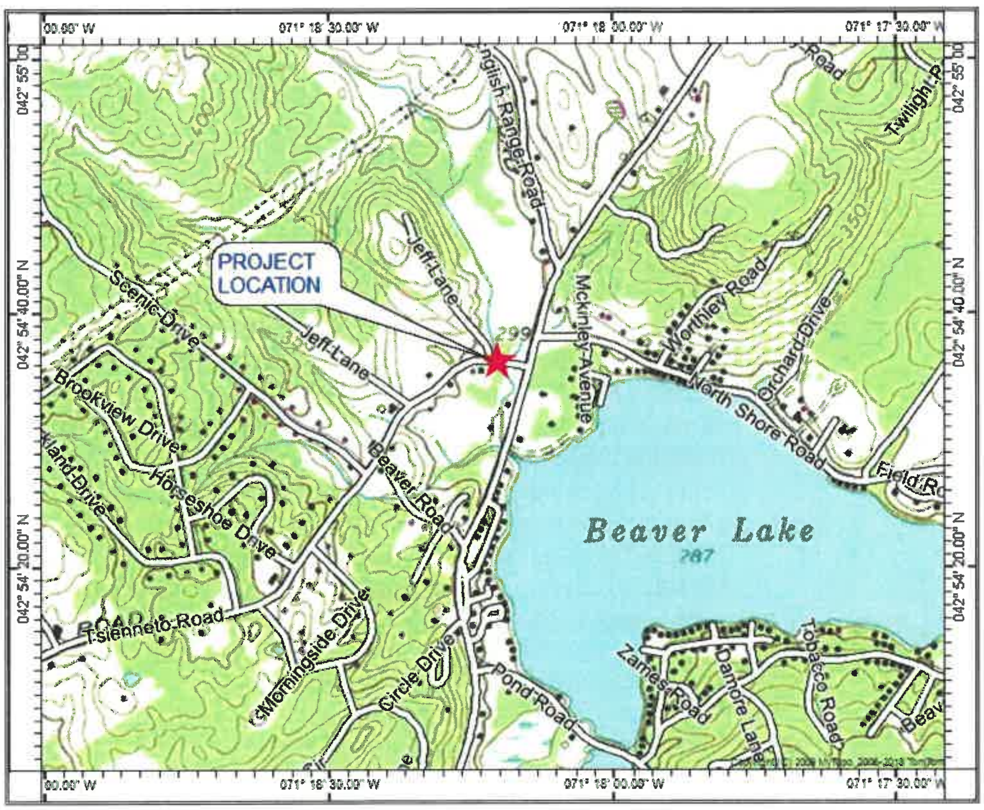
Due to the undersized culverts and contributed by the formation of frequent beaver dams, the upstream reach has developed into a wetland. The Town has obtained a "Prime" designation for the wetland. As such, the Tsienneto Road replacement structure must meet NHDOT requirements to accommodate flood flows, but also ensure the wetland area is not adversely affected by the larger structure.

Downstream Invert

The next downstream structure from the Tsienneto Road Crossing is the Route 102 Crossing. The culvert at Route 102 is a single 36-inch RCP. This pipe is severely undersized and results in frequent overtopping at Route 102. A secondary Tributary, Tributary D, also passes under Route 102 through an 18-inch CMP just on the other side of a drive. Although the two tributaries pass through separate culverts, during high flows, the flooding potential upstream of Route 102 is increased and the two flood boundaries overlap.

1.2 Site Location

The culvert is located on Tsienneto Road over Tributary E in the Town of Derry, Rockingham County, New Hampshire. See Location Map.




Location Map

## 2. DESIGN CRITERIA

The Hydrologic and Hydraulic Study was completed in accordance with the NHDOT Bridge Design Manual dated January 2015 with current revisions (Reference 1).

2.1 Design Frequency and Freeboard

Tsienneto Road is a paved road in Derry heading away from downtown. This road would currently be considered a Highway Tier 5 local road. Its classification will not change after completion of the Exit 4A project. Per the NHDOT Bridge Design Manual Table 2.7.4-1 Design Frequencies, for a Tier 5 road, the 50-year flood event is the design flood and the 100-year flood event is the check flood. A new bridge must be designed for the "Design Flood" with the specified freeboard requirements. The bridge must also be checked against the "Check Flood" for high flow damage and is considered an extreme limit state.

### 2.2 Proposed Bridge Requirements

The proposed bridge substructures must be designed for the 100-year design flood event scour potential, and checked against the 500-year check flood event scour potential. Scour countermeasures and channel protection must be designed to protect against scour for the design flood. However, an evaluation of the replacement structure type and corresponding scour analysis are outside the scope of this report. Therefore, the scour potential at this crossing has not been calculated as part of this report, however, riprap sizing calculations for channel protection have been included and are discussed in Section 5.2.1.

## 3. HYDROLOGY

### 3.1 Drainage Basin Description

The FEMA Flood Insurance Rate Maps (FIRMs) for the project location indicate that the crossing itself is in Zone A, no base flood elevations determined. However, Tributary E from the outlet of the CMPs at the Tsienneto Road crossing to the tributary's convergence with Beaver Lake downstream is located in Zone AE, a detailed study area with base flood elevations determined. Therefore, the FEMA Flood Insurance Study (FIS) does essentially provide drainage areas and flow values for the Tsienneto Road Crossing. See Appendix C for FEMA FIS Information. The site is currently in a wooded suburban area with wetland immediately upstream and homes and a junkyard downstream. The basin consists of mostly forested areas with some urban drainage and only about 1.3 percent storage area. The overall upstream channel slope is at approximately 1.7 percent, but is shallower within the wetland immediately upstream. The total contributing drainage area is 1.3 square miles (about 851 acres). The maximum elevation at the upper limit of the main channel is approximately 484 feet with an elevation at the Tsienneto Road Crossing of approximately 294 feet resulting in a 190-foot drop in elevation (Reference 2). See Appendix B for the Watershed Area Map.

### 3.2 River Channel and Floodplain

The upstream channel is within a wetland that has been designated as "Prime" wetland by the Town of Derry. The wetland has likely formed due to a combination of undersized pipes at the Tsienneto Road crossing and beaver dams, which are prevalent throughout the reach evaluated in this report. The immediate downstream channel narrows significantly from the upstream channel with well-defined banks and is also prone to beaver dams and blockages due to debris and a second undersized culvert crossing at Route 102. The channel appears to have been straightened before flowing through the 36-inch RCP at Route 102 and outletting into Beaver Lake. The channel between Tsienneto Road and Route 102 has been impacted by development, with encroachment from junkyard fill and a small pedestrian bridge. A wall has been built along the front of one building.

Downstream Reach

Upstream Reach

A full stream assessment has not been performed at this location. However, the delineated bankfull width (BFW) is 32 feet based on the upstream channel. The downstream channel is only 19 feet wide, which is similar to the calculated bankfull width using the regional hydraulic curve. A structure size of 40 feet (based on the delineated bankfull width) is recommended to meet stream crossing requirements of 1.2 times BFW plus 2 feet. A downstream grade control will be incorporated into the hydraulic model to ensure the upstream water surface elevations are maintained for low flows and the wetland is preserved.

## 3.3 Flood History

Mike Fowler, the Town of Derry Director of Public Works, provided pictures of flooding that occurred at the Tsienneto Road crossing on April 16, 2007 that resulted in closing the road. He indicated the flooding may have been attributable to beaver dams or some other blockage. Mike also indicated that Route 102 often overtops at the Route 102 culvert with more frequency than at the Tsienneto Road crossing.

April 16, 2007 Flooding Pictures at Home Upstream of Tsienneto Road Crossing

3.4 Hydrologic Study Approach

NHDOT Bridge Design Manual (Reference 1) methodologies indicate that for an ungauged site such as this one, one of the two preferred analysis methods for determining runoff rates/volumes; USGS StreamStats for NH (Reference 4) or the Natural Resources Conservation Service (NRCS) (SCS) Unit Hydrograph Method; should be chosen for analysis. Two of the accepted check methods; Flood Insurance Studies, Runoff Estimates for Small Rural Watersheds and Development of a Sound Method (Reference 5), the New England Hill and Lowlands (NEHL) and Adirondack White Mountains (AWM) Method (Reference 6), and the Index Flood Method; should be chosen to confirm the accuracy of the chosen analysis method.

Based on site conditions with respect to drainage area size and storage area, the USGS StreamStats for NH was chosen for the analysis method. Since the project is located in a FEMA Detailed Study Area, the Flood Insurance Study (FIS) was utilized as a check method. The Runoff Estimates for Small Rural Watersheds and Development of a Sound Method was chosen as the other check method for this project.

Fuss and O'Neill established the following design flow rates for the Tributary E crossing at Tsienneto Road based on the USGS StreamStats for NH analysis method:

| Recurrence Interval in Years | Flow Rate in Cubic Feet per Second (CFS) | |
|---|---|---|
| Q2 | 61.9 | |
| Q10 | 146 | |
| Q25 | 201 | |
| Q50 | 248 | Design Flood |
| Q100 | 305 | Check Flood |
| Q500 | 448 | |

The design flow rates from the FEMA FIS and the Runoff Estimates for Small Rural Watersheds and Development of a Sound Method (FHWA 5-Parameter Method and 7-Parameter Method) were within the allowable prediction error of the design flow rates from the USGS StreamStats. See Appendix D for Hydrologic Discharge Calculations.

As noted in Section 1.1, a secondary tributary, Tributary D, outlets into the channel just downstream of the Route 102 crossing through an 18-inch CMP. The culvert for this Tributary was not included in the hydraulic models because survey for that channel was not obtained, however the additional flow it contributes to the downstream reach would impact the results of the model. Therefore, StreamStats was utilized to obtain the Tributary D flow at the Route 102 crossing and added to the downstream boundary condition for the model.

Fuss and O'Neill established the following design flow rates for the Tributary D crossing at Route 102 based on the USGS StreamStats for NH analysis method:

| Recurrence Interval in Years | Flow Rate in Cubic Feet per Second (CFS) | |
|---|---|---|
| Q2 | 18.5 | |
| Q10 | 46.9 | |
| Q25 | 66.6 | |
| Q50 | 83.5 | Design Flood |
| Q100 | 104 | Check Flood |
| Q500 | 159 | |

## 4. RIVER HYDRAULIC ANALYSIS

### 4.1 General Hydraulic Model Approach

The Federal Highway Administration's (FHWA's) Surface-Water Modeling System (SMS) 12.3.3 was utilized to develop the existing and proposed hydraulic models for this project (Reference 7). SMS is a graphical pre- and post-processor for SRH-2D, a 2D modeling engine. SMS was utilized as opposed to HEC-RAS due to two complexities associated with this project that would be difficult to model with a one dimensional program; the use of a downstream grade control at the Tsienneto Road crossing to minimize impacts to the prime wetland upstream, and the impacts on the Route 102 crossing resulting from an increased opening area at the Tsienneto Road crossing.

Survey (Reference 8) and LIDAR provided by the Town of Derry were merged together within the program to create a single scatter set (surface) for the existing model. A domain, a series of polygons that enclose the project area within the scatter set and define the elements within it, was then created. Each polygon was divided into smaller "patches (polygons)" or "paving (triangles)". The polygons were then assigned elevations based on the scatter set. The domain was then converted into a mesh, which is used by SRH-2D to process the hydraulic model.

Additional polygons were then created to assign material properties, i.e. appropriate Manning's roughness coefficients, to the floodplain areas, channel, road, etc., as determined from aerial photos utilizing Google Earth Pro. A characteristic Manning's roughness coefficient of 0.05 for the channel was utilized upstream of the Route 102 crossing, and a value of 0.04 was utilized downstream of the Route 102 crossing. A Manning's roughness coefficient of 0.09 was used in forested areas of the floodplain, and 0.035 was used to represent fields/lawns. A Manning's roughness coefficient of 0.016 was used for the roads.

Entrance and Exit Boundary conditions were then defined to specify the flows and specified as subcritical inflow and outflow. The upstream "entrance" boundary condition was defined based on the flow values determined for the Tsienneto Road crossing in Section 3.4. The downstream "exit" boundary condition was calculated utilizing a downstream normal depth slope of 0.004 based on the channel elevations from the downstream face of the Route 102 crossing (neglecting an existing scour hole) and the limit of the surface model at the Beaver Lake outlet, a Manning's roughness value of 0.04, and the combined flow values Tributary E and Tributary D. Culvert boundary conditions were also developed and will be discussed in Section 4.2.

Expansion and contraction values are not required for an SMS model as they are processed internally based on the geometry of the mesh and the boundary conditions of the crossings.

See Appendix E to see the project limits, meshes, and cross section location plans used for the existing and proposed models.

## 4.2 Existing Bridge

### 4.2.1 Hydraulic Modeling Approach

The existing Tsienneto Road crossing consists of a 30-inch CMP and a 36-inch CMP, and the Route 102 crossing consists of a 36-inch RCP. As noted previously, Tributary D and its 18-inch CMP under Route 102 were not included in the hydraulic models other than to incorporate its flow at the downstream boundary condition. The existing roadways were modeled in the surface from the LIDAR provided by the Town of Derry. The invert elevations for all three existing pipes were obtained from the survey and input into SMS using HY-8, which is built into the program to model the flow through the culvert. All discharge and tailwater data is provided by the SMS model and is grayed out in the HY-8 program.

### 4.2.2 Hydraulic Performance of Existing Bridge

The results of the existing bridge model indicate that Tsienneto Road is overtopped for all storms greater than the 25-year flood event and Route 102 is overtopped for all storms greater than the 2-year flood event. The backwater from the undersized culverts at Tsienneto Road results in flooding at the intersection of Tsienneto Road and Route 102 and the upstream abutter's property adjacent to the intersection. Backwater from the Route 102 culvert results in flooding in the adjacent properties on both sides of an existing pump house. The flooding at both crossings correspond with observations from the Town of Derry as discussed in Section 3.3. Please note that as the model does not include the Tributary D CMP under Route 102, the flood limits upstream of the Route 102 crossing are not necessarily accurate. The Tributary D channel and CMP should be incorporated into the model if a replacement Route 102 crossing structure is to be sized in the future.

As the FEMA flow values are similar to the StreamStats flow values, a second flow scenario was not developed, however, the downstream water surface elevations using the StreamStats flow values were compared to the base flood elevations provided in the FEMA FIRM and FIS flood profiles. The results indicate a significant decrease of 4.2 feet for the 500-year flood event as compared to the FEMA 500-year flood event. However, the 50-year and 100-year flood events result in only 1.6-inch and 0.1-inch decreases, respectively. The 10-year flood event resulted in an 11.8-inch increase. Given the difference in modeling methods/programs, as well as changes to the geometry of the channel and wetland since the FEMA model was developed, these results, with the exception of the 500-year flow, are fairly consistent. It should be noted that the FEMA model begins at the Tsienneto Road crossing and therefore does not incorporate the storage provided by the wetland for the larger flood events.

This may explain the large drop in water surface elevations for the 500 year flood as compared to FEMA.

The FEMA FIS flood profiles indicate that Tsienneto Road and Route 102 are overtopped above the 10-year flood event. This differs from the existing model that indicates that Tsienneto Road is overtopped above the 25-year flood event at its intersection with Route 102, and Route 102 is overtopped above the 2-year flood event. It should be noted that the existing hydraulic model indicates that backwater encroaches upon the upstream shoulder of Tsienneto Road for the 10-year and 25-year flood events without overtopping. The upstream abutting property, according to the existing model, experiences various levels of flooding above the 2-year flood event.

The existing FEMA HEC-2 model input was obtained to compare to the SMS model developed for this project. However, the development of a duplicate effective model as required for a FEMA Letter of Map Revision (LOMR) application is outside the scope of this project. The 2D model developed for this project can be used to guide the development of a corrected effective model utilizing HEC-RAS. The FEMA HEC-2 input data is included in Appendix C of this report along with HEC-2 Input Descriptions.

See Appendix F for the existing structure hydraulic model input and output.

## 4.3 Proposed Bridge

### 4.3.1 Alternative Selection

As noted previously, a stream assessment has not been completed for this project. For the purposes of this hydraulic model, a 40-foot clear span structure was evaluated, however, a final structure type has not yet been determined. A 40-foot span is too long for most buried structure types, however it may be possible to obtain an Alternate Design from the NHDES and decrease the span while still meeting hydraulic requirements. The structure length was approximated based on the proposed roadway width. It was assumed channel banks would be incorporated inside the structure and meet the delineated upstream bankfull width of 32 feet.

A weir has been modeled just downstream of the Tsienneto Road structure. The weir has been modeled as a broad-crested weir with its crest set at elevation 293.3 feet, however, a sharp-crested weir could easily be utilized instead. For the purposes of the report, the crest elevation of the weir was set to ensure the upstream water surface elevations for the 2-year flood event remain similar to the existing upstream water surface to preserve the upstream wetland. It is anticipated that the weir will ultimately be designed with a low flow channel to accommodate fish passage, but a low flow channel was not incorporated in the hydraulic model.

### 4.3.2 Proposed Bridge Geometry

Based on the discussions in Section 4.3.1, the proposed structure was modeled in SMS as a 40-foot clear span, 5.5-foot rise, 42-foot long structure with 2H:1V channel banks extending though the length of the structure. The actual minimum required structure rise and area are discussed in Section 4.3.4. The proposed structure is aligned with the tributary and skewed to the road approximately 20 degrees.

### 4.3.3 Hydraulic Modeling Approach

To develop the proposed scatter set, the proposed roadway surface developed from Microstation InRoads was merged with the existing scatter set to develop a new proposed scatter set. The stamping feature in SMS, which allows for the development of a proposed trapezoidal channel scatter set based on design parameters to be stamped into an existing surface, was then utilized to develop the proposed channel from the anticipated proposed limit of channel work upstream, through Tsienneto Road, and to the anticipated limit of channel work downstream. The proposed invert elevations were approximated based on the existing channel surface outside the limits of the upstream and downstream scour holes. The scour holes were removed with the development of the channel stamps. The scatter set created by the stamping was then merged with the proposed scatter set, converted into a mesh, and evaluated for any inconsistencies.

The boundary conditions for the proposed structure were then incorporated into the model as a pressure flow structure with no overtopping. The ceiling elevations for the upstream and downstream low chords were based on a 5.5-foot structure rise. The Route 102 crossing boundary conditions were not changed from existing as no changes to that structure are currently included in the scope of work. The 2-year flood event was processed with SRH-2D to evaluate the water surface elevations. It showed a significant drop in water surface elevations from existing to proposed, which confirmed the requirement for a downstream grade control to ensure the upstream wetland is preserved.

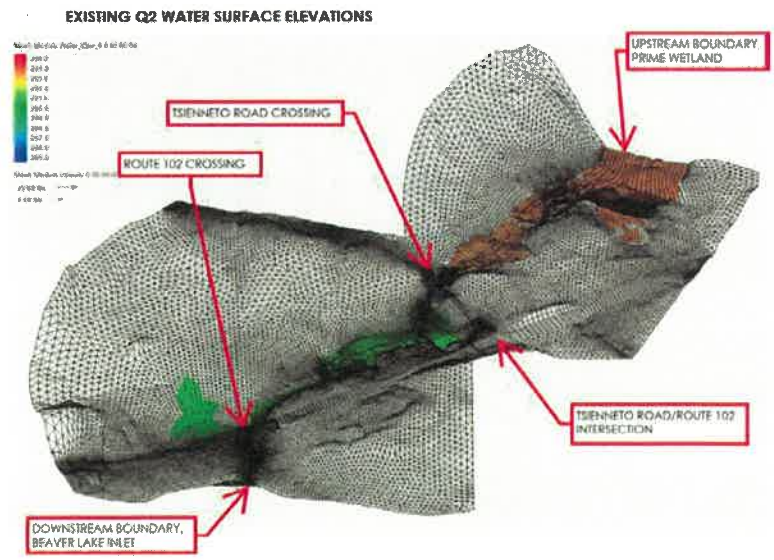
An additional boundary condition for the weir was incorporated into the model just downstream of the proposed crossing structure at Tsienneto Road. It was assumed the weir would be approximately located at the ends of the downstream wingwalls. The weir was modeled with a broad crest with an elevation equal to the existing upstream water surface elevation for the 2-year flood event. This flood event was chosen as it is the largest flood event evaluated that does not cause overtopping of either Tsienneto Road or Route 102. Therefore, for normal flows up to and including the 2-year flood event, the upstream wetland would see little to no change as compared to existing. For flood events greater than the 2-year flood event, flooding is eliminated or reduced.

As noted above, a rise of 5.5 feet was assumed initially based on the geometry at the project location. The roadway crest elevation is only approximately 7.6 feet above the upstream invert. This does not provide much room to accommodate a buried structure. Therefore, a structure depth of 2 feet was assumed to accommodate either an at-grade structure or bridge. This rise provides more than the required capacity for hydraulic requirements, but was sufficient to provide unrestricted flow for the purpose of determining the minimum low chord elevation for the proposed structure.

See Appendix F for the proposed structure hydraulic model input.

4.3.4 Hydraulic Performance of Proposed Conditions

The water surface elevations for the proposed bridge model are significantly lower than the water surface elevations for the existing model for all flood events above the 2-year flood. Figure 1 shows the existing and proposed water surface elevations for the 2-year flood event superimposed on the existing and proposed meshes. The Figure shows that the upstream water surface elevations are almost identical. Figure 2 shows the proposed water surface elevations for the 2-year flood event without the weir. A visual inspection of the upstream channel shows that the upstream water surface elevations are much lower without the weir.



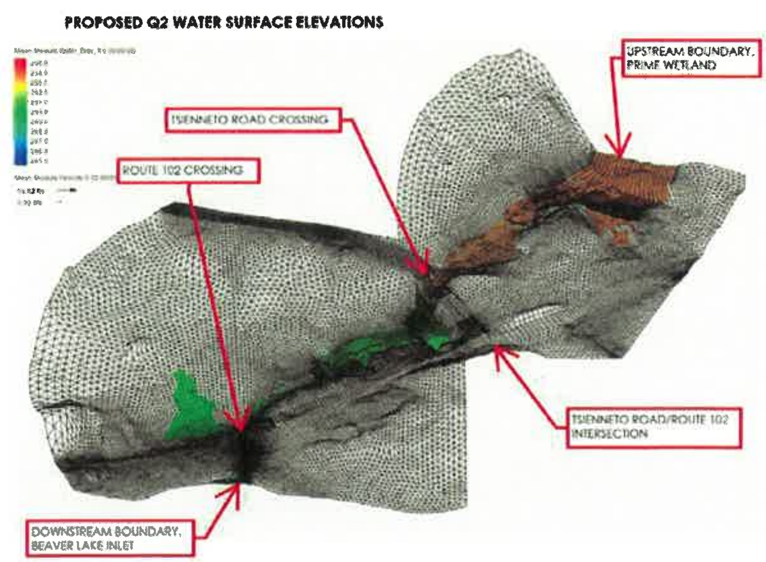




**FIGURE 1. – EXISTING AND PROPOSED 2-YEAR FLOOD EVENT WATER SURFACE ELEVATIONS**

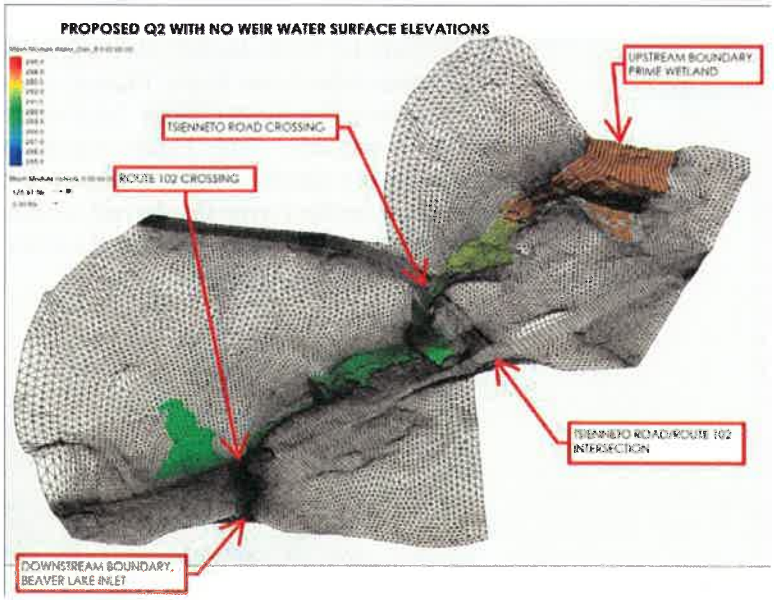



**FIGURE 2. – PROPOSED 2-YEAR FLOOD EVENT WITHOUT WEIR WATER SURFACE ELEVATIONS**

Figure 3 shows a cross section immediately upstream of the Tsienneto Road crossing with the existing and proposed 2-year flood event water surface elevations shown. The cross section shows the elevations are almost identical, confirming the crest elevation of the weir at 293.3 feet is sufficient to preserve the storage within the upstream wetland.

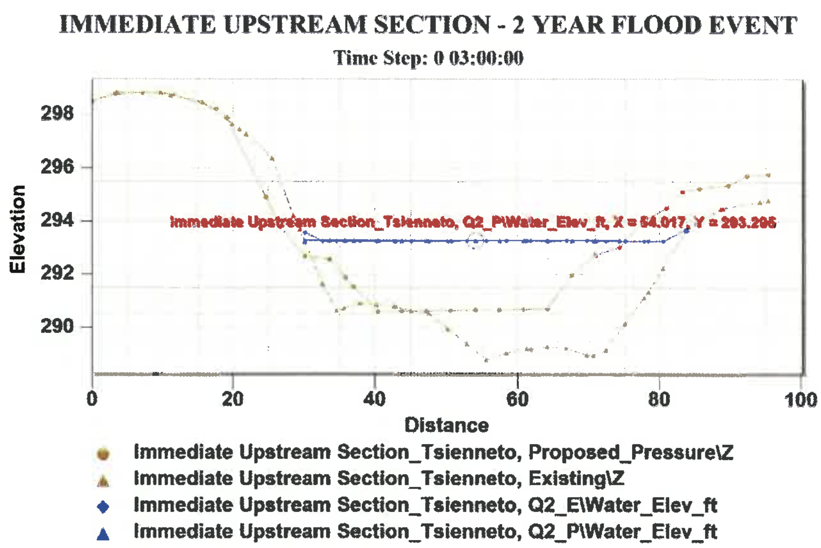



**FIGURE 3. – IMMEDIATE UPSTREAM CROSS SECTION – 2-YEAR FLOOD EVENT WATER SURFACE ELEVATIONS**

See Figure 4 for the existing and proposed water surface elevations for the design 50-year flood event. Based on a visual inspection of the images, the 50-year flood event water surface elevations are significantly decreased for the proposed structure. It is also clear that the design flow passes through the proposed structure without overtopping, while the existing image shows overtopping near the Tsienneto Road intersection with Route 102.

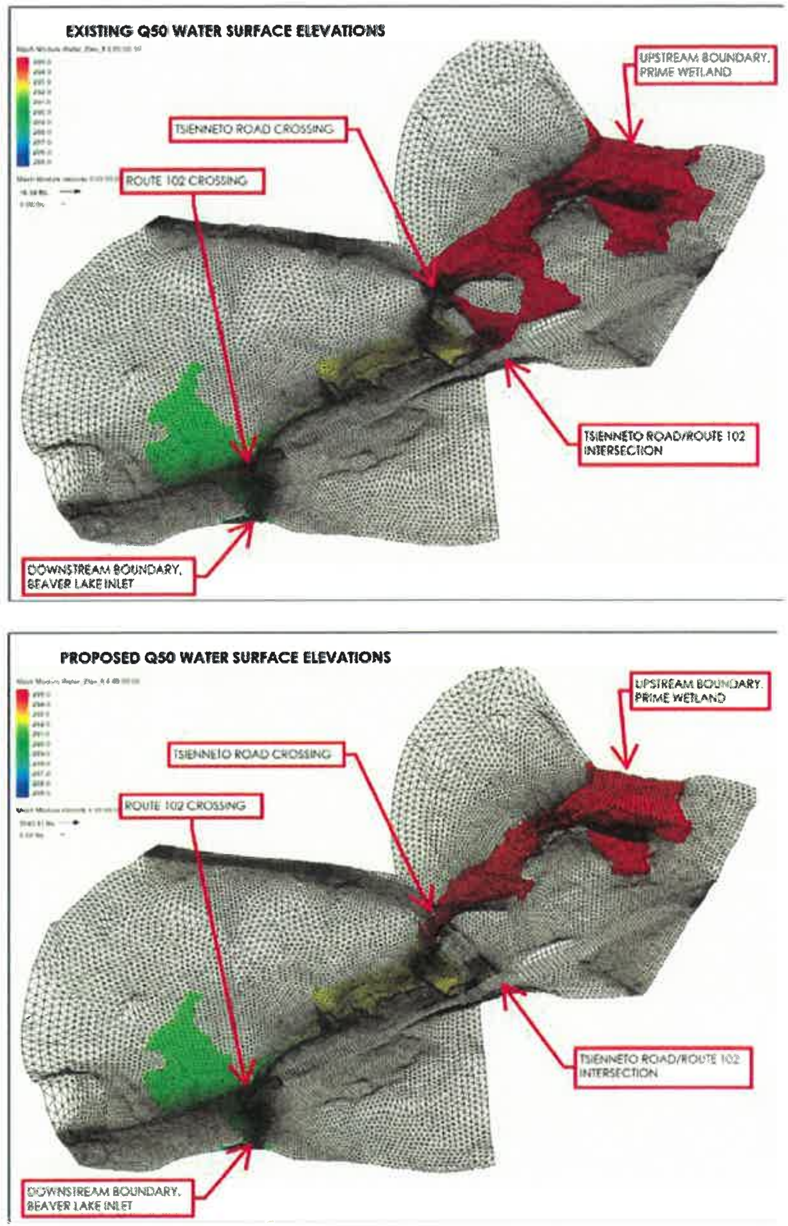



**FIGURE 4. – EXISTING AND PROPOSED 50-YEAR FLOOD EVENT WATER SURFACE ELEVATIONS**

See Table 1 for a summary of the water surface elevations for the existing model compared to the proposed model at the upstream section for the design and check flood events.

| | 50-Year Design Flood Event (ft.) | 100-Year Check Flood Event (ft.) |
|---|---|---|
| Existing | 296.26 | 296.43 |
| 40-Foot Span | 294.19 | 294.41 |
| Difference | -2.07 | -2.02 |

**TABLE 1. – SUMMARY OF WATER SURFACE ELEVATIONS AT THE UPSTREAM SECTION**

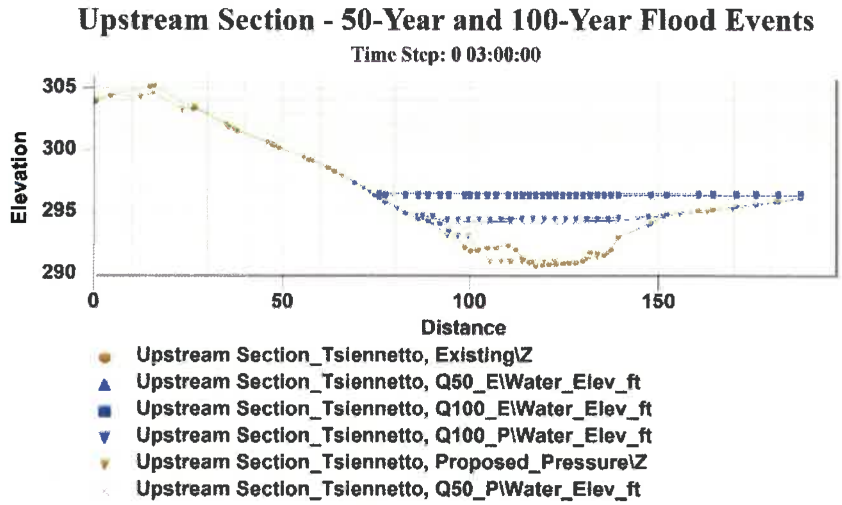



**FIGURE 5. – UPSTREAM CROSS SECTION – 50-YEAR AND 100-YEAR FLOOD EVENT WATER SURFACE ELEVATIONS**

Per the NHDOT Bridge Design Manual, the freeboard at the upstream face of the bridge for a HEC-RAS model shall be the greater of the flow depth measured at the immediate upstream section or the flow depth measured at the uncontracted upstream section applied at the upstream face of the bridge plus 1 foot. The same principal was applied for the SMS model. Based on the results of the 40-foot clear span structure model, the immediate upstream section controls and results in a minimum low chord elevation of 295 feet. The resulting minimum structure rise is therefore 4.6 feet, resulting in a minimum required opening area of 160 square feet. See Appendix F for freeboard and minimum opening area calculations and for images, cross sections, and water surface elevations for all flood events.

The effects on the downstream Route 102 crossing structure from the change in opening area at the Tsienneto Road structure was then evaluated. The model shows slightly increased water surface elevations at the Route 102 crossing for the 2-year flood event only. The model does not show any increases in water surface elevations for the larger flood events. The 2-year flood event is the only flood event evaluated that does not result in the existing Tsienneto Road culverts flowing full. This because Route 102 is not overtopped for the 2-year storm event, resulting in some backwater due to the undersized RCP. For the larger flood events, Route 102 is overtopped resulting in no increases to the upstream water surface elevations. See water surface elevation tables at the upstream section of the Route 102 crossing in Appendix F.

See Table 2 for a comparison of the design and check flood maximum velocities between existing and proposed structures at the downstream outlets of the crossing locations. The decrease in velocity from existing to proposed as shown in the table will result in decreased scour potential.

| | 100-Year Design Flood Event (fps) | 500-Year Check Flood Event (fps) |
|---|---|---|
| Existing | 5.50 | 5.59 |
| 40-Foot Span | 2.36 | 2.65 |
| Difference | -3.14 | -2.94 |

**TABLE 2. – SUMMARY OF VELOCITIES AT DOWNSTREAM SECTION AT TSIENNETO ROAD CROSSING**

The channel velocities were then checked just downstream of the weir against the existing velocities. See Table 3 for these results.

| | 100-Year Design Flood Event (fps) | 500-Year Check Flood Event (fps) |
|---|---|---|
| Weir | 2.02 | 2.62 |

**TABLE 3. – SUMMARY OF PROPOSED VELOCITIES DOWNSTREAM OF WEIR**

As seen in the Table, the velocities downstream of the weir are lower than both the existing and proposed velocities downstream of the existing culvert and proposed structure.

See Appendix F for the proposed bridge hydraulic model input and output tables.

## 5. STABILITY AND SCOUR ASSESSMENT

### 5.1 Channel Description

As discussed in Section 3.2, the river channel upstream is within a wetland that has been designated as a "Prime" wetland by the Town of Derry. The immediate downstream channel extends between a parking lot and residential backyards. The immediate downstream channel narrows significantly from the upstream channel with well-defined banks and is also prone to beaver dams and blockages due to debris and a second undersized culvert crossing at Route 102. The tributary outlets into Beaver Lake just downstream of the Route 102 crossing.

A full stream assessment has not been performed at this location, however, a concern in designing stream crossing structures is channel stability and lateral extension. Channel stability and lateral movement is highly dependent on the adjacent stability of the natural stream bank. If existing stream bank stability is impacted, the channel could quickly become unstable. To compensate for possible channel instability and wider bankfull flows, larger crossing structures and/or flood plain drainage structures should be considered.

As a stream assessment has not been completed and the channel materials such as the D50 have not been determined, channel stability and scour assessment have not been further evaluated at this time. If a closed-bottom buried structure is the chosen proposed structure type, a scour assessment may not be required.

### 5.2 Foundation and Countermeasure Recommendations

#### 5.2.1 Scour Countermeasures

The proposed structure should be designed to be stable with minimal damage should that scour occur during the 100-year design flood event. The structure should be designed to be stable during the 500-year check flood event, even if extensive damage occurs, to prevent potential loss of life.

Riprap is typically used as a scour countermeasure to protect the substructure. Riprap sizing calculations were performed (See Appendix G) to determine the required riprap for the design and check flood events based on the maximum velocity and depth within the contracted section of the bridge for each event. These equations were based on the HEC-23, Design Guideline 14 – Sizing Rock Riprap at Abutments (Reference 9). For the 40-foot clear span structure, the resulting D50 of the riprap was calculated to be 0.14 feet for the 100-year design flood event and 0.22 feet for 500-year check flood event. This D50 corresponds to NHDOT Riprap, Class III (Reference 1) for both design flood events.

Both abutment walls should have this riprap extending from the toe of the abutment into the bridge waterway approximately 8 feet for the 100-year design flood event. However, the 500-year check flood event requires 9 feet. It is recommended that the larger 9-foot value is used to ensure stability during the 500-year flood event. The riprap thickness for Class III Riprap should be at least 2-feet deep.

The riprap should extend from the face of each abutment wall back along each downstream roadway approach embankment (or along the faces of the wingwalls) at least 25 feet to protect the downstream roadway approach embankment, and should extend up the embankments at least to the 100-year design flood event elevation at the bridge. The top of the riprap (or simulated streambed material if it is placed on top of or mixed in with the riprap) should be flush with the existing channel grade.

#### 5.2.2 Channel Protection

The potential contraction scour depths in the channel have not been calculated, however, it is likely channel protection will be required. If a buried structure is proposed, NHDES Stream Crossing rules will require streambed material through the new structure. It is recommended based on the stone sizing calculations that the Class III Riprap extend across the full width of the channel inside the proposed structure. Therefore, any streambed material specified for the channel should incorporate the Class III Riprap for scour protection. If an open-bottom structure is proposed, Class III Riprap should be utilized to develop the bank slopes and be incorporated with any streambed material that may be proposed to develop the new bridge channel where the existing culvert used to be.

## 6. CONCLUSIONS AND RECOMMENDATIONS

### 6.1.1 Conclusions

The existing structure is undersized and only passes up to the 25-year flood event without overtopping the road. The proposed replacement structure is a 40-foot clear span structure with channel banks, which meets hydraulic requirements, with a downstream weir with a crest elevation set at 293.3 feet.

### 6.1.2 Recommendations

The 40-foot clear span structure results in decreased proposed velocities as compared to existing, which results in decreased scour potential. The larger span also meets bankfull width requirements and decreases the potential for structure instability due to channel lateral migration. It accommodates all hydraulic requirements for the future safety of the crossing for vehicles and pedestrians. A smaller span structure could be utilized and still meet hydraulic requirements in order to meet the project budget and accommodate site constraints if an alternative design is obtained as part of the NHDES permitting process.

## 7. REFERENCES


1. NHDOT Bridge Design Manual, January 2015 – V 2.0 (Revised Feb. 2016).
2. Terrain Navigator, TOPO Map, Derry, NH Quadrangle 1985.
3. Field reconnaissance by F&O personnel.
4. StreamStats for NH, http://water.usgs.gov/osw/streamstats/new_hampshire.html
5. Drainage Design for Highways, NHDOT, April 1998
6. Runoff Estimates for Small Rural Watersheds and Development of a Sound Design Method, Utah Water Research Lab., Logan, October 1977.
7. Surface-Water Modeling System (SMS) Version 12.3.3, May 30, 2018, Aquaveo LLC, http://www.aquaveo.com.
8. Survey Base Plan.
9. Hydraulic Engineering Circular No. 23, Bridge Scour and Stream Instability Countermeasures: Experience, Selection, and Design Guidance – Third Edition, Federal Highway Administration, September 2009.

# Attachment D

## Stormwater Memo

FUSS & O'NEILL

# MEMORANDUM

**TO:** New Hampshire Department of Transportation

**FROM:** Kristen Hayden, PE

**DATE:** July 31, 2018 (Revised April 4, 2019)
(Revised July 03, 2019)
(Revised November 12, 2019)

**RE:** Exit 4A, Derry-Londonderry 13065
Proposed Stormwater Treatment
Fuss & O'Neill Reference No. 20190127.A10

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The Towns of Derry and Londonderry and the New Hampshire Department of Transportation (NHDOT), in cooperation with the Federal Highway Administration (FHWA), are advancing an updated Environmental Study for the I-93 Exit 4A Project (Project). The Project consists of a new diamond interchange on I-93 in the Town of Londonderry, approximately one mile north of Exit 4.

The purpose of the Project is to reduce congestion; improve safety along NH 102 from I-93 easterly through downtown Derry; and promote economic vitality in the Derry/Londonderry area.

The new diamond interchange would provide access to the east side of I-93. A one-mile connector roadway would be built on new alignment from the interchange to Folsom Road, near the intersection of North High Street and Madden Road, in the Town of Derry. Folsom Road, and subsequently Tsienneto Road, would be upgraded, and the intersections would be improved. In total, the proposed Project corridor from I-93 to the intersection of Tsienneto Road and NH Route 102/Chester Road would be 3.2 miles.

The Towns of Derry and Londonderry are located within an Urbanized Area and are regulated communities under the Municipal Separate Storm Sewer System General Permit (MS4). The MS4 requires 80% Total Suspended Solids (TSS) removal and 50% phosphorus reduction for redeveloped pavement and 90% TSS removal and 60% phosphorus reduction for newly developed pavement. Based on this criterion and the treatment removal efficiencies of Best Management Practices (BMPs), 100% treatment of both redeveloped and newly developed pavement is required under the MS4 to the maximum extent practicable.

Fuss & O'Neill has developed a conceptual stormwater treatment plan utilizing Infiltration Basins, Wet Extended Detention Basins, Dry Swales, Swales and removal of existing pavement to treat approximately 89% of the redeveloped and newly developed roadway pavement areas for the proposed Exit 4A improvements. In areas where the redeveloped and newly developed roadway pavement could not feasibly be treated, treatment of existing pavement outside of the project footprint was considered. Additional ROW impacts will be required for proposed BMPs as shown on the attached plan.

**Proposed Treatment**

The proposed treatment areas and BMPs (depicted on the attached plan, and summarized in the attached tables) consist of the following:

- **Existing BMP B1649,** constructed under Contract 14633D, was built with additional capacity in an effort to accommodate future treatment of the Exit 4A ramps. Runoff from portions of the Exit 4A NB Off Ramp and SB On Ramp will be directed toward the existing BMP. The design of this BMP will need to be evaluated to determine how much extra capacity is available and if additional modifications will be required to accommodate the additional runoff.
- **Existing BMP B1670,** constructed under Contract 14633I, was constructed with additional capacity in an effort to accommodate future treatment of the Exit 4A ramps. Runoff from portions of the Exit 4A ramps will be directed toward the existing BMP. The design of this BMP will need to be evaluated to determine how much extra capacity is available and if additional modifications will be required to accommodate the additional runoff.
- **Potential Proposed B1012** is located adjacent to the Connector Road at approximately 1012+00, RT and will collect runoff from 1008+45 to 1022+50. The soils in this area are 140C, Chatfield-Hollis-Canton complex, and are considered well drained, making this location feasible for infiltration. Infiltration testing should be performed in this area to confirm the feasibility of an infiltration basin at this location. The infiltration basin has been sized to hold the runoff from roadway pavement for the 50-year event. To minimize impacts to the surrounding wetlands and vernal pools, the access road/berm around the basin has been set at an elevation of 370.00 and the bottom of the infiltration basin at 365.00. The easement has been sized to include a forebay that can hold at least 25% of the WQV and the basin has been sized to detain the 50-year event since all of the pavement directed to this BMP is newly developed. The easement has also been sized to provide a maintenance access road from 1016+50, RT. The access road will go from an elevation of 402.00 down to the BMP elevation of 370.00' over 300 feet with a slope of 10.7%. The basin will infiltrate/discharge to the adjacent wetland 68, which is a Palustrine Forested Emergent Wetland (PF01E).
- **Potential Proposed B1038** is located to the north of the Collector Road at approximately 1038+00, LT and collects runoff from 1022+50 to 1036+50. The BMP is proposed to be a Wet Extended Detention Basin that will be relatively large in size, as it will be treating new impervious from the proposed Connector Road. The outfall from the roadway closed system is assumed to occur at 1036+50, LT at an elevation of 352.00 and it is anticipated to be a 24 inch pipe. The access road berm has been set at an elevation of 352.00 and the top of the permanent pool has been set at 347.00 and the basin has been sized to hold the runoff from roadway pavement for the 50-year event. The basin will discharge to a non-perennial tributary of Shields Brook. It should be noted that the connection from wetland 35, a PF01E, to the non-perennial tributary will need to be regraded to go around the BMP

or will need to be piped. Today, wetland 35 is conveyed to the non-perennial tributary via a drive pipe.

- **Potential Proposed B1052** is located adjacent to the Connector Road at approximately 1052+00, LT and will collect runoff from 1036+50 to 1053+25 and runoff from 602+75 to 609+50 of the proposed bike path. The BMP is proposed to be a Wet Extended Detention Basin. Runoff will be conveyed to the BMP through an 18 inch pipe from the Connector Road at 1053+25 and a 24 inch pipe from the bike path at 606+95. The BMP is be located on an existing commercial site, proposed to be acquired by the project due to roadway impacts. The existing commercial building and impervious parking lot are in the anticipated area of the BMP; heavily compacted soils may need to be excavated and replaced. The access road berm has been set at an elevation of 287.00 and the top of the permanent pool has been set at 282.00. The BMP has two locations where it could potentially be accessed, either from the bike path at 607+00, which can be accessed at 14+00, LT off of High Street or an access driveway can be graded from the Connector Road at approximately 1053+00. It will need to be confirmed that maintenance equipment can fit through the bike path structure. The BMP has been sized to hold the runoff from the roadway and bike path pavement for the 50-year event. The BMP will discharge directly into Shields Brook.
- **Potential Proposed B15** is expected to be located to the east of North High Street at approximately 17+00, LT and collects runoff from 10+75 to 18+75 on North High Street and 599+75 to 602+75 on the bike path. It is anticipated that the BMP will be a Wet Extended Detention Basin. The outfall from the roadway closed system is assumed to be an 18 inch pipe at 19+00, LT. The access road berm has been set an elevation of 273.00 and the top of the permanent pool has been set at 268.00. Access to the BMP is proposed to be along an existing sewer easement at the end of Ferland Drive. The basin has been sized to hold the runoff from the roadway pavement for the 50-year event. The BMP will discharge into Shields Brook before it reaches Hoods Pond. There appears to be an existing BMP for the adjacent condo facility in the same vicinity, but B15 has been designed to avoid impacts to it. Coordination between the existing sewer pipe and the outfall pipe from this BMP will be required.
- **Potential Proposed B11** is located to the east of Ferland Dr. at approximately 11+00, LT and collects runoff from approximately 10+50 to 12+00, LT on Ferland Dr. and from 1053+25 to 1054+25 on the Connector. The BMP is located on an existing residential parcel proposed to be acquired by the project due to roadway impacts. Runoff will be conveyed to the BMP from a catch basin located along the left side of the roadway. The BMP is anticipated to be a dry swale with a 0.5% slope and an underdrain. The swale is proposed to be 125 feet in length, 5 feet wide with 4:1 side slopes and 1.5 feet deep. This will achieve a WQF of less than 4 inches and a 10 minute hydraulic residence time, while maintaining a foot of freeboard during the peak elevation of a 10-year storm event. The swale outfalls to Shields Brook. The amount of runoff that can collected for treatment at this location is limited due to the Shields Brook bridge under the Connector Road. It is

assumed that a forebay will not be required and that deep sump catch basins will provide pre-treatment.

- **Potential Proposed B1062** is located to the north of the Connector Road/Folsom Road and collects runoff from 1063+00 to 1085+00 and 218+75 to 220+00 from NH Route 28. It is anticipated that the BMP will be a Wet Extended Detention Basin. The closed drainage system will need to run through a small high point at 1067+22 resulting in a deep closed system (10' to 15') for 400 to 500 feet. The outfall from the roadway will be a 30 inch pipe at 1063+00. The access road berm has been set an elevation of 286.00 and the top of the permanent pool has been set at 281.00. The BMP has been placed at the rear of the properties to allow the frontage along Folsom Road to remain for future development. In order to place the basin toward the back of the property, the closed drainage system will need to have reduced cover (2 feet) at the low point on Tsienneto Road at 1071+71. If a 0.5% grade is held for the closed system pipes from 1071+71 to 1063+00 (eliminating the 3 inch drop, but still having the top crown of pipes match when the size increases), this will achieve an invert of 284.00' at the outfall to the basin to minimize tailwater on the closed system. Access to the BMP is anticipated to be from the north end of the Franklin Place Condominium parking lot (Town of Derry Assessor's Map 35, Lot 6). Runoff from the proposed development of the Town of Derry Assessor's Map 35, Lot 11-1 parcel has also been taken into consideration in the sizing of the B1062 as the BMP for the proposed development would be impacted by B1062. The basin has been sized to hold the runoff from the roadway pavement and the runoff that is directed to the displaced BMP for the proposed development for the 25-year storm event. The BMP will discharge into an existing wetland/pond located on the Town of Derry Assessor's Map35, Lot 5-4 parcel, which overflows into Shields Brook. Please note that there is a knoll on the property and significant common and rock excavation will be required in close proximity to surrounding buildings to construct this BMP. Concern with PFOA's from the adjacent property to the northwest has also been noted in this area.
- **Potential Proposed B208** is located to the east of NH Route 28 (Crystal Ave.) at approximately 209+00, RT and collects runoff from 210+50 to 217+00. The BMP is anticipated to be a swale. The swale is proposed to be 275 feet in length with a slope of 1.1%. In order to achieve the hydraulic residence time while maintaining less than 4 inches of flow for the WQF, the swale will need to be 8 feet wide with 4:1 side slopes. It will discharge into an existing wetland located on the Town of Derry Assessor's Map 36, Lot 19. It is assumed that a forebay will not be required and that deep sump catch basins will provide pre-treatment.
- **Potential Proposed B1085** is located to the north of Tsienneto Road at approximately 1085+00, LT and collects runoff from 1085+00 to 1110+25. It is anticipated the BMP will be a Wet Extended Detention Basin. The outfall from the roadway closed system is anticipated to be a 24 inch pipe at an elevation of 316.00' at 1085+00, LT. The access road berm has been set an elevation of 316.00 and the top of the permanent pool has been set at

311.00. Access to the BMP is anticipated to be from the northeast corner of the Fireye, Inc. parking lot (Town of Derry Assessor's Map 8D, Lot 269). The basin has been sized to hold the 50-year storm event and the grading of this BMP was based on 2-foot aerial mapping contours. It will discharge into existing wetland located in the back of the Fireye property, which is connected to an existing wetland in the west corner of the NH Route 28 and Tsienneto Road intersection, next to the Derry Police Department. The wetlands are connected through an existing drain pipe running underneath NH Route 28.

- **Potential Proposed B308** is located to the east of NH Route 28 Bypass (N. Main Street) at approximately 310+00, RT, collecting NH Route 28 Bypass runoff from 310+00 to 333+30 and Tsienneto Road runoff from 1111+00 to 1113+50. Roadside ditches or curbing will need to be added to NH Route 28 Bypass from 320+35 to 333+30 to collect runoff from existing pavement. This portion of NH Route 28 Bypass is currently outside of the project limits. The BMP is proposed to be located in an open area on the Town of Derry Assessor's Map 8C, Lot 71 and is anticipated to be a Wet Extended Detention Basin. The outfall from the roadway closed system is assumed to occur at 311+35, RT at an elevation of 366.00 and it is anticipated to be a 24 inch pipe. The BMP has been set back from the road in an effort to allow for future development of the parcel and to minimize impacts to the trees adjacent to the wetland. The access road berm has been set an elevation of 360.00 and the top of the permanent pool has been set at 356.00. Minimal detention has been provided since the majority of the runoff to this BMP is from existing pavement. Access to the BMP should be determined after the parcel is developed. The BMP will discharge into an existing wetland located on the Town of Derry Assessor's Map 8C, Lot 68.
- **Potential Proposed B1117** is located to the south of Tsienneto Road at approximately 1117+25, RT and collects runoff from approximately 1113+50 to 1124+70. The BMP is anticipated to be a dry swale with a 1.0% slope and an underdrain. The swale is proposed to be 300 feet in length, 8 feet wide with 4:1 side slopes and 2.0 feet deep. This will achieve a WQF of less than 4 inches and a 12 minute hydraulic residence time, while maintaining a foot of freeboard during the peak elevation of the 10-year storm event. The swale has been designed to follow the future proposed driveway for Pinkerton Academy. Roadway runoff will be conveyed to the treatment swale via a ditch and drive pipes. The beginning of the ditch is shown going through a portion of a building. Pinkerton Academy is planning on removing this portion of the building with their proposed development. The swale will outfall to an existing pond located on the Town of Derry Assessor's Map 8C, Lot 68. It is assumed that a forebay will not be required and that deep sump catch basins will provide pre-treatment.
- **Potential Proposed B1128** is located south of Tsienneto Road at approximately 1128+00, RT. The BMP is anticipated to be a swale, collecting runoff from 1124+70 to 1134+50. The swale is proposed to be 200 feet in length with a slope of 0.5%. In order to achieve the hydraulic residence time of 11 minutes while maintaining less than 4 inches of flow for the WQF, the swale will need to be 8 feet wide with 4:1 side slopes. It will discharge into an

existing pond located towards the back of the Town of Derry Assessor's Map 8C, Lot 66-3. It is assumed that a forebay will not be required and that deep sump catch basins will provide pre-treatment.

- **Potential Proposed B1159** is located to the south of Tsienneto Road at approximately 1159+00, RT. The BMP collects runoff from 1134+50 to 1161+80 on Tsienneto Road and portions of Jeff Lane, Scenic Drive, Beaver Road, Horseshoe Drive and Barkland Drive. Runoff from portions of Jeff Lane and Scenic Drive that are curbed today, located outside of the project limits, are conveyed to this BMP. The BMP is anticipated to be a Wet Extended Detention Basin. The outfall from the roadway closed system is presumed to be at 1159+00, RT via a 24 inch pipe. The ground will need to be regraded over the pipe in order to achieve cover. The access road berm has been set at an elevation of 298.00 and the top of the permanent pool has been set at 293.00. Minimal detention should be required at this location, as most of the runoff being conveyed to the BMP is from existing pavement. The BMP will outfall to the wetland located on the Town of Derry Assessor's Map 55, Lot 12-1. The wetland outfalls to Abbott Brook, which feeds into Beaver Lake. The BMP has been graded to avoid impacts to the parcel identified as Map 55, Lot 15 on the Town of Derry Assessor's Map. If the property owner of this parcel is amenable to impacts to their parcel to accommodate additional stormwater treatment, the amount of detention provided in the BMP could be increased.
- **Potential Proposed B412** is located to the north of NH Route 102 from approximately 411+50 to 412+50, LT and collects runoff from approximately 411+50 to 412+50. LT. The BMP is anticipated to be a swale with a 0.5% slope. The swale is proposed to be 150 feet in length, 2 feet wide with 4:1 side slopes and 1.5 feet deep. This will achieve a WQF of less than 4 inches and an 18 minute hydraulic residence time, while maintaining a foot of freeboard during the peak elevation of a 10-year storm event. The swale will outfall to wetlands located on the Town of Derry Assessor's Map 55, Lot 21. The wetland outfalls to Abbott Brook, which feeds into Beaver Lake. This location was also evaluated as a dry swale, but the elevation of the receiving water body would be higher than the outfall from the underdrain. The swale is collecting runoff via sheet flow which does not allow for a formal method of pre-treatment, but some level of pre-treatment will be obtained in the foreslopes to the swale.
- **Potential Proposed B415** is located to the south of NH Route 102 from approximately 414+50 to 416+50, RT and collects runoff from approximately 414+50 to 416+25, RT. The BMP is anticipated to be a dry swale with a 1.4% slope and an underdrain. The swale is proposed to be 175 feet in length, 4 feet wide with 4:1 side slopes and 1.5 feet deep. This will achieve a WQF of less than 4 inches and an 11 minute hydraulic residence time, while maintaining a foot of freeboard during the peak elevation of a 10-year storm event. The swale will have 3 feet of filter material consisting of a layer of sand and a layer of stone. The underdrain will be 2 inches above the bottom of stone. The underdrain will outfall to an existing catch basin on the southeast corner of NH Route 102 and North Shore Road. The

cross pipe under North Shore Road will need to be lowered 2 feet to accommodate the proposed underdrain. The cross pipe under NH Route 102 does not need to be modified. The drainage network will outfall to wetlands located on the Town of Derry Assessor's Map 55, Lot 21. The wetland outfalls to Abbott Brook, which feeds into Beaver Lake. The swale is collecting runoff via sheet flow which does not allow for a formal method of pre-treatment, but some level of pre-treatment will be obtained in the foreslopes to the swale.

- **Potential Proposed B417** is located to the south of NH Route 102 from approximately 416+50 to 419+00, RT and collects runoff from approximately 416+50 to 419+00, RT and 419+00 to 424+00, LT and RT. Sloped granite curb will need to be added along the shoulder from approximately 419+50 to 424+50, RT. The BMP is anticipated to be a dry swale with a 1.0% slope and an underdrain. The swale is proposed to be 225 feet in length, 4 feet wide with 4:1 side slopes and 2 feet deep. This will achieve a WQF of less than 4 inches and a 10 minute hydraulic residence time, while maintaining a foot of freeboard during the peak elevation of a 10-year storm event. It is divided by a driveway and will require a culvert under the driveway at 417+75, RT, but there is the potential this access could be removed, as the property also has a driveway off of North Shore Road. The swale will have 3 feet of filter material consisting of a layer of sand and a layer of stone. The underdrain will be 2 inches above the bottom of stone. The drainage network currently outfalls to a wetland located on the Town of Derry Assessor's Map 55, Lot 21. The wetland outfalls to Abbott Brook, which feeds into Beaver Lake. The swale is collecting runoff via sheet flow which does not allow for a formal method of pre-treatment, but some level of pre-treatment will be obtained in the foreslopes to the swale.
- **Potential Proposed B101** is expected to be located to the north of North Shore Road at approximately 101+00, LT. It collects runoff from North Shore Road outside of the proposed project limits. The BMP is anticipated to be a dry swale with a 2.0% slope and an underdrain. The swale is proposed to be 125 feet in length, 4 feet wide with 4:1 side slopes and 2 feet deep. This will achieve a WQF of less than 4 inches and a 12 min. hydraulic residence, while maintaining a foot of freeboard during the peak elevation of a 10-year event. The swale will have 3 feet of filter material consisting of a layer of sand and a layer of stone. The underdrain will be 2 inches above the bottom of stone. The underdrain is expected to outfall to the same existing catch basin as B417. The swale is collecting runoff via sheet flow which does not allow for a formal method of pre-treatment, but some level of pre-treatment will be obtained in the foreslopes to the swale.
- **Pavement Removal:** As a result of the re-alignment of existing roadways, approximately 73,500 square feet of pavement removal is expected.

**Non-Practicable Treatment Alternatives**

- Providing a BMP at the low point located at approximately 1056+00 to the west of Franklin Street Extension and the north of Folsom Road was evaluated. To accomplish this Franklin Street Extension would need to be curbed on both sides of the road in order to collect the runoff from the proposed pavement. The BMP was anticipated to be a swale. Upon further investigation it was determined that there is not enough elevation change or space available to achieve treatment in a swale at this location. The depth of the flow and the hydraulic residence time could not be achieved in the available space. Normandeau Associates, Inc. (NAI) revisited this area and found that there was a stream located in the vicinity, which was not previously shown on the plans, making treatment even less feasible at this location.

Whether or not this area could be treated in B1062 was also considered, but the approximate roadway closed system outfall is 273.5' at the low point at 1057+85 and the outfall from B1062 to the brook is approximately at 280.00'.

- A BMP was investigated outside of the project limits at approximately 204+00, RT on NH Route 28 (Crystal Ave) behind the McDonalds and Gibbs gas station. The BMP was proposed to be a wet extended detention basin and would have collected runoff from 196+50 to 220+00 on NH Route 28. This BMP did propose to collect runoff from a significant amount of existing pavement that is outside of the project on a roadway that is already curbed with an existing closed drainage system in order to offset some of the areas in the project where treatment of the redeveloped pavement is not feasible. Unfortunately, there is not enough elevation change to provide a wet extended detention basin. A swale was also investigated at this location. The existing catch basin in the roadway has a rim elevation of 290.00'. If cover over the outfall pipe from the roadway is reduced to 2 feet, a 24" diameter outfall pipe from the road that extends under the adjacent parking lot would outfall at approximately 285.20'. The bottom of the adjacent wetland is at 284.00', but the water level in the wetland appears to be at 286.00'. A swale at this location does not appear to be feasible due to tailwater. As a result a smaller amount of pavement has been treated via B208.

- The treatment of the remainders of Tsienneto Road and portions of NH Route102 were not considered to be practicable due to the density of the surrounding wetlands and a lack of vertical separation from the wetlands to provide treatment. The following alternatives were considered:
  - The treatment of NH Route 102 in B1159 was considered, but there was no way to cross the treatment under the existing brook.
  - Collecting runoff from Tsienneto Road (1163+50 to 1169+40) and NH Route 102 (415+00 to 427+40) and constructing a BMP basin at 92 Tsienneto Road was considered, but the elevations did not work. The outfall from the roadway into the basin would need to be at an elevation of 292.00' and the surrounding wetland is at an elevation of 295.00'.
  - Although roadside ditches are not considered stormwater treatment, we are proposing to add treatment swales along portions of NH Route102 where they do

not exist today. This will be an improvement to the existing condition, as today runoff flows along the gravel shoulders of the roadway.

- Treatment of many of the small side road connections were not considered feasible, as they are not curbed today and curbing them or providing roadside ditches to collect runoff would result in significant impacts while providing minimal additional treatment. Many of the connecting side roads flow away from the project, making treatment of these areas a challenge.

The Project has approximately 1,717,000 square feet of redeveloped and newly developed pavement areas that require treatment. Of the 1,717,000 square feet, we are proposing to treat approximately 1,528,000 square feet or 89% of the required amount. Existing pavement that will be redeveloped by this project accounts for 827,700 square feet of the pavement requiring treatment. Currently, none of that pavement has treatment; therefore the implementation of the proposed stormwater treatment should provide a significant improvement in the water quality of the existing watershed. Considering the constraints of the project area and the proposed improvement to the existing condition, stormwater treatment has been provided to the maximum extent practicable.

KAH:jr
AWV

cc: Keith Cota - NHDOT
Mark Hemmerlein - NHDOT
Marc Laurin - NHDOT
John Butler - NHDOT
Wayne Brooks - NHDOT
Lee Carbonneau - NAI
Joel Detty - NAI
JoAnn Fryer - Fuss & O'Neill
Nicole Fox – Fuss & O'Neill
Leo Tidd – LB/WSP
Susan Van Dyke– LB/WSP

| Roadway Impervious Area to be Treated | 1,716,285 SF |
|---|---|

| Roadway | Begin Station | End Station | New Impervious (SF) | Existing Impervious (SF) | Total Treatment Area (SF) |
|---|---|---|---|---|---|
| Connector | 1001+50 | 1008+42 | 50,074 | | 50,074 |
| Connector (B1012) | 1008+42 | 1022+47 | 96,582 | | 96,582 |
| Connector (B1038) | 1022+47 | 1036+50 | 89,061 | | 89,061 |
| Connector (B1052) | 1036+50 | 1053+25 | 98,857 | 35,385 | 134,242 |
| Connector (B11) | 1053+25 | 1054+25 | 7,288 | 2,160 | 9,448 |
| Connector | 1054+25 | 1063+00 | 66,442 | 16,308 | 82,750 |
| Connector/Tsienneto (B1062) | 1063+00 | 1085+00 | 81,990 | 146,489 | 228,479 |
| Tsienneto (B1085) | 1085+00 | 1110+25 | 39,328 | 119,061 | 158,389 |
| Tsienneto (B308) | 1110+25 | 1113+50 | 5,490 | 19,041 | 24,531 |
| Tsienneto (B1117) | 1113+50 | 1124+70 | 15,132 | 39,367 | 54,499 |
| Tsienneto (B1128) | 1124+70 | 1134+50 | 4,313 | 32,396 | 36,709 |
| Tsienneto (B1159) | 1134+50 | 1161+75 | 10,572 | 93,101 | 103,673 |
| Tsienneto | 1161+75 | 1169+75 | 7,131 | 22,871 | 30,002 |
| | | Tsienneto Subtotal | 572,260 | 526,179 | 1,098,439 |
| SB On Ramp (B1649) | 46+15 | 66+50 | 36,721 | | 36,721 |
| SB On Ramp | 66+50 | 73+90 | 22,359 | | 22,359 |
| SB Off Ramp (B1670) | 80+40 | 89+20 | 25,172 | | 25,172 |
| SB Off Ramp | 89+20 | 96+90 | 15,351 | | 15,351 |
| NB On Ramp (B1670) | 40+40 | 51+60 | 36,391 | | 36,391 |
| NB On Ramp | 51+60 | 64+20 | 16,083 | | 16,083 |
| NB Off Ramp (B1649) | 13+00 | 28+10 | 37,302 | | 37,302 |
| NB Off Ramp (B1670) | 28+10 | 35+50 | 20,508 | | 20,508 |
| | | Ramp Subotal | 209,887 | 0 | 209,887 |
| Madden Road | 10+60 | 19+40 | 13,198 | 5,428 | 18,626 |
| North High Street (B15) | 10+75 | 18+75 | 22,760 | 19,548 | 42,308 |
| Bike Path (B1052) | 602+75 | 609+50 | 4,069 | 1,690 | 5,759 |
| Bike Path (B15) | 599+75 | 602+75 | 2,425 | 493 | 2,918 |
| Ferland Drive | 10+50 | 13+50 | 382 | 5,634 | 6,016 |
| Ferland Drive (B11) | 10+50 | 12+00 | | 2,128 | 2,128 |
| Franklin Street Extension | 30+50 | 34+00 | 4,177 | 9,936 | 14,113 |
| Franklin Street | 28+75 | 21+50 | 9,902 | 19,483 | 29,385 |
| Laconia Ave | 70+60 | 72+50 | 188 | 3,713 | 3,901 |
| Route 28 (Manchester Road) | 220+00 | 220+50 | 657 | 5,000 | 5,657 |
| Route 28 (Crystal Ave)(B208) | 210+50 | 217+00 | 9,109 | 50,241 | 59,350 |
| Route 28 (Crystal Ave) | 208+75 | 210+50 | 675 | 9,813 | 10,488 |
| Pinkerton | 60+50 | 65+00 | 3,351 | 24,007 | 27,358 |
| Route 28 Bypass (Londonderry Tpk)(B308) | 316+30 | 320+40 | 1,350 | 22,026 | 23,376 |
| Route 28 Bypass (N. Main Street)(B308) | 310+00 | 315+60 | 923 | 26,124 | 27,047 |
| Barkland Drive (B1159)(Left) | 10+25 | 12+00 | 29 | 2,203 | 2,232 |
| Barkland Drive (Right) | 10+25 | 12+00 | 100 | 2,266 | 2,366 |
| Fieldstone Drive | 20+15 | 21+40 | 99 | 3,968 | 4,067 |
| Horseshoe Drive (B1159) | 30+25 | 32+75 | 0 | 6,599 | 6,599 |
| Morningside Drive | 40+15 | 42+00 | 144 | 5,676 | 5,820 |
| Scenic Drive (B1159) | 50+25 | 52+40 | 260 | 5,372 | 5,632 |
| Beaver Road (B1159) | 60+15 | 61+60 | 176 | 3,440 | 3,616 |
| Beaver Road | 61+60 | 62+75 | | 1,886 | 1,886 |
| Route 102 | 406+75 | 427+50 | 32,445 | 64,866 | 97,311 |
| | | Side Road Total | 106,419 | 301,540 | 407,959 |
| | | TOTAL IMPERVIOUS | 888,566 | 827,719 | 1,716,285 |

| **Untreated Impervious:** | **187,762 SF** |
|---|---|

| **% Impervious Treated** | **89%** |
|---|---|

| BMP | BMP Type | Roadway | Begin Station | End Station | Impervious Area Treated (SF) | Town |
|---|---|---|---|---|---|---|
| B1649 (Existing BMP constructed with 14633D) | Wet Extended Detention Basin | NB Off Ramp<br>SB On Ramp | 13+00<br>46+15 | 28+10<br>66+50 | 74,020 | Londonderry |
| B1670 (Existing BMP constructed with 14633I) | Wet Extended Detention Basin | Connector Road<br>NB On Ramp<br>NB Off Ramp<br>SB On Ramp<br>SB Off Ramp | 1001+50<br>40+40<br>28+10<br>66+50<br>80+40 | 1008+45<br>51+60<br>35+50<br>73+90<br>89+20 | 154,503 | Londonderry |
| B1012 | Infiltration Basin | Connector Road | 1008+45 | 1022+50 | 96,582 | Londonderry |
| B1038 | Wet Extended Detention Basin | Connector Road | 1022+50 | 1036+50 | 89,060 | Londonderry |
| B1052 | Wet Extended Detention Basin | Connector Road<br>Bike Path | 1036+50<br>602+75 | 1053+25<br>609+50 | 139,988 | Derry |
| B15 | Wet Extended Detention Basin | North High Street<br>Bike Path | 10+75<br>599+75 | 18+75<br>602+75 | 45,220 | Derry |
| B11 | Dry Swale | Ferland Drive<br>Connector Road | 10+50<br>1053+25 | 12+00<br>1054+25 | 11,570 | Derry |
| B1062 | Wet Extended Detention Basin | Tsienneto Road<br>Route 28 | 1063+00<br>218+75 | 1085+00<br>220+00 | 228,490 | Derry |
| B208 | Swale | Crystal Ave | 210+50 | 217+00 | 59,350 | Derry |
| B1085 | Wet Extended Detention Basin | Tsienneto | 1085+00 | 1110+25 | 158,380 | Derry |
| B308 | Wet Extended Detention Basin | NH 28 Bypass<br>Tsienneto Road | 310+00<br>1111+00 | 333+30<br>1113+50 | 128,140 | Derry |
| B1117 | Dry Swale | Tsienneto Road | 1113+50 | 1124+70 | 54,500 | Derry |
| B1128 | Swale | Tsienneto | 1124+70 | 1134+50 | 36,700 | Derry |
| B1159 | Wet Extended Detention Basin | Tsienneto | 1134+50 | 1161+80 | 139,700 | Derry |
| B412 | Swale | Route 102 | 411+50 | 412+50 | 1,680 | Derry |
| B415 | Dry Swale | Route 102 | 414+50 | 416+25 | 6,630 | Derry |
| B417 | Dry Swale | Route 102 | 416+50 | 424+50 | 29,100 | Derry |
| B101 | Dry Swale | North Shore Road | 100+75 | 102+00 | 1,450 | Derry |
| Pavement Removal | Removal of existing impervious area | | | | 73,460 | |

**Total Treated Impervious Area** **1,528,523 SF**


PINKERTON ACADEMY
RT. 28 NORTH MAIN STREET
TSIENNETO ROAD
SILVESTRI CIRCLE
NESMITH STREET
CHESTER ROAD
NEWELL'S MEADOW LANE
HOOD KROFT DRIVE
THORTON STREET

Pinkerton Academy
LINLEW DRIVE
RT. 28 NORTH MAIN STREET
TSIENNETO ROAD
PINKERTON STREET
NESMITH STREET
SALTMARSH AVE
SILVESTRI CIRCLE
NEWELL'S MEADOW LANE
HOOD KROFT DRIVE
RT. 28 NORTH MAIN STREET
THORTON STREET
CHESTER ROAD

# Attachment E

## Mitigation Meeting Notes

FUSS & O'NEILL

# MEETING NOTES

**March 15, 2019, 10:30 am**

**PROJECT NUMBER:** NHDOT 13065
**PROJECT NAME:** Derry-Londonderry, Exit 4A
**RE:** Resource Agency Meeting
Mitigation Approach for Wetlands, Streams and Vernal Pools

**ATTENDEES:**

| Name | Company |
|---|---|
| Jamison S. Sikora | FHWA-NH |
| Dale Keirstead | NHDES |
| Lori L. Sommer | NHDES |
| Andrew O'Sullivan | NHDOT |
| John Butler | NHDOT |
| Keith A. Cota | NHDOT |
| Kevin Nyhan | NHDOT |
| Marc G. Laurin | NHDOT |
| Sarah Large | NHDOT |
| Michael Fowler | Town of Derry |
| Janusz J. Czyzowski | Town of Londonderry |
| Lindsey Lefebvre | USACE |
| Ruth Ladd | USACE |
| Michael C. Hicks | USACE |
| Mark Kern | USEPA |
| | |
| Lee Carbonneau | Project Team (Normandeau Associates) |
| Leo Tidd (phone) | Project Team (Louis Berger) |
| Christopher Bean | Project Team (Fuss & O'Neill) |

**SUBMITTED BY:** CB/jr

1. **Introductions**

2. **Project Description and Schedule – K. Cota**
   a. Purpose & Need: To reduce traffic on NH 102 in downtown Derry and to promote economic development
   b. Preferred Alternative A was presented at a combined NHDOT, NHDES and ACOE Public Hearing on 12.5.18
   c. The layout includes a new diamond shaped interchange located approximately 1 mile north of Exit 4 with access to the east only, a 1 mile long connector road to N. High

Street / Folsom Road intersection then approximately 2.2 miles of improvements east along Folsom Road and Tsienneto Road to and including the intersection with NH 102

- **d.** Several drainage easements are proposed at stormwater outlets to allow for treatment options
- **e.** Have applied for NHDES and ACOE wetland permits
- **f.** Currently addressing hearing comment for the Report of the Commissioner
- **g.** Goal is for a Special Committee Finding of Necessity Meeting in late May or early June
- **h.** Target is for the Final EIS / ROD in June 2019
- **i.** Looking for assurances that we are working cooperatively so the permits are not needed to be issued prior to the ROD
- **j.** Using Design / Build process, NHDOT will be shortlisting Design-Build (DB) Teams, will make the selection of a DB Team, then get the DB Team to provide information to get the WQC in about one year from now
- **k.** NHDOT is now working in collaboration with both Towns but will take over full responsibility for construction of the project after the ROD is issued. After construction the new Exit 4A interchange will be under NHDOT management while the roadways from the ramps east will be under the Towns' management
- **l.** The selected DB Team will get the Base Technical Concept (BTC), which they may adjust the layout of to reduce impacts and address constructability issues
- **m.** NHDES Wetland Permit
    - **i.** NHDOT is looking to get the permit now based on the BTC then modify by amendment as the DB Team develops final design
    - **ii.** Lori Sommer noted she was not sure if this is acceptable and will get back to NHDOT
- **n.** The development of the 401 Water Quality Certification application will be the responsibility of the Design/ Build Contractor. The NHDOT will submit the application to NHDES

**3. RFMI Update – L. Carbonneau**

- **a.** NHDOT met with NHDES on 1.3.19 to go over NHDES comments on the wetland permit application.
- **b.** Lee Carbonneau noted that revised plans and the narrative for the 20 questions along with written responses to all the comments will be provided to NHDES before the end of the month
- **c.** Lori Sommer asked and it was agreed that a meeting will be set up to go over the revisions

**4. Stream Mitigation – S. Large**

- a. Purpose of this PPT presentation was to get approval that the SPIP (Stream Passage Improvement Program) approach was acceptable for this project.
- b. S. Large noted the Town of Derry submitted two town road crossings (Cemetery Road over West Running Brook and Sunset Ave over the West Running Brook Tributary) and the NHDOT added 4 for consideration (NH 102 over Tributary E, NH 28 Bypass over West Running Brook, NH 102 over Manter Brook, and NH 102 over Unnamed Brook in Derry). The locations are within the HUC 12 Beaver Brook watershed.
- c. Existing data for each crossing was reviewed.

d. Noted some evaluation on the PPT and handout may not be an accurate assessment of the stream or culvert characteristics. Once approval is given to proceed, additional assessments will occur and a rating form will be created to identify the highest priorities and costs.
e. Goal would be to develop each project separately with a full assessment of historic, archaeological, hydraulic and other constrains. If the project moves forward to construction, then the costs would be covered as part of the mitigation payments. If all the Stream Mitigation funds cannot be spent as part of the SPIP Program, any remaining funds will be directed back to the ARM Fund.
f. Consensus was reached that pursuing the SPIP Program will be acceptable.
g. Goal will be to come up with two culverts
h. Lori Sommer agreed to discuss internally and work with NHDOT as more information is obtained. Other culverts may need to be investigated

5. **Vernal Pool Impact Mitigation – L Carbonneau**
   a. Direct impacts were included in the Forested Wetland ARM
   b. Vernal Pool quality multipliers for direct impacts were added to the ARM
   c. Vernal Pool 11 impact has been avoided.
   d. The Corps and EPA made it clear that mistakes were made in two areas:
      i. The calculation of mitigation for direct impacts to VPs was done incorrectly.
      ii. Secondary impacts to VPs were not included in the write-up and this needs to be added.
   e. Ruth Ladd noted that for pools eliminated by direct fill and mitigated through in-lieu-fee, the 13,000 factor was developed to account for the representative cost to preserve 1 vernal pool; 39,000 to preserve 3 vernal pools; and 62,000 to preserve 5 vernal pools. The 250 foot life zone is not evaluated in the mitigation costs. Lee Carbonneau noted that direct impacts to four vernal pools would likely result in their being eliminated, and there will be direct impacts to three others that we expect to continue functioning as vernal pools.
   f. Ruth Ladd indicated that for partially impacted pools, as well as those not directly filled but have Critical Terrestrial Habitat (CTH) impacts (i.e., vernal pools within 750 feet of the proposed road), secondary impact mitigation is based on the reduction in habitat value. For each high or medium value vernal pool, we must re-evaluate the vernal pool assessment form assuming the built condition, re-calculate the total score, and compare it to the VP value under existing conditions. If the total value score under the built condition drops the VP level below the existing condition, then this loss in value is to be included in the ARM fund calculator as a secondary impact. For example if a high value VP of 65,000 drops to a medium value VP of 39,000 the loss value of 26,000 is entered in the ARM fund calculator. Similarly, if a high value pool drops to a low value, then the area to be included is 52,000 (65,000 – 13,000 = 52,000). Low value vernal pools do not need to be evaluated. Typically vernal pools over approximately 450 feet from the impact limits will not be affected sufficiently to drop in value. We should refer to Table 4.12-5 of the SDEIS to identify pools with impacted CTH.
   g. Ruth Ladd noted to subtract the "edge effects" mitigation cost where there is secondary edge effect overlap.

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h. Project Team will re-quantify the impacts and mitigation quantities and then coordinate directly with Ruth Ladd to insure consistency with the guidance.

6. **Other Mitigation Option – K Cota**
   a. NHDOT was contacted by Bob Spoerl, Derry Conservation Commission about a potential preservation mitigation of a 34 acres parcel at 4 Gill Road, near Ballard Pond and adjacent to Ballard State Forest, The parcel is in the Spicket River watershed, with a $250K assessed value by Derry.
   b. DNCR (formally DRED) may be interested in taking over the management of the parcel if it is purchased.
   c. The parcel appears to be mostly uplands with fringing wetlands along Ballard Pond. The Rockingham Recreational Trail is adjacent to it.
   d. Keith asked if there interest to pursue this parcel? There was consensus that the parcel should be evaluated even though it is not in the Beaver Brook watershed. The parcel will be considered as long as DNCR will manage it, that it is used for passive recreation only, and the owner agrees to the purchase price (no eminent domain).
   e. Ruth Ladd noted to use the USACE 20:1 preservation ratio to determine credits for the wetlands; it is 15:1 for uplands.
   f. A field review will be conducted by NHDOT and coordinated with the agencies, Town of Derry and DNCR to determine if it is appropriate parcel to preserve.
   g. Kevin Nyhan stated that if the parcel purchase works out, 35 acres of preservation is estimated to be equivalent to 1.5 to 2 acres reduction in ARM payment. (1.5 acres of Derry mitigation is worth about $330K.)

**If this memo is not in conformance with your recollection of the meeting, please contact us within 5 business days.**

cc by email: Attendees

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**TO:** File

**FROM:** Christopher R. Bean, P.E.

**DATE:** December 11, 2012, *Updated to Incorporate Comments 1-16-13, Updated 1-18-13*

**RE:** Derry-Londonderry
Exit 4A Interchange EIS
CLD Reference No. 05-0244

**SUBJECT:** Discussion of Exit 4A Mitigation Package

**LOCATION:** CLD Consulting Engineers, Manchester, NH

**ATTENDEES:** See Attached List

**MEETING MINUTES**

**1. Introductions and Purpose of Meeting**

Attendees introduced themselves around the table. This meeting was a follow up to the 9/18/12 meeting. The purpose was to have further discussion on the mitigation package requirements for both the Exit 4A and the Hyrax/ Pillsbury Development projects.

**2. Exit 4A Mitigation Proposal**

Mr. Broadwater passed out a sketch of the proposed mitigation involving the Caras parcels (see attached). As a result of input at the 9/18/12 meeting, the Town of Derry was asked and agreed that it would be acceptable for us to carve out a portion of the northerly parcel for mitigation. No land area was originally proposed to be taken from this parcel. Ian identified an additional 8 acres of land adjacent to the Prime Wetland on the west side of the parcel for mitigation, making the total proposed mitigation area approximately 134 acres. The remainder of the northerly parcel (approximately 29 acres) would remain available for the Town to develop recreation fields in the future.

Mr. Kern felt the additional area was helpful, but in general he felt that the proposed package would only mitigate impacts associated with half of the 7 vernal pool impacts. It was acceptable to the group that the idea of providing an in-lieu fee to cover the shortfall would be adequate. For guidance purposes, it was suggested by the Regulators that as a minimum, $250K should be used to compensate for the loss of a high quality vernal pool.

*Mark Kern comment: "I stated that it would take at least $1 million of an ILF payment to complete the package for the highway alone, but the amount should be worked out with the*

*Corps mitigation staff and the other agencies."*

The Project Team appreciated this guidance and agreed to modify the package to better meet the expectations.

**3. Hyrax/ Pillsbury Mitigation Proposal**

As a result of the 9/18/12 meeting, the Regulators suggested that instead of 70 acres of onsite preservation and vernal pool creation, another option would be for the Developers to purchase an off-site parcel that would allow for preservation and/or creation of vernal pools, or those funds should be used to increase the State's in-lieu fee contribution.

*Mark Kern comment: "I would suggest that you replace that par with this: Aquatic impacts still need to be avoided, minimized, and compensated. So protecting the remaining aquatic resources on the remaining 70 acres via deed restriction will still have some value for minimizing the impacts. However, the remaining habitat will be too small and narrow (not sustainable) for us to want to put more resources (vernal pool creation) on-site. Instead, to compensate for the direct and indirect impacts to wetlands and especially vernal pools they should put together a package which could have the following:*

*a) Paying into the ILF program;*

*b) Protecting a large area that contains many valuable vernal pools; and*

*c) Creating vernal pools in a large, sustainable area."*

On behalf of the Developers, Mr. Bean presented the revised development proposal.

- Recognizing that the Regulators did not place a high value on preserving the on-site lands avoided by the previously proposed development pad, approximately 29 additional acres of development area was presented on a modification of Plan 5, which had been presented at the last meeting (see attached). With this additional area, the Developers could spread out their development slightly, providing them more flexibility and the potential for additional funds which could be directed to purchase an off-site mitigation parcel. The additional pad areas resulted in the increase of wetland impacts from about 1.4 acres to 1.9 acres and the addition of one vernal pool impact bringing the total to 15 vernal pools. In general, this concept was not rejected by the Regulators, as long as the overall impacts were mitigated.

  Discussion then took place regarding the EPA's guidance that they will only recognize about 50% of vernal pool impacts in the form of created vernal pools, because their experience has been that often times the created pools are unsuccessful. Mr. Wilson and Mr. Parsont noted that any created vernal pools on behalf of the Developers would be created in a systematic fashion over time with monitoring of their success included in the proposal for a period of up to 10 years. The opinion of the EPA was that they are not set up to enforce or monitor effectiveness of vernal pool creation,-so they would not entertain it as a significant viable option. Others at the meeting, including ACOE and FHWA, were intrigued by the idea and seemed open to the thought of allowing it to move forward. However, it was then reiterated by Mr. Kern that, if implemented, the Developers would get credit for all created vernal pools as compensation for those impacted by the project, but the creation would need to be at a 2:1 or 3:1 ratio AND only 50% of the created vernal pools would receive credit. The other Regulators did not voice an objection to these parameters.

*Mark Kern comment: In the middle of that par is says that EPA would "not entertain it (VP creation) as a significant viable option. This is not accurate and should be removed. Offering to give up to 50% credit for VP creation as part of a package is giving it quite a bit of credit. I stated that there is a lot of uncertainty to creating vernal pools, so even if they found an ideal site (300+ acres with ideal hydrology and some existing pools), we don't want to put all our eggs in one basket.*

Mr. Parsont then explained that the Developers had identified a 30-acre parcel of land in Londonderry that was apparently located adjacent to another 30-acre NHDOT mitigation parcel, and surrounded by wetland and/or surface water areas, and proposed a combination of preservation and wetland/vernal pool creation on the parcel. Mr. Parsont noted that he was not aware of the exact location, but he understood that the land was currently approved for 22 house lots. The Regulators were interested; however, Mr. Kern stated that the 30 acres was too little land unless its placement was in conjunction with protected parcels totaling in the 200 acre range or less, if connected to lands identified as "Highest Ranked Wildlife Habitat in NH". Mr. Kern noted at this point that without knowing where it was located or what it was associated with beyond the adjacent NHDOT mitigation parcel, he considered the described 30-acre mitigation parcel to be in the 10-15% range for required mitigation.

*Mark Kern comment: I would suggest that you either remove the statement (The Regulators were interested) or state who said what. I have no memory of anyone saying that this was a good site for mitigation (we knew so little about it except its small size--30 acres). Also, right after this statement you quote something that I said, but I am not sure it makes sense. You may want to replace it with something like this: Mr. Kern said that 30 acres was way too small to be sustainable for vernal pool creation and protection unless it is connected to other large protected parcels (200+ acres).*

*At the meeting, I also stated that the VP impacts of the development will be larger than the road (direct fill of 9 pools vs. 5 by the road) and the mitigation will need to be bigger as well. Like for the road, I encourage you to produce a package that includes:*

*a) Paying into the ILF program;*

*b) Protecting a large area that contains many valuable vernal pools; and*

*c) Creating vernal pools in a large, sustainable area.*

*However, if you only choose to pay into the ILF program, then it will likely cost at least $5 million (to be worked out with Corps mitigation staff).*

After a full discussion, it was agreed that the Developers would gather more information on the proposed off-site parcel option then coordinate further with the Regulators as to its suitability for meeting the mitigation needs of the Development project, as well as to discuss other options including in-lieu fee requirements.

**4. Discussions Regarding Removal of Development Proposal**

A limited access right-of-way was discussed. Mr. Roach suggested that one solution to the need to mitigate for the Development would be to create a Limited Access Right-of-Way along the Connector Road. This would not allow the Developer to have close access to the interchange. Mr. Bean dismissed this idea as not viable because it would not serve one of the original purposes of the project, which was to promote economic development and resulting tax revenue for both communities.

Mr. Roach referred to the Manchester Airport roadway project. He noted that there was a similar situation, and up-front environmental protection was required to cover future impacts. In this case, the Towns could complete the mitigation required to compensate for the anticipated development impacts and then charge the Developers to recoup the costs once their development project(s) take place, before allowing them access to the Exit 4A roadway. The Regulators noted their position is that without the development of the project parcels taken into account, the Exit 4A project will not be allowed to happen.

FHWA commented they will not fund mitigation for secondary impacts.

*Jamie Sikora Comment: They could not sign off on the ROD until the FEIS process has been completed and adequate funding programmed to implement the Interchange Project.*

Additional vernal pool discussion involved the Regulators acceptance of creating vernal pool groupings similar to those impacted, with required buffers provided around the grouping as opposed to the individual pools.

**5. Next Steps**

- Project Team will finalize the Exit 4A mitigation proposal.
- The Developer's Team will investigate the off-site parcel option further and then coordinate with the Regulators as needed to finalize their proposal.
- Complete the FEIS with the proposed compensation packages.
- Developers to complete permit applications for the development pad construction.

**If this memo is not in conformance with your recollection of the meeting, please contact us within 5 business days.**

CRB:lab

cc: Attendees

*Mark Kern Comment: We should start including the Corps mitigation staff (Ruth and Paul) in whatever we are discussing so I have added them to the cc list, as well as some EPA folks.*

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**TO:** File

**FROM:** Christopher R. Bean, P.E. Noted by: Ian Broadwater and Geoff Wilson

**DATE:** September 18, 2012

**RE:** Derry-Londonderry
Exit 4A Interchange EIS
CLD Reference No. 05-0244

**SUBJECT:** Discussion of Exit 4A Mitigation Package

**LOCATION:** CLD Consulting Engineers, Manchester NH

**ATTENDEES:** See Attached List.

## MEETING MINUTES

### 1. Introductions and Purpose of Meeting

Attendees introduced themselves around the table. This meeting was a follow up to several meetings held in 2011 where discussions were had on coordinating the mitigation packages of the Exit 4A and the adjacent Hyrax/ Pillsbury Development projects. Chris Bean explained that the Project Team had a goal of submitting the FEIS to the FHWA by 10/30/12 (in 6 weeks) so it was important that we reach agreement on the mitigation package as soon as possible so it can be included in the FEIS. John Anderson and William Hart spoke in favor of the project and reemphasized the need to get this mitigation phase completed.

### 2. Pre-Meeting Submission

On Monday morning (9/17) a copy of the key presentation materials was distributed to all parties in advance of this meeting.

### 3. Hyrax/ Pillsbury Mitigation Proposal

As a result of the 5/24/11 meeting with the Cooperating Agencies, direction was given to work with the Developers to generate a coordinated mitigation plan that would meet the needs of both projects. Since preserving the two existing wetlands in the southeast quadrant of the development site was identified as an Exit 4A mitigation goal, we immediately began to work with the Developers to avoid and minimize impacts to wetlands and vernal pools across the site, while still preserving the economic development potential of the site. Over the next 5 months, a series of 5 concept plans were developed, with each one minimizing impacts to wetlands and vernal pools. Plan 1 had impacts to 29 vernal pools and 9.5 acres of wetlands and Plan 5 had impacts to 14 vernal pools and 1.5 acres of wetlands. The permitting agencies were satisfied with the steps taken to avoid and minimize impacts as much as possible.

Geoff Wilson then presented the proposed compensation package as described in the narrative (provided previously). It was noted that the proposed mitigation package surpassed both the NHDES and ACOE guideline for required mitigation for the 1.5 acres of wetland impact by 274.69% for the NHDES mitigation criteria and by 245.90% for the ACOE mitigation criteria without consideration of biological impacts to vernal pools.

The Hyrax/ Pillsbury mitigation proposal consisted of:

- 70 Acres of undeveloped on-site lands provided for preservation.
- Creation of an 11 vernal pool network linking the preservation area with wildlife corridors abutting the site.
- Habitat enhancements to the preservation areas to advance and stabilize forest trajectories to successional stages consistent with vernal pool species habitat requirements.
- Provision of culverts under roadways to provide for on-site wildlife passage.
- Contribution of $10K to the NH in-lieu fee program.
- Contribution of $20K ($10K to Derry and Londonderry) for creation of a Vernal Pool and Sensitive Habitat Revolving Fund administered by the Conservation Commissions.

The Regulators felt that the avoidance of the 70 acres was seen as an adequate minimization and avoidance step. During our recent field trip to the site, Mark Kern had expressed concerns about the long-term viability of the vernal pools on the site. After listening to his specific concerns, the latest mitigation proposal was developed in a way to address those concerns as much as possible. At the meeting today, Mark continued to question the long-term viability of the on-site preservation areas. He also questioned creating a network of 11 vernal pools. Instead, he suggested that maybe 5 vernal pools would be more appropriate since he felt that extending the vernal pool network to the Shields Brook riparian corridor would be of little value because vernal pool species would not be found in riparian corridors. After further open discussion, the Regulators concluded that instead of creating vernal pools on this site, those funds should be used to increase the State's in-lieu fee contribution. However, even with the no on-site mitigation value, the Regulators still expected that wildlife passage corridors under roadways would be provided. The Regulators also suggested that another option would be for the Developers to purchase an off-site parcel that would allow for preservation and/or creation of vernal pools.

The Regulators also agreed that if the Developers wanted to set up a vernal pool fund for each community that would be fine; however, it would not be recognized as a mitigation measure.

**4. Exit 4A Mitigation Package**

The Exit 4A project was reevaluated in May 2011 as the elevation of the proposed Connector Road profile was adjusted in the vicinity of the Hyrax/ Pillsbury Development to better match into the proposed building pad. As a result, wetland impacts caused by construction of the new exit and roadway were projected to increase slightly from 3.11 acres to 3.48 acres. A total of 7 vernal pools would likely be destroyed during the construction of the new exit; 6 by direct impacts and 1 by impacts of over 25% to its 250-foot critical habitat buffer.

During the same timeframe, it became apparent that the owners of the Bollinger Site (Site 4 in the DEIS) were not interested in selling the lot for mitigation. It was also felt that the Developers were better suited to deal with the crossing improvement on Shields Brook (Site 5 in the DEIS) as it is located within their development area. This action was passed to the Developers. This left very little mitigation for the Exit 4A project. The list of potential sites presented in the DEIS was revisited and none of the sites were very appealing and/or available. At this point, both Derry and Londonderry Conservation Commission members were contacted to develop a new list of potential sites that could be preserved and have vernal pools created on them. Six properties were evaluated in both Derry and Londonderry. The most appealing parcels were found in Derry and included the Sawyer Site (Site 1 from the DEIS) and the Caras Site.

After discussion with the Town of Derry, they had a preference for the Caras Site to be preserved as this is the area of town where the most development has occurred in the last 10 to 20 years. The Caras property has development on three sides and, in an improved housing market, would likely be under threat of development. Site walks of the Caras parcel were completed with regulatory officials who expressed interest in the property for preservation. Several (i.e. seven) locations were identified where vernal pools could be created with minor grading and vegetation disturbance. There are likely several other locations on the property for creation. Therefore, the property was proposed as a component of the Exit 4A compensation package.

The Exit 4A compensation package presented consisted of:

- Relocation of the unnamed stream and in the footprint of the Exit 4A Southbound On-Ramp. Action to include the creation of riparian buffer around the relocated stream channel,
- Preserving 125 acres of the Caras Property consisting of the eastern parcel and western parcel,
- Creating five clusters of 3 vernal pools on the Caras Property.

Mark Kern indicated that although this site is okay, it is not a large as he would like to see for long-term sustainability. Rich Roach indicated the more land that can be added to the Caras property preservation area, the better.

## 5. Next Steps

- Discuss additional mitigation approaches with the Developers and the Towns.
- Revise compensation packages and re-submit to the Regulatory Agencies for review.
- Complete the FEIS with the proposed compensation packages.
- Developers to complete permit applications for the development pad construction.

**If this memo is not in conformance with your recollection of the meeting, please contact us within 5 business days.**

CRB:lab

cc: Attendees

CLD CONSULTING ENGINEERS

**SIGN-IN SHEET**

| | | | |
|---|---|---|---|
| MEETING: | Mitigation Package for Exit 4A FEIS Interchange | | |
| PROJECT: | Exit 4A FEIS | | |
| DATE: | September 18, 2012 | TIME: | 9:30 AM |
| LOCATION | CLD Conference Rooms 2 & 3 | | |

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# Attachment F

## NH Natural Heritage Bureau Report
## NHB19-3453
## (location details omitted)

NORMANDEAU ASSOCIATES
Environmental Consultants

# Stream Survey Report
# Shields Brook and Tributary E
# Exit 4A Project - Derry, NH


NHDOT Project Number: 13065
Federal Project Number: IM-0931(201)
CLD/Towns Project Number 05-0244



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November 13, 2019

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# 1.0 Introduction

Normandeau Associates Inc. was contracted by Fuss & O'Neill, Inc. in April 2019 to complete supporting studies for stream crossing design as required by the New Hampshire Department of Environmental Services Stream Crossing Rules (Env-Wt 900) for the Exit 4A Project in Derry, NH. The studies consisted of completing field data collection, stream assessment, and classification to characterize two perennial streams in the vicinity of the Project - Shields Brook and Tributary E. The studies, completed on July 3 – 12, 2019, and resulting stream characterization values are provided in support of the hydrologic and hydraulic analyses for culvert design.

The studies consisted of two primary tasks – field data collection and stream assessment/classification as summarized below:

**Task 1.0 - Field Data Collection**

The following data/measurements were collected at field-selected cross-section locations near the road crossing and at a suitable reference reach on each stream:

- Stream channel longitudinal profile
- Bankfull width and bankfull depth measurements
- Floodplain width
- Water surface slope
- Pebble counts and substrate assessment
- Observations of current geomorphological impairments

**Task 2.0 - Stream Assessment and Classification**

Using the field data collected in Task 1, we calculated the sinuosity, flood-prone area and entrenchment ratio and determined the Rosgen Classification to level II for each stream. This information was provided to Fuss & O'Neill for their use in hydrologic and hydraulic modeling, bed load sediment transport calculations, and culvert/ bridge design.

# 2.0 Methods

Field data were collected according to standard methods for stream surveying (e.g. Harrelson et al., 1994) and included level surveying of longitudinal channel profiles, channel cross sections, and stream crossing structures. GPS data were collected with a Trimble Geo 7X and included a GPS survey of the longitudinal profile, channel cross sections, and stream crossing structures. Additional field data were collected in the form of pebble counts (e.g. Rosgen, 1994) and site photos. At both the Shields Brook and Tributary E stream crossing locations the goal was to complete a longitudinal profile and channel cross section in a reference reach upstream of impacts from the road crossing as well as in the vicinity of the road crossing (including the stream crossing structure(s)). Longitudinal profile lengths were to be 7-

10 times the bankfull width at the reference reach cross sections. Channel cross section surveys were to be completed upstream and downstream of the crossings. Pebble counts and stream bed characterization were to be completed at each cross section location.

The stream crossing locations on Shields Brook and Tributary E were in heavily developed areas with evidence of significant alterations to the natural stream and surrounding landscape. Because of the alterations to the natural stream, locating ideal reference reaches at both Shields Brook and Tributary E was problematic. Therefore, it was necessary to evaluate each crossing with best professional judgement to identify a representative location within the altered streams to serve as a reference reach; i.e. the stream section within the project area determined to be least altered and in its most natural state. For Shields Brook, the reference reach was the head of the reach to the upstream end of the culvert and included a single cross section (CS-1, as discussed below). At the Tributary E crossing the reference reach was located below the twin culverts and included a longitudinal profile and a single cross section (CS-3, as discussed below).

Pebble counts were completed at each cross section according to standard methods (e.g. Rosgen, 1994). However, at one location (CS-1 on Tributary E) it was necessary to vary from the standard technique of grabbing or touching the substrate by hand due to the depth of the water. At that location, the substrate was felt with the level rod or foot to determine the size classification. We don't feel that this variance is significant as the substrate grains could be felt and identified with a high degree of confidence due to relative uniformity in the substrate.

Stream characteristics were determined from the field data collected according to the methods of Rosgen (1994) and include calculations of bankfull elevation, bankfull width, floodprone elevation, floodprone width, entrenchment ratio, width/depth ratio, sinuosity, water surface slope, and substrate grain size distribution. Most of the calculated stream characteristics were based on the level survey data collected, while sinuosity was determined from the level survey as well as the GPS surveys of each longitudinal profile and grain size distribution was determined from the pebble count data collected.

## 3.0 Shields Brook

The Shields Brook crossing is located on N. High St. immediately east of Ferland Drive in the Town of Derry, NH. The brook and a tributary merge approximately 80 ft. upstream of the road crossing and flow southeast through a wooded streambank-floodplain area to a 5.5 ft. diameter corrugated metal pipe culvert that carries the stream beneath Folsom Rd. Downstream of the road crossing, Shields Brook flows through a developed residential area and shows signs of alteration, particularly on the left bank. The brook was determined to be a Rosgen stream type C4 based on the data collected. Stream type C is described as *"low gradient, meandering, point-bar, riffle-pool, alluvial channels with broad, well defined floodplains"* and with features that include *"broad valleys with terraces, in association with floodplains, alluvial soils. Slightly entrenched with well defined meandering channel. Riffle-pool bed morphology"* (from Rosgen, 1994). The C4 stream type is also characterized by a predominately fine gravel channel material. Shields Brook was surveyed by Normandeau personnel on July 3 and July 5, 2019. Stream characteristics and survey data collected are summarized below.

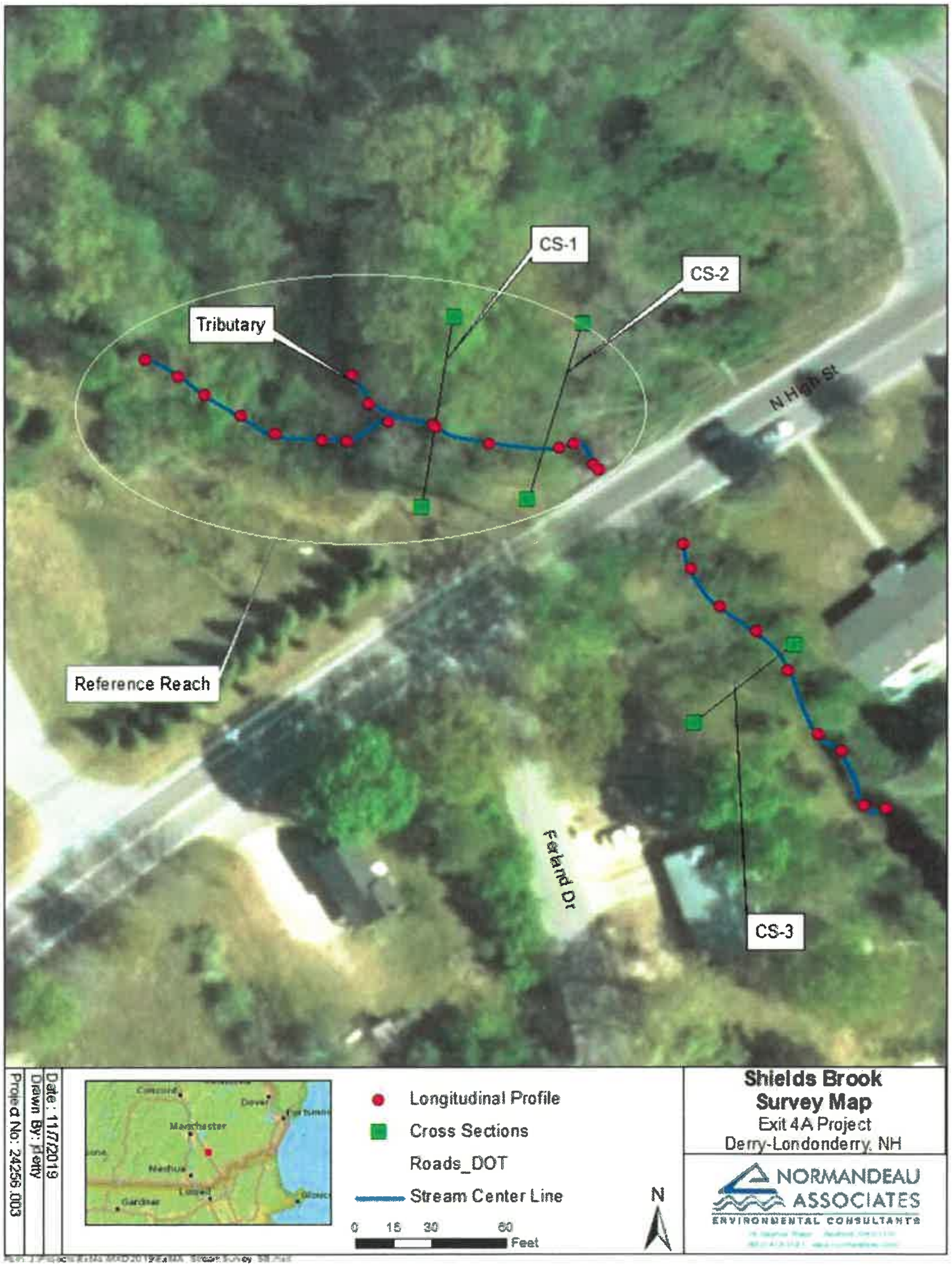



Figure 1. Site map of Shields Brook survey – data collected July 3 & 5, 2019

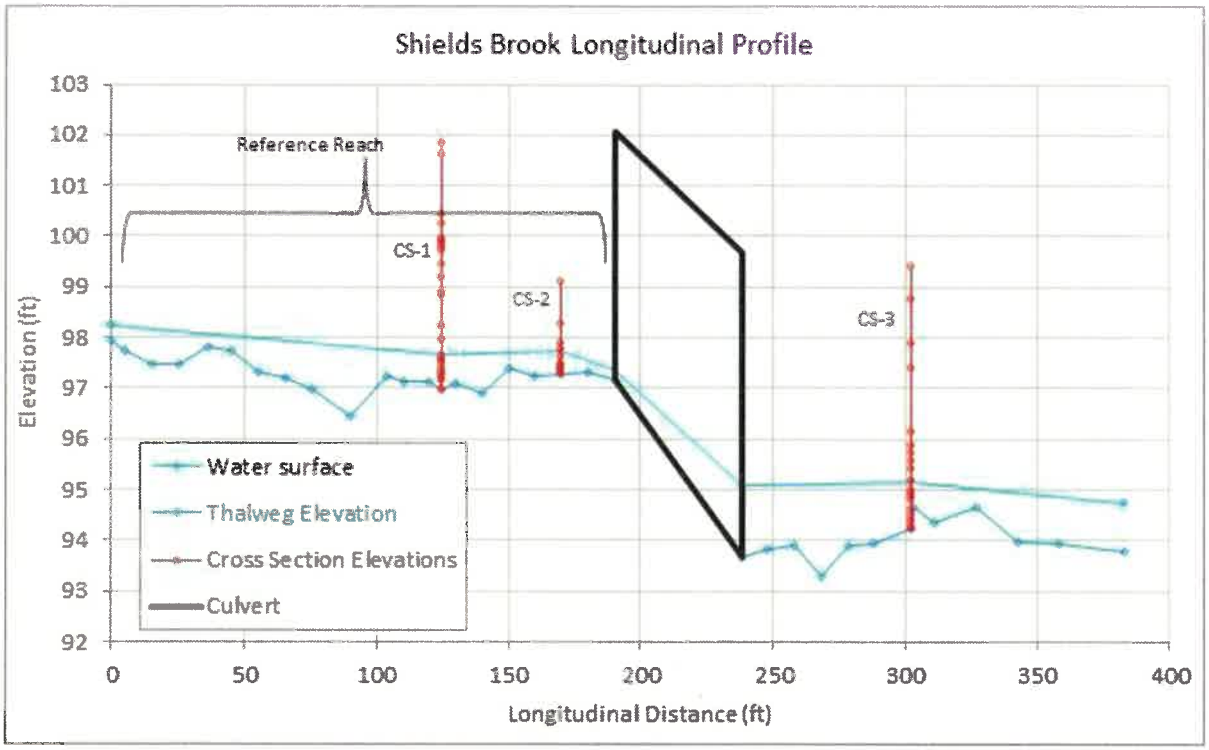



Figure 2. Shields Brook longitudinal profile – data collected July 3 & 5, 2019

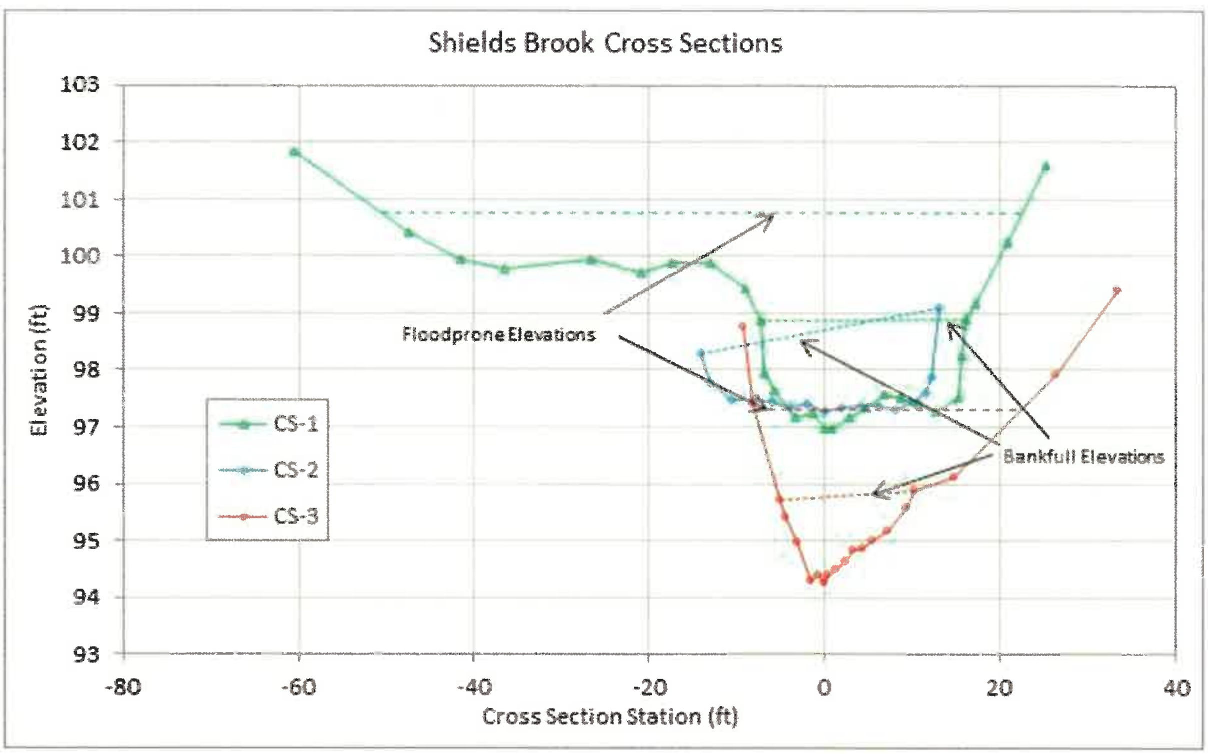



Figure 3. Shields Brook cross sections – data collected July 3 & 5, 2019

Table 1. Shields Brook pebble count summary – data collected July 3 & 5, 2019

| | CS-1 | | | CS-2 | | | CS-3 | | |
|---|---|---|---|---|---|---|---|---|---|
| Particle Size (ft.) | Pebble Counts | Class % | Cum. % finer | Pebble Counts | Class % | Cum. % finer | Pebble Counts | Class % | Cum. % finer |
| Sand (< 0.007') | 50 | 50 | 50 | 37 | 37 | 37 | 8 | 8 | 8 |
| Gravel (0.007 - 0.21') | 47 | 47 | 97 | 59 | 58 | 95 | 11 | 11 | 19 |
| Cobble (0.21-0.83') | 3 | 3 | 100 | 4 | 4 | 99 | 70 | 70 | 89 |
| Boulder (0.83-13.3') | 0 | 0 | 100 | 0 | 0 | 99 | 11 | 11 | 100 |
| Bedrock (> 13.3') | 0 | 0 | 100 | 0 | 0 | 100 | 0 | 0 | 100 |
| Total | 100 | - | - | 100 | - | - | 100 | - | - |

Table 2. Shields Brook stream characteristics summary – data collected July 3 & 5, 2019

| Characteristics | Reference Reach (CS-1) | Reach Upstream of Culvert (CS-2) | Reach Downstream of Culvert (CS-3) | Shields Brook Overall |
|---|---|---|---|---|
| Mean bankfull depth (ft.) | 1.47 | 1.21 | 0.87 | - |
| Maximum bankfull depth (ft.) | 1.89 | 1.64 | 1.52 | - |
| Bankfull width (ft.) | 23.5 | 27.0 | 15.4 | - |
| Floodprone width (ft.) | 73.2 | - | 30.5 | - |
| Entrenchment ratio | 3.11 | - | 1.98 | - |
| Width/depth ratio | 16.0 | 22.2 | 17.8 | - |
| Sinuosity | 1.04 | - | 1.09 | 1.11 |
| Water surface slope | 0.004 | - | 0.002 | 0.009 |

Table 3. Shields Brook survey data – longitudinal profile

| Longitudinal Profile - Shields Brook 7/3/19 | | | |
|---|---|---|---|
| Longitudinal Distance | Station | Thalweg Elevation | Notes |
| (ft.) | (ft.) | (ft.) | |
| 0 | 0 | 97.93 | Top of reach, riffle, water depth = 0.3 ft. |
| 5 | 5 | 97.74 | Riffle |
| 15 | 15 | 97.46 | Bottom of riffle |
| 25 | 25 | 97.48 | Run |
| 36 | 36 | 97.83 | Top of riffle |
| 45 | 45 | 97.75 | In riffle |
| 55 | 55 | 97.33 | Bottom of riffle |
| 65 | 65 | 97.21 | Run |
| 75 | 75 | 96.98 | Run |
| 90 | 90 | 96.44 | Run |
| 104 | 104 | 97.25 | Confluence with east tributary |
| 110 | 110 | 97.12 | Run |
| 120 | 120 | 97.13 | Run |
| 125 | 125 | 96.97 | Cross Section 1; Run, water depth = 0.7 ft. |
| 130 | 130 | 97.1 | Run |
| 140 | 140 | 96.89 | Run |
| 150 | 150 | 97.39 | Run |
| 160 | 160 | 97.25 | Run |
| 170 | 170 | 97.28 | Cross Section 2; Run, water depth = 0.45 ft. |
| 180 | 180 | 97.31 | Run |
| 190 | 190 | 97.17 | Culvert invert, inlet, water depth = 0.2 ft., dia. = 4.9 ft. |
| 238 | 238 | 93.69 | Culvert invert, outlet, water depth = 1.4 ft., dia. = 6.0 ft. |
| 248 | 248 | 93.84 | Pool below culvert |
| 258 | 258 | 93.89 | Pool below culvert |
| 268 | 268 | 93.31 | Bottom of pool |
| 278 | 278 | 93.89 | Run/deep run |
| 288 | 288 | 93.95 | Run/deep run |
| 302 | 302 | 94.25 | Cross Section 3; Top of Riffle, water depth = 0.9 ft. |
| 303 | 303 | 94.67 | Top of riffle |
| 311 | 311 | 94.37 | Middle of riffle |
| 327 | 327 | 94.65 | Bottom of riffle |
| 343 | 343 | 93.96 | Deep run |
| 358 | 358 | 93.95 | Deep run |
| 383 | 383 | 93.79 | Bottom of reach, Deep run. Below this is a dammed area and modified channel, water depth = 0.95 ft. |

Table 4. Shields Brook survey data – culvert profile

| Culvert Elevations - Shields Brook 7/3/19 | | | |
|---|---|---|---|
| Longitudinal Distance | Station | Elevation | Notes |
| (ft) | (ft) | (ft) | |
| 190 | 190 | 102.08 | Top of culvert, inlet |
| 190 | 190 | 97.17 | Culvert invert, inlet |
| 238 | 238 | 93.69 | Culvert invert, outlet |
| 238 | 238 | 99.69 | Top of culvert, outlet |

Table 5. Shields Brook survey data – cross section 1

| Cross Section 1 - Shields Brook 7/5/19 | | | |
|---|---|---|---|
| Longitudinal Distance | Cross Section Distance | Elevation | Notes |
| (ft.) | (ft.) | (ft.) | |
| 125 | -60.7 | 101.83 | Slope on left bank |
| 125 | -47.5 | 100.42 | Break in slope |
| 125 | -41.5 | 99.95 | Break in slope |
| 125 | -36.5 | 99.78 | Left bank |
| 125 | -26.5 | 99.94 | Left bank |
| 125 | -21 | 99.70 | Left bank |
| 125 | -17.5 | 99.88 | Left bank |
| 125 | -13 | 99.89 | Left bank |
| 125 | -9 | 99.43 | Break in slope on left bank |
| 125 | -7.3 | 98.85 | Top of bank, left bank |
| 125 | -6.8 | 97.96 | Bottom of bank, left bank |
| 125 | -5.8 | 97.64 | Edge of water, left bank |
| 125 | -3.3 | 97.18 | Channel |
| 125 | -1.3 | 97.22 | Channel |
| 125 | 0 | 96.97 | Thalweg |
| 125 | 0.7 | 96.97 | Channel |
| 125 | 2.7 | 97.16 | Channel |
| 125 | 4.7 | 97.34 | Channel |
| 125 | 6.7 | 97.57 | Channel |
| 125 | 8.7 | 97.51 | Channel |
| 125 | 10.7 | 97.41 | Channel |
| 125 | 12.7 | 97.27 | Channel |
| 125 | 15.3 | 97.50 | Edge of water, right bank |
| 125 | 15.8 | 98.24 | Bottom of bank, right bank |
| 125 | 16.2 | 98.88 | Top of bank, right bank |
| 125 | 17.3 | 99.18 | Break in slope, right bank |
| 125 | 21 | 100.24 | Right bank |
| 125 | 25.3 | 101.62 | Right bank |

Table 6. Shields Brook survey data – cross section 2

| Cross Section 2 - Shields Brook 7/3/19 - located downstream of CS-1 and upstream of culvert | | | |
|---|---|---|---|
| Longitudinal Distance | Cross Section Distance | Elevation | Notes |
| (ft.) | (ft.) | (ft.) | |
| 170 | -14 | 98.27 | Top of bank, left bank |
| 170 | -13 | 97.79 | Bottom of bank, left bank |
| 170 | -10.7 | 97.48 | Edge of water, left bank |
| 170 | -8 | 97.47 | Channel |
| 170 | -6 | 97.43 | Channel |
| 170 | -4 | 97.33 | Channel |
| 170 | -2 | 97.40 | Channel |
| 170 | 0 | 97.28 | Thalweg |
| 170 | 2 | 97.34 | Channel |
| 170 | 4 | 97.36 | Channel |
| 170 | 6 | 97.37 | Channel |
| 170 | 8 | 97.31 | Channel |
| 170 | 10 | 97.45 | Channel |
| 170 | 11.6 | 97.62 | Edge of water, right bank |
| 170 | 12.2 | 97.88 | Bottom of bank, right bank |
| 170 | 13 | 99.11 | Top of bank, right bank |

Table 7. Shields Brook survey data – cross section 3

| Cross Section 3 - Shields Brook 7/3/19 & 7/5/19 - located downstream of culvert | | | |
|---|---|---|---|
| Longitudinal Distance | Cross Section Distance | Elevation | Notes |
| (ft.) | (ft.) | (ft.) | |
| 302 | -9.2 | 98.76 | Slope on left bank |
| 302 | -8.2 | 97.39 | Left bank |
| 302 | -5.1 | 95.72 | Top of bank, left bank |
| 302 | -4.5 | 95.42 | Bottom of bank, left bank |
| 302 | -3.1 | 94.96 | Edge of water, left bank |
| 302 | -1.7 | 94.30 | Channel |
| 302 | -0.7 | 94.40 | Channel |
| 302 | 0 | 94.25 | Thalweg |
| 302 | 0.3 | 94.40 | Channel |
| 302 | 1.3 | 94.50 | Channel |
| 302 | 2.3 | 94.63 | Channel |
| 302 | 3.3 | 94.83 | Channel |
| 302 | 4.3 | 94.88 | Channel |
| 302 | 5.3 | 94.99 | Channel |
| 302 | 7.1 | 95.18 | Edge of water, right bank |
| 302 | 9.4 | 95.58 | Bottom of bank, right bank |
| 302 | 10.3 | 95.88 | Top of bank, right bank |
| 302 | 14.8 | 96.13 | Break in slope, right bank |
| 302 | 26.5 | 97.90 | Edge of path, gravel/grass drive, right bank |
| 302 | 33.5 | 99.40 | Break in slope in path, right bank |

## 4.0 Tributary E

The Tributary E crossing is located on Tsienetto Rd. immediately west of the intersection with Rte. 102 in the Town of Derry, NH. The tributary flows through a large wetland complex north of the road crossing area and then into a flooded single channel stream to a pair of culverts (30 in. & 36 in. CMP) that carry the tributary beneath Tsienetto Rd. Debris in the culverts significantly obstructs the inlets and causes water to dam behind it in a pool area that extends at least 50 ft. upstream of the road crossing. Below the road crossing the tributary flows through a low gradient area characterized by one or more channels, with dense vegetation and a broad floodplain on the west side and a steep vegetated bank on the east side that shows evidence of alteration (e.g. block, brick, metal debris embedded in the bank) along Tsienetto Rd. and Rte. 102. Tributary E in the vicinity of the Tsienetto Rd. crossing presented a logistically difficult site for selecting a reference reach. Above the road crossing the stream flowed through wetland areas or was affected by the flow obstruction in the culverts and there were no obvious reaches for characterizing the channelized stream in a natural state. Downstream of the road crossing the stream is influenced by the altered left stream bank and at about 400 ft. enters a heavily altered stream channel. Therefore, a reference reach was selected in the area downstream of the culvert where the stream appeared to be in its most natural state in the area 230 – 360 ft. below the culvert outlets. A single channel cross section was characterized in the reference reach and cross sections were also characterized in the areas immediately above and below the road crossing. Tributary E was determined to be a Rosgen stream type C5/C6 based on the data collected. Stream type C is described as "*low gradient, meandering, point-bar, riffle-pool, alluvial channels with broad, well defined floodplains*" and with features that include "*broad valleys with terraces, in association with floodplains, alluvial soils. Slightly entrenched with well defined meandering channel. Riffle-pool bed morphology*" (from Rosgen, 1994). The C5/C6 stream type is also characterized by a predominately sandy to silt-clay channel material. The Tributary E channel material was only identified to the sand size class by the pebble count method; further grain size analysis would be required to determine whether the channel material was sand or silt-clay dominated. Tributary E was surveyed by Normandeau personnel on July 8, 11 and 12, 2019. Stream characteristics and survey data collected are summarized below.

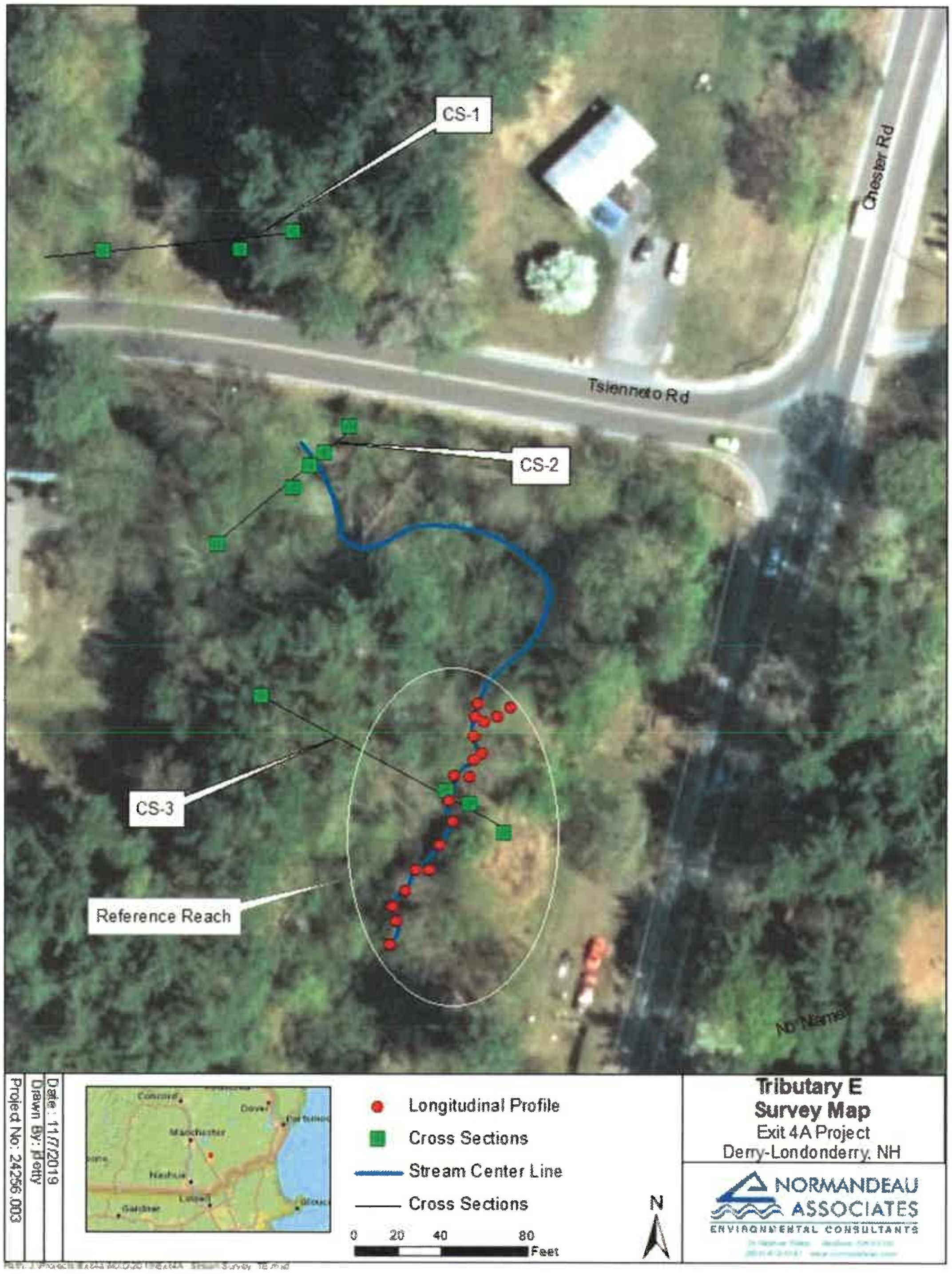



Figure 4. Site map of Tributary E survey – data collected July 8, 11 & 12, 2019

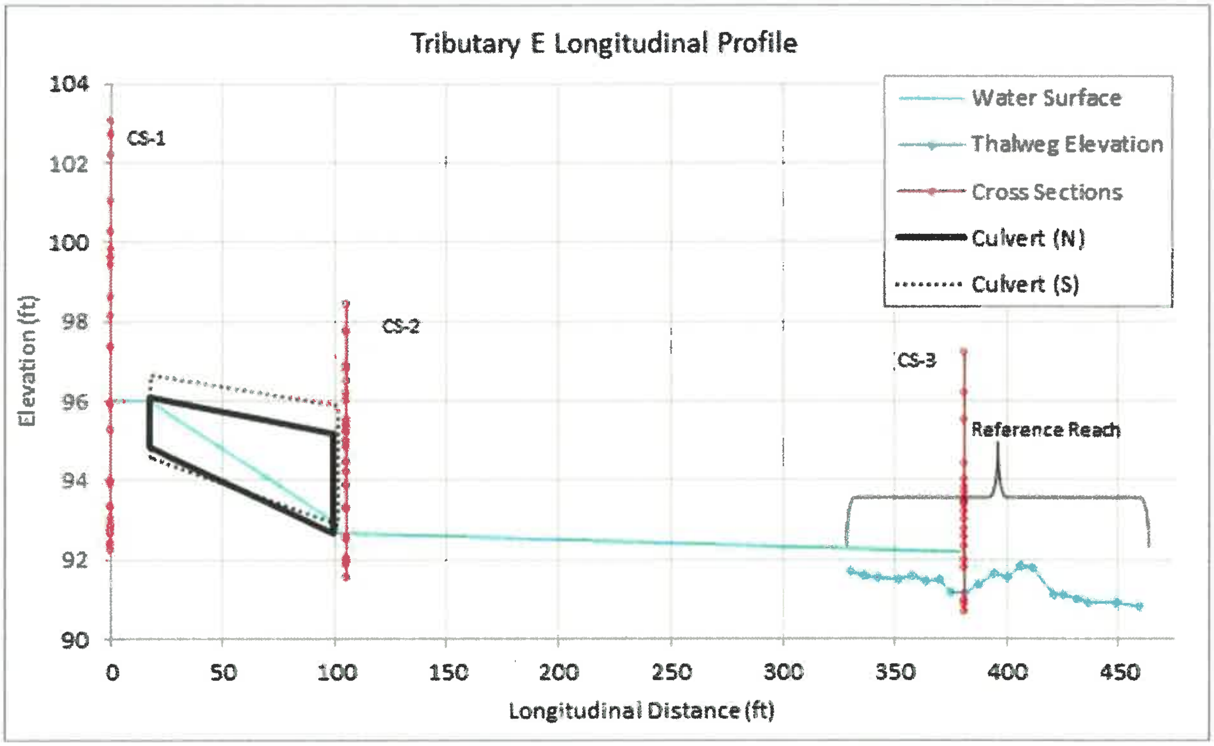



Figure 5. Tributary E longitudinal profile – data collected July 8, 11 & 12, 2019

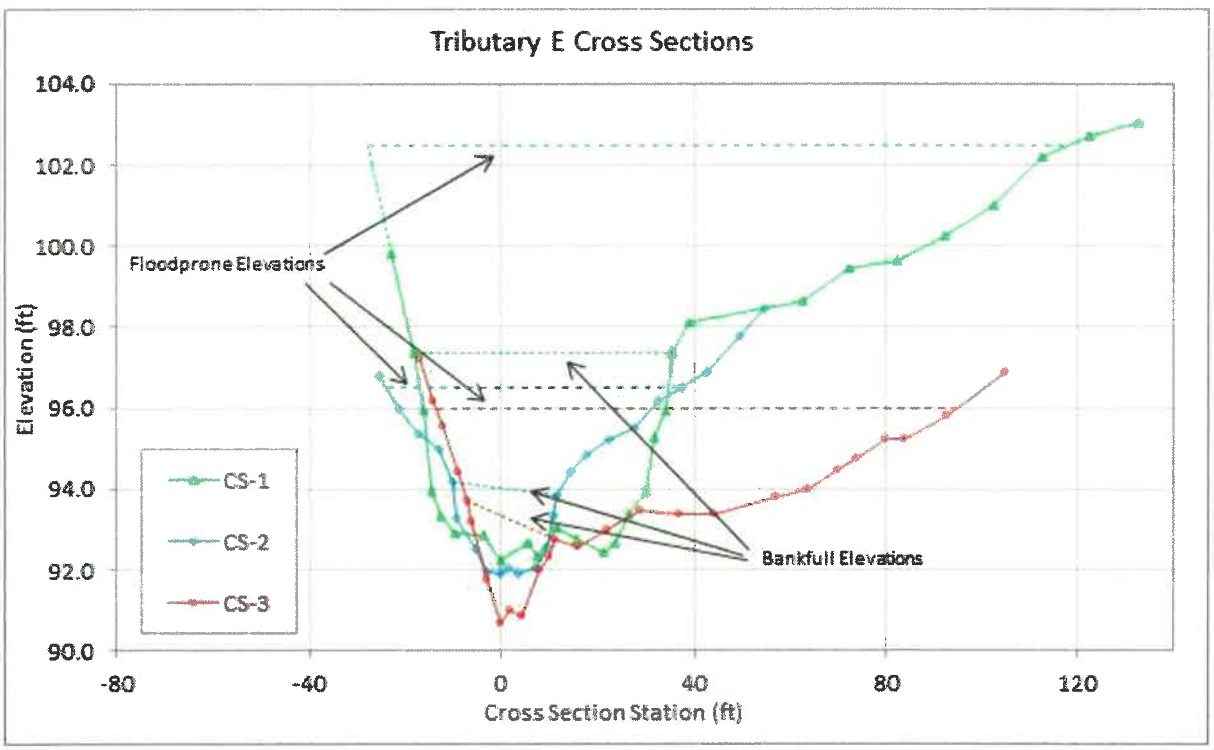



Figure 6. Tributary E cross sections – data collected July 8, 11 & 12, 2019

Table 8. Tributary E pebble count summary – data collected July 8, 11, & 12, 2019

| | CS-1 | | | CS-2 | | | CS-3 | | |
|---|---|---|---|---|---|---|---|---|---|
| Particle Size (ft.) | Pebble Counts | Class % | Cum. % finer | Pebble Counts | Class % | Cum. % finer | Pebble Counts | Class % | Cum. % finer |
| Sand (< 0.007') | 75 | 75 | 75 | 33 | 33 | 33 | 97 | 97 | 97 |
| Gravel (0.007 - 0.21') | 1 | 1 | 76 | 21 | 21 | 53 | 3 | 3 | 100 |
| Cobble (0.21-0.83') | 19 | 19 | 95 | 44 | 44 | 97 | 0 | 0 | 100 |
| Boulder (0.83-13.3') | 5 | 5 | 100 | 2 | 2 | 99 | 0 | 0 | 100 |
| Bedrock (> 13.3') | 0 | 0 | 100 | 0 | 0 | 100 | 0 | 0 | 100 |
| Total | 100 | - | - | 100 | - | - | 100 | - | - |

Table 9. Tributary E stream characteristics summary – data collected July 8, 11, & 12, 2019

| Characteristics | Reach upstream of culvert (CS-1) | Reach downstream of culvert (CS-2) | Reference reach (CS-3) | Tributary E Overall |
|---|---|---|---|---|
| Mean bankfull depth (ft.) | 4.05 | 1.61 | 1.51 | - |
| Maximum bankfull depth (ft.) | 5.13 | 2.47 | 2.64 | - |
| Bankfull width (ft.) | 53.6 | 22.1 | 18.3 | - |
| Floodprone width (ft.) | 146.3 | 61.5 | 108.2 | - |
| Entrenchment ratio | 2.73 | 2.78 | 5.91 | - |
| Width/depth ratio | 13.25 | 13.77 | 12.13 | - |
| Sinuosity | - | - | 1.08 | 1.38 |
| Water surface slope | - | - | 0.002 | 0.008 |

Table 10. Tributary E survey data – longitudinal profile

| Longitudinal Profile - Tributary E 7/12/19 | | | |
|---|---|---|---|
| Longitudinal Distance | Station | Thalweg Elevation | Notes |
| (ft.) | (ft.) | (ft.) | |
| 330.74 | 330.74 | 91.69 | Top of longitudinal profile, Run |
| 336.74 | 336.74 | 91.58 | Run |
| 342.74 | 342.74 | 91.53 | Run |
| 351.74 | 351.74 | 91.52 | Run |
| 357.74 | 357.74 | 91.6 | Run |
| 363.74 | 363.74 | 91.44 | Run |
| 369.74 | 369.74 | 91.48 | Run |
| 375.74 | 375.74 | 91.15 | Run |
| 381.74 | 381.74 | 91.16 | CS-3, 1.9 ft. water depth, run |
| 387.74 | 387.74 | 91.36 | Run |
| 394.74 | 394.74 | 91.64 | Run |
| 400.74 | 400.74 | 91.53 | Run |
| 406.74 | 406.74 | 91.84 | Run |
| 411.74 | 411.74 | 91.77 | Run |
| 420.74 | 420.74 | 91.12 | Run |
| 425.74 | 425.74 | 91.13 | Run |
| 431.74 | 431.74 | 91.03 | Run |
| 436.74 | 436.74 | 90.94 | Run |
| 448.74 | 448.74 | 90.92 | Run |
| 458.74 | 458.74 | 90.84 | End of longitudinal profile, run |

Table 11. Tributary E survey data – culvert profile (north culvert)

| Culvert Elevations (North Culvert) - Tributary E 7/8/19 & 7/11/19 | | | |
|---|---|---|---|
| Longitudinal Distance | Station | Elevation | Notes |
| (ft) | (ft) | (ft) | |
| 17 | 17 | 94.86 | Sediment surface in invert, inlet |
| 17 | 17 | 96.11 | Top of culvert, inlet |
| 98.9 | 98.9 | 95.16 | Top of culvert, outlet |
| 98.9 | 98.9 | 92.66 | Sediment surface in invert, outlet |

Table 12. Tributary E survey data – culvert profile (south culvert)

| Culvert Elevations (South Culvert) - Tributary E 7/8/19 & 7/11/19 | | | |
|---|---|---|---|
| Longitudinal Distance | Station | Elevation | Notes |
| (ft) | (ft) | (ft) | |
| 17 | 17 | 94.57 | Sediment surface in invert, inlet |
| 17 | 17 | 96.63 | Top of culvert, inlet |
| 98.9 | 101 | 95.87 | Top of culvert, outlet |
| 98.9 | 101 | 92.86 | Sediment surface in invert, outlet |

Table 13. Tributary E survey data – cross section 1

| Cross Section 1 - Tributary E 7/8/19 - upstream of culverts | | | |
|---|---|---|---|
| Longitudinal Distance | Cross Section Distance | Elevation | Notes |
| (ft) | (ft) | (ft) | |
| 0 | -22.9 | 99.83 | Top of slope, left bank |
| 0 | -18.3 | 97.35 | Top of bank, left bank |
| 0 | -16 | 95.94 | Edge of water, bottom of bank, left bank |
| 0 | -14.5 | 93.95 | channel, break in slope |
| 0 | -12.5 | 93.32 | channel, break in slope |
| 0 | -9.5 | 92.90 | channel, break in slope |
| 0 | -3.5 | 92.83 | channel, break in slope |
| 0 | 0 | 92.23 | channel, thalweg (3.76 ft. water depth) |
| 0 | 5.5 | 92.65 | channel, break in slope |
| 0 | 7.7 | 92.35 | Channel (3.64 ft. water depth) |
| 0 | 11.5 | 93.06 | channel, break in slope |
| 0 | 15.5 | 92.76 | channel, break in slope |
| 0 | 21.1 | 92.41 | channel, break in slope |
| 0 | 23.5 | 92.67 | channel, break in slope |
| 0 | 26.5 | 93.35 | channel, break in slope |
| 0 | 30 | 93.92 | channel, break in slope |
| 0 | 31.8 | 95.27 | channel, break in slope |
| 0 | 34.1 | 95.92 | Edge of water, bottom of bank, right bank |
| 0 | 35.3 | 97.36 | Top of bank, right bank |
| 0 | 38.8 | 98.13 | Edge of road, break in slope, right bank |
| 0 | 62.5 | 98.63 | Edge of Access road, right bank |
| 0 | 72.5 | 99.43 | Floodplain, right bank |
| 0 | 82.5 | 99.63 | Floodplain, right bank |
| 0 | 92.5 | 100.26 | Floodplain, right bank |
| 0 | 102.5 | 101.01 | Floodplain, right bank |
| 0 | 112.5 | 102.18 | Floodplain, right bank |
| 0 | 122.5 | 102.70 | Floodplain, right bank |
| 0 | 132.5 | 103.06 | Floodplain, right bank |

Table 14. Tributary E survey data – cross section 2

| Cross Section 2 - Tributary E 7/11/19 - downstream of culverts | | | |
|---|---|---|---|
| Longitudinal Distance | Cross Section Distance | Elevation | Notes |
| (ft) | (ft) | (ft) | |
| 104.9 | -25.5 | 96.79 | Floodplain, left bank |
| 104.9 | -21.5 | 95.98 | Floodplain, left bank |
| 104.9 | -17.5 | 95.38 | Floodplain, left bank |
| 104.9 | -13 | 94.96 | Floodplain, left bank |
| 104.9 | -10.3 | 94.19 | Top of bank, left bank |
| 104.9 | -9.1 | 93.29 | Bottom of bank, left bank |
| 104.9 | -5.1 | 92.54 | Edge of water, left bank |
| 104.9 | -2.9 | 91.95 | Channel |
| 104.9 | 0 | 91.88 | Channel, thalweg, 0.76 ft. water depth |
| 104.9 | 1.5 | 92.04 | Channel |
| 104.9 | 3.5 | 91.91 | Channel |
| 104.9 | 7 | 92.05 | Channel |
| 104.9 | 9.5 | 92.55 | Edge of water, right bank |
| 104.9 | 11 | 93.31 | Bottom of bank, right bank |
| 104.9 | 11.8 | 93.86 | Top of bank, right bank |
| 104.9 | 14.5 | 94.43 | Floodplain, right bank |
| 104.9 | 17.5 | 94.83 | Floodplain, right bank |
| 104.9 | 22.5 | 95.21 | Floodplain, right bank |
| 104.9 | 27.5 | 95.52 | Floodplain, right bank |
| 104.9 | 32.5 | 96.17 | Floodplain, right bank |
| 104.9 | 37.5 | 96.48 | Floodplain, right bank |
| 104.9 | 42.5 | 96.86 | Floodplain, right bank |
| 104.9 | 49.5 | 97.76 | Floodplain, right bank |
| 104.9 | 54.5 | 98.44 | Floodplain, right bank |

Table 15. Tributary E survey data – cross section 3

| Cross Section 3 - Tributary 7/11/19 - reference reach | | | |
|---|---|---|---|
| Longitudinal Distance | Cross Section Distance | Elevation | Notes |
| (ft) | (ft) | (ft) | |
| 381.74 | -17 | 97.19 | Floodplain, left bank |
| 381.74 | -14 | 96.18 | Floodplain, left bank |
| 381.74 | -12 | 95.53 | Floodplain, left bank |
| 381.74 | -9 | 94.39 | Floodplain, left bank |
| 381.74 | -7 | 93.69 | Top of bank, left bank |
| 381.74 | -6 | 93.20 | Bottom of bank, left bank |
| 381.74 | -3 | 91.77 | Edge of water, left bank |
| 381.74 | 0 | 90.69 | Channel, thalweg, 1.6 ft. water depth |
| 381.74 | 2 | 90.99 | Channel, 1.4 ft. water depth |
| 381.74 | 4.5 | 90.88 | Channel, 1.5 ft. water depth |
| 381.74 | 8 | 91.98 | Edge of water, right bank |
| 381.74 | 10 | 92.34 | Bottom of bank, right bank |
| 381.74 | 11.3 | 92.74 | Top of bank, right bank |
| 381.74 | 16 | 92.57 | Floodplain, right bank |
| 381.74 | 22 | 93.00 | Floodplain, right bank |
| 381.74 | 29 | 93.47 | Floodplain, right bank |
| 381.74 | 37 | 93.38 | Floodplain, right bank |
| 381.74 | 44 | 93.38 | Floodplain, right bank |
| 381.74 | 57 | 93.82 | Floodplain, right bank |
| 381.74 | 64 | 94.01 | Floodplain, right bank |
| 381.74 | 70 | 94.46 | Floodplain, right bank |
| 381.74 | 74 | 94.74 | Floodplain, right bank |
| 381.74 | 80 | 95.24 | Floodplain, right bank |
| 381.74 | 84 | 95.23 | Floodplain, right bank |
| 381.74 | 93 | 95.80 | Floodplain, right bank |
| 381.74 | 105 | 96.89 | Floodplain, right bank |

# 5.0 References

Harrelson, Cheryl C.; Rawlins, C.L.; Potyondy, John P. 1994. Stream channel reference sites: an illustrated guide to field technique. Gen. Tech. Rep. RM-245. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Montain Forest and Range Experiment Station.

Rosgen, D.L. 1994. A classification of natural rivers. In: Catena 22 (1994) 169-199.

# Appendices

# Appendix A Shields Brook Photos

Shields Brook (Upstream): End of reach looking US

Shields Brook (Upstream): End of reach looking DS

Shields Brook (Upstream): End of reach LB

Shields Brook (Upstream): End of reach RB

Shields Brook (Upstream): CS-2 looking DS

Shields Brook (Upstream): CS-2 looking US

Shields Brook (Upstream): CS-2 RB

Shields Brook (Upstream): CS-2 LB

Shields Brook (Upstream): Main stem looking US

Shields Brook (Upstream): Tributary of main stem...

Shields Brook (Upstream): CS-2 substrate

Shields Brook (Upstream): CS-2 substrate

Shields Brook (Upstream): CS-2 substrate

Shields Brook (Upstream): At culvert looking DS

Shields Brook (Upstream): At culvert facing US

Shields Brook (Upstream): CS-1 RB

Shields Brook (Upstream): CS-1 LB

Shields Brook (Upstream): CS-1 looking DS

Shields Brook (Upstream): CS-1 looking US

Shields Brook (Upstream): CS-1 substrate

Shields Brook (Upstream): CS-1 substrate

Shields Brook (Upstream): CS-1 substrate

Shields Brook (Downstream): At culvert looking US

Shields Brook (Downstream): At culvert looking DS

Shields Brook (Downstream): CS-3 looking US

Shields Brook (Downstream): CS-3 looking DS

Shields Brook (Downstream): CS-3 RB

Shields Brook (Downstream): CS-3 LB

Shields Brook (Downstream): CS-3 substrate

Shields Brook (Downstream): CS-3 substrate

Shields Brook (Downstream): CS-3 substrate

Shields Brook (Downstream): End of reach LB

Shields Brook (Downstream): End of reach RB

Shields Brook (Downstream): End of reach looking US

Shields Brook (Downstream): End of reach looking DS

Shields Brook (Downstream): Benchmark

Shields Brook (Downstream): Benchmark

# Appendix B Tributary E Photos

Tributary E (Upstream): Facing culverts

Tributary E (Upstream): Facing culverts

Tributary E (Upstream): US of culverts facing LB

Tributary E (Upstream): US of culverts looking US

Tributary E (Upstream): US of culverts looking US

Tributary E (Upstream): At culverts looking US

Tributary E (Upstream): CS-1, at culverts looking US

Tributary E (Upstream): CS-1 LB

Tributary E (Upstream): CS-1 RB

Tributary E (Downstream): On road looking DS

Tributary E (Downstream): DS culverts

Tributary E (Downstream): Facing culverts looking US

Tributary E (Downstream): At culverts looking DS

Tributary E (Downstream): CS-2 looking DS

Tributary E (Downstream): CS-2 looking US

Tributary E (Downstream): CS-2 RB

Tributary E (Downstream): CS-2 LB

Tributary E (Downstream): Near CS-3 looking DS

Tributary E (Downstream): US end of long profile looking US

Tributary E (Downstream): DS end of long profile looking DS

Tributary E (Downstream): CS-3 looking DS

Tributary E (Downstream): CS-3 looking US

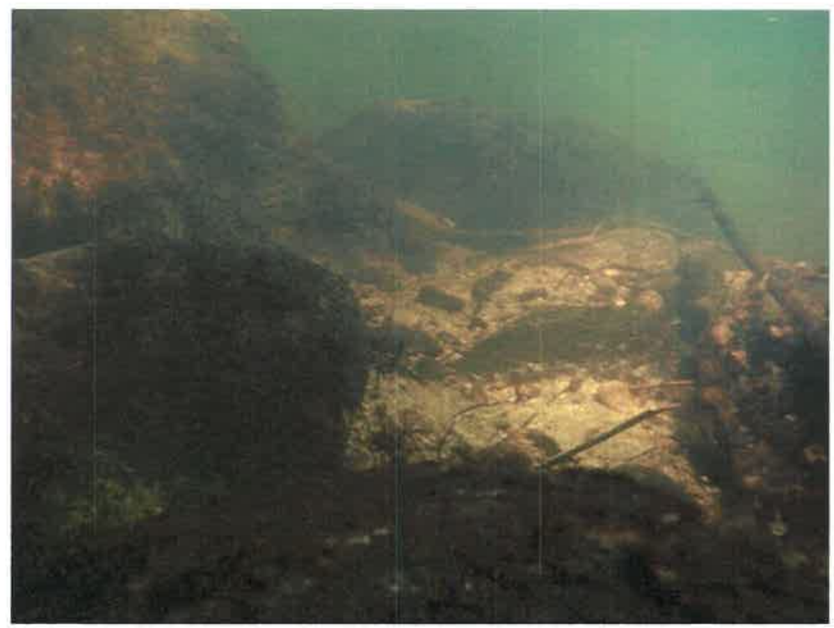
Tributary E (Downstream): CS-3 LB

Tributary E (Downstream): CS-3 RB

Tributary E (Downstream): DS end of long profile looking DS

Tributary E (Downstream): DS end of long profile looking US

Tributary E (Downstream): CS-2 substrate



Tributary E (Downstream): CS-2 substrate

# Attachment H

## TSL Reports - Shields Brook, Tributary E

FUSS & O'NEILL

February 4, 2020

Mr. Keith A. Cota, PE
Chief Project Manager
New Hampshire Department of Transportation
7 Hazen Drive
P.O. Box 483
Concord, NH 03302

Re: Connector Road over Shields Brook, Exit 4A
Type, Span, and Location Study
Fuss & O'Neill Reference No. 20190127.A10

Dear Mr. Cota:

Fuss & O'Neill is pleased to provide the following TSL Report for the construction of the Exit 4A Connector Road Bridge over Shields Brook. This report summarizes the layout and superstructure type, and evaluates the substructure types for the proposed bridge.

Executive Summary

- The bridge will replace the existing undersized 6-foot diameter corrugated metal pipe structure and will accommodate the widening of the Connector Road.
- A NEXT F-Beam bridge with a composite concrete deck is recommended.
- Concrete cantilever abutments bearing on structural fill is recommended.

Existing Condition

The existing Folsom Road/North High Street consists of two 11-foot lanes with a 3-foot shoulder on either side. The existing structure is a 6-foot diameter corrugated metal pipe with a 22 degree skew. Shields Brook converges with an unnamed stream approximately 90 feet upstream of the existing structure. According to the Folsom Road/North High Street over Shields Brook Hydrologic and Hydraulic report dated November 2018, the pipe is undersized and the road is overtopped for all storms greater than the 2-year event.

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Proposed Roadway Alignment and Profile

As part of the Exit 4A Interchange Project, the existing 28-foot wide Folsom Road/North High Street roadway will be replaced with a four-lane connector road on a new alignment with two additional turning lanes at the project location. The proposed curb-to-curb width for the Connector Road will be 83 feet with a sidewalk on both sides and fully encompasses the existing Folsom Road/North High Street with the entirety of the existing road located in the eastbound lanes of the proposed roadway. The proposed structure will be located on a horizontal curve with a radius of 2000 feet and a superelevation of 2.6%.

The finished grade elevations of the proposed Connector Road will be 7 to 8 feet higher than the existing elevations along the existing Folsom Road/North High Street. The bridge will be located on a sag vertical curve with the low point occurring at station 1057+85, which is well beyond the limits of work for the replacement structure.

Proposed Bridge Layout

Two bridge layout options have been evaluated; a buried structure with a clear-span of 28.5 feet and an at-grade structure with a span of 63 feet. These options are discussed below.

*Option 1 – Buried Structure*

This layout option consists of a buried 28.5-foot clear-span structure. The buried structure alignment follows the stream alignment and requires an approximate skew of 40 degrees. This was the structure type and width used for the hydraulic model. The hydraulic analysis shows that with a 28.5-foot clear span, a minimum 4.7-foot rise structure is required to pass the 100-year design flood event with the required 1-foot minimum freeboard. Due to the raise in profile at this location, this results in over 10 feet of fill over the top of the buried structure.

A 28.5-foot clear-span was initially estimated for the hydraulic analysis, which assumes 1.2 times bankfull width plus 2 feet with a delineated bankfull width of 22 feet. However, the NHDES Stream Crossing Requirements state that the clear-span should be equal to the bankfull width times a factor based on the "low" side of the entrenchment ratio as specified by "The Key to the Rosgen Classification of Natural Rivers" (Rosgen) chart. The stream survey, conducted after the hydraulic analysis was completed, determined an entrenchment ratio of 3.1 and a bankfull width of 23.5 feet. Based on the Rosgen chart and an entrenchment ratio of 3.1, a factor of 2.2 should be used, which results in a clear-span of 52 feet. Therefore, that the buried structure does not meet NHDES Stream Crossing Requirements.

The proposed Connector Road alignment is shifted north of the existing Folsom Road/North High Street alignment. This shift combined with the substantially increased width of the Connector Road as compared to the existing road encroaches into the Shields Brook upstream channel. This pushes the proposed upstream invert of the buried structure upstream past the convergence of Shields Brook with the unnamed stream, which will require realigning the unnamed stream to shift the convergence further upstream within the delineated wetland. Realignment of the stream will result in significant wetland impacts.

This option is not recommended because the structure will not meet NHDES Stream Crossing Requirements and will result in significant wetland impacts.

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*Option 2 – At-Grade Structure*

This layout option consists of an at-grade structure with a clear-span of 52 feet (perpendicular to the stream) with a skew of 30-degrees, which results in a span length of 63 feet along the alignment from centerline-of-bearing to centerline-of-bearing. The structure meets NHDES Stream Crossing Requirements with a minimum clear-span of 52 feet. The new Connector Road alignment and roadway width will result in encroachment on Shields Brook by the embankment slopes in the front of the upstream wingwall, which will require realignment of a short section of the brook immediately upstream of the bridge. A reduction in skew from 40 degrees to 30 degrees can also be accommodated due to the increased span. This option was not analyzed in the hydraulic analysis, but since the width and height of the opening are greater than for Option 1, this structure will pass the required flows using engineering judgement. Stream banks will be carried through the structure similarly to Option 1, but additional hydraulic capacity is provided by this larger span. A minimum low chord elevation of 275.5 feet based on the buried structure hydraulic analysis would be provided.

This is the recommended option as it will meet NHDES Stream Crossing Requirements, will result in fewer wetland impacts than Option 1, and provides greater hydraulic capacity. It should be noted that the hydraulic analysis will need to be updated for the 52-foot clear-span bridge in order to provide accurate flood flow elevations and/or decrease the minimum low chord elevation if desired. A scour analysis will also be required. As the crossing occurs in a FEMA detailed study area that includes a floodway delineation, a Letter of Map Revision (LOMR) application will be required at the completion of construction and an updated hydraulic analysis utilizing as-built survey will be required to complete the application.

Bridge Superstructure

The bridge out-to-out width will be 98 feet. Eastbound and westbound traffic will be divided by a 4-foot concrete median. Two 11-foot travel lanes, a 5-foot shoulder, and a 2-foot shoulder will be provided in the westbound direction and four 11-foot travel lanes, a 5-foot shoulder, and a 1-foot shoulder will be provided in the eastbound direction. A 6-foot sidewalk with T4 bridge rail will also be provided on both sides of the road. The bridge will be located on a horizontal and vertical curve and have a superelevation of 2.6%.

*Option 1 – NEXT Beams*

Given the span length of 63 feet, the use of precast, prestressed concrete NEXT beams would normally be viable. However, PCI recommends a maximum skew of 20 degrees for NEXT beams. Therefore, this option was not evaluated further.

*Option 2 – Precast, Prestressed Concrete Voided Slabs*

Concrete is more durable than steel in close proximity to water; and for shorter spans, concrete is often more economical than steel. However, a preliminary analysis determined that the proposed span and skew could not be accommodated by a voided slab bridge. Therefore, this option was not evaluated further.

*Option 3 – Rolled Steel Girder*

The preliminary girder layout and design for the rolled steel girder bridge with composite concrete deck provides 11 girders spaced at 9'-3" on center. The girders were designed to be parallel to the bridge chord. Because the bridge is on a horizontal curve with straight girders, the overhang distance will vary. As structure depth is not a concern due to the significant profile grade increase and larger span, an economical beam can be utilized resulting in cost savings. A W36x160 was assumed for the preliminary design, but a similar size plate girder could also be utilized.

The steel girders could be weathering steel, galvanized, or metalized. The NHDOT Bridge Design Manual v1.0 section 630.3.2 states that weathering steel shouldn't be used when the height clearance is less than 10 feet for stagnant water or 8 feet above moving water. Since the area upstream of the structure is a delineated wetland, there will be standing water during low flows, so the stagnant water limit will be used. The calculated low chord elevation of the proposed structure is 282.8 feet. The estimated normal high water elevation (2-year event) from the hydraulic report is 272.85 feet, which gives a height clearance of 9.95 feet. Since the clearance height is below the stagnant water limit, the use of weathering steel is not recommended. Due to the length of the proposed beams and the lack of larger kettle lengths locally, double dipping would be required to galvanize the beam, or the beam would need to be sent out of the region. A splice could be utilized to shorten the beam length, however the beam would not be shortened enough to be accommodated by the local kettles. Double dipping would roughly double the cost of galvanizing per pound of steel, and shipping the beams out of the region to dip them would also be expensive. Due to the high cost of galvanizing, metalizing is recommended.

As the precast options were not viable and the rolled beams required for this option are economical, this option is recommended.

<u>Geotechnical</u>

Borings have been completed at the approximate location of the wingwalls on the south side of the structure. The borings indicate that the approximate bedrock elevations are 264.5 feet and 262.3 feet for Abutment A and B, respectively. Both borings consist of organic silt and fine sand with very low blow counts from existing ground to an elevation of 267.2 feet for Abutment A and 265.3 feet for Abutment B. Below the organic material is a layer of glacial outwash. At Abutment A, the glacial outwash layer sits directly on bedrock. At Abutment B, there is a layer of glacial till beginning at elevation 263.3 feet below the glacial outwash, then bedrock below the glacial till.

Abutment Type

Several abutment types have been evaluated for the recommended bridge layout; integral/semi-integral, cantilever on piles, and cantilever on spread footings. The evaluated abutment types are discussed below.

*Cantilever Abutment on Piles*

This option consists of a cantilever abutment supported on piles driven into bedrock. An expansion joint should be located at Abutment A because it has the higher finished grade elevation. The joint should also be located behind the backwall to protect the bearings and beam seat from future leaking.

According to the NHDOT Bridge Design Manual section 6.2.2.B, the bottom of a footing founded on piles should be 4 feet below finished grade. The proposed minimum finished grades in front of the abutments are 276 feet and 275 feet for Abutments A and B, respectively, which leaves a bottom of footing elevation of 272 feet and 271 feet. This results in proposed pile lengths of 7.5 feet for Abutment A and 8.7 feet for Abutment B. Due to these short pile lengths, it is not cost effective to mobilize pile driving for such short piles. Therefore, this option is not recommended.

*Cantilever Abutment on Spread Footings*

This option consists of a cantilever abutment on structural fill or rock and will have the same geometry as the cantilever abutment on piles option.

According to the NHDOT Bridge Design Manual section 6.2.2.B, the bottom of a footing founded on soil should be 5 feet below grade. This results in bottom of footing elevations of 271 feet and 270 feet for Abutments A and B. Based on the boring logs, the soils at these elevations are not suitable to support spread footings. Therefore, the unsuitable material will need to be excavated to competent bearing surface. This will likely be to bedrock at elevation 264.5 feet for Abutment A and possibly to glacial till at an elevation of 263.3 feet for Abutment B, but should be confirmed by a geotechnical engineer. Any material removed below the proposed bottom of footing elevations will be replaced with structural fill or a tremie seal/subfooting. Additionally, the competency of the bedrock for bearing will need to be evaluated by a geotechnical engineer. The cost to do this work would be less than driving short piles, therefore spread footings are recommended. However, it should be noted that a scour analysis has not yet been performed and may dictate the bottom of footing elevations and/or subgrade materials below the footings.

*Integral/Semi-Integral Abutments*

According to the NHDOT Bridge Design Manual sec. 6.4.2.B, integral abutments with skews greater than or equal to 20 degrees cannot be designed utilizing the simplified method documented in the VTrans Integral Abutment Bridge Design Guidelines. Although a more advanced method could be utilized to design integral abutments at a 30 degree skew, it is not a feasible option due to the short pile lengths.

Semi-integral abutments on spread footings would be a reasonable alternative to integral abutments and would be preferable to cantilever abutments because it moves the joint off the bridge to the end of the approach slab. The approach slabs will be supported by sleeper slabs, with the sidewalk and bridge rail constructed on top of the approach slab. In the south east corner, the end of the approach slab and the sleeper slab will be located within the intersection with Ferland Drive. In this corner it is recommended to construct the sidewalk on the approach slab, but drive the bridge approach rail beyond the slab instead of mounting it to the approach slab. This will allow the rail splice to be located only at the end of the bridge, which avoids the curved section of the rail needing to expand and contract with the bridge. Semi-integral abutment details will conform to the current NHDOT bridge design manual, which have been included at the end of this report.

Maintenance of Traffic

Two lanes of traffic will be maintained throughout construction, one lane in each direction, and the construction will be completed in two phases. This structure is located in close proximity to the proposed rail trail structure; therefore, the phases in which they are constructed will need to be coordinated to avoid impacting the other structure.

For the first phase of construction, two lanes of traffic will remain on the existing roadway while the northern portion of the proposed structure is built. The two westbound lanes, shoulders, and sidewalk will be constructed. Excavation support will be needed to support the existing roadway before excavating for the proposed footings, but because of the shallow depth to bedrock, tie back anchors may be required. During phase 1 construction, enough of the rail trail structure will need to be completed to support phase 2 traffic before moving on to phase 2.

During the first phase of construction, a portion of Abutment B will be located where the existing inlet for the 6-foot diameter corrugated pipe is located, which prevents the existing pipe from being utilized during construction to maintain stream flow. However, it may be possible to cut the existing pipe at the phase 1 excavation support and divert the water through the shortened existing pipe. Alternatively, a new temporary pipe could be installed through the existing roadway embankment to maintain stream flow during construction. This work will require multiple days of one-way alternating traffic or a temporary closure to excavate and install the pipe. Jacking the pipe through the embankment could be done, but would likely not be cost effective. Pumping the water and utilizing a temporary pipe bypassed just beneath the roadway surface to the east of Abutment B could also be an option.

To support phase 1 backfilling of the abutments, excavation support is required to support the new road while phase 2 excavation operations commence to construct the rest of each abutment. Traffic will be shifted onto the newly constructed westbound lanes for phase 2 construction while the four eastbound lanes, shoulders, and sidewalk are constructed.

Access to and from Ferland Drive, which is located just to the west of Abutment A, will be maintained during phase 1 construction. However, due to the 7- to 8-foot increase in grade for the newly constructed phase 1 portion of the road as compared to existing, access to and from Ferland Drive will only be maintained from the west during phase 2 construction. Traffic leaving Ferland Drive will be detoured west onto the existing Folsom Road/North High Street, onto the proposed High Street and then north to the proposed High Street and the Connector Road intersection. Traffic will then be detoured east onto the completed phase 1 section of the Connector Road and over the new phase 1 portion of the Shield Brook bridge. Traffic trying to turn left onto Ferland Road will travel the reverse of this same detour. For this detour to be feasible, a temporary intersection will need to be created to connect the existing Folsom Road/North High Street with the proposed High Street. The proposed intersection between the proposed High Street and the Connector Road will also need to be completed prior to phase 2 construction. It should be noted that traffic control for the Connector Road construction has not yet been determined. The above traffic control concept depends on a specific timeline. Changes to the Connector Road traffic control timeline will affect the phasing for the Shields Brook Bridge and access to and from Ferland Drive.

It should be noted that the turning radius for traffic traveling onto and off of Ferland Drive during phase 2 construction will need to be examined due to its proximity to the west structure approach. The intersection may need to be widened to maintain traffic without impacting the construction of the west approach and to provide construction access to the west side of the bridge.

Cost Estimate

A preliminary cost estimate, for the bridge only, has been prepared using the slope intercept method. The cost for the base bridge items was calculated using a square foot cost of $190.00 for the rolled steel girder option. This price was based on recently bid, similar type, projects.

**63-Foot Span Steel Structure**

| | |
|---|---|
| Base Bridge Items: | $ 2,080,000 |
| Cofferdams: | $ 290,000 |
| Culvert Removal: | $ 20,000 |
| Mobilization (10%): | $ 240,000 |
| Engineering & Permitting (10%) | $ 270,000 |
| Construction Engineering (15%) | $ 400,000 |
| **GRAND TOTAL** | **$ 3,300,000** |

Recommendations

The recommended bridge type is a 63-foot, simple-span, steel girder bridge with composite concrete deck supported on semi-integral abutments with spread footings. This option meets both NHDOT hydraulic requirements and NHDES Stream Crossing Guidelines and has the least amount of wetland impacts.

Please contact me if you have questions, comments, or require any additional information.

Sincerely,

Jaime French

Jaime French, PE
Bridge Team Lead | Project Manager

Enclosures

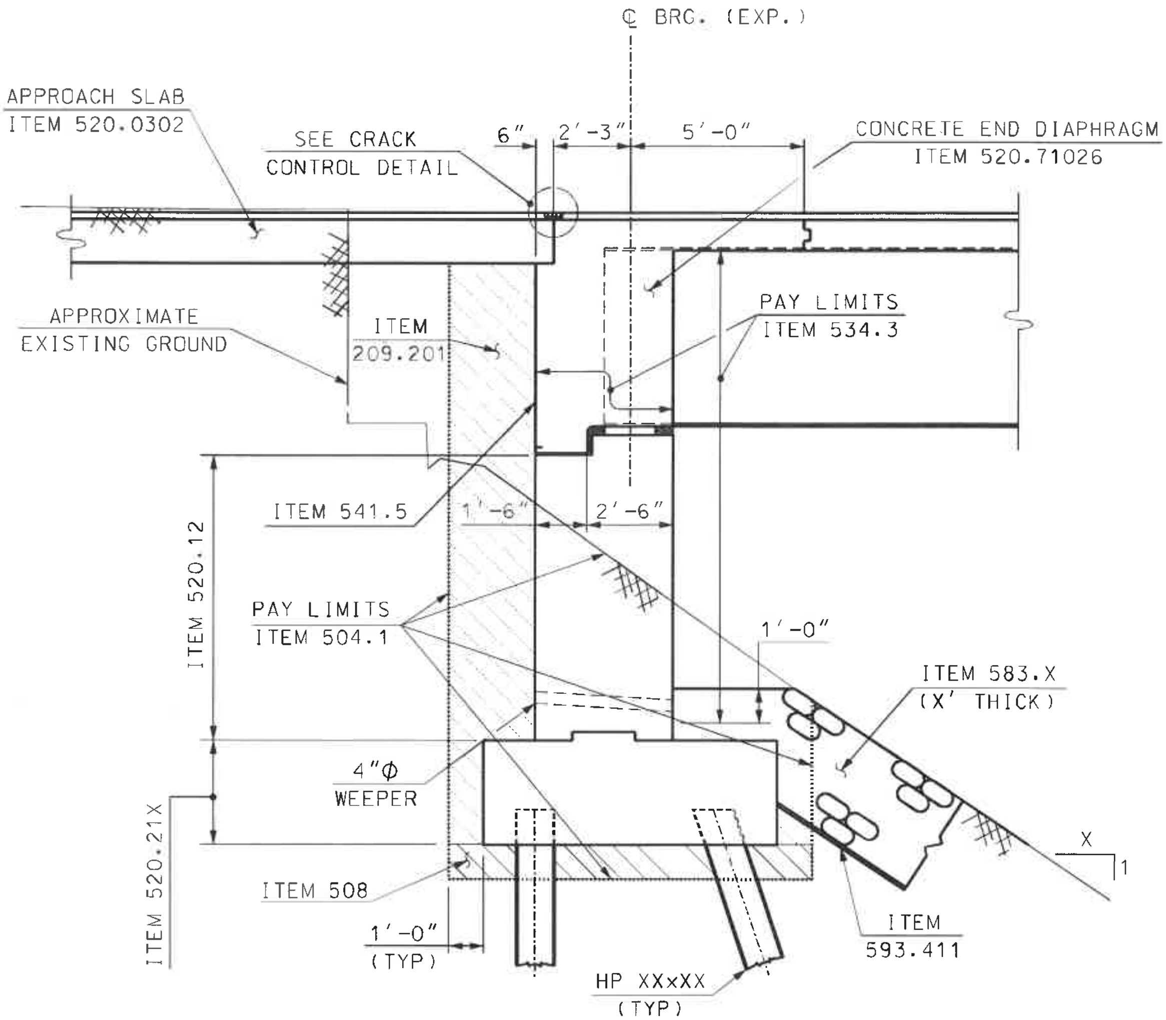
# NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION

New Hampshire DOT Department of Transportation

## BUREAU OF BRIDGE DESIGN

DESCRIPTION: SUBSTRUCTURE DETAILS - TYP. SEMI-INTEGRAL ABUTMENT SECTION

DATE REVISED: 2/8/2016



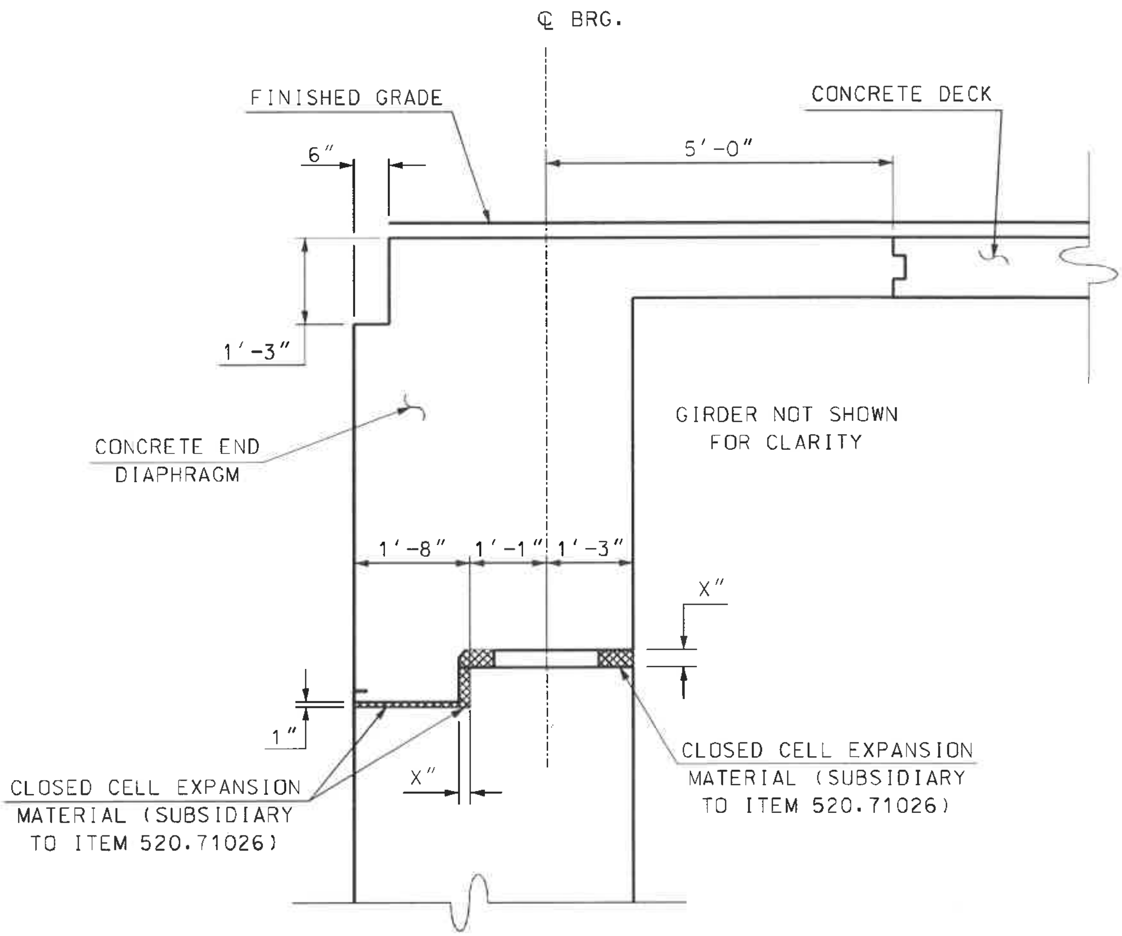

TYPICAL SEMI-INTEGRAL ABUTMENT SECTION

MODIFY TO FIT PROJECT

# NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION

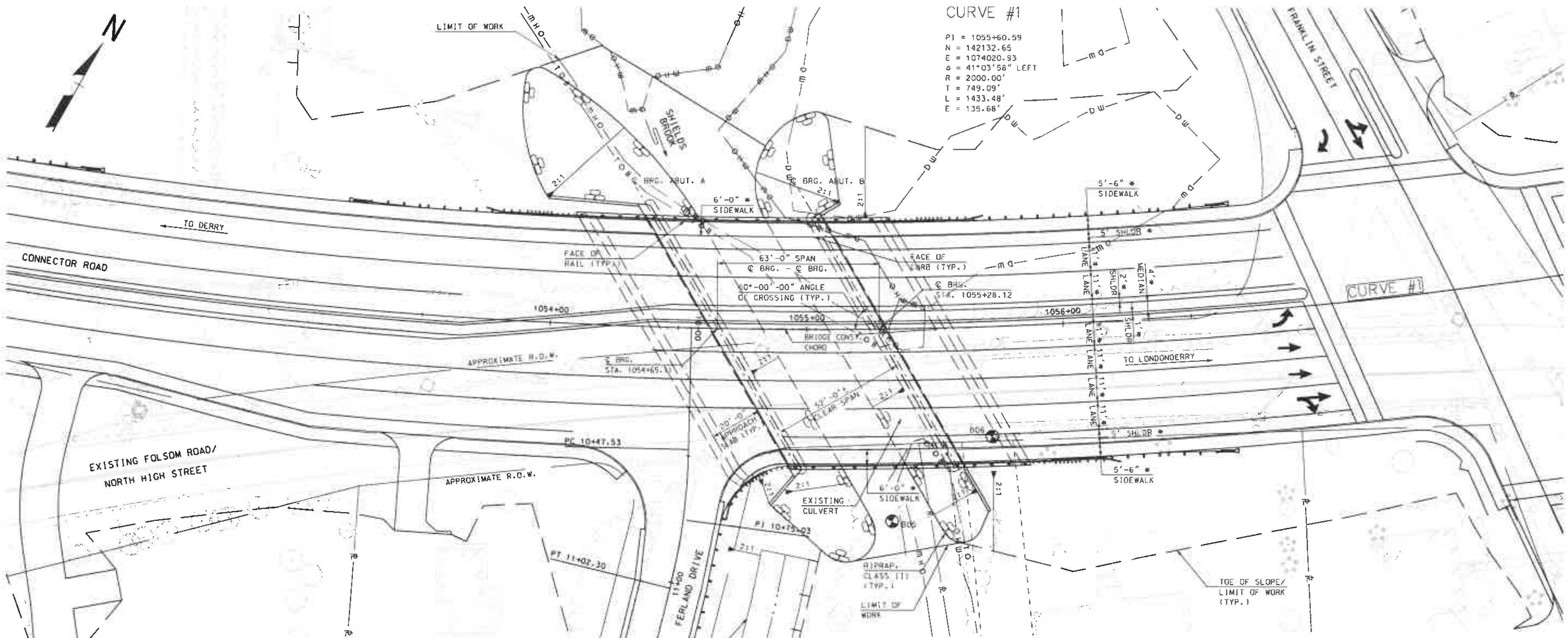
## BUREAU OF BRIDGE DESIGN

| DESCRIPTION: SUBSTRUCTURE DETAILS - TYPICAL SEMI-INTEGRAL DIAPHRAGM SECTION | DATE REVISED: 2/8/2016 |
|---|---|




TYPICAL SEMI-INTEGRAL DIAPHRAGM SECTION

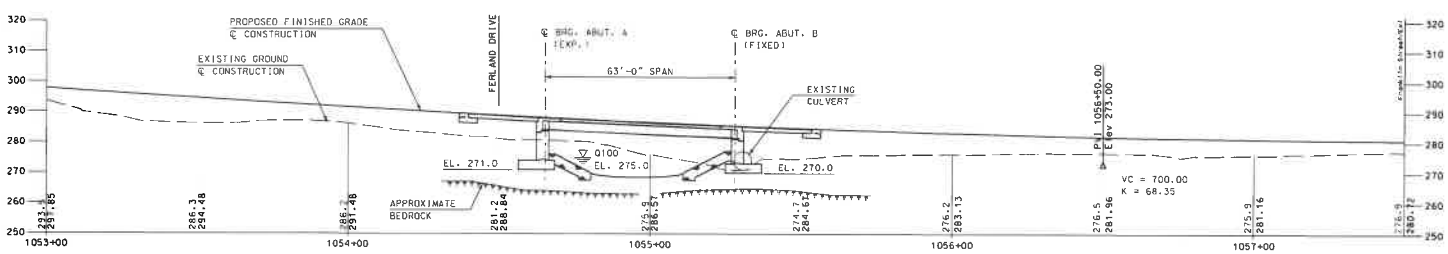
MODIFY TO FIT PROJECT




## GENERAL PLAN

SCALE: 1" = 20'-0"

* DENOTE RADIAL DIMENSION




## PROFILE

SCALE: 1" = 20'-0"

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION * BUREAU OF BRIDGE DESIGN

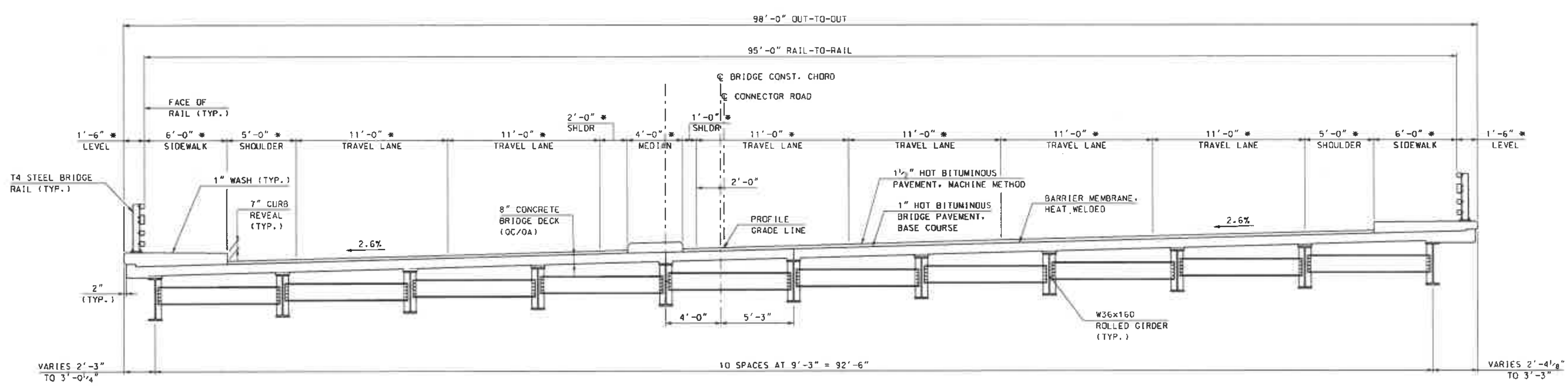
| | | | | | |
|---|---|---|---|---|---|
| TOWN | DERRY AND LONDONDERRY | BRIDGE NO. | 053/110 | STATE PROJECT | 13065 |
| LOCATION | THE CONNECTOR ROAD OVER SHIELDS BROOK | | | | |

### GENERAL PLAN AND PROFILE

| REVISIONS AFTER PROPOSAL | | BY | DATE | | BY | DATE | BRIDGE SHEET |
|---|---|---|---|---|---|---|---|
| | DESIGNED | ETC | 1/20 | CHECKED | SRB | 1/20 | 1 OF 3 |
| | DRAWN | MWS | 1/20 | CHECKED | ETC | 1/20 | FILE NUMBER |
| | QUANTITIES | | | CHECKED | | | |
| | ISSUE DATE | | | FEDERAL PROJECT NO. | SHEET NO. | | TOTAL SHEETS |
| | REV. DATE | | | ---------- | 1 | | 3 |

FUSS & O'NEILL

| SUBDIRECTORY | DGN LOCATOR | SHEET SCALE |
|---|---|---|
| XX | 13065PrelGen | AS NOTED |




* DENOTES RADIAL DIMENSION

TYPICAL DECK SECTION - STEEL BEAM OPTION

SCALE: ¼" = 1'-0"

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION * BUREAU OF BRIDGE DESIGN

| | | | |
|---|---|---|---|
| TOWN DERRY AND LONDONDERRY | BRIDGE NO. 053/110 | STATE PROJECT 13065 | |
| LOCATION THE CONNECTOR ROAD OVER SHIELDS BROOK | | | |

TYPICAL BRIDGE SECTIONS

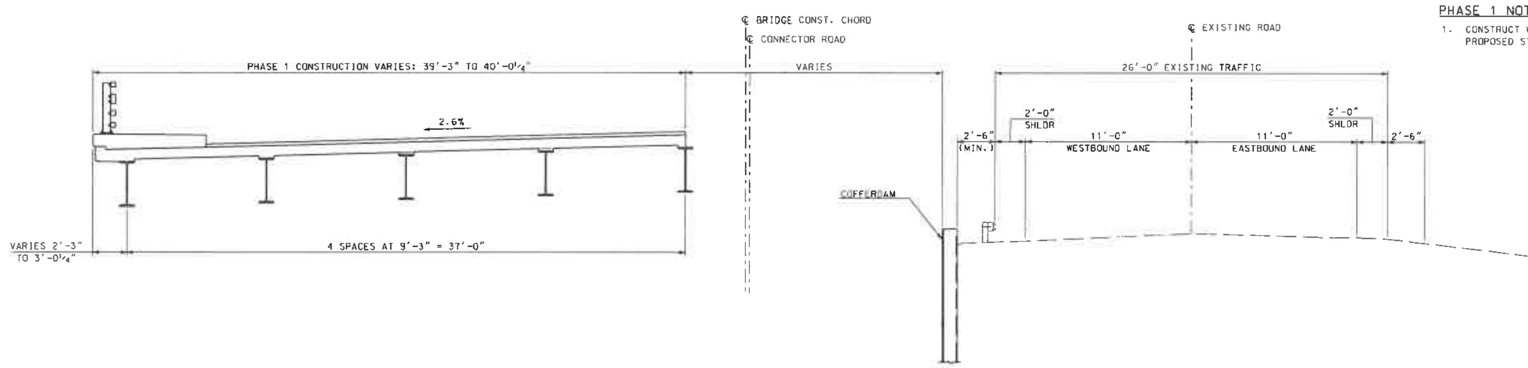
REVISIONS AFTER PROPOSAL

| | BY | DATE | | BY | DATE |
|---|---|---|---|---|---|
| DESIGNED | ETC | 1/20 | CHECKED | SRB | 1/20 |
| DRAWN | MWS | 1/20 | CHECKED | ETC | 1/20 |
| QUANTITIES | | | CHECKED | | |
| ISSUE DATE | | | | | |
| REV. DATE | | | | | |

BRIDGE SHEET 2 OF 3
FILE NUMBER
FEDERAL PROJECT NO. ——
SHEET NO. 2
TOTAL SHEETS 3

FUSS & O'NEILL

| SUBDIRECTORY | DGN LOCATOR | SHEET SCALE |
|---|---|---|
| XX | 13065DeckSect | AS NOTED |

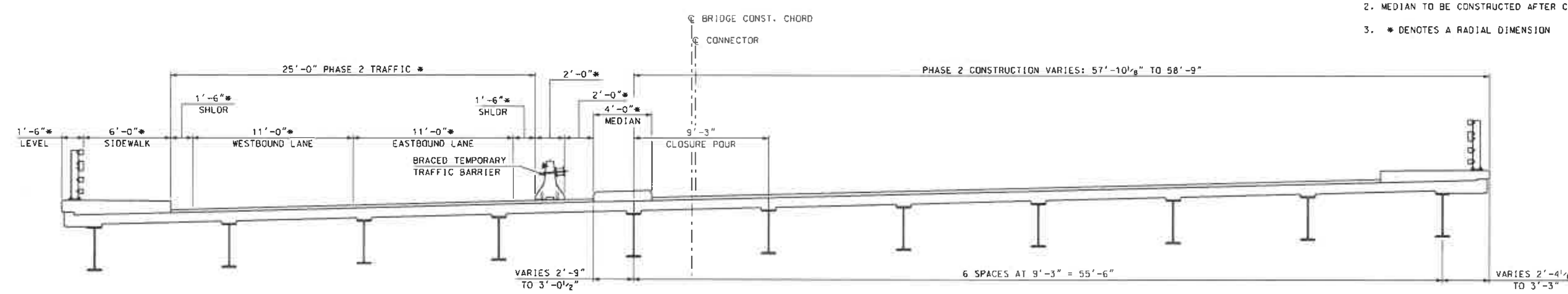



PHASE 1 NOTES:

1. CONSTRUCT WESTBOUND LANES OF PROPOSED STRUCTURE

## PHASE 1 CONSTRUCTION

SCALE: ¼" = 1'-0"




PHASE 2 NOTES:

1. MOVE TRAFFIC ONTO WESTBOUND LANES AND CONSTRUCT EASTBOUND LANES.
2. MEDIAN TO BE CONSTRUCTED AFTER CLOSURE POUR.
3. * DENOTES A RADIAL DIMENSION

## PHASE 2 CONSTRUCTION

SCALE: ¼" = 1'-0"

FUSS & O'NEILL

| SUBDIRECTORY | DGN LOCATOR | SHEET SCALE |
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| XX | 13065Phasing | AS NOTED |

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION * BUREAU OF BRIDGE DESIGN

TOWN DERRY AND LONDONDERRY — BRIDGE NO. 053/110 — STATE PROJECT 13065

LOCATION THE CONNECTOR ROAD OVER SHIELDS BROOK

CONSTRUCTION PHASING - STEEL OPTION

REVISIONS AFTER PROPOSAL

| | BY | DATE | | BY | DATE |
|---|---|---|---|---|---|
| DESIGNED | ETC | 1/20 | CHECKED | SRB | 1/20 |
| DRAWN | MWS | 1/20 | CHECKED | ETC | 1/20 |
| QUANTITIES | | | CHECKED | | |

ISSUE DATE

REV. DATE

| BRIDGE SHEET | FILE NUMBER | FEDERAL PROJECT NO. | SHEET NO. | TOTAL SHEETS |
|---|---|---|---|---|
| 3 OF 3 | | ---------- | 3 | 3 |

FUSS & O'NEILL

February 4, 2020

Mr. Keith A. Cota, PE
Chief Project Manager
New Hampshire Department of Transportation
7 Hazen Drive
P.O. Box 483
Concord, NH 03302

Re: Tsienneto Road over Tributary E, Exit 4A
Type, Span and Location Study
Fuss & O'Neill Reference No. 20190127.A10

Dear Mr. Cota:

Fuss & O'Neill is pleased to provide the following TSL Report for the construction of the Exit 4A Tsienneto Road Bridge over Tributary E. This report summarizes the layout and superstructure type, and evaluates the substructure types for the proposed bridge.

Executive Summary

- The bridge will replace the two existing undersized 30-inch and 36-inch diameter corrugated metal pipes.
- A simple-span prestressed precast concrete solid (or voided) slab bridge with a composite concrete overlay is recommended.
- Concrete cantilever abutments bearing on soil is recommended.

Existing Condition

The existing Tsienneto Road consists of two 11-foot lanes with a 3.25-foot shoulder on either side for a curb-to-curb width of 28.5 feet. The existing structure consists of a 30-inch diameter corrugated metal pipe (CMP) and a 36-inch diameter CMP skewed 30 degrees to the road. An additional 30-inch CMP begins in the driveway of the northeast abutter upstream and outlets at the same location of the other CMPs. This pipe will be removed in the vicinity of the bridge. The area upstream/north of the structure was delineated by the Town of Derry as a prime wetland; therefore, it is imperative a larger replacement structure does not result in a reduction of the water surface elevations within the wetland for normal flows. According to the Tsienneto Road over Tributary E Hydrologic and Hydraulic Report dated November 2019, the pipes are undersized and Tsienneto Road is overtopped for all storms greater than the 25-year event.

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Proposed Roadway Alignment and Profile

The proposed Tsienneto Road will be widened as part of the project to accommodate 5-foot shoulders for a curb-to-curb width of 32 feet as well as a 5.5-foot sidewalk on the north side. The sidewalk width will transition to 6-feet over the bridge. The centerline of the proposed structure will be on a horizontal tangent, however, due to the 30-degree skew of the proposed replacement structure, the northwest corner of the bridge will be within the horizontal approach curve. Due to the location of the structure in relation to the horizontal approach curve, the cross slope along the length of bridge will be along the superelevation runoff transition.

The existing roadway embankment is only 6 to 7 feet above the thalweg of Tributary E, which limits the possible structure replacement types to those with shallow structure depths. As part of the proposed roadway improvements and to maximize the available clearance for a replacement structure, the Tsienneto Road profile will be raised 2 feet, and the vertical profile at the project location will be on a tangent. Although an additional increase in the roadway profile would be beneficial for the hydraulic design, the amount of the raise is limited by the intersection of Tsienneto Road and Chester Road (Route 102), which is located several hundred feet to the east and is at the project limits.

Proposed Bridge Layout

Adjacent to the upstream invert of the existing crossing is a gravel drive that provides access to the abutter's property. Due to the limited frontage of this property along the road that is further reduced by the extensive wetlands present on the property, relocating this drive is not feasible. Therefore, the bridge will be located far enough away from the drive to provide sufficient room to accommodate a wingwall and to properly terminate the guardrail that will need to wrap around the edge of the drive. The location of the bridge is further limited by the horizontal alignment of the proposed road. To ensure the bridge is not located partially on a horizontal curve resulting in complicated geometry, the bridge will be located far enough to the east to ensure the entire centerline of the bridge is located on the tangent of the road.

Based on the above factors, the bridge will be placed just past the tangent point, which will also provide enough space past the drive to accommodate guardrail along the edge of the adjacent drive and a flared wingwall on the proposed structure. The gravel drive itself will be paved to the limit of work past the end of the guardrail terminal.

A 40-foot clear-span was initially estimated for the hydraulic analysis, which assumes 1.2 times bankfull width plus 2 feet with a delineated bankfull width of 32 feet. However, the NHDES Stream Crossing Requirements state that the clear-span should be equal to the bankfull width times a factor based on the "low" side of the entrenchment ratio as specified by "The Key to the Rosgen Classification of Natural Rivers" (Rosgen) chart. The stream survey, conducted after the hydraulic analysis was completed, determined an entrenchment ratio of 5.91 and a revised bankfull width of 18.3. Based on the Rosgen chart and an entrenchment ratio of 5.91, a factor of 2.2 should be used, which results in a clear-span of 40 feet. As the resulting clear-span did not change from what was originally estimated, the results of the hydraulic report are accurate and do not need to be updated. The hydraulic analysis indicates that a 40-foot clear-span structure passes the design 50-year event without overtopping based on an assumed structure depth of 3 feet. However, a scour analysis has not been performed and will be required.

As the crossing occurs within a FEMA detailed study area that includes a floodway delineation, a Letter of Map Revision (LOMR) application will be required at the completion of construction and hydraulic analyses of existing and proposed conditions will be required. As-built survey will be required to complete the application.

The proposed structure is recommended to be skewed 30 degrees to the road to align with Tributary E as closely as possible. A clear-span of 40 feet (perpendicular to the stream) results in a 50-foot span along the alignment from centerline-of-bearing to centerline-of-bearing.

To ensure no reduction in the wetland water surface elevations for normal flows, a weir structure will be utilized at the outlet of the replacement bridge, and the 293.3-foot elevation of the weir crest was set based on the hydraulic analysis to maintain existing upstream water surface elevations up to and including the 2-year event. Upstream water surface elevations will decrease as compared to existing for storm events greater than the 2-year event. A low flow channel will be built into the weir structure to accommodate fish passage.

Bridge Superstructure

A span length of 50 feet eliminates buried structures as a replacement option, therefore the replacement structure will be a bridge.

T4 bridge rail with a 6-foot sidewalk will be provided on the north side of the bridge, and T3 bridge rail will be provided on the south side. As noted previously, the bridge will be located on a horizontal and vertical tangent with cross slopes along the length of bridge on a superelevation runoff transition.

Based on the hydraulic analysis, the controlling low chord elevation to accommodate the minimum 1-foot of freeboard for the 50-year design event is 295 feet. This results in a maximum structure depth of approximately 3 feet. Given this fairly shallow structure depth, two bridge superstructure options were ultimately considered suitable for the project requirements; precast, prestressed concrete solid (or voided) slabs with a composite cast-in-place concrete overlay and rolled steel girders with a composite cast-in-place concrete deck. A precast, prestressed concrete NEXT beam bridge was eliminated as an option as the required depth of the NEXT beam for this span would be too deep to accommodate the required 1-foot of freeboard. The concrete solid slab and steel options are discussed below.

*Option 1 – Rolled Steel Girders*

Two 11-foot travel lanes and a 5-foot shoulder will be provided in the eastbound and westbound directions. The out-to-out bridge width of this option is 41.5 feet. After accounting for the cross-slope, pavement, deck, and haunch; the 3-foot structure depth results in an allowable beam depth of approximately 18.4 inches. The preliminary girder layout assumed a small 6-foot girder spacing to minimize the required beam depth. This spacing results in a total of 7 beams with 2.5-foot overhangs. The shallowest beam that meets the live load deflection criteria of L/1000 for the proposed layout is a W14x311. However, this beam is not economical and the steel cost for this option will be high for the relative size of the bridge. A more economical W18x211 rolled beam was then selected as the next shallowest beam to meet the live load deflection criteria. However, the actual beam depth of this section is 20.7 inches, which results in a 2.3 inch reduction of the required 1-foot of freeboard; therefore, it is not recommended. In order to meet the 1-foot freeboard requirement, the W14x311 beam or similar size plate girder, will be required for the steel superstructure option.

For the 10-year event, the low chord of the structure is less than 2 feet from the water, therefore, weathering steel is not recommended. Due to the length of the proposed beams and the lack of larger kettle lengths locally, double dipping would be required to galvanize the beam, or the beam would need to be sent out of the region. A splice could be utilized to shorten the beam length, but is not ideal. Double dipping would roughly double the cost of galvanizing per pound of steel, and shipping the beams out of the region to dip them would also be expensive. Due to the high cost of galvanizing, metalizing is recommended.

Since the size of the rolled beam needed to meet both the deflection and freeboard requirements is uneconomical, this option is not recommended.

*Option 2 – Precast, Prestressed Concrete Solid (or Voided) Slabs*

As precast, prestressed concrete slab units come in specific whole number widths, the bridge out-to-out width of this option had to be increased to 42 feet. One 11-foot travel lane and a 5.5-foot shoulder will be provided in the eastbound direction and one 11-foot travel lane and a 5-foot shoulder will be provided in the westbound direction. The additional 6 inches in bridge width was added to the east shoulder. The structure will consist of a combination of 3- and 4-foot wide by 21-inch deep precast, prestressed solid (or voided) slab units with a 6-inch composite cast-in-place concrete overlay. This option will give a structure depth of 29.5 inches, which is below the maximum allowable 36 inches (3 feet).

Due to the varying cross slopes, it is recommended the slabs be set level transversely and the cross-slope will be made up by varying the thickness of the concrete overlay. Concrete is also preferred as compared to steel when in close proximity to surface water.

This option is recommended as it meets the freeboard requirement, is more cost effective than the steel beam option, and is more durable than steel in close proximity to water.

## Geotechnical

Four borings were taken near the proposed abutment locations. The borings furthest from the stream on either side have approximate bedrock elevations of 288.5 feet (B01) and 285.3 feet (B06). The bedrock for these borings are listed as slightly to moderately weathered and moderately to extremely fractured. The rock quality designation for the cores sampled were 54% (B01) and 61% (B06). The two borings closest to the stream and approximate abutment location have approximate bedrock elevations of 277.3 feet (B03) and 276.8 feet (B05). In both B03 and B05, the soil above the approximate bedrock consists of dense sand and gravel with high blow counts per foot.

## Abutment Type

Several abutment types have been evaluated for the recommended bridge layout; integral/semi-integral, cantilever on piles, and cantilever on spread footings. The evaluated abutment types are discussed below.

### *Cantilever Abutment on Piles*

This option consists of a cantilever abutment supported on piles driven into bedrock. An expansion joint should be located at Abutment A because it has the higher finished grade elevation. The joint should also be located behind the backwall to protect the bearings and beam seat from future leaking.

According to the NHDOT Bridge Design Manual section 6.2.2.B, the bottom of a footing founded on piles should be 4 feet below finished grade. The proposed minimum finished grade in front of both abutments is 290.4 feet which leaves a bottom of footing elevation of approximately 286 feet. This would result in a maximum depth to bedrock of 9.2 feet from the bottom of footing, and it is possible that the bedrock would be above or just below one or both of the abutment footings. It is therefore not cost effective to mobilize pile driving for such short piles, so this option is not recommended.

### *Cantilever Abutment on Spread Footings*

This option consists of a cantilever abutment on soil or rock and will have the same geometry as the cantilever abutment on piles option.

According to the NHDOT Bridge Design Manual section 6.2.2.B, the bottom of a footing founded on soil should be 5 feet below grade. This results in a bottom of footing elevation of approximately 285 feet. The competency of the existing soil for bearing should be confirmed by a geotechnical engineer. If the soil is found to be competent, the footing could be founded directly on the existing soil. If it is not considered competent, the existing soil could be excavated to bedrock and replaced with either structural fill or a tremie seal/subfooting depending on the actual bedrock elevations once the subgrade has been revealed. Additionally, the competency of the bedrock for bearing will need to be evaluated by a geotechnical engineer.

The cost to do this work would be less than driving short piles, therefore spread footings are recommended. However, it should be noted that a scour analysis has not yet been performed and may dictate the bottom of footing elevations and/or subgrade materials below the footings.

*Integral/Semi-Integral Abutments*

According to the NHDOT Bridge Design Manual sec. 6.4.2.B, integral abutments with skews greater than or equal to 20 degrees cannot be designed utilizing the simplified method documented in the VTrans Integral Abutment Bridge Design Guidelines. Although a more advanced method could be utilized to design integral abutments at a 30 degree skew, it is not a feasible option due to the short pile lengths. However, semi-integral abutments on spread footings could be utilized and would be preferable to a cantilever abutment because it moves the joint off the bridge. The spread footings for this option are required to satisfy the same requirements as the cantilever abutments on spread footings discussed above. A semi-integral abutment will conform to the current NHDOT bridge design manual details, which have been included at the end of this report.

Maintenance of Traffic

Phased construction will be utilized to construct the replacement structure. Three phases will be required to complete the work. During phase 1 and phase 2 construction, eastbound traffic will be detoured via Bypass 28 and Route 102 and westbound traffic will be maintained on Tsienneto Road over the bridge utilizing phased construction. See the traffic control memo (attached) for the traffic analyses. Phase 3 construction will maintain two lanes of traffic on the bridge while constructing the sidewalk. In order to maintain two lanes of traffic throughout construction (one lane in each direction), a structure width of 59 feet would be required or the horizontal alignment would have to be shifted. Since the wetland upstream is delineated as prime and there are delineated wetlands downstream as well, over-widening the structure or shifting the alignment would require significant additional impact to these wetlands and therefore is not recommended.

For the first phase of construction, one lane of traffic will remain on the existing south portion of the roadway while the northern portion of the proposed structure is built. One westbound lane and shoulders will be constructed. The sidewalk will not be built during the first phase because extra room will be needed to accommodate phase two traffic. Excavation support will be required to support the existing roadway while excavating for the proposed abutment footings.

While driving the sheeting to support the existing roadway during the first phase, stream flow must be maintained through the construction area. Due to the proximity of the existing pipes to the proposed Abutment A, the pipe closest to the abutment could be removed with the other pipe being maintained during construction. However, this would reduce the existing hydraulic opening which is already significantly undersized. In addition, the condition of this pipe is unknown and the removal of the pipe adjacent to it could compromise its integrity and prevent its use. Alternatively, a new temporary pipe could be installed through the existing roadway embankment to maintain stream flow during construction. This work will require multiple days of one-way alternating traffic or a temporary closure to excavate and install the pipe. Alternatively, jacking the pipe through the embankment could be done, but would likely not be cost effective. Pumping the water and utilizing a temporary pipe bypassed just beneath the roadway surface to the east of Abutment B could also be an option.

To support phase 1 backfilling of the abutments, excavation support attached to each of the new abutments is required to support the new road while phase 2 excavation operations commence to construct the rest of each abutment. During phase two, traffic will be shifted onto the newly constructed westbound lane while the eastbound lane, shoulder, and railing are constructed. For the third phase of construction, two lanes of traffic will be accommodated by shifting both lanes to the east of the newly constructed bridge so that the sidewalk and railing can be constructed. Temporary one-lane alternating traffic may be required utilizing flaggers during daytime hours for some construction activities such as reinforcement delivery or concrete placement.

Cost Estimate

A preliminary cost estimate, for the bridge only, has been prepared for both superstructure options using the slope intercept method. For the precast, prestressed solid slabs option, the base bridge items were calculated using a square foot cost of $245. For the steel structure option, the base bridge item square foot cost was originally $210. Since an uneconomical beam is needed to accommodate the low chord elevation, the base bridge item square foot cost was raised to $255 to account for the additional steel weight that is required for the uneconomical section as compared to a more economical steel beam section that would have been utilized had structure depth not been a controlling factor. These prices were based on recently bid, similar type, projects.

**50-Foot Span Steel Structure**

| | |
|---|---|
| Base Bridge Items: | $ 870,000 |
| Cofferdams: | $ 180,000 |
| Weir Construction: | $ 70,000 |
| Culvert Removal: | $ 20,000 |
| Mobilization (10%): | $ 120,000 |
| Engineering & Permitting (10%): | $ 130,000 |
| Construction Engineering (15%): | $ 190,000 |
| **GRAND TOTAL** | **$ 1,580,000** |

**50-Foot Span Precast, Prestressed Solid Slabs Structure**

| | | |
|---|---|---|
| Base Bridge Items: | $ | 850,000 |
| Cofferdams: | $ | 180,000 |
| Weir Construction: | $ | 70,000 |
| Culvert Removal: | $ | 20,000 |
| Mobilization (10%): | $ | 120,000 |
| Engineering & Permitting (10%): | $ | 130,000 |
| Construction Engineering (15%): | $ | 190,000 |
| **GRAND TOTAL** | **$** | **1,560,000** |

Recommendations

The recommended bridge type is a 50-foot simple-span precast, prestressed concrete solid slab bridge with a composite concrete overlay supported on semi-integral abutments on spread footings. This option meets both the NHDOT hydraulic requirements and the NHDES Stream Crossing Guidelines, is the more economical option, and is more durable than steel in close proximity to the water.

Please contact me if you have questions, comments, or require any additional information.

Sincerely,

Jaime French

Jaime French, PE
Bridge Team Lead | Project Manager

Enclosures

# NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION

New Hampshire DOT Department of Transportation

## BUREAU OF BRIDGE DESIGN

| DESCRIPTION: SUBSTRUCTURE DETAILS - TYP. SEMI-INTEGRAL ABUTMENT SECTION | DATE REVISED: 2/8/2016 |
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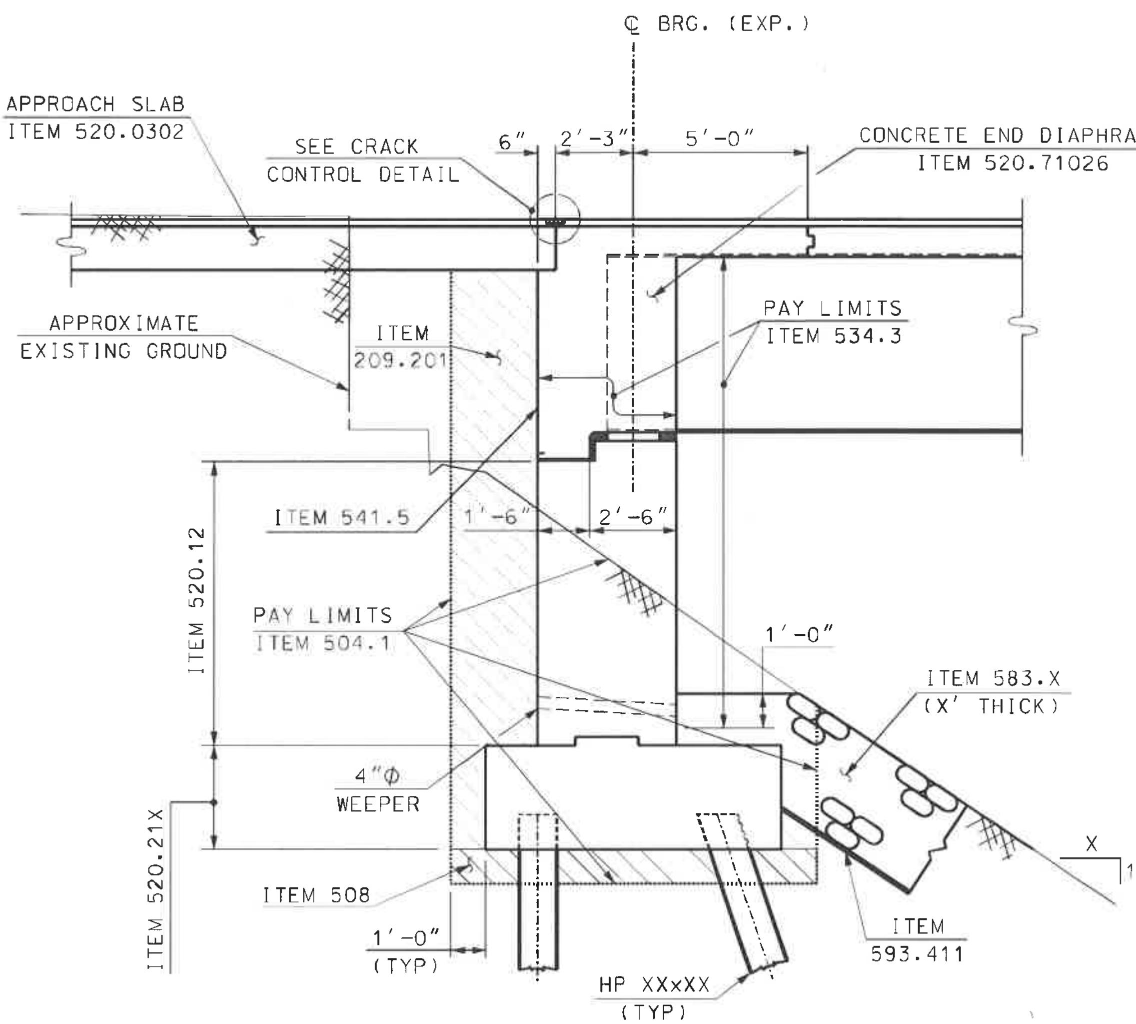


## TYPICAL SEMI-INTEGRAL ABUTMENT SECTION

**MODIFY TO FIT PROJECT**

# NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION

New Hampshire DOT Department of Transportation

## BUREAU OF BRIDGE DESIGN

| DESCRIPTION: SUBSTRUCTURE DETAILS - TYPICAL SEMI-INTEGRAL DIAPHRAGM SECTION | DATE REVISED: 2/8/2016 |
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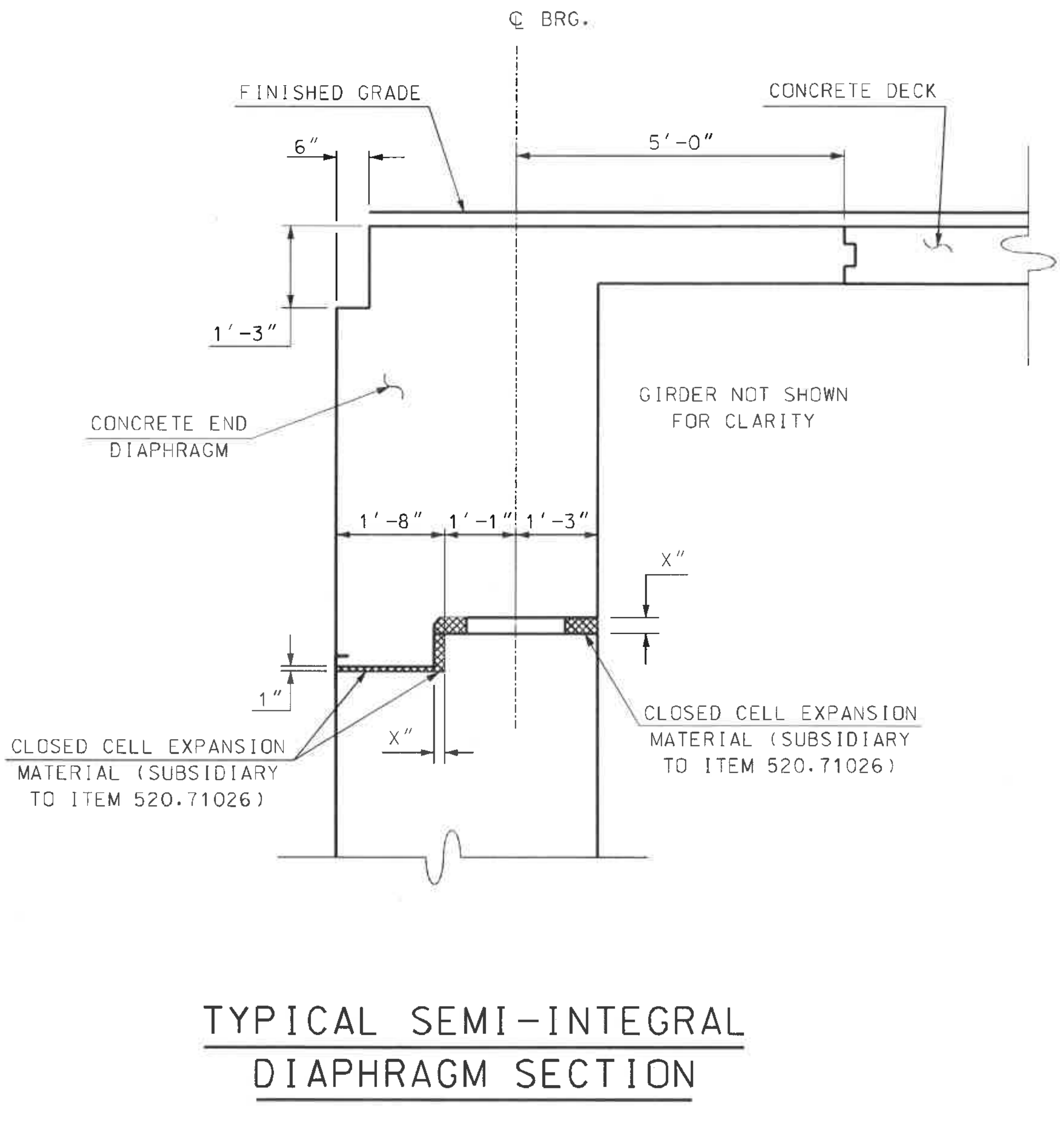
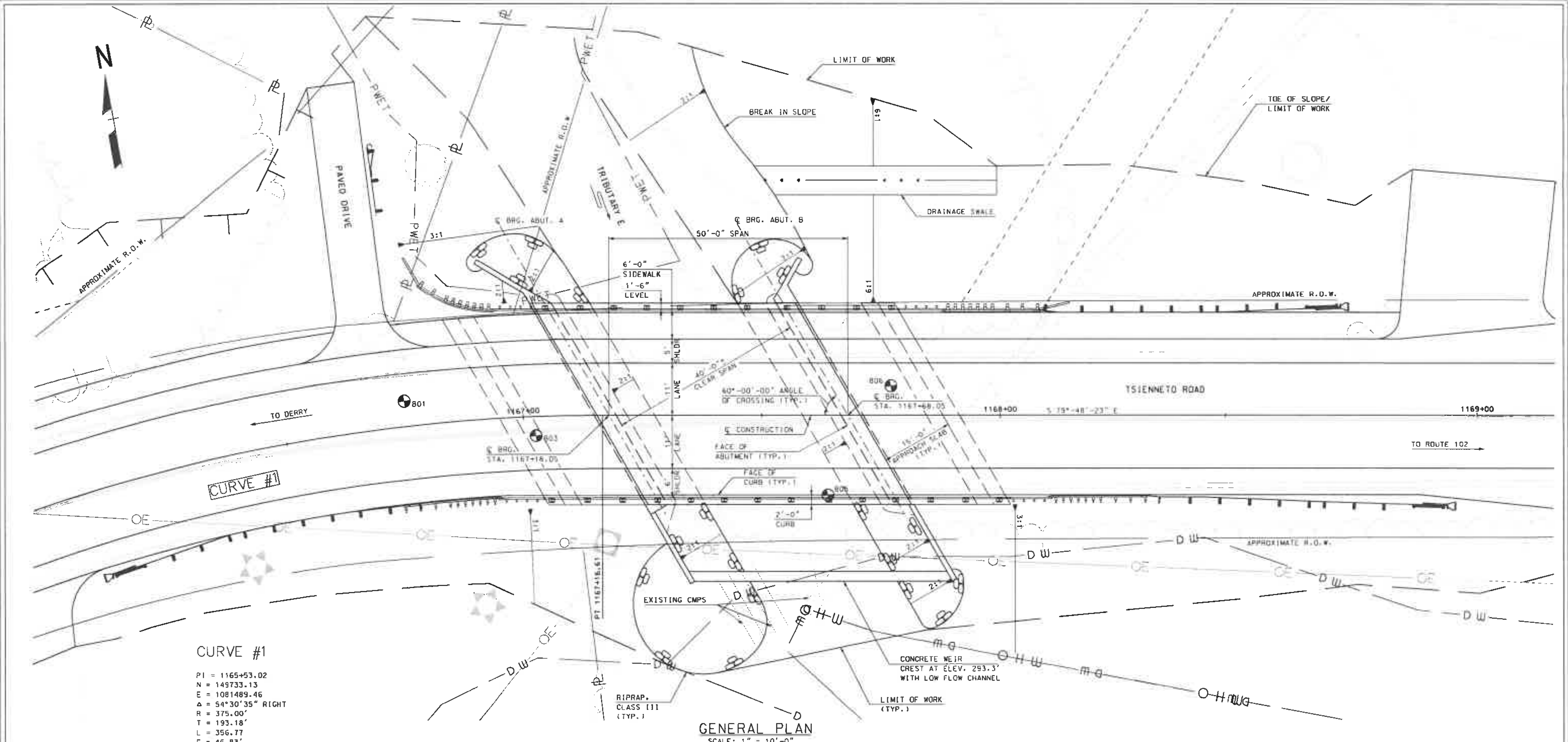
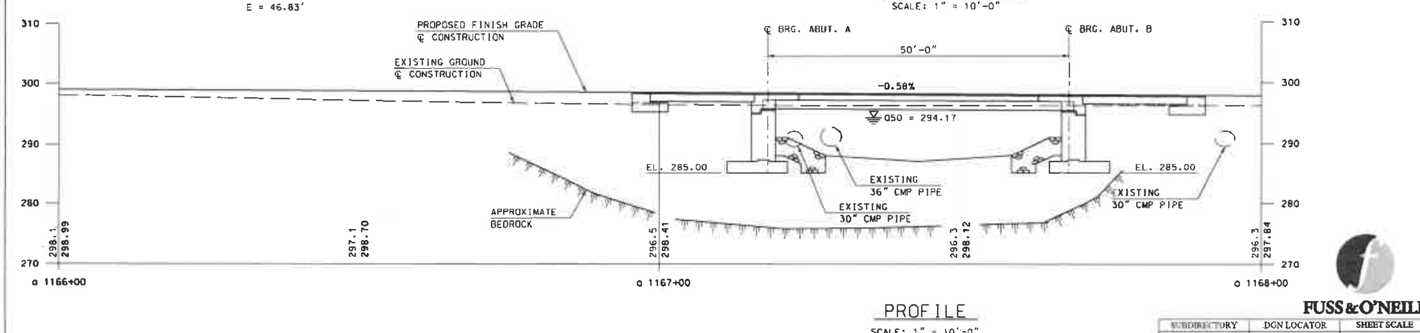



TYPICAL SEMI-INTEGRAL DIAPHRAGM SECTION

MODIFY TO FIT PROJECT




GENERAL PLAN
SCALE: 1" = 10'-0"




PROFILE
SCALE: 1" = 10'-0"

FUSS & O'NEILL

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STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION * BUREAU OF BRIDGE DESIGN

TOWN DERRY AND LONDONDERRY BRIDGE NO. 085\140 STATE PROJECT 13065

LOCATION TSIENNETO ROAD OVER TRIBUTARY E

GENERAL PLAN AND PROFILE

| REVISIONS AFTER PROPOSAL | | BY | DATE | | BY | DATE |
|---|---|---|---|---|---|---|
| | DESIGNED | KAC | 9/19 | CHECKED | SRB | 9/19 |
| | DRAWN | MWS | 9/19 | CHECKED | KAC | 9/19 |
| | QUANTITIES | | | CHECKED | | |
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| | REV. DATE | | | | | |

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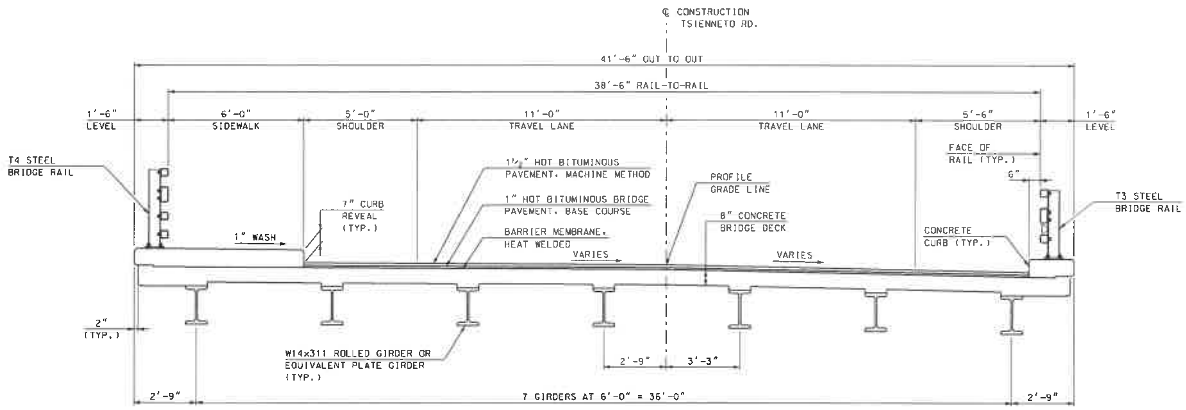
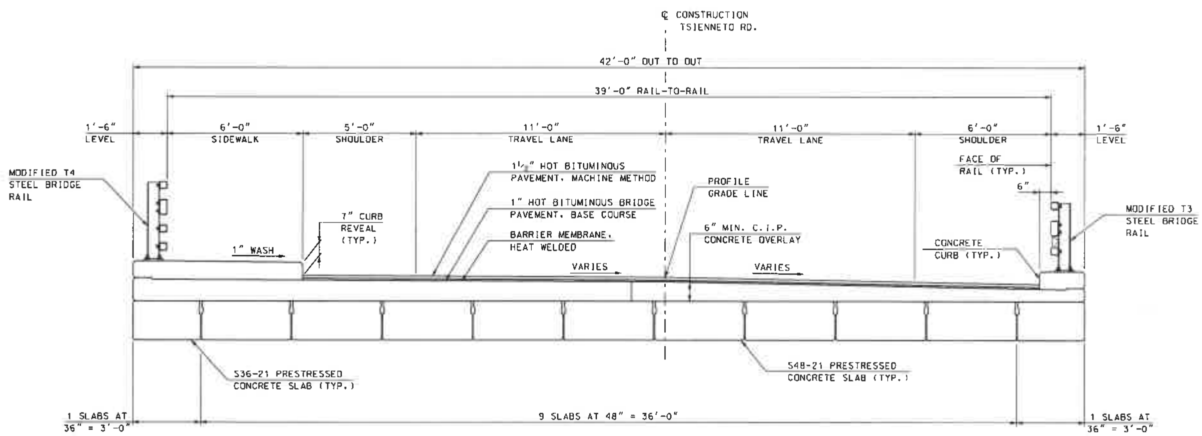



TYPICAL DECK SECTION - STEEL BEAM OPTION

SCALE: ⅜" = 1'-0"




TYPICAL DECK SECTION - SOLID SLAB OPTION

SCALE: ⅜" = 1'-0"

FUSS&O'NEILL

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STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION * BUREAU OF BRIDGE DESIGN

TOWN DERRY AND LONDONDERRY BRIDGE NO. 085/140 STATE PROJECT 13065

LOCATION TSIENNETO ROAD OVER TRIBUTARY E

TYPICAL DECK SECTION

REVISIONS AFTER PROPOSAL

| | BY | DATE | | BY | DATE |
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| DESIGNED | KAC | 1/20 | CHECKED | SRB | 1/20 |
| DRAWN | MWS | 1/20 | CHECKED | KAC | 1/20 |
| QUANTITIES | | | CHECKED | | |

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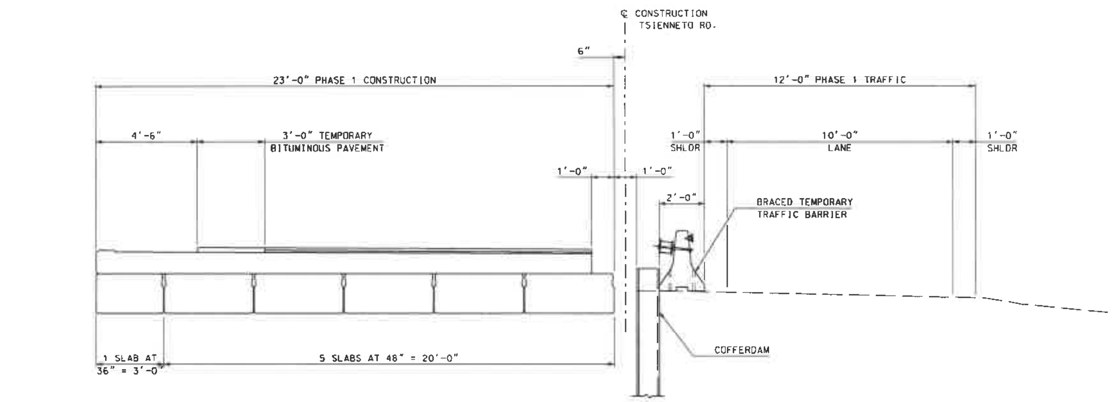
BRIDGE SHEET 2 OF 3

FILE NUMBER

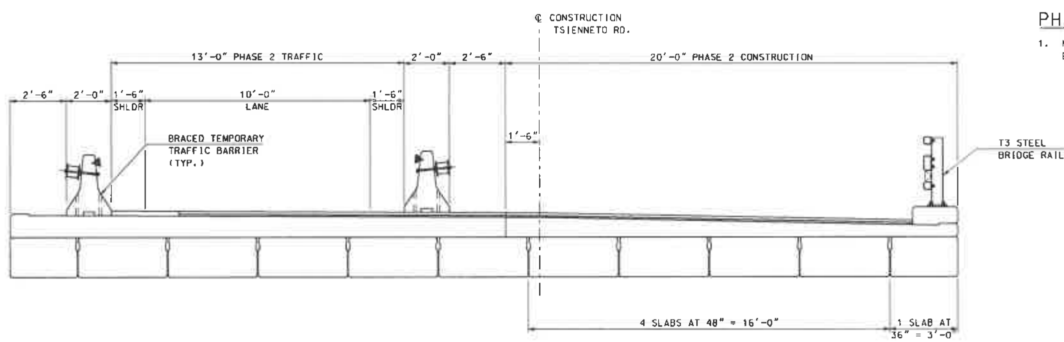



## PHASE 1 CONSTRUCTION

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

## PHASE 1 NOTES:

1. CONSTRUCT WESTBOUND LANE OF PROPOSED STRUCTURE (THE WESTBOUND SIDEWALK AND BARRIER WILL BE CONSTRUCTED IN PHASE 3).

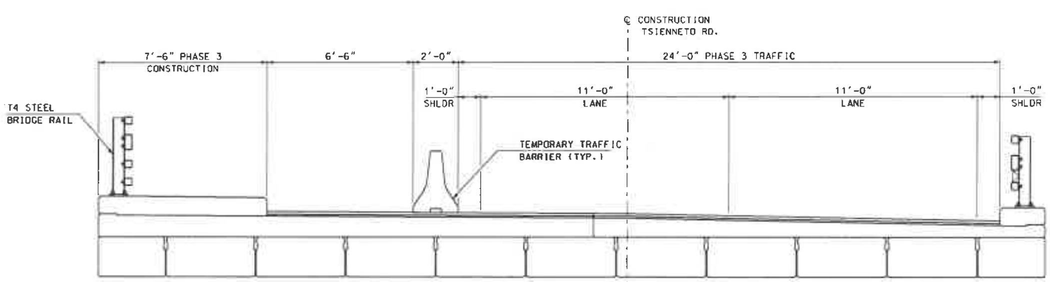



## PHASE 2 CONSTRUCTION

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

## PHASE 2 NOTES:

1. MOVE TRAFFIC ONTO WESTBOUND LANE AND CONSTRUCT EASTBOUND LANE AND BARRIER.




## PHASE 3 CONSTRUCTION

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

## PHASE 3 NOTES:

1. MOVE TRAFFIC ONTO EASTERN SIDE OF BRIDGE AND CONSTRUCT SIDEWALK AND BARRIER ON WESTBOUND SIDE OF THE STRUCTURE.

FUSS&O'NEILL

| SUBDIRECTORY | DGN LOCATOR | SHEET SCALE |
|---|---|---|
| XX | 13065Phase | AS NOTED |

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION * BUREAU OF BRIDGE DESIGN

TOWN DERRY AND LONDONDERRY BRIDGE NO. 085\140 STATE PROJECT 13065
LOCATION TSIENNETO ROAD OVER TRIBUTARY E

STAGED CONSTRUCTION PHASING

| REVISIONS AFTER PROPOSAL | | BY | DATE | | BY | DATE | BRIDGE SHEET |
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| | DESIGNED | ETC | 1/20 | CHECKED | SRB | 1/20 | 3 OF 3 |
| | DRAWN | MWS | 1/20 | CHECKED | ETC | 1/20 | FILE NUMBER |
| | QUANTITIES | | | CHECKED | | | |
| | ISSUE DATE | | FEDERAL PROJECT NO. | | SHEET NO. | | TOTAL SHEETS |
| | REV. DATE | | ---------- | | 3 | | 3 |

# Attachment I

## USFWS Northern Long-eared Bat Coordination

New Hampshire DOT Department of Transportation

# THE STATE OF NEW HAMPSHIRE
## DEPARTMENT OF TRANSPORTATION

Victoria F. Sheehan
Commissioner

William Cass, P.E.
Assistant Commissioner

MEMO

TO: File

FROM: Marc G. Laurin, Senior Environmental Manager

DATE: November 27, 2019

RE: Section 7 Endangered Species Act Consultation Derry-Londonderry, 13065, IM-0931(201)

The Project includes construction of a new interchange with I-93 (known as Exit 4A) in Londonderry, NH, with additional improvements on local roads in Derry and Londonderry, and other transportation improvements to reduce congestion and improve safety along NH Route 102, from I-93 Exit 4 easterly through downtown Derry, NH. The Project is approximately 3.2 miles in length between the new, proposed I-93 Exit 4A interchange and the eastern terminus in Derry. There would be approximately 1 mile of new roadway construction on a new alignment and 2.2 miles of existing roadway reconstruction. The new alignment would originate from the new I-93 Exit 4A interchange location and travel southeast through a wooded area to Folsom Road, near its intersection with North High Street and Madden Road in Derry. This project would continue to follow Folsom Road to Ross' Corner (Manchester Road/NH 28) and continue on Tsienneto Road across NH 28 Bypass to its intersection with NH 102, adjacent to Beaver Lake.

The IPAC review for Federally-listed ESA species identified that the Northern Long-eared Bat (NLEB), *Myotis septentrionalis,* could occur within the proposed project location, and/or may be affected by the proposed project. No critical habitats were identified within the project area. No other Federally-listed species were identified.

In August 2016 a Northern Long-eared Bat Acoustic Survey for the potential presence or absence of the NLEB was performed within the I-93 Exit 4A interchange project area by environmental consultants Normandeau Associates, Inc. The survey was conducted in conformance with the methods and approach outlined in the USFWS Guidelines. The field survey and the data analysis were conducted by personnel trained and qualified to conduct their respective tasks. Although Kaleidoscope Pro software identified four potential NLEB calls (one night each at Segments 9 and 12, and both nights at Segment 7) the P-values for these nights are not below the required threshold to confirm this identification. Therefore, per USFWS survey protocols no manual analysis was conducted and NLEB were deemed to not be present. A copy of the Acoustic Survey was provided to the USFWS on August 31, 2016, who concurred that the survey was performed per the survey plan.

For these reasons, NHDOT concludes that the Exit 4A Project will have "no effect" on the NLEB.

s:\environment\projects\derry\13065\2015-2017 feis update\nleb\nleb no effects memo.docx

# United States Department of the Interior

FISH AND WILDLIFE SERVICE
New England Ecological Services Field Office
70 Commercial Street, Suite 300
Concord, NH 03301-5094
Phone: (603) 223-2541 Fax: (603) 223-0104
http://www.fws.gov/newengland


In Reply Refer To:
Consultation Code: 05E1NE00-2020-SLI-0599
Event Code: 05E1NE00-2020-E-01582
Project Name: Derry-Londonderry, 13065

November 26, 2019

Subject: List of threatened and endangered species that may occur in your proposed project location, and/or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the ECOS-IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the ECOS-IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at:

http://www.fws.gov/endangered/esa-library/pdf/TOC-GLOS.PDF

Please be aware that bald and golden eagles are protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668 *et seq.*), and projects affecting these species may require development of an eagle conservation plan (http://www.fws.gov/windenergy/eagle_guidance.html). Additionally, wind energy projects should follow the wind energy guidelines (http://www.fws.gov/windenergy/) for minimizing impacts to migratory birds and bats.

Guidance for minimizing impacts to migratory birds for projects including communications towers (e.g., cellular, digital television, radio, and emergency broadcast) can be found at: http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/towers.htm; http://www.towerkill.com; and http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/comtow.html.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Tracking Number in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment(s):

- Official Species List

# Official Species List

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

**New England Ecological Services Field Office**
70 Commercial Street, Suite 300
Concord, NH 03301-5094
(603) 223-2541

## Project Summary

Consultation Code: 05E1NE00-2020-SLI-0599

Event Code: 05E1NE00-2020-E-01582

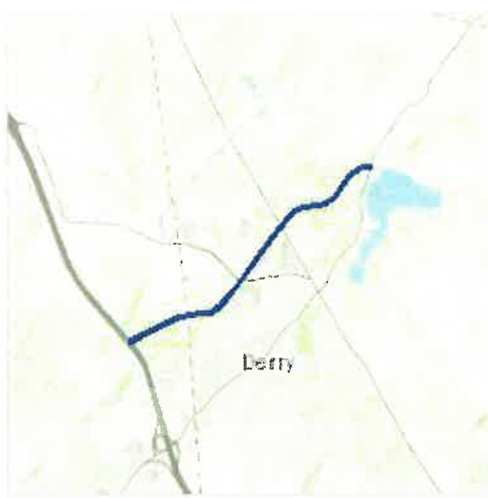
Project Name: Derry-Londonderry, 13065

Project Type: TRANSPORTATION

Project Description: The Project includes construction of a new interchange with I-93 (known as Exit 4A) in Londonderry, NH, with additional improvements on local roads in Derry and Londonderry, and other transportation improvements to reduce congestion and improve safety along NH Route 102, from I-93 Exit 4 easterly through downtown Derry, NH. The Project is approximately 3.2 miles in length between the new, proposed I-93 Exit 4A interchange and the eastern terminus in Derry. There would be approximately 1 mile of new roadway construction on a new alignment and 2.2 miles of existing roadway reconstruction. The new alignment would originate from the new I-93 Exit 4A interchange location and travel southeast through a wooded area to Folsom Road, near its intersection with North High Street and Madden Road in Derry. This project would continue to follow Folsom Road to Ross' Corner (Manchester Road/NH 28) and continue on Tsienneto Road across NH 28 Bypass to its intersection with NH 102, adjacent to Beaver Lake.

Project Location:

Approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/place/42.89752851830917N71.32326925530609W



Counties: Rockingham, NH

# Endangered Species Act Species

There is a total of 1 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

---

1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

## Mammals

| NAME | STATUS |
| --- | --- |
| Northern Long-eared Bat *Myotis septentrionalis*<br>No critical habitat has been designated for this species.<br>Species profile: https://ecos.fws.gov/ecp/species/9045 | Threatened |

## Critical habitats

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

**From:** Laurin, Marc
**To:** Lee Carbonneau
**Subject:** FW: [EXTERNAL] Derry-Londonderry, 13065 - Presence/Absence Survey
**Date:** Monday, November 25, 2019 2:50:14 PM

Lee,

FYI. Here is Susi's response to my inquiry on the P/A review.

Marc

**From:** vonOettingen, Susi <susi_vonoettingen@fws.gov>
**Sent:** Monday, November 25, 2019 12:55 PM
**To:** Laurin, Marc <Marc.Laurin@dot.nh.gov>
**Cc:** Martin, Rebecca <Rebecca.Martin@dot.nh.gov>; Jamie Sikora <jamie.sikora@dot.gov>
**Subject:** Re: [EXTERNAL] Derry-Londonderry, 13065 - Presence/Absence Survey

**EXTERNAL:** Do not open attachments or click on links unless you recognize and trust the sender.

Hi Marc,

I generally do not confirm survey reports. I did not have any comments to send Sarah, I believe they performed the survey per the survey plan. And since I am not a trained acoustic call analyzer, I don't review the data for mis-IDs.

I would say you are good to go if the verification form was submitted and you received no response.

Susi

****************************************
Susi von Oettingen
Endangered Species Biologist
New England Field Office
70 Commercial Street, Suite 300
Concord, NH 03301
(W) 603-227-6418
(Fax) 603-223-0104

www.fws.gov/newengland

On Mon, Nov 25, 2019 at 12:06 PM Laurin, Marc <Marc.Laurin@dot.nh.gov> wrote:

Susi,

I am following up on the August 2016 P/A NLEB survey conducted for the project, which proposes the construction of a new Exit 4A Interchange on I-93 in Londonderry, with a new connector road extending east only into Derry to Madden Road and requiring upgrades to Folsom Road, and Tsienneto Road, to its intersection with NH 102.

I have a copy of the Normandeau report in my files, and the attached email to you from Sarah Barnum indicating that it was forwarded to FWS. However I did not find any correspondence from USFW on concurrence on the survey results. I have inquired of Normandeau and they also did not find any.

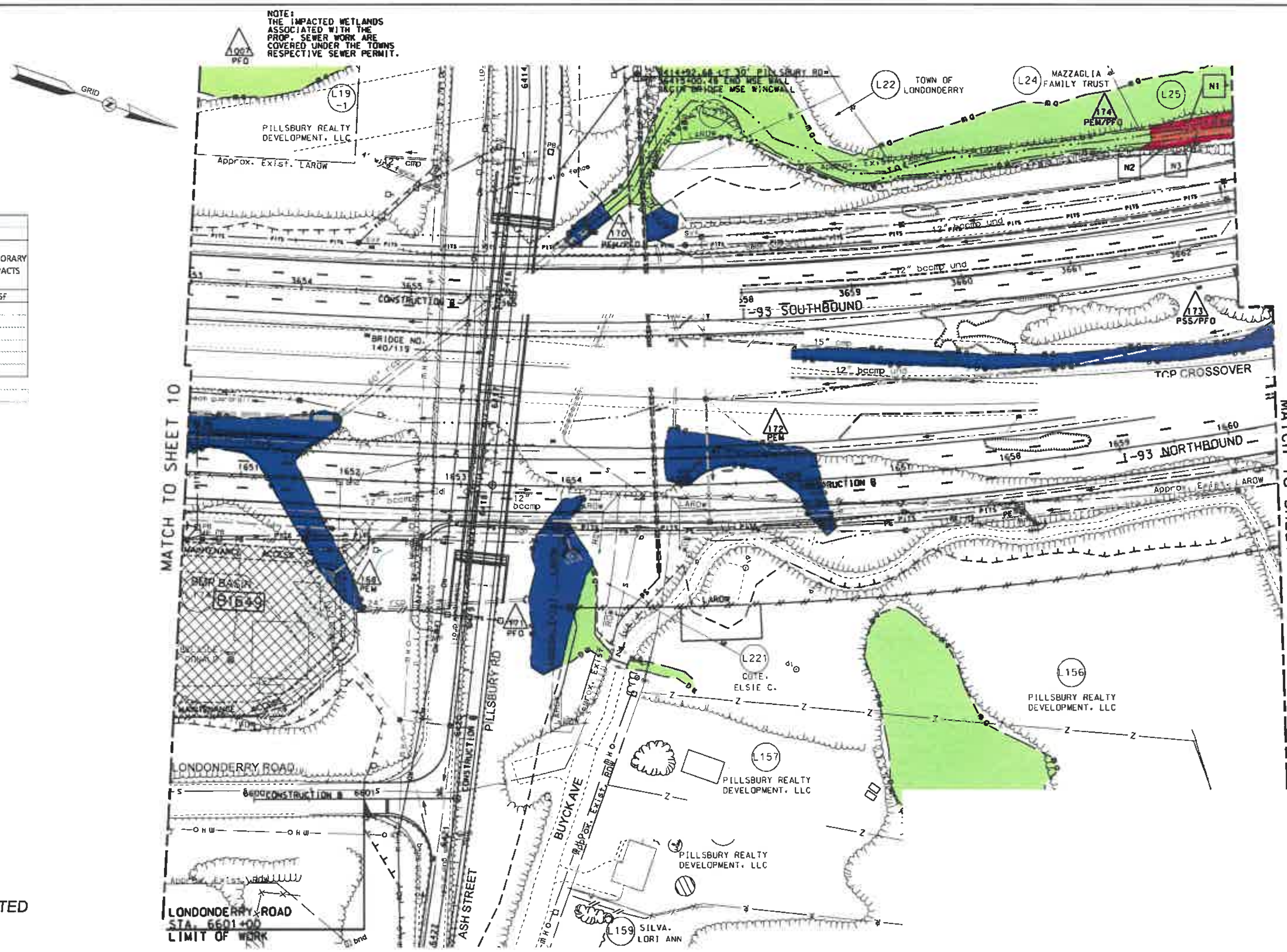
Can we assume that this was an oversight and that the P/A determination was appropriately performed?
Let me know if this is something you can provide at this time or if you need more information, as NHDOT is planning to submit an updated application to the Corps in early December and they will want to confirmation that we have coordinated appropriately on the ESA.

Thanks,

Marc

# Attachment J

## Map of Previously Permitted/Mitigated Wetlands




| WETLAND NUMBER | WETLAND CLASSIFICATION | LOCATION | PERMANENT N.H.W.B. & A.C.O.E. (WETLAND) | BANK | CHANNEL | TEMPORARY IMPACTS |
|---|---|---|---|---|---|---|
| | | | SF | LF | LF | SF |
| 174 | PEM/PFO | N1 | 13551 | | | |
| 174 | PEM/PFO | N2 | 3535 | | | |
| stream | R4UB | N3 | 7137 | | 803 | |
| 174 | PEM/PFO | N4 | 5292 | | | |
| 174 | PEM/PFO | N5 | 1832 | | | |

WETLAND IMPACT SUMMARY

Note: Impacts N1-N4 are from Contract 14633D, N5 is from Contract 14633I

| TOTAL IMPACTS FOR WETLANDS | |
|---|---|
| WETLAND AND STREAM IMPACTS (AREA) | |
| PERMANENT IMPACTS (WETLAND) | 24,210.00 SF |
| PERMANENT IMPACTS (STREAM) | 7,137.00 SF |
| TEMPORARY IMPACTS | 0.00 SF |
| TOTAL WETLAND IMPACTS: | 31,347.00 SF |
| STREAM IMPACTS (LINEAR) | |
| PERMANENT IMPACTS TO BANKS | 0.00 LF |
| PERMANENT IMPACTS TO CHANNEL | 803.00 LF |
| TEMPORARY IMPACTS TO BANKS | 0.00 LF |
| TEMPORARY IMPACTS TO CHANNEL | 0.00 LF |
| TOTAL STREAM IMPACTS: | 803.00 LF |

I-93 AS-BUILT CONDITIONS

PREVIOUSLY PERMITTED/ SELF MITIGATED STREAM IMPACTS

PREVIOUSLY PERMITTED/ MITIGATED WETLAND IMPACTS

LEGEND

WETLAND
IMPACT AREA
SURFACE WATERS
PREVIOUSLY ACCOUNTED IMPACT
SCALE IN FEET -50 0 50 100

PROPOSED BMP BASIN
DETENTION EXCAVATION
CUT
FILL

INTERSTATE 93 IMPROVEMENTS
SALEM TO MANCHESTER
A004(375) 14633D
I-93 NB MAINLINE STA. 1555+00 THRU STA. 1668+42
I-93 SB MAINLINE STA. 3552+50 THRU STA. 3676+75
EXIT 4 INTERCHANGE, ASH ST/PILLSBURY RD & NH ROUTE 102

AT: TOWNS OF DERRY & LONDONDERRY

IN: COUNTY OF ROCKINGHAM NEW HAMPSHIRE

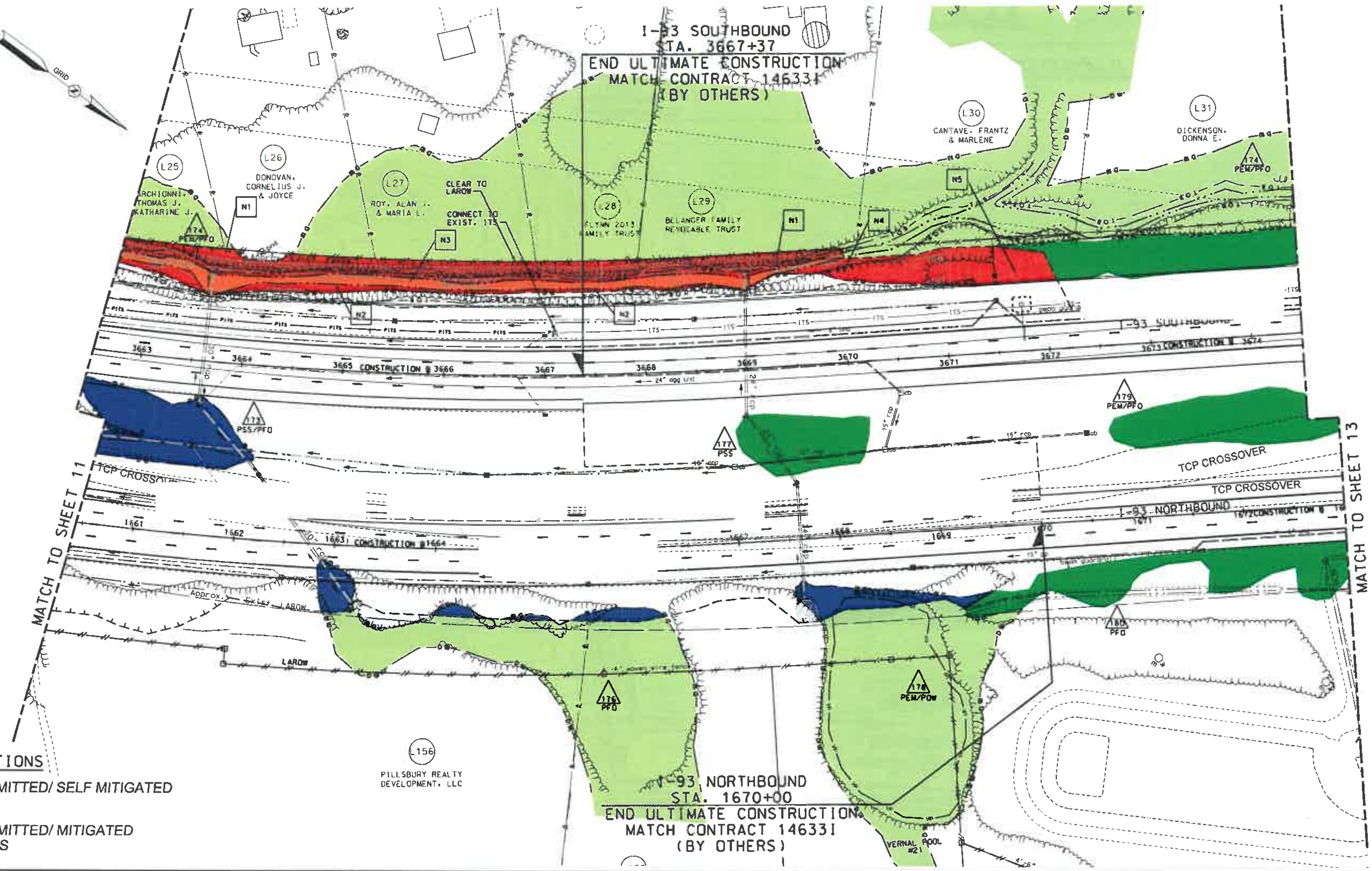
PARSONS BRINCKERHOFF

NHDOT

THE STATE OF NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION

DATE: 11-22-2016

SHEET:$SHT$ OF




I-93 AS-BUILT CONDITIONS

PREVIOUSLY PERMITTED/ SELF MITIGATED STREAM IMPACTS

PREVIOUSLY PERMITTED/ MITIGATED WETLAND IMPACTS

LEGEND

WETLAND

IMPACT AREA

SURFACE WATERS

PREVIOUSLY ACCOUNTED IMPACT

PROPOSED BMP BASIN

CUT

FILL

SCALE IN FEET -50 0 50 100

INTERSTATE 93 IMPROVEMENTS
SALEM TO MANCHESTER
A004(375) 14633D
I-93 NB MAINLINE STA. 1555+00 THRU STA. 1668+42
I-93 SB MAINLINE STA. 3552+50 THRU STA. 3676+75
EXIT 4 INTERCHANGE, ASH ST/PILLSBURY RD & NH ROUTE 102

AT: TOWNS OF DERRY & LONDONDERRY

IN: COUNTY OF ROCKINGHAM
NEW HAMPSHIRE

PARSONS BRINCKERHOFF

NHDOT

THE STATE OF NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION

DATE: 11-22-2016

SHEET:$SHT$ OF

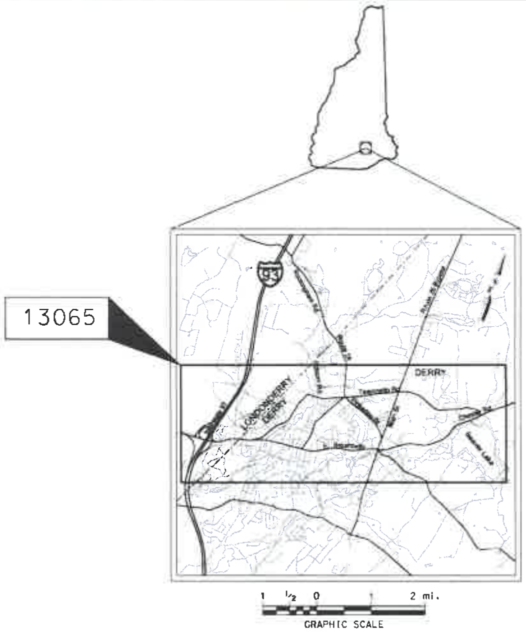
# STATE OF NEW HAMPSHIRE
# DEPARTMENT OF TRANSPORTATION

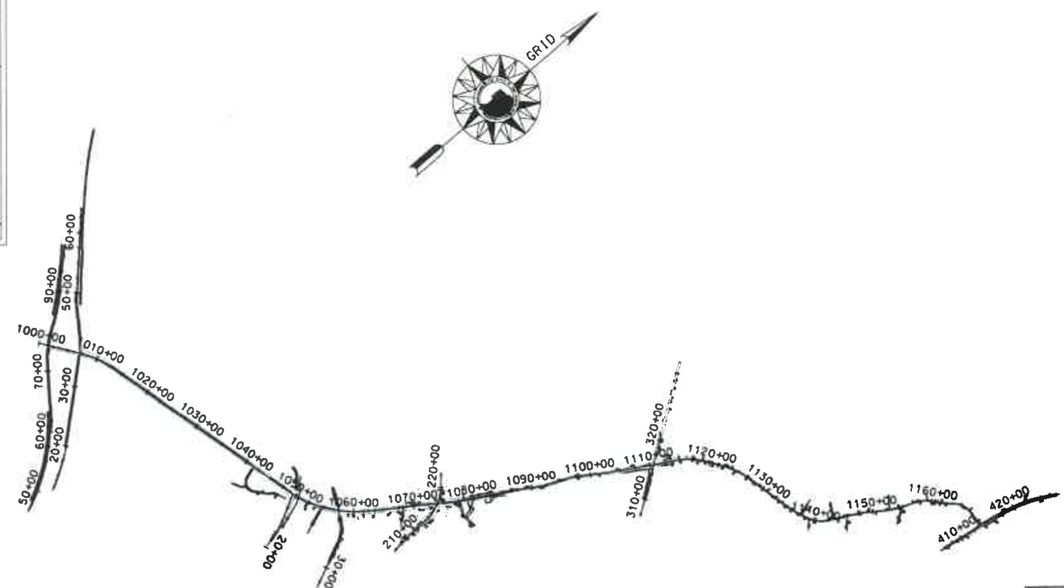
# WETLAND PLANS

## I-93 EXIT 4A DERRY-LONDONDERRY
## FEDERAL PROJECT IM-0931(201)
## NH PROJECT 13065

INDEX OF SHEETS

| | |
|---|---|
| 1 | FRONT SHEET |
| 2-3 | STANDARD SYMBOLS |
| 4-5 | WETLAND IMPACT TABLES |
| 6-28 | WETLAND IMPACT PLANS |




TOWNS OF LONDONDERRY & DERRY
COUNTY OF ROCKINGHAM
SCALE : 1" = 1000'
FOR CONSTRUCTION AND ALIGNMENT DETAILS - SEE CONSTRUCTION PLANS

1000 0 1000 2000
SCALE IN FEET

| | |
|---|---|
| DRAWN BY MGS | DATE 1/14/2020 |
| CHECKED BY NCF | DATE 1/14/2020 |

NHDOT THE STATE OF NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION

RECOMMENDED FOR APPROVAL:
DIRECTOR OF PROJECT DEVELOPMENT DATE

APPROVED:
ASSISTANT COMMISSIONER AND CHIEF ENGINEER DATE

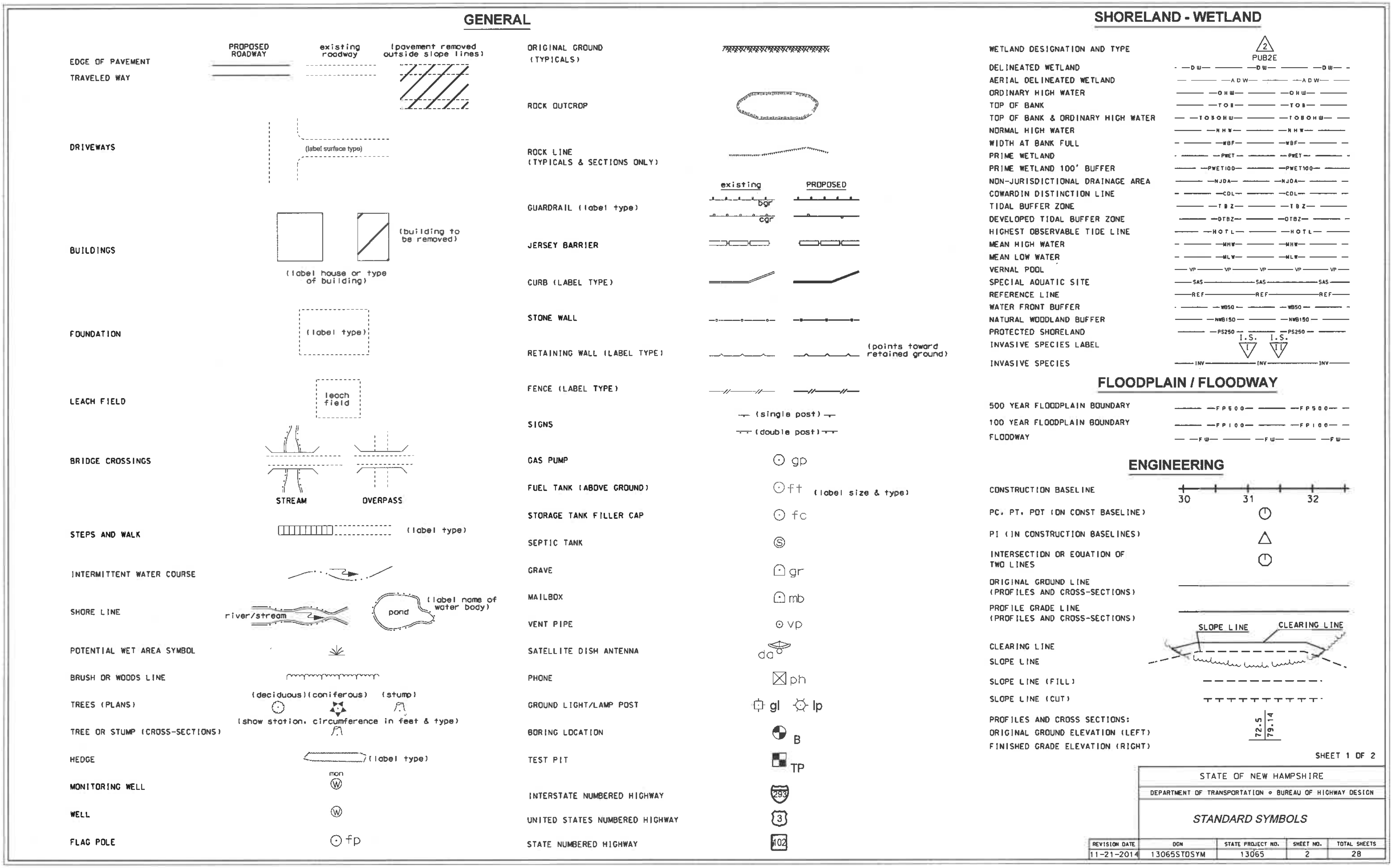
U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

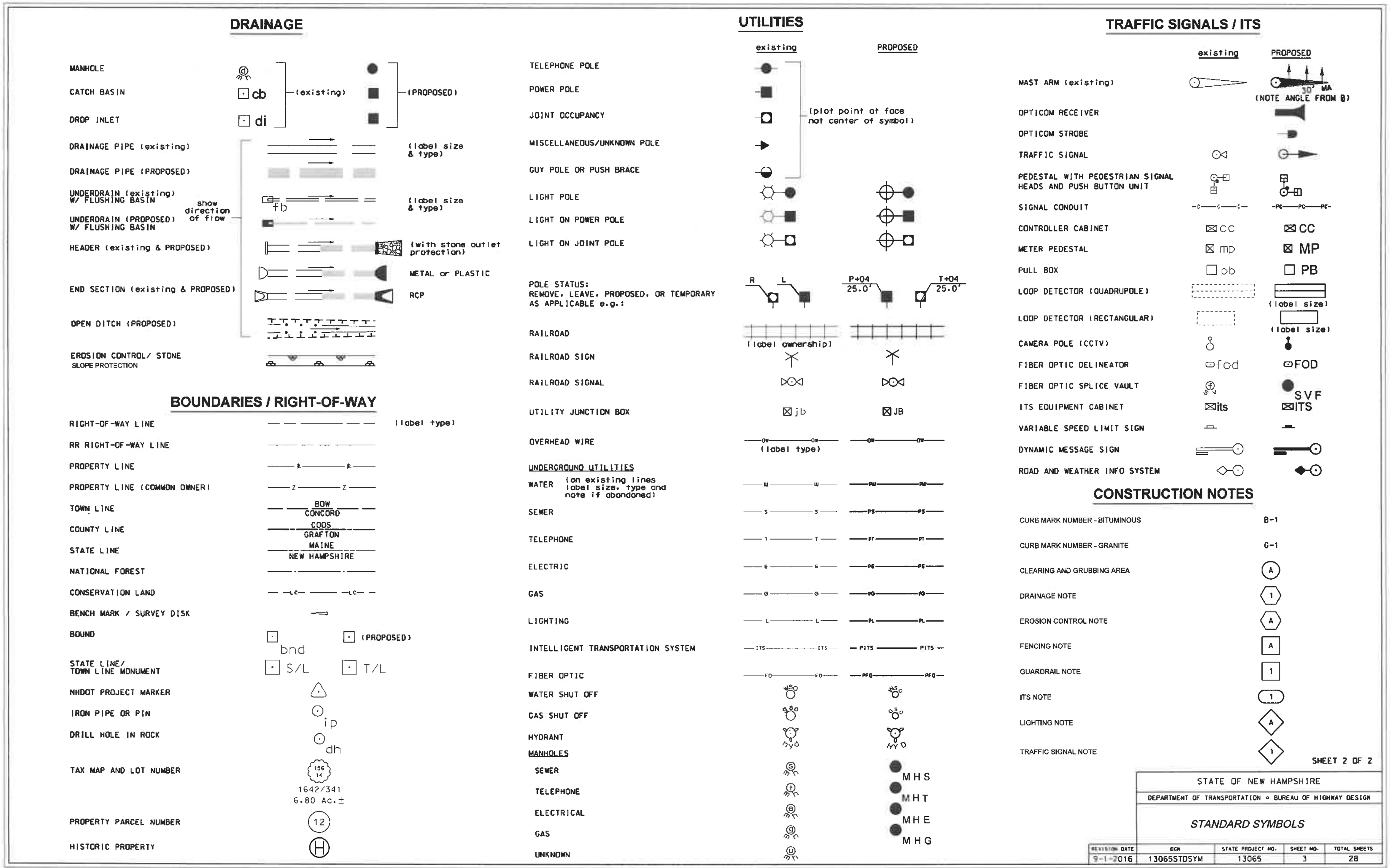
APPROVED:
DIVISION ADMINISTRATOR DATE

| FEDERAL PROJECT NO. | STATE PROJECT NO. | SHEET NO. | TOTAL SHEETS |
|---|---|---|---|
| IM-0931(201) | 13065 | 1 | 28 |

No. 123
2/7/20

2/7/2020


GENERAL
PROPOSED ROADWAY
existing roadway
(pavement removed outside slope lines)
EDGE OF PAVEMENT
TRAVELED WAY
DRIVEWAYS
(label surface type)
BUILDINGS
(building to be removed)
(label house or type of building)
FOUNDATION
(label type)
LEACH FIELD
leach field
BRIDGE CROSSINGS
STREAM
OVERPASS
STEPS AND WALK
(label type)
INTERMITTENT WATER COURSE
SHORE LINE
river/stream
pond
(label name of water body)
POTENTIAL WET AREA SYMBOL
BRUSH OR WOODS LINE
TREES (PLANS)
(deciduous)(coniferous)
(stump)
TREE OR STUMP (CROSS-SECTIONS)
(show station, circumference in feet & type)
HEDGE
(label type)
MONITORING WELL
mon
WELL
FLAG POLE
fp
ORIGINAL GROUND (TYPICALS)
ROCK OUTCROP
ROCK LINE (TYPICALS & SECTIONS ONLY)
existing
PROPOSED
GUARDRAIL (label type)
bgr
cgr
JERSEY BARRIER
CURB (LABEL TYPE)
STONE WALL
RETAINING WALL (LABEL TYPE)
(points toward retained ground)
FENCE (LABEL TYPE)
SIGNS
(single post)
(double post)
GAS PUMP
gp
FUEL TANK (ABOVE GROUND)
ft
(label size & type)
STORAGE TANK FILLER CAP
fc
SEPTIC TANK
S
GRAVE
gr
MAILBOX
mb
VENT PIPE
vp
SATELLITE DISH ANTENNA
da
PHONE
ph
GROUND LIGHT/LAMP POST
gl
lp
BORING LOCATION
B
TEST PIT
TP
INTERSTATE NUMBERED HIGHWAY
293
UNITED STATES NUMBERED HIGHWAY
3
STATE NUMBERED HIGHWAY
102
SHORELAND - WETLAND
WETLAND DESIGNATION AND TYPE
2
PUB2E
DELINEATED WETLAND
DW
AERIAL DELINEATED WETLAND
ADW
ORDINARY HIGH WATER
OHW
TOP OF BANK
TOB
TOP OF BANK & ORDINARY HIGH WATER
TOBOHW
NORMAL HIGH WATER
NHW
WIDTH AT BANK FULL
WBF
PRIME WETLAND
PWET
PRIME WETLAND 100' BUFFER
PWET100
NON-JURISDICTIONAL DRAINAGE AREA
NJDA
COWARDIN DISTINCTION LINE
CDL
TIDAL BUFFER ZONE
TBZ
DEVELOPED TIDAL BUFFER ZONE
DTBZ
HIGHEST OBSERVABLE TIDE LINE
HOTL
MEAN HIGH WATER
MHW
MEAN LOW WATER
MLW
VERNAL POOL
VP
SPECIAL AQUATIC SITE
SAS
REFERENCE LINE
REF
WATER FRONT BUFFER
WB50
NATURAL WOODLAND BUFFER
NWB150
PROTECTED SHORELAND
PS250
INVASIVE SPECIES LABEL
I.S.
I
II
INVASIVE SPECIES
INV
FLOODPLAIN / FLOODWAY
500 YEAR FLOODPLAIN BOUNDARY
FP500
100 YEAR FLOODPLAIN BOUNDARY
FP100
FLOODWAY
FW
ENGINEERING
CONSTRUCTION BASELINE
30
31
32
PC, PT, POT (ON CONST BASELINE)
PI (IN CONSTRUCTION BASELINES)
INTERSECTION OR EQUATION OF TWO LINES
ORIGINAL GROUND LINE (PROFILES AND CROSS-SECTIONS)
PROFILE GRADE LINE (PROFILES AND CROSS-SECTIONS)
SLOPE LINE
CLEARING LINE
CLEARING LINE
SLOPE LINE
SLOPE LINE (FILL)
SLOPE LINE (CUT)
PROFILES AND CROSS SECTIONS:
ORIGINAL GROUND ELEVATION (LEFT)
FINISHED GRADE ELEVATION (RIGHT)
72.5
79.14
SHEET 1 OF 2
STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION • BUREAU OF HIGHWAY DESIGN
STANDARD SYMBOLS
REVISION DATE
11-21-2014
DGN
13065STDSYM
STATE PROJECT NO.
13065
SHEET NO.
2
TOTAL SHEETS
28


DRAINAGE
MANHOLE
CATCH BASIN
DROP INLET
cb
di
(existing)
(PROPOSED)
DRAINAGE PIPE (existing)
DRAINAGE PIPE (PROPOSED)
(label size & type)
UNDERDRAIN (existing) W/ FLUSHING BASIN
UNDERDRAIN (PROPOSED) W/ FLUSHING BASIN
show direction of flow
fb
(label size & type)
HEADER (existing & PROPOSED)
(with stone outlet protection)
END SECTION (existing & PROPOSED)
METAL or PLASTIC
RCP
OPEN DITCH (PROPOSED)
EROSION CONTROL/ STONE
SLOPE PROTECTION
BOUNDARIES / RIGHT-OF-WAY
RIGHT-OF-WAY LINE
(label type)
RR RIGHT-OF-WAY LINE
PROPERTY LINE
PROPERTY LINE (COMMON OWNER)
TOWN LINE
BOW
CONCORD
COUNTY LINE
COOS
GRAFTON
STATE LINE
MAINE
NEW HAMPSHIRE
NATIONAL FOREST
CONSERVATION LAND
BENCH MARK / SURVEY DISK
BOUND
bnd
(PROPOSED)
STATE LINE/ TOWN LINE MONUMENT
S/L
T/L
NHDOT PROJECT MARKER
IRON PIPE OR PIN
ip
DRILL HOLE IN ROCK
dh
TAX MAP AND LOT NUMBER
156 14
1642/341
6.80 Ac.±
PROPERTY PARCEL NUMBER
12
HISTORIC PROPERTY
H
UTILITIES
existing
PROPOSED
TELEPHONE POLE
POWER POLE
JOINT OCCUPANCY
(plot point at face not center of symbol)
MISCELLANEOUS/UNKNOWN POLE
GUY POLE OR PUSH BRACE
LIGHT POLE
LIGHT ON POWER POLE
LIGHT ON JOINT POLE
POLE STATUS: REMOVE, LEAVE, PROPOSED, OR TEMPORARY AS APPLICABLE e.g.:
R
L
P+04 25.0'
T+04 25.0'
RAILROAD
(label ownership)
RAILROAD SIGN
RAILROAD SIGNAL
UTILITY JUNCTION BOX
jb
JB
OVERHEAD WIRE
(label type)
UNDERGROUND UTILITIES
WATER (on existing lines label size, type and note if abandoned)
SEWER
TELEPHONE
ELECTRIC
GAS
LIGHTING
INTELLIGENT TRANSPORTATION SYSTEM
FIBER OPTIC
WATER SHUT OFF
GAS SHUT OFF
HYDRANT
hyd
HYD
MANHOLES
SEWER
TELEPHONE
ELECTRICAL
GAS
UNKNOWN
MHS
MHT
MHE
MHG
TRAFFIC SIGNALS / ITS
existing
PROPOSED
MAST ARM (existing)
30° MA
(NOTE ANGLE FROM ℄)
OPTICOM RECEIVER
OPTICOM STROBE
TRAFFIC SIGNAL
PEDESTAL WITH PEDESTRIAN SIGNAL HEADS AND PUSH BUTTON UNIT
SIGNAL CONDUIT
CONTROLLER CABINET
cc
CC
METER PEDESTAL
mp
MP
PULL BOX
pb
PB
LOOP DETECTOR (QUADRUPOLE)
(label size)
LOOP DETECTOR (RECTANGULAR)
(label size)
CAMERA POLE (CCTV)
FIBER OPTIC DELINEATOR
fod
FOD
FIBER OPTIC SPLICE VAULT
SVF
ITS EQUIPMENT CABINET
its
ITS
VARIABLE SPEED LIMIT SIGN
DYNAMIC MESSAGE SIGN
ROAD AND WEATHER INFO SYSTEM
CONSTRUCTION NOTES
CURB MARK NUMBER - BITUMINOUS
B-1
CURB MARK NUMBER - GRANITE
G-1
CLEARING AND GRUBBING AREA
A
DRAINAGE NOTE
1
EROSION CONTROL NOTE
A
FENCING NOTE
A
GUARDRAIL NOTE
1
ITS NOTE
1
LIGHTING NOTE
A
TRAFFIC SIGNAL NOTE
1
SHEET 2 OF 2
STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION • BUREAU OF HIGHWAY DESIGN
STANDARD SYMBOLS
REVISION DATE 9-1-2016
DGN 13065STDSYM
STATE PROJECT NO. 13065
SHEET NO. 3
TOTAL SHEETS 28

## WETLAND IMPACT SUMMARY

| WETLAND NUMBER | WETLAND CLASSIFICATION | LOCATION | PERMANENT N.H.W.B. & A.C.O.E. (WETLAND) | BANK | CHANNEL | TEMPORARY IMPACTS | TOWN | COMMENTS |
|---|---|---|---|---|---|---|---|---|
| | | | SF | LF | LF | SF | | |
| S1 | R4UB3 | A | | | 44 | 336 | L | self-mitigating |
| S1 | R4UB3 | B | | | 1638 | 19364 | L | self-mitigating |
| 14 | PFO1/2E | C | 21575 | | | | L | |
| 14 | PFO1/2E | D | 13598 | | | | L | |
| 15 | PFO1E | E | 4382 | | | | L | |
| VP2 | VP | F | 7236 | | | | L | |
| 14 | PFO1/2E | G | 6278 | | | | L | |
| 15 | PFO1E | H | 1324 | | | | L | |
| 16 | PFO1E | I | 2336 | | | | L | |
| VP3 | VP | J | 9387 | | | | L | |
| 16 | PFO1E | K | 507 | | | | L | |
| S70 | R4SB5 | L | 187 | | 70 | | L | |
| 14 | PFO1/2E | M | 16866 | | | | L | |
| 14 | PFO1/2E | N | 37008 | | | | L | |
| 16 | PFO1E | O | 199 | | | | L | |
| VP4 | VP | P | 9278 | | | | L | |
| 16 | PFO1E | Q | 2061 | | | | L | |
| 16 | PFO1E | R | 1919 | | | | L | |
| S9 | R4SB5 | S | 48 | | 23 | | L | |
| 17 | PFO1E | T | 39 | | | | L | |
| S7 | R4SB5 | U | 884 | | 117 | | L | |
| 17 | PFO1E | V | 3484 | | | | L | |
| S7 | R4SB5 | W | 738 | | 116 | | L | |
| 13 | PFO1E | X | 1820 | | | | L | |
| 66 | PFO1E | Y | 692 | | | | L | |
| 11 | PFO1E | Z | 909 | | | | L | |
| 11 | PFO1E | AA | 3312 | | | | L | |
| 67 | PFO1E | AB | 1483 | | | | L | |
| 11 | PFO1E | AC | 366 | | | | L | |
| 11 | PFO1E | AD | 2519 | | | | L | |
| 19 | PFO1E | AE | 9131 | | | | L | |
| VP42 | VP | AF | 5415 | | | | L | |
| 18 | PEM1E | AG | 659 | | | | L | |
| S8 | R4SB5 | AH | 1232 | | 291 | | L | |
| 20 | PFO1E | AI | 273 | | | | L | |
| 20 | PFO1E | AJ | 1232 | | | | L | |
| 21 | PFO1E | AK | 361 | | | | L | |
| VP46 | VP | AL | 611 | | | | L | |
| 22 | PFO1E | AM | 216 | | | | L | |
| 24 | PFO1E | AN | 167 | | | | L | |
| VP6 | VP | AO | 15631 | | | | L | |
| 24 | PFO1E | AP | 5 | | | | L | |
| 24 | PFO1E | AQ | 452 | | | | L | |
| 24 | PFO1E | AR | 58 | | | | L | |
| 24 | PFO1E | AS | 2598 | | | | L | |
| 24 | PFO1E | AT | 168 | | | | L | |
| 90 | PFO1E | AU | 1148 | | | | L | |
| 35 | PFO1E | AV | 136 | | | | L | |
| 35 | PFO1E | AW | 1155 | | | | L | |
| VP8 | VP | AX | 10722 | | | | L | |
| 35 | PFO1E | AY | 21 | | | | L | |
| 35 | PFO1E | AZ | 301 | | | | L | |
| 35 | PFO1E | BA | 5 | | | | L | |
| 35 | PFO1E | BB | 526 | | | | L | |
| VP9 | VP | BC | 3335 | | | | L/D | |
| 64 | PFO1E | BD | 180 | | | | L/D | |
| 64 | PFO1E | BE | 382 | | | | L/D | |
| 64 | PFO1E | BF | 1139 | | | | L/D | |
| 39 | PEM1F | BG | 4379 | | | | D | |
| S11 | R4SB5 | BH | 77 | | 77 | | D | |
| 40 | PSS1E | BI | 852 | | | | D | |

## WETLAND IMPACT SUMMARY

| WETLAND NUMBER | WETLAND CLASSIFICATION | LOCATION | PERMANENT N.H.W.B. & A.C.O.E. (WETLAND) | BANK | CHANNEL | TEMPORARY IMPACTS | TOWN | COMMENTS |
|---|---|---|---|---|---|---|---|---|
| | | | SF | LF | LF | SF | | |
| 86 | PFO1E | BJ | 552 | | | | D | |
| 72 | PSS1/PEM1/PFO1B | BK | 155 | | | | D | Prime Wetland |
| S2 | R3UB3 | BL | 4048 | 404 | 202 | | D | |
| 41 | PFO1E | BM | 176 | | | | D | |
| 41 | PFO1E | BN | 6901 | | | | D | |
| S2 | R3UB3 | BO | 780 | 107 | 45 | | D | |
| 46 | PFO1E | BP | 2561 | | | | D | |
| 73 | PEM1/PSS1E | BQ | 2850 | | | | D | |
| 49 | PFO1E | BR | 3025 | | | | D | |
| 100 | PFO1E | BS | 311 | | | | D | |
| 102 | PEM1E | BT | 90 | | | | D | |
| S101 | R4SB2 | BU | 54 | | 13 | | D | |
| 61 | PFO1E | BV | 582 | | | | D | |
| 81 | PFO | BW | 273 | | | | D | |
| 54 | PEM1E | BX | 62 | | | | D | |
| S3 | R4SB5 | BY | 159 | | 24 | | D | |
| S3 | R4SB5 | BZ | 265 | | 33 | | D | |
| S4 | R4SB5 | CA | 219 | | 46 | | D | |
| S4 | R4SB5 | CB | 196 | | 29 | | D | |
| 80 | PFO1E/PEM1E | CC | 941 | | | | D | |
| 80 | PFO1E/PEM1E | CD | 81 | | | | D | |
| 80 | PFO1E/PEM1E | CE | 215 | | | | D | |
| 80 | PFO1E/PEM1E | CF | 598 | | | | D | |
| 80 | PFO1E/PEM1E | CG | 40 | | | | D | |
| S100 | R4SB6 | CH | 125 | | 22 | | D | |
| 59 | PFO1E | CI | 815 | | | | D | |
| 56 | PEM1E | CJ | 615 | | | | D | |
| 62 | PSS/PEM1E | CK | 1389 | | | | D | Prime Wetland |
| 59 | PFO1E | CL | 1666 | | | | D | |
| 62 | PSS/PEM1E | CM | 172 | | | | D | Prime Wetland |
| S5 | R3UB3 | CN | 109 | 32 | 11 | | D | |
| 62 | PSS/PEM1E | CO | 410 | | | | D | Prime Wetland |
| S102 | R4SB2 | CP | 212 | | 41 | | D | |
| 19 | PFO1E | CQ | 497 | | | | L | |
| S1 | R4UB3 | CR | | | 37 | 694 | L | self-mitigating |
| | | | | | | | | |
| S1 | R4UB3 | TA | | | 5 | 42 | L | |
| S1 | R4UB3 | TB | | | 5 | 150 | L | |
| 14 | PFO1/2E | TC | | | | 1261 | L | |
| 15 | PFO1E | TD | | | | 290 | L | |
| 15 | PFO1E | TE | | | | 145 | L | |
| VP2 | VP | TF | | | | 606 | L | |
| 15 | PFO1E | TG | | | | 50 | L | |
| 14 | PFO1/2E | TH | | | | 593 | L | |
| VP3 | VP | TI | | | | 810 | L | |
| 14 | PFO1/2E | TJ | | | | 1239 | L | |
| 14 | PFO1/2E | TK | | | | 1072 | L | |
| S1 | R4UB3 | TL | | | 5 | 68 | L | |
| 14 | PFO1/2E | TM | | | | 1267 | L | |
| S9 | R4SB5 | TN | | | 5 | 16 | L | |
| 66 | PFO1E | TO | | | | 271 | L | |
| 11 | PFO1E | TP | | | | 457 | L | |
| 11 | PFO1E | TQ | | | | 703 | L | |
| 67 | PFO1E | TR | | | | 691 | L | |
| 9 | PFO1 | TS | | | | 77 | L | |
| 9 | PFO1 | TT | | | | 52 | L | |
| 11 | PFO1E | TU | | | | 1206 | L | |
| 21 | PFO1E | TZ | | | | 177 | L | |
| VP46 | VP | TAA | | | | 68 | L | |
| 22 | PFO1E | TAB | | | | 38 | L | |
| VP6 | VP | TAC | | | | 126 | L | |

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WETLAND IMPACT TABLES

| DGN | STATE PROJECT NO. | SHEET NO. | TOTAL SHEETS |
|---|---|---|---|
| 13065TABLE | 13065 | 4 | 28 |

REVISIONS AFTER PROPOSAL

| NUMBER | DATE | STATION | STATION | DESCRIPTION |
|---|---|---|---|---|

| | | | |
|---|---|---|---|
| SDR PROCESSED | | DATE | |
| NEW DESIGN | EMM | DATE | 2/6/2020 |
| SHEET CHECKED | NCF | DATE | 2/6/2020 |
| AS BUILT DETAILS | | DATE | |

| SDR PROCESSED | | DATE |
|---|---|---|
| NEW DESIGN | EMM | DATE 2/6/2020 |
| SHEET CHECKED | NCF | DATE 2/6/2020 |
| AS BUILT DETAILS | | DATE |

REVISIONS AFTER PROPOSAL

| NUMBER | DATE | STATION | STATION | DESCRIPTION |
|---|---|---|---|---|

## WETLAND IMPACT SUMMARY

| WETLAND NUMBER | WETLAND CLASSIFICATION | LOCATION | PERMANENT N.H.W.B. & A.C.O.E. (WETLAND) | BANK | CHANNEL | TEMPORARY IMPACTS | TOWN | COMMENTS |
|---|---|---|---|---|---|---|---|---|
| | | | SF | LF | LF | SF | | |
| 24 | PFO1E | TAD | | | | 79 | L | |
| 24 | PFO1E | TAE | | | | 32 | L | |
| VP6 | VP | TAF | | | | 378 | L | |
| 24 | PFO1E | TAG | | | | 7 | L | |
| 90 | PFO1E | TAH | | | | 105 | L | |
| 35 | PFO1E | TAI | | | | 76 | L | |
| VP8 | VP | TAJ | | | | 15 | L | |
| VP8 | VP | TAK | | | | 611 | L | |
| 35 | PFO1E | TAL | | | | 90 | L | |
| 35 | PFO1E | TAM | | | | 7 | L | |
| VP8 | VP | TAN | | | | 619 | L | |
| 35 | PFO1E | TAO | | | | 38 | L | |
| 39 | PEM1F | TAP | | | | 356 | D | |
| S2 | R3UB3 | TAQ | | 32 | 20 | 129 | D | |
| 72 | PSS1/PEM1/PFO1B | TAR | | | | 100 | D | Prime Wetland |
| S2 | R3UB3 | TAS | | 10 | 5 | 85 | D | |
| 41 | PFO1E | TAT | | | | 150 | D | |
| S2 | R3UB3 | TAU | | 10 | 5 | 154 | D | |
| 41 | PFO1E | TAV | | | | 160 | D | |
| S2 | R3UB3 | TAW | | 10 | 5 | 77 | D | |
| S2 | R3UB3 | TAX | | 10 | 5 | 87 | D | |
| 85 | PSS1E | TAY | | | | 63 | D | |
| 46 | PFO1E | TAZ | | | | 646 | D | |
| 73 | PEM1/PSS1E | TBA | | | | 1281 | D | |
| 83 | PEM1E | TBB | | | | 100 | D | |
| 49 | PFO1E | TBC | | | | 459 | D | |
| 102 | PEM1E | TBD | | | | 53 | D | |
| 60 | PFO1E | TBE | | | | 54 | D | |
| 81 | PEM1H/PUB5H | TBF | | | | 144 | D | |
| 81 | PEM1H/PUB5H | TBG | | | | 260 | D | |
| 54 | PEM1E | TBH | | | | 162 | D | |
| 103 | PFO1 | TBI | | | | 9 | D | |
| S3 | R4SB5 | TBJ | | | 5 | 19 | D | |
| S3 | R4SB5 | TBK | | | 5 | 34 | D | |
| S4 | R4SB5 | TBL | | | 5 | 33 | D | |
| S4 | R4SB5 | TBM | | | 5 | 15 | D | |
| 80 | PFO1E/PEM1E | TBN | | | | 420 | D | |
| 80 | PFO1E/PEM1E | TBO | | | | 561 | D | |
| 80 | PFO1E/PEM1E | TBP | | | | 213 | D | |
| 80 | PFO1E/PEM1E | TBQ | | | | 130 | D | |
| 80 | PFO1E/PEM1E | TBR | | | | 52 | D | |
| 59 | PFO1E | TBS | | | | 176 | D | |
| 56 | PEM1E | TBT | | | | 112 | D | |
| 62 | PSS/PEM1E | TBU | | | | 1228 | D | Prime Wetland |
| 59 | PFO1E | TBV | | | | 92 | D | |
| 59 | PFO1E | TBW | | | | 94 | D | |
| S5 | R3UB3 | TBX | | 25 | 5 | 135 | D | |
| 59 | PFO1E | TBY | | | | 482 | D | |
| S5 | R3UB3 | TBZ | | 18 | 8 | 22 | D | |
| 62 | PSS/PEM1E | TCA | | | | 73 | D | Prime Wetland |
| 62 | PSS/PEM1E | TCB | | | | 159 | D | Prime Wetland |
| 54 | PEM1E | TCC | | | | 27 | D | |
| VP11 | VP | TCD | | | | 87 | D | |
| S1 | R4UB3 | TCE | | | 5 | 114 | L | |
| S1 | R4UB3 | TCF | | | 121 | 370 | L | |

## WETLAND CLASSIFICATION CODES

| | |
|---|---|
| BANK | BANK |
| PEM1E | PALUSTRINE, EMERGENT, PERSISTENT, SEASONALLY FLOODED /SATURATED |
| PEM1F | PALUSTRINE, EMERGENT, PERSISTENT, SEMIPERMANENTLY FLOODED |
| PEM1H/PUB5H | PERMANENTLY FLOODED PALUSTRINE EMERGENT, PERSISTENT WETLAND, MIXED WITH OPEN WATER, UNCONSOLIDATED BOTTOM |
| PFO1/2E | PALUSTRINE, FORESTED, DOMINANTLY BROAD-LEAVED DECIDUOUS, MIXED WITH NEEDLE-LEAVED DECIDUOUS, SEASONALLY FLOODED /SATURATED |
| PFO1E | PALUSTRINE, FORESTED, BROAD-LEAVED DECIDUOUS, SEASONALLY FLOODED /SATURATED |
| PFO1E/PEM1E | PALUSTRINE, FORESTED, BROAD-LEAVED DECIDUOUS WETLAND MIXED WITH SEASONALLY SATURATED EMERGENT PERSISTENT WETLAND |
| PSS/PEM1E | PALUSTRINE, DOMINANTLY SCRUB-SHRUB, MIXED WITH EMERGENT, PERSISTENT, SEASONALLY FLOODED /SATURATED |
| PSS1E | PALUSTRINE, SCRUB-SHRUB, BROAD-LEAVED DECIDUOUS, SEASONALLY FLOODED /SATURATED |
| R3UB3 | RIVERINE, UPPER PERENNIAL, UNCONSOLIDATED BOTTOM, MUD |
| R4UB3 | RIVERINE, INTERMITTENT, UNCONSOLIDATED BOTTOM, MUD |
| R4SB | RIVERINE, INTERMITTENT, STREAMBED |
| R4SB5 | RIVERINE, INTERMITTENT, STREAMBED, MUD |
| VP | VERNAL POOL |

| TOTAL IMPACTS FOR WETLANDS | |
|---|---|
| WETLAND AND STREAM IMPACTS (AREA) | |
| PERMANENT IMPACTS (WETLAND) | 234,853.00 SF |
| PERMANENT IMPACTS (STREAM) | 9,333.00 SF |
| TEMPORARY IMPACTS | 43,103.00 SF |
| TOTAL WETLAND IMPACTS: | 287,289.00 SF |
| STREAM IMPACTS (LINEAR) | |
| PERMANENT IMPACTS TO BANKS | 543.00 LF |
| PERMANENT IMPACTS TO CHANNEL | 1,160.00 LF |
| TEMPORARY IMPACTS TO BANKS | 115.00 LF |
| TEMPORARY IMPACTS TO CHANNEL | 1,938.00 LF |
| TOTAL STREAM IMPACTS: | 3,756.00 LF |

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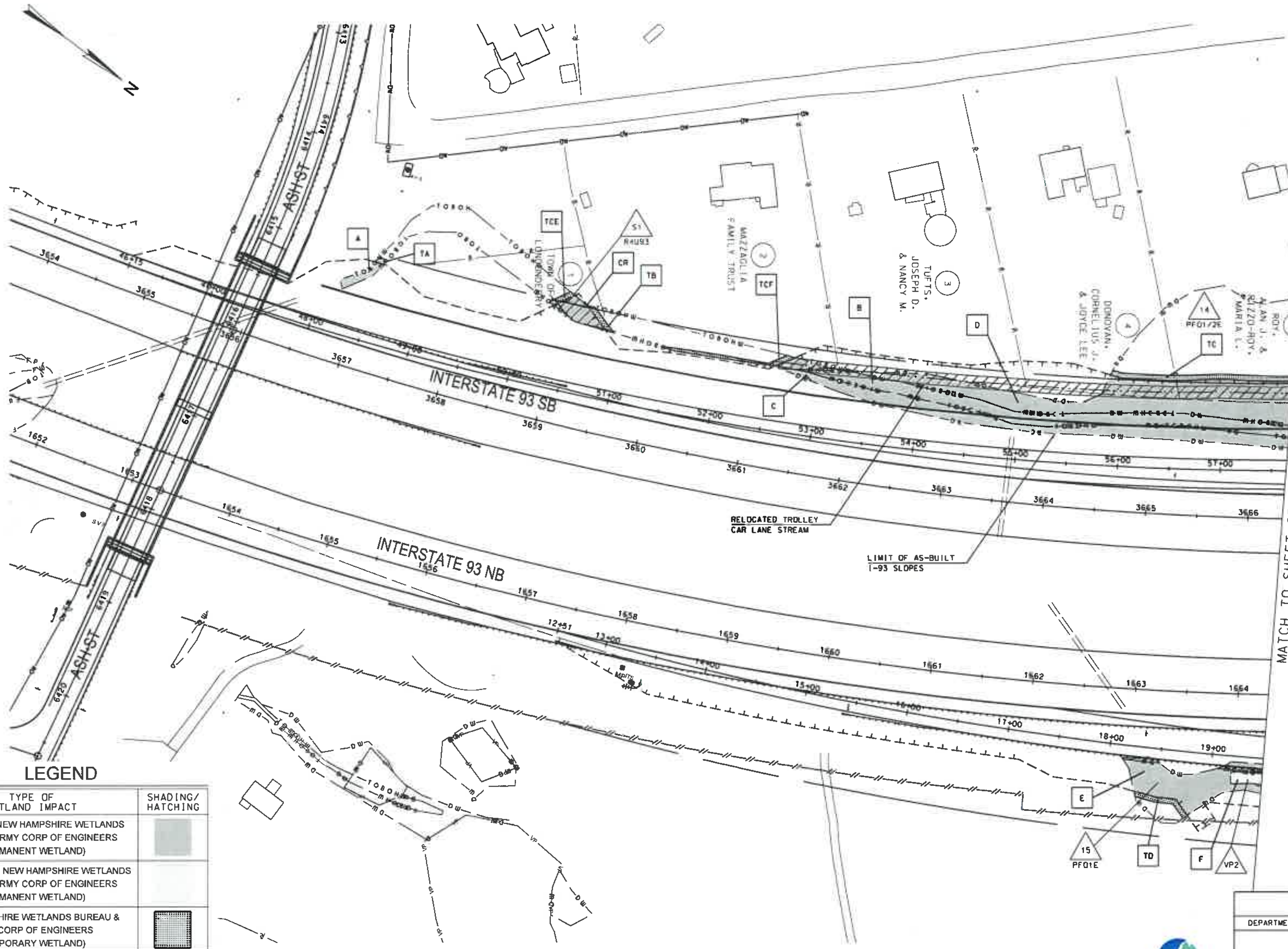
WETLAND IMPACT TABLES

| DGN | STATE PROJECT NO. | SHEET NO. | TOTAL SHEETS |
|---|---|---|---|
| 13065TABLE | 13065 | 5 | 28 |




## LEGEND

| TYPE OF WETLAND IMPACT | SHADING/ HATCHING |
|---|---|
| WETLANDS - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
| VERNAL POOL - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
| NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (TEMPORARY WETLAND) | |
| RELOCATED STREAM SELF MITIGATING | |

| REVISIONS AFTER PROPOSAL | | | | |
|---|---|---|---|---|
| NUMBER | DATE | STATION | STATION | DESCRIPTION |

| | | |
|---|---|---|
| SDR PROCESSED | | DATE |
| NEW DESIGN | EMM | DATE 2/6/2020 |
| SHEET CHECKED | NCF | DATE 2/6/2020 |
| AS BUILT DETAILS | | DATE |

STATE OF NEW HAMPSHIRE

DEPARTMENT OF TRANSPORTATION • BUREAU OF HIGHWAY DESIGN

FUSS & O'NEILL

*WETLAND IMPACT PLAN*

| DGN | STATE PROJECT NO. | SHEET NO. | TOTAL SHEETS |
|---|---|---|---|
| 13065WETL | 13065 | 6 | 28 |

| SDR PROCESSED | | DATE | |
|---|---|---|---|
| NEW DESIGN | EMM | DATE | 2/6/2020 |
| SHEET CHECKED | NCF | DATE | 2/6/2020 |
| AS BUILT DETAILS | | DATE | |

REVISIONS AFTER PROPOSAL

| NUMBER | DATE | STATION | STATION | DESCRIPTION |
|---|---|---|---|---|
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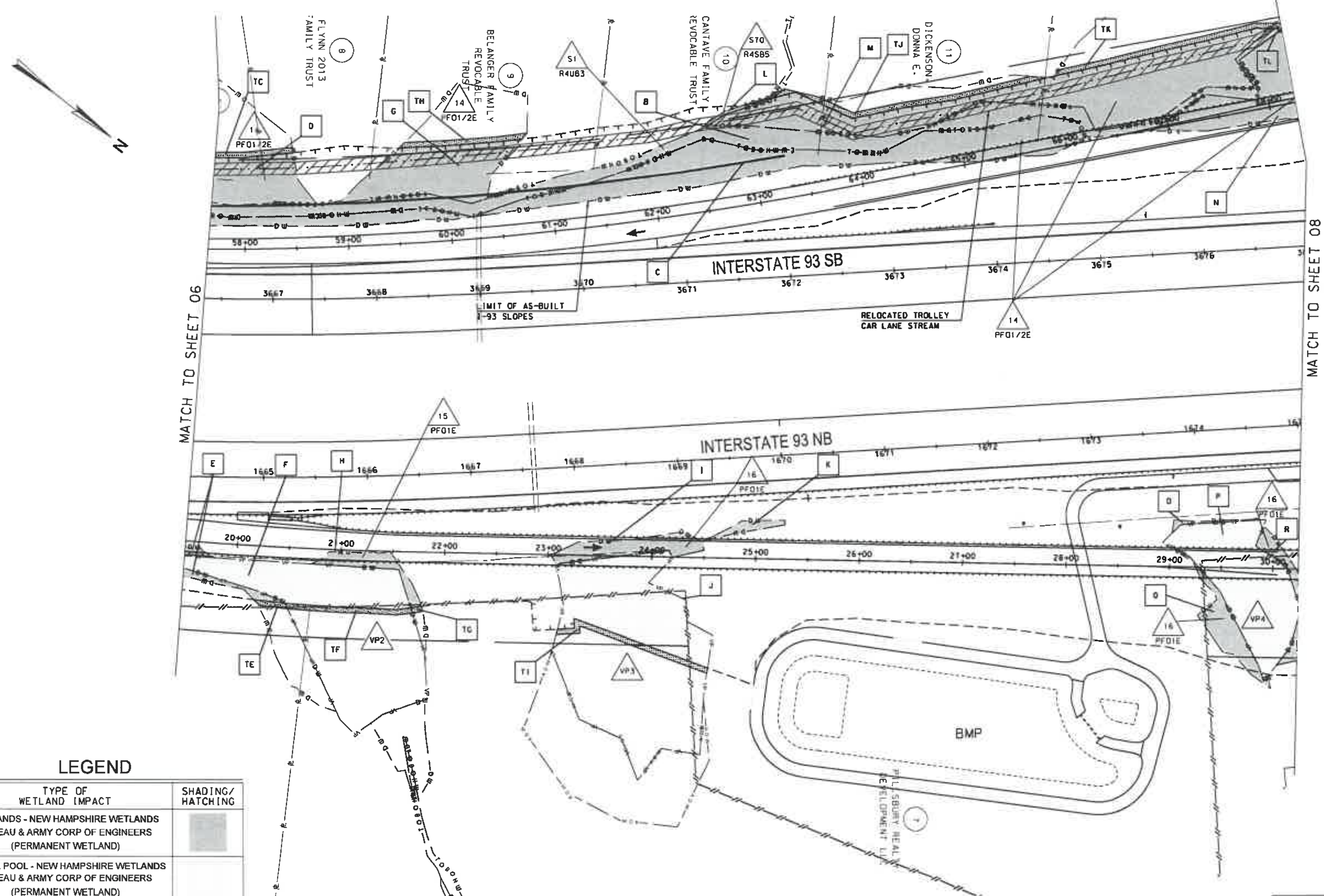


## LEGEND

| TYPE OF WETLAND IMPACT | SHADING/ HATCHING |
|---|---|
| WETLANDS - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
| VERNAL POOL - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
| NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (TEMPORARY WETLAND) | |
| RELOCATED STREAM SELF MITIGATING | |

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## WETLAND IMPACT PLAN

| DGN | STATE PROJECT NO. | SHEET NO. | TOTAL SHEETS |
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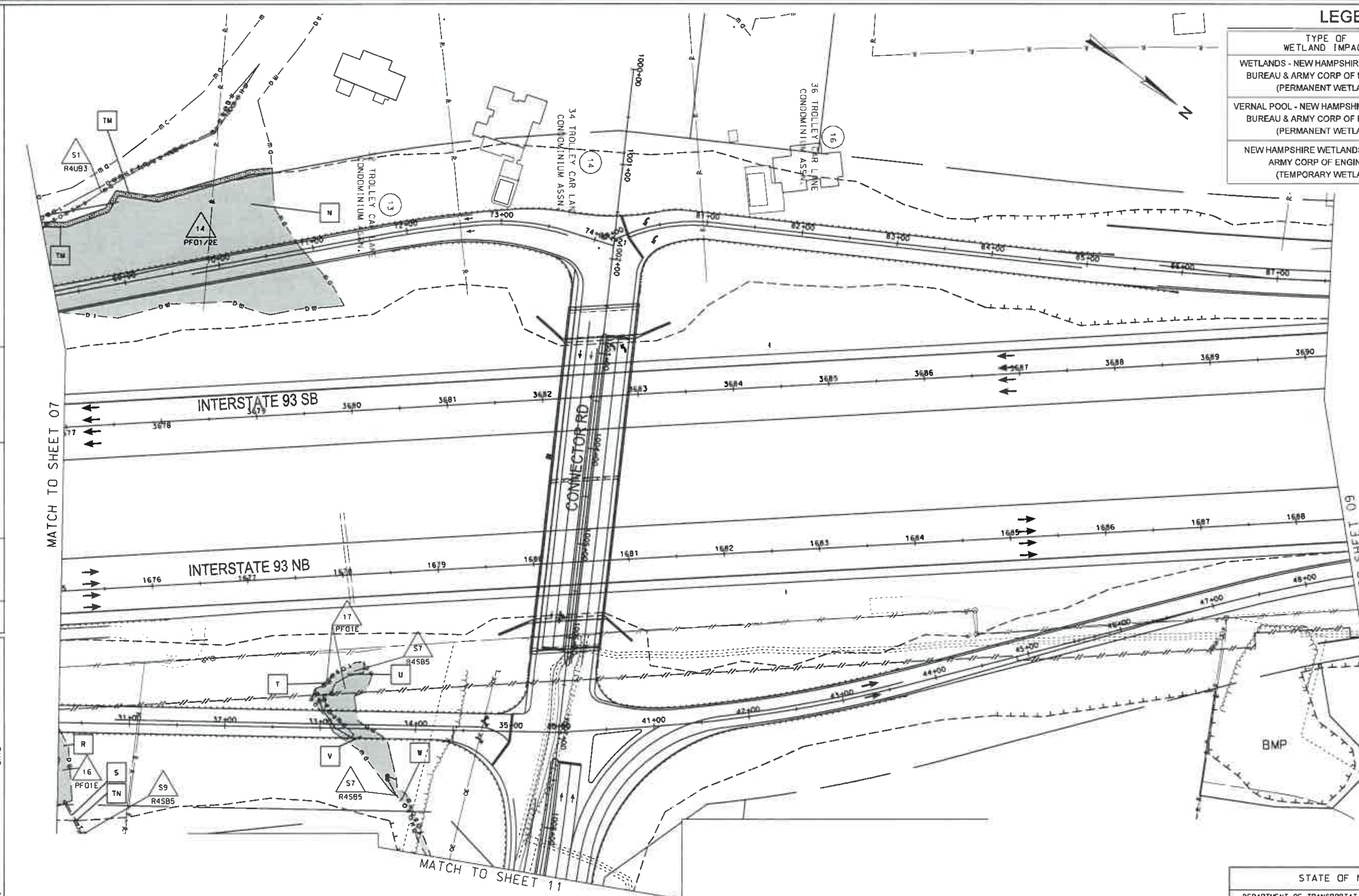


## LEGEND

| TYPE OF WETLAND IMPACT | SHADING/ HATCHING |
|---|---|
| WETLANDS - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
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| NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (TEMPORARY WETLAND) | |

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*WETLAND IMPACT PLAN*

| DGN | STATE PROJECT NO. | SHEET NO. | TOTAL SHEETS |
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| 13065WETL | 13065 | 8 | 28 |

REVISIONS AFTER PROPOSAL

| NUMBER | DATE | STATION | STATION | DESCRIPTION |
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| SDR PROCESSED | | DATE |
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| SHEET CHECKED | NCF | DATE 2/6/2020 |
| AS BUILT DETAILS | | DATE |

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| NEW DESIGN | EMM | DATE | 2/6/2020 |
| SHEET CHECKED | NCF | DATE | 2/6/2020 |
| AS BUILT DETAILS | | DATE | |

REVISIONS AFTER PROPOSAL

| NUMBER | DATE | STATION | STATION | DESCRIPTION |
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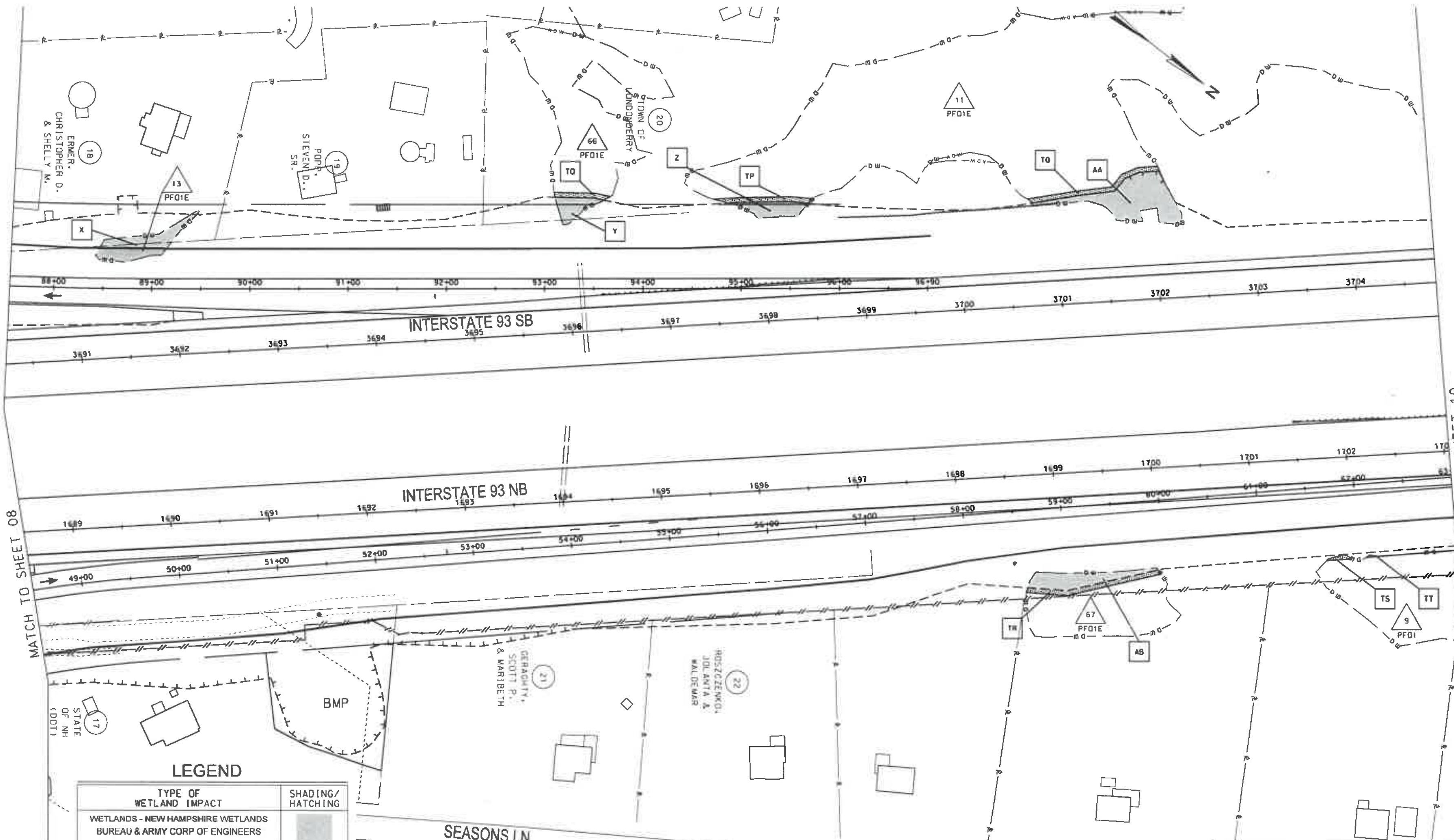


## LEGEND

| TYPE OF WETLAND IMPACT | SHADING/ HATCHING |
|---|---|
| WETLANDS - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
| VERNAL POOL - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
| NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (TEMPORARY WETLAND) | |

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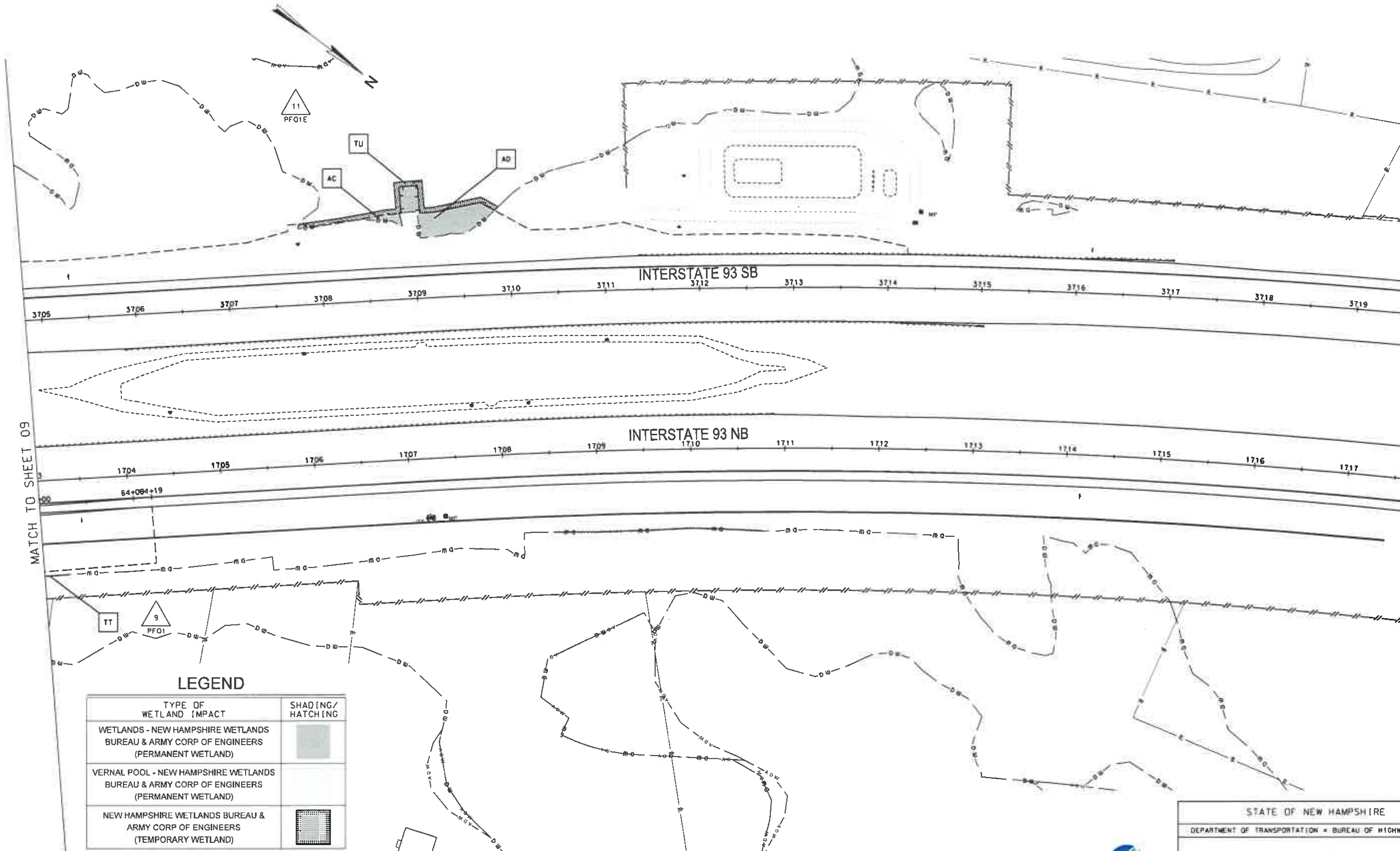
STATE OF NEW HAMPSHIRE

DEPARTMENT OF TRANSPORTATION • BUREAU OF HIGHWAY DESIGN

## WETLAND IMPACT PLAN

| DGN | STATE PROJECT NO. | SHEET NO. | TOTAL SHEETS |
|---|---|---|---|
| 13065WETL | 13065 | 9 | 28 |




## LEGEND

| TYPE OF WETLAND IMPACT | SHADING/ HATCHING |
|---|---|
| WETLANDS - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
| VERNAL POOL - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
| NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (TEMPORARY WETLAND) | |

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SCALE IN FEET

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WETLAND IMPACT PLAN

| DGN | STATE PROJECT NO. | SHEET NO. | TOTAL SHEETS |
|---|---|---|---|
| 13065WETL | 13065 | 10 | 28 |

| REVISIONS AFTER PROPOSAL | | | | |
|---|---|---|---|---|
| NUMBER | DATE | STATION | STATION | DESCRIPTION |

| | | | |
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| SDR PROCESSED | | DATE | |
| NEW DESIGN | EMM | DATE | 2/6/2020 |
| SHEET CHECKED | NCF | DATE | 2/6/2020 |
| AS BUILT DETAILS | | DATE | |

| SDR PROCESSED | | DATE |
|---|---|---|
| NEW DESIGN | EMM | DATE 2/6/2020 |
| SHEET CHECKED | NCF | DATE 2/6/2020 |
| AS BUILT DETAILS | | DATE |

REVISIONS AFTER PROPOSAL

| NUMBER | DATE | STATION | STATION | DESCRIPTION |
|---|---|---|---|---|
| | | | | |

## LEGEND

| TYPE OF WETLAND IMPACT | SHADING/ HATCHING |
|---|---|
| WETLANDS - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
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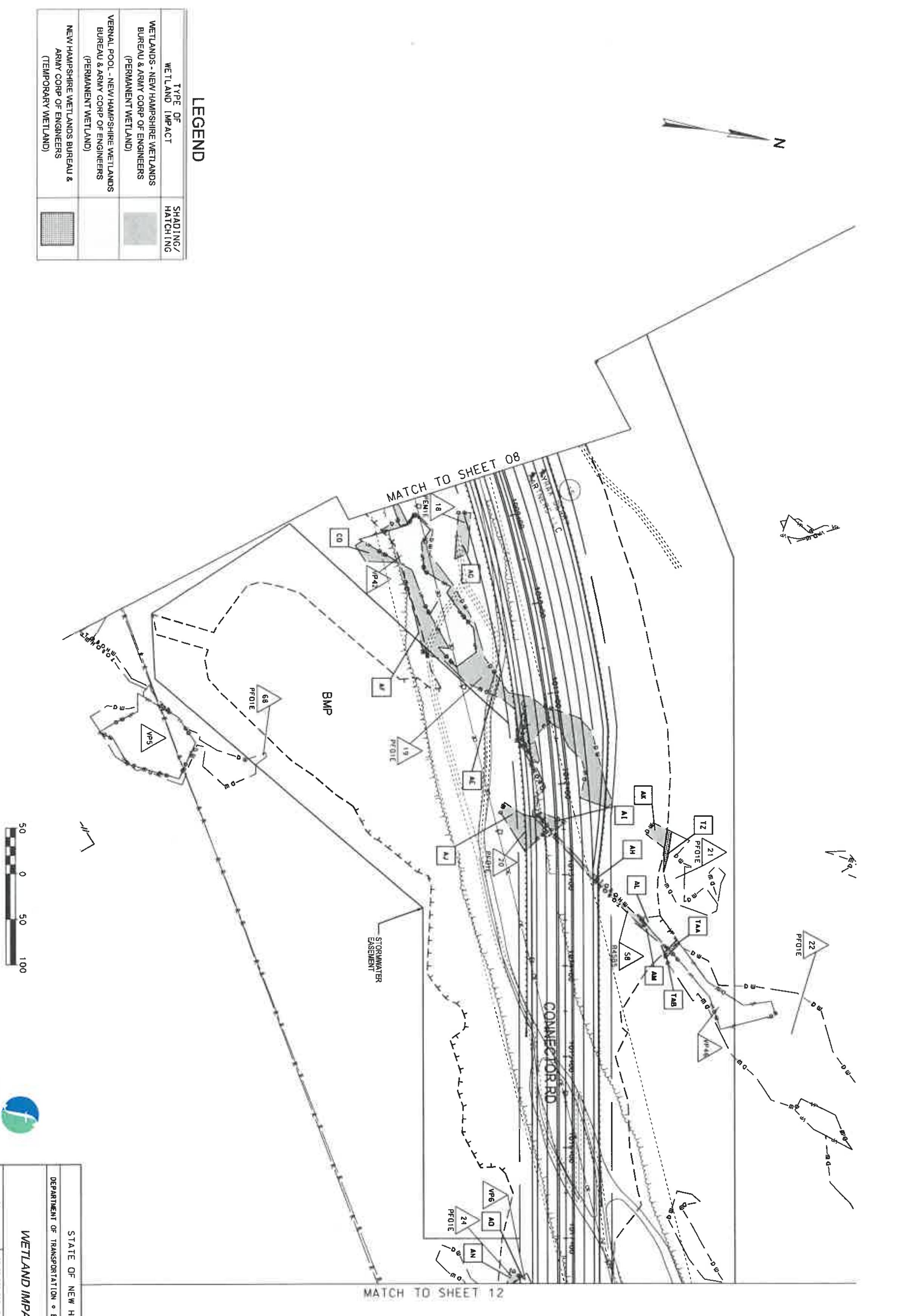
| NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (TEMPORARY WETLAND) | |

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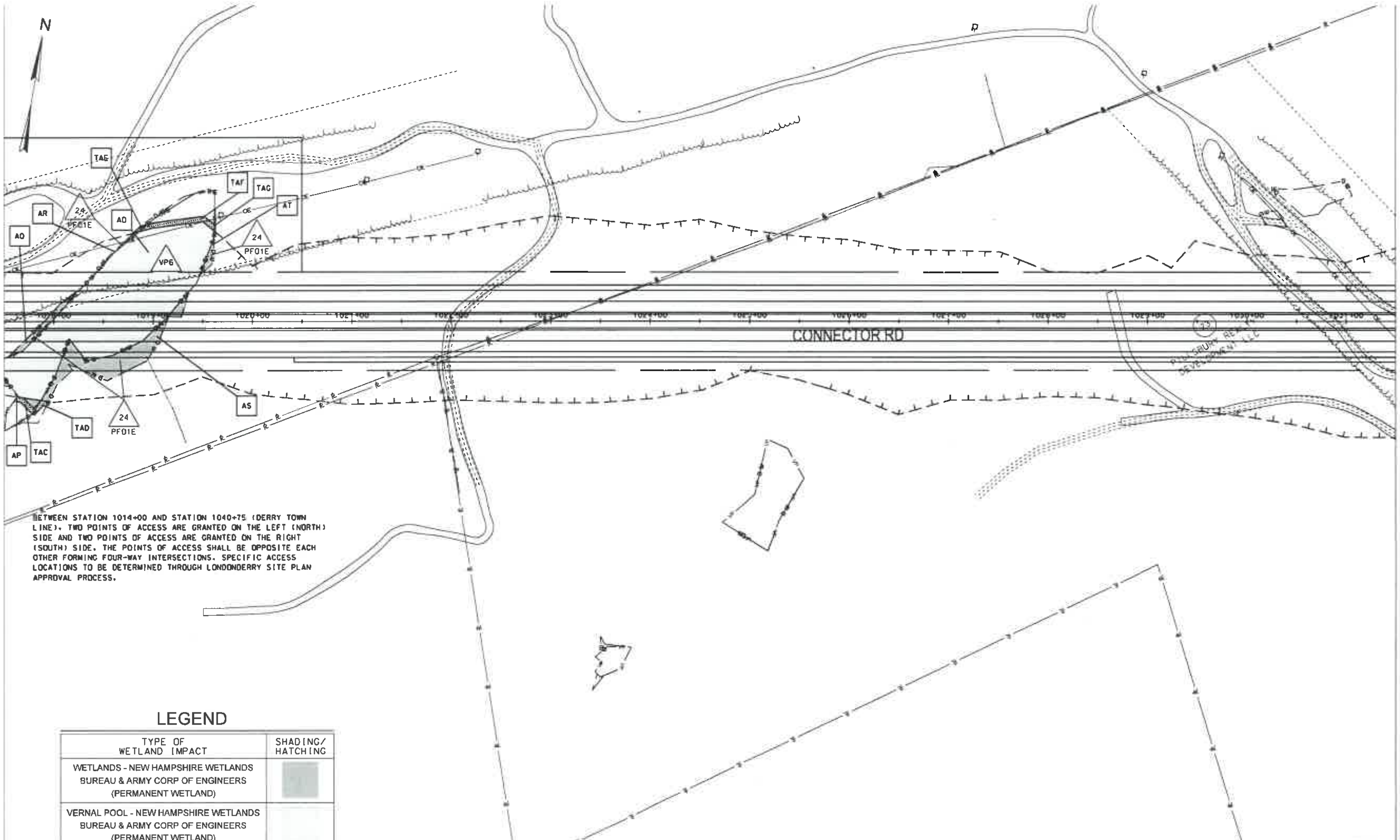
### WETLAND IMPACT PLAN

| DGN | STATE PROJECT NO. | SHEET NO. | TOTAL SHEETS |
|---|---|---|---|
| 13065WETL | 13065 | 11 | 28 |




BETWEEN STATION 1014+00 AND STATION 1040+75 (DERRY TOWN LINE), TWO POINTS OF ACCESS ARE GRANTED ON THE LEFT (NORTH) SIDE AND TWO POINTS OF ACCESS ARE GRANTED ON THE RIGHT (SOUTH) SIDE. THE POINTS OF ACCESS SHALL BE OPPOSITE EACH OTHER FORMING FOUR-WAY INTERSECTIONS. SPECIFIC ACCESS LOCATIONS TO BE DETERMINED THROUGH LONDONDERRY SITE PLAN APPROVAL PROCESS.

## LEGEND

| TYPE OF WETLAND IMPACT | SHADING/ HATCHING |
|---|---|
| WETLANDS - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
| VERNAL POOL - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
| NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (TEMPORARY WETLAND) | |

50 0 50 100
SCALE IN FEET

FUSS&O'NEILL

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION ◦ BUREAU OF HIGHWAY DESIGN

WETLAND IMPACT PLAN

| DGN | STATE PROJECT NO. | SHEET NO. | TOTAL SHEETS |
|---|---|---|---|
| 13065WETL | 13065 | 12 | 28 |

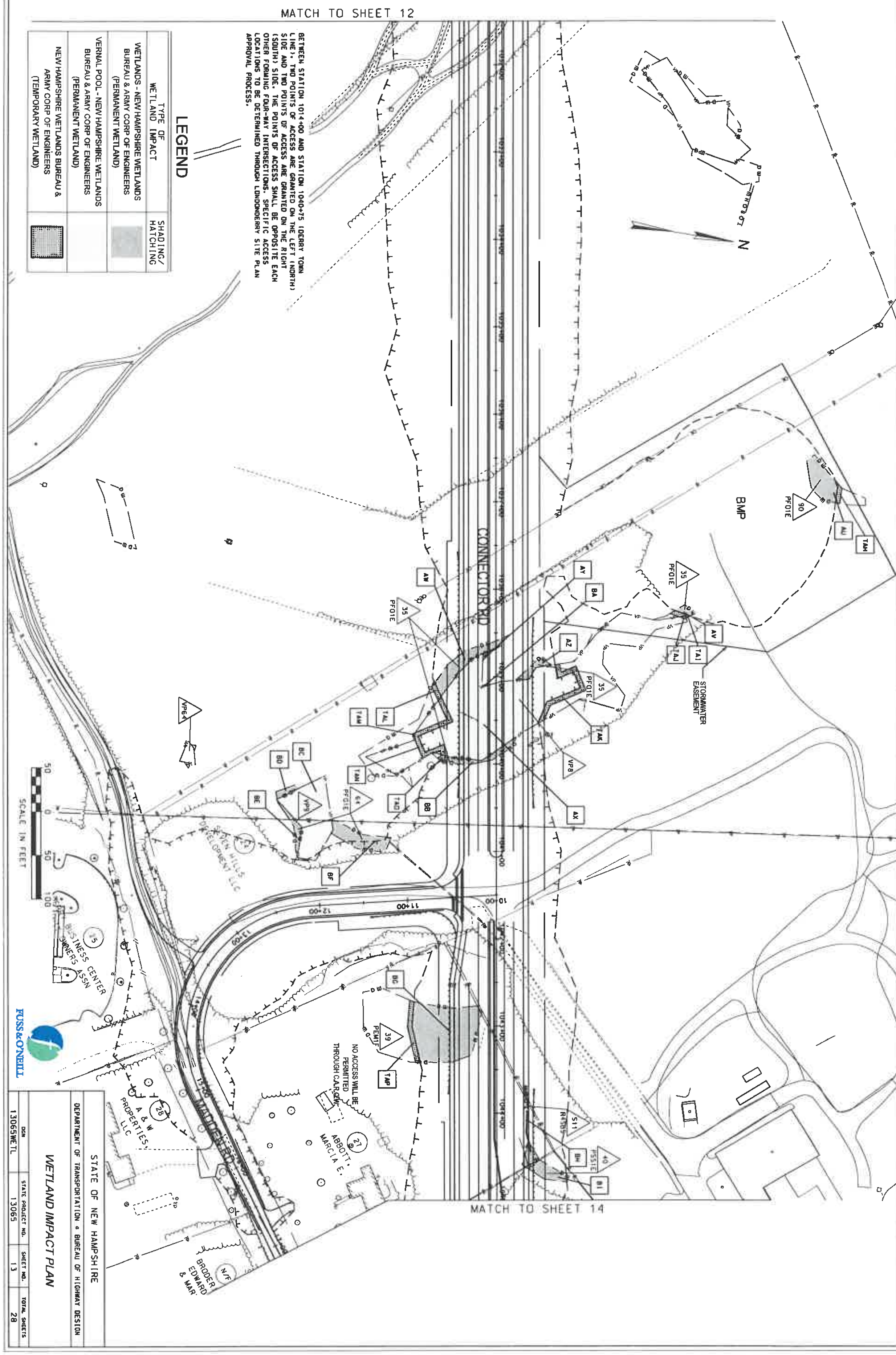
| REVISIONS AFTER PROPOSAL | | | | |
|---|---|---|---|---|
| NUMBER | DATE | STATION | STATION | DESCRIPTION |

| | | |
|---|---|---|
| SDR PROCESSED | | DATE |
| NEW DESIGN | EMM | DATE 2/6/2020 |
| SHEET CHECKED | NCF | DATE 2/6/2020 |
| AS BUILT DETAILS | | DATE |

| SDR PROCESSED | | DATE | |
|---|---|---|---|
| NEW DESIGN | EMM | DATE | 2/6/2020 |
| SHEET CHECKED | NCF | DATE | 2/6/2020 |
| AS BUILT DETAILS | | DATE | |

REVISIONS AFTER PROPOSAL

| NUMBER | DATE | STATION | STATION | DESCRIPTION |
|---|---|---|---|---|
| | | | | |




## LEGEND

| TYPE OF WETLAND IMPACT | SHADING/ HATCHING |
|---|---|
| WETLANDS - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
| VERNAL POOL - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
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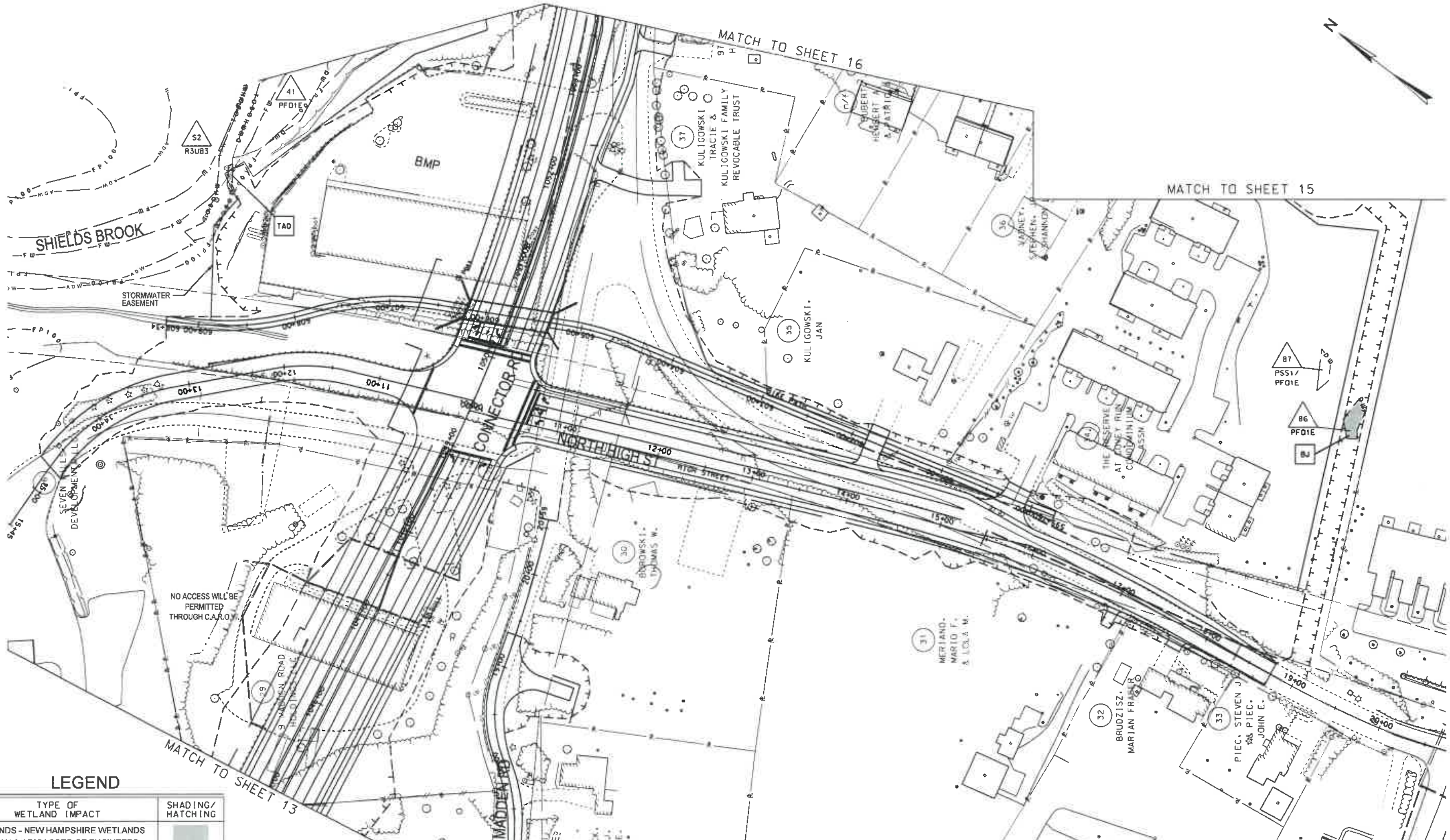
FUSS & O'NEILL

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION • BUREAU OF HIGHWAY DESIGN

WETLAND IMPACT PLAN

| DGN | STATE PROJECT NO. | SHEET NO. | TOTAL SHEETS |
|---|---|---|---|
| 13065WETL | 13065 | 13 | 28 |




## LEGEND

| TYPE OF WETLAND IMPACT | SHADING/ HATCHING |
|---|---|
| WETLANDS - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
| VERNAL POOL - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
| NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (TEMPORARY WETLAND) | |

50 0 50 100
SCALE IN FEET

FUSS & O'NEILL

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION • BUREAU OF HIGHWAY DESIGN

### WETLAND IMPACT PLAN

| DGN | STATE PROJECT NO. | SHEET NO. | TOTAL SHEETS |
|---|---|---|---|
| 13065WETL | 13065 | 14 | 28 |

| | | |
|---|---|---|
| SDR PROCESSED | | DATE |
| NEW DESIGN | EMM | DATE 2/6/2020 |
| SHEET CHECKED | NCF | DATE 2/6/2020 |
| AS BUILT DETAILS | | DATE |

REVISIONS AFTER PROPOSAL

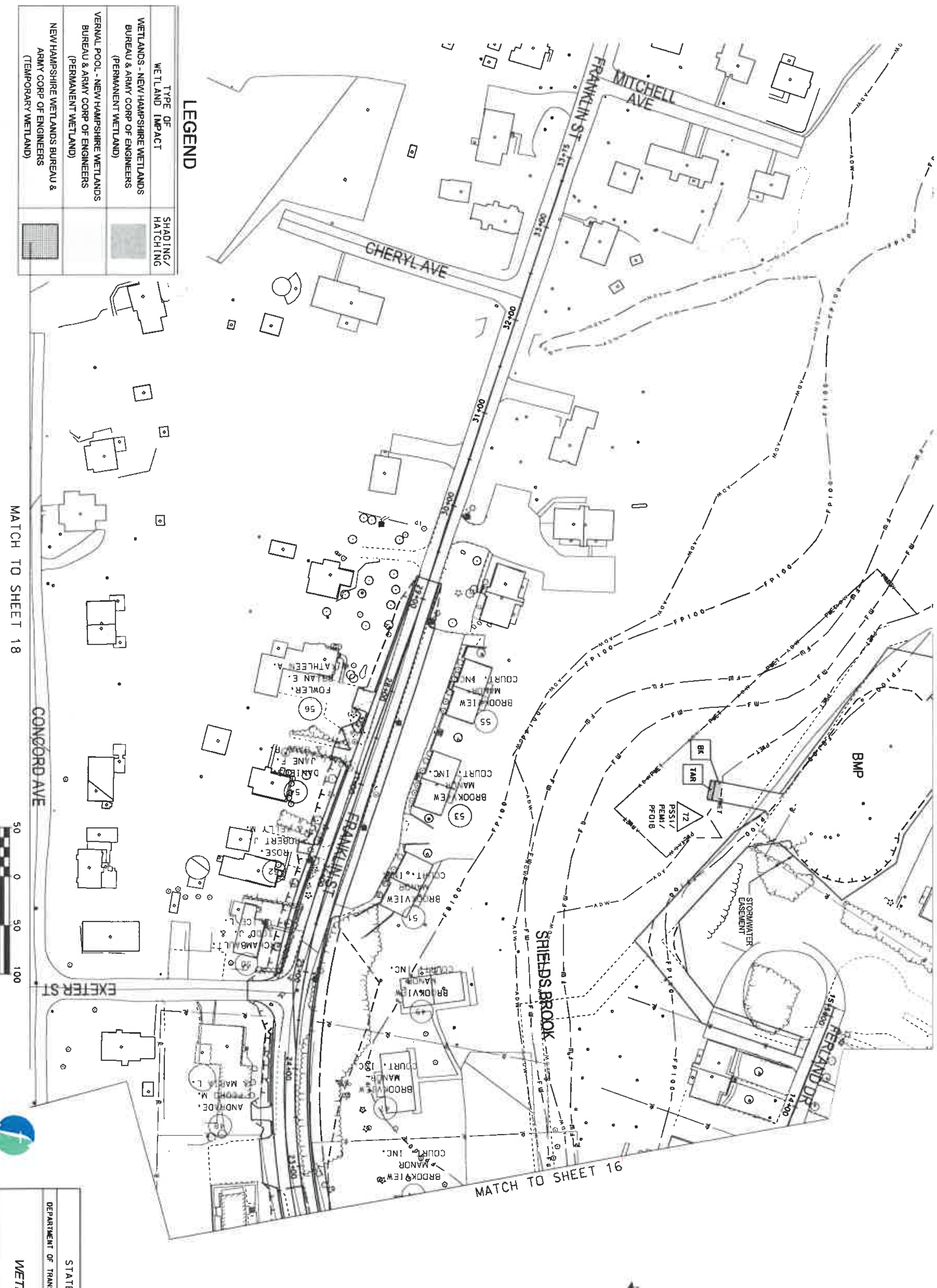
| NUMBER | DATE | STATION | STATION | DESCRIPTION |
|---|---|---|---|---|

| SDR PROCESSED | | DATE | |
|---|---|---|---|
| NEW DESIGN | EMM | DATE | 2/6/2020 |
| SHEET CHECKED | NCF | DATE | 2/6/2020 |
| | | | |
| AS BUILT DETAILS | | DATE | |

| REVISIONS AFTER PROPOSAL | | | | |
|---|---|---|---|---|
| NUMBER | DATE | STATION | STATION | DESCRIPTION |
| | | | | |
| | | | | |

## LEGEND

| TYPE OF WETLAND IMPACT | SHADING/ HATCHING |
|---|---|
| WETLANDS - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
| VERNAL POOL - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
| NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (TEMPORARY WETLAND) | |




FUSS & O'NEILL

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION • BUREAU OF HIGHWAY DESIGN

### WETLAND IMPACT PLAN

| DGN | STATE PROJECT NO. | SHEET NO. | TOTAL SHEETS |
|---|---|---|---|
| 13065WETL | 13065 | 15 | 28 |


## LEGEND

| TYPE OF WETLAND IMPACT | SHADING/ HATCHING |
|---|---|
| WETLANDS - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
| VERNAL POOL - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
| NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (TEMPORARY WETLAND) | |

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SCALE IN FEET

FUSS & O'NEILL

STATE OF NEW HAMPSHIRE

DEPARTMENT OF TRANSPORTATION • BUREAU OF HIGHWAY DESIGN

WETLAND IMPACT PLAN

| DGN | STATE PROJECT NO. | SHEET NO. | TOTAL SHEETS |
|---|---|---|---|
| 13065WETL | 13065 | 16 | 28 |

| SDR PROCESSED | | DATE | |
|---|---|---|---|
| NEW DESIGN | EMM | DATE | 2/6/2020 |
| SHEET CHECKED | NCF | DATE | 2/6/2020 |
| AS BUILT DETAILS | | DATE | |

REVISIONS AFTER PROPOSAL

| NUMBER | DATE | STATION | STATION | DESCRIPTION |
|---|---|---|---|---|

| SDR PROCESSED | | DATE |
|---|---|---|
| NEW DESIGN | EMM | DATE 2/6/2020 |
| SHEET CHECKED | NCF | DATE 2/6/2020 |
| AS BUILT DETAILS | | DATE |

REVISIONS AFTER PROPOSAL

| NUMBER | DATE | STATION | STATION | DESCRIPTION |
|---|---|---|---|---|
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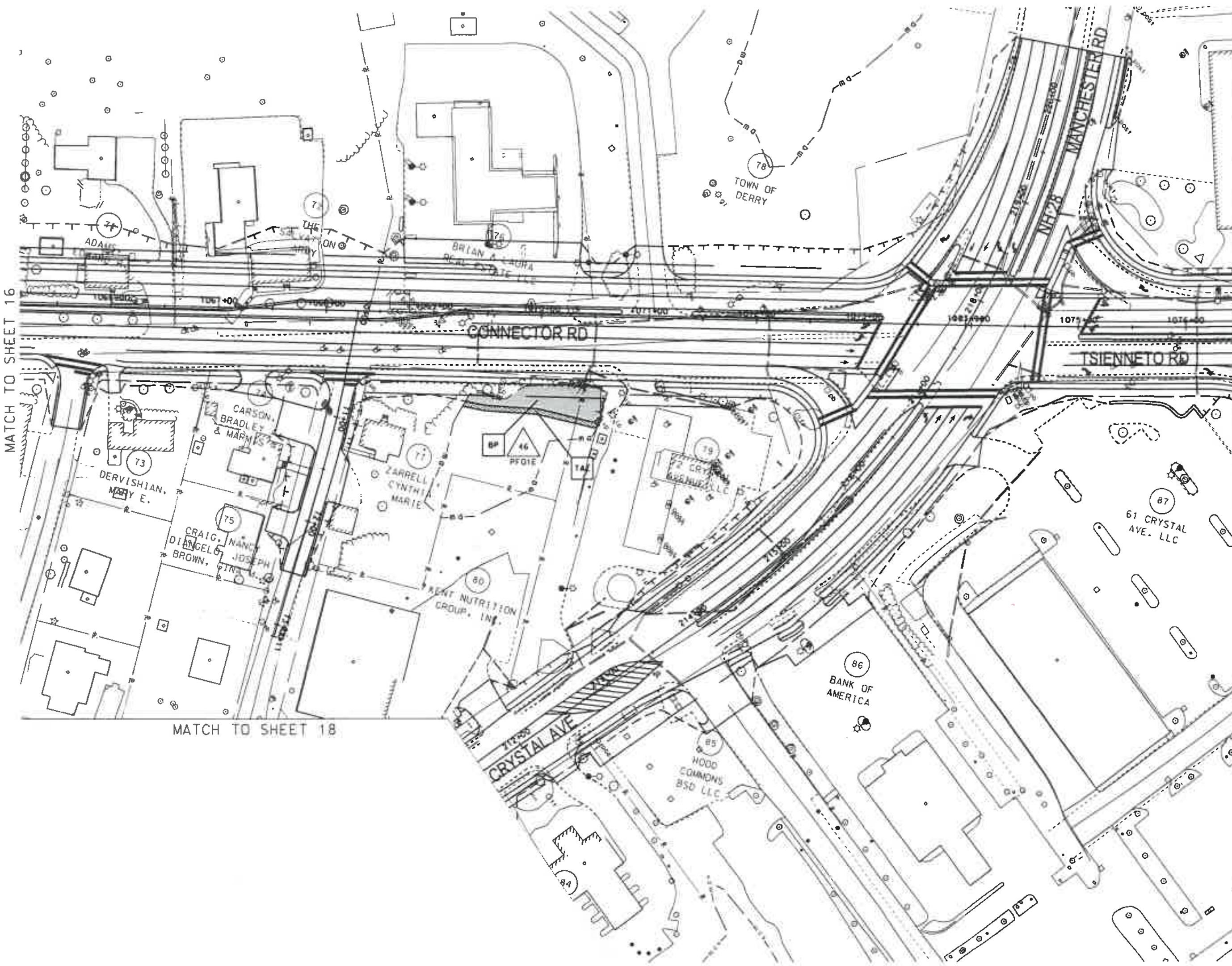



## LEGEND

| TYPE OF WETLAND IMPACT | SHADING/ HATCHING |
|---|---|
| WETLANDS - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
| VERNAL POOL - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
| NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (TEMPORARY WETLAND) | |

50 0 50 100
SCALE IN FEET

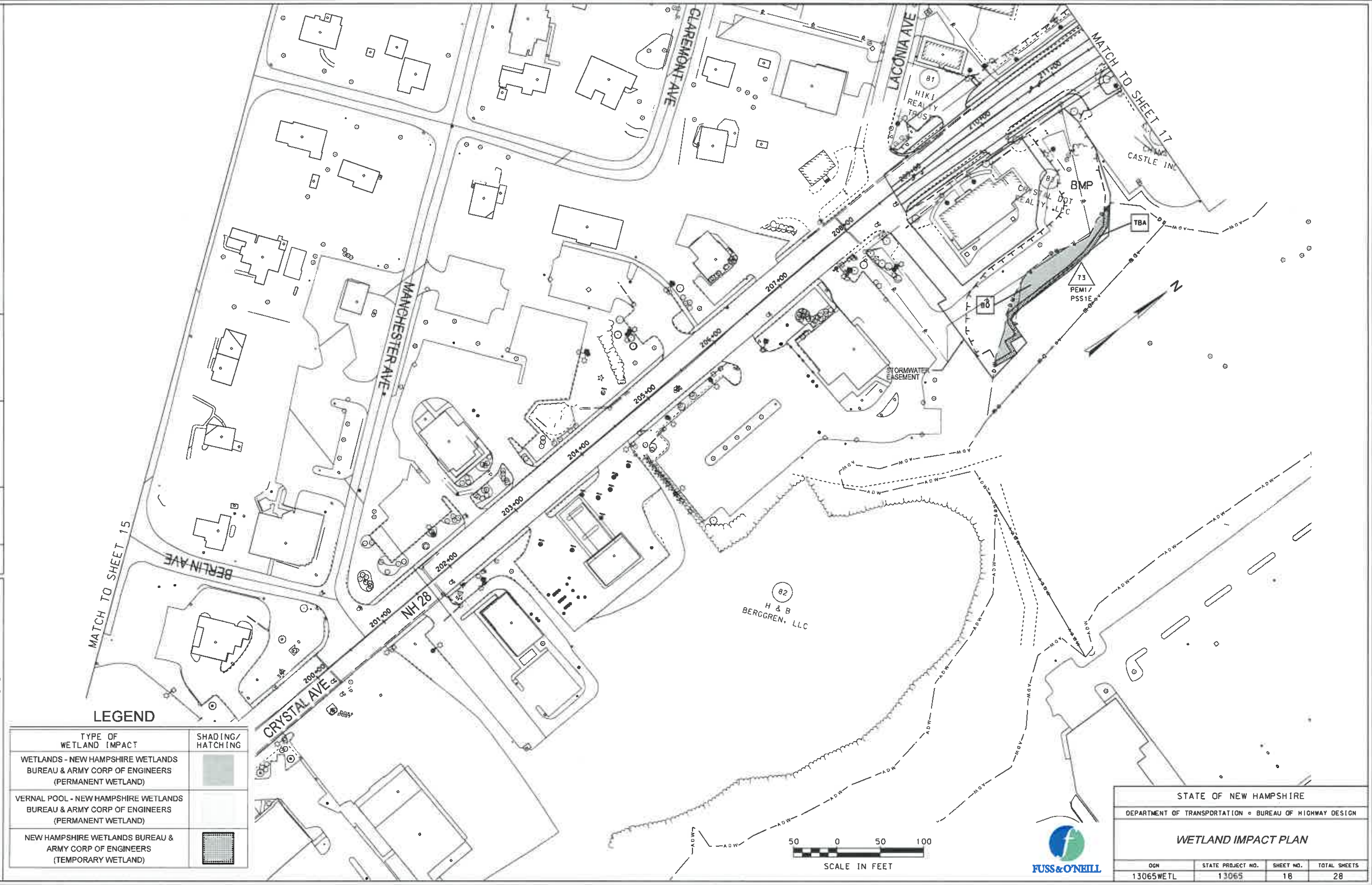
FUSS & O'NEILL

STATE OF NEW HAMPSHIRE

DEPARTMENT OF TRANSPORTATION • BUREAU OF HIGHWAY DESIGN

WETLAND IMPACT PLAN

| DGN | STATE PROJECT NO. | SHEET NO. | TOTAL SHEETS |
|---|---|---|---|
| 13065WETL | 13065 | 17 | 28 |




## LEGEND

| TYPE OF WETLAND IMPACT | SHADING/ HATCHING |
|---|---|
| WETLANDS - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
| VERNAL POOL - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
| NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (TEMPORARY WETLAND) | |

STATE OF NEW HAMPSHIRE

DEPARTMENT OF TRANSPORTATION ◦ BUREAU OF HIGHWAY DESIGN

FUSS&O'NEILL

### WETLAND IMPACT PLAN

| DGN | STATE PROJECT NO. | SHEET NO. | TOTAL SHEETS |
|---|---|---|---|
| 13065WETL | 13065 | 18 | 28 |

| | | | |
|---|---|---|---|
| SDR PROCESSED | | DATE | |
| NEW DESIGN | EMM | DATE | 2/6/2020 |
| SHEET CHECKED | NCF | DATE | 2/6/2020 |
| AS BUILT DETAILS | | DATE | |

REVISIONS AFTER PROPOSAL

| NUMBER | DATE | STATION | STATION | DESCRIPTION |
|---|---|---|---|---|

| SDR PROCESSED | | DATE | |
|---|---|---|---|
| NEW DESIGN | EMM | DATE | 2/6/2020 |
| SHEET CHECKED | NCF | DATE | 2/6/2020 |
| AS BUILT DETAILS | | DATE | |

REVISIONS AFTER PROPOSAL

| NUMBER | DATE | STATION | STATION | DESCRIPTION |
|---|---|---|---|---|
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## LEGEND

| TYPE OF WETLAND IMPACT | SHADING/ HATCHING |
|---|---|
| WETLANDS - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
| VERNAL POOL - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
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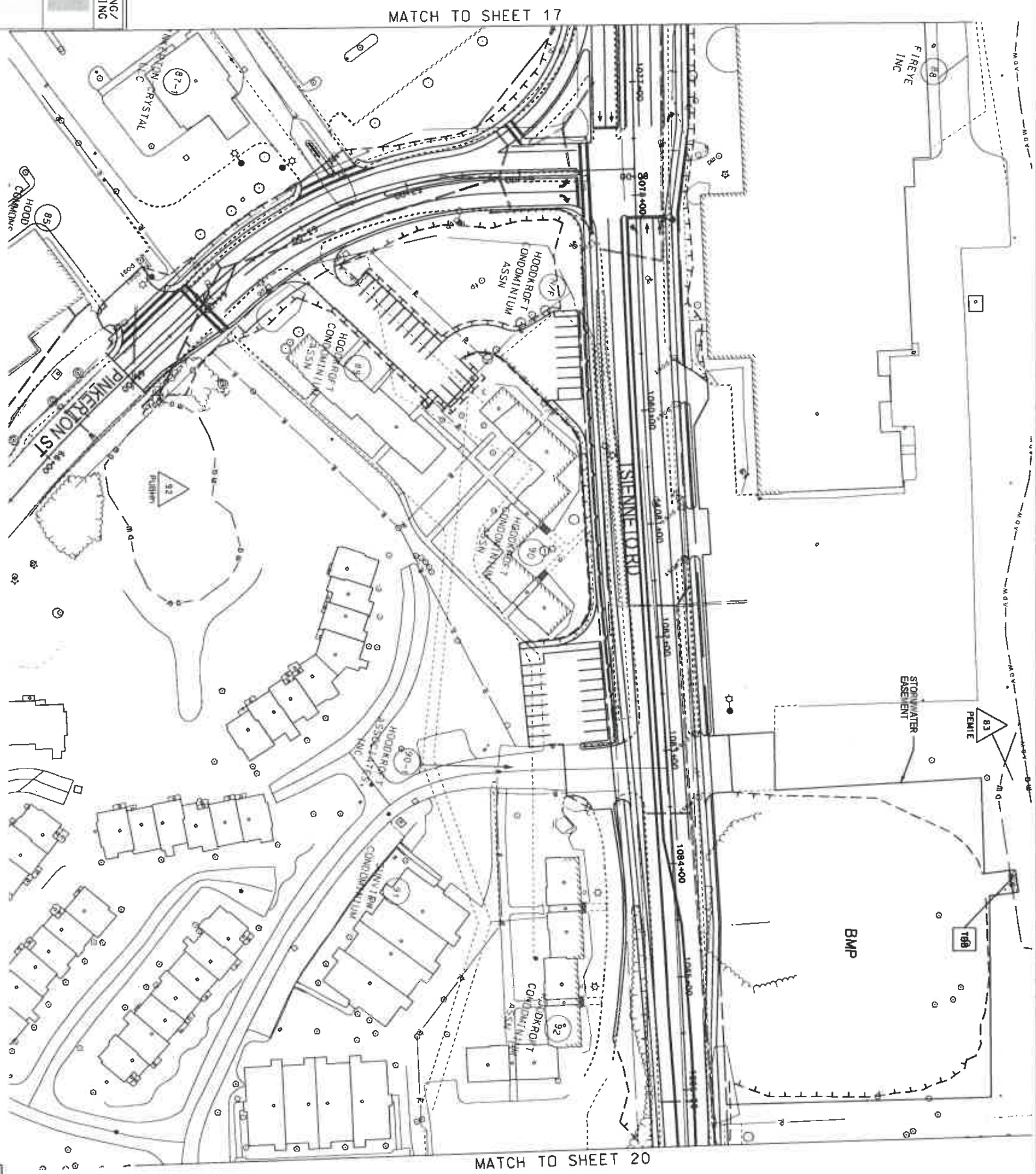


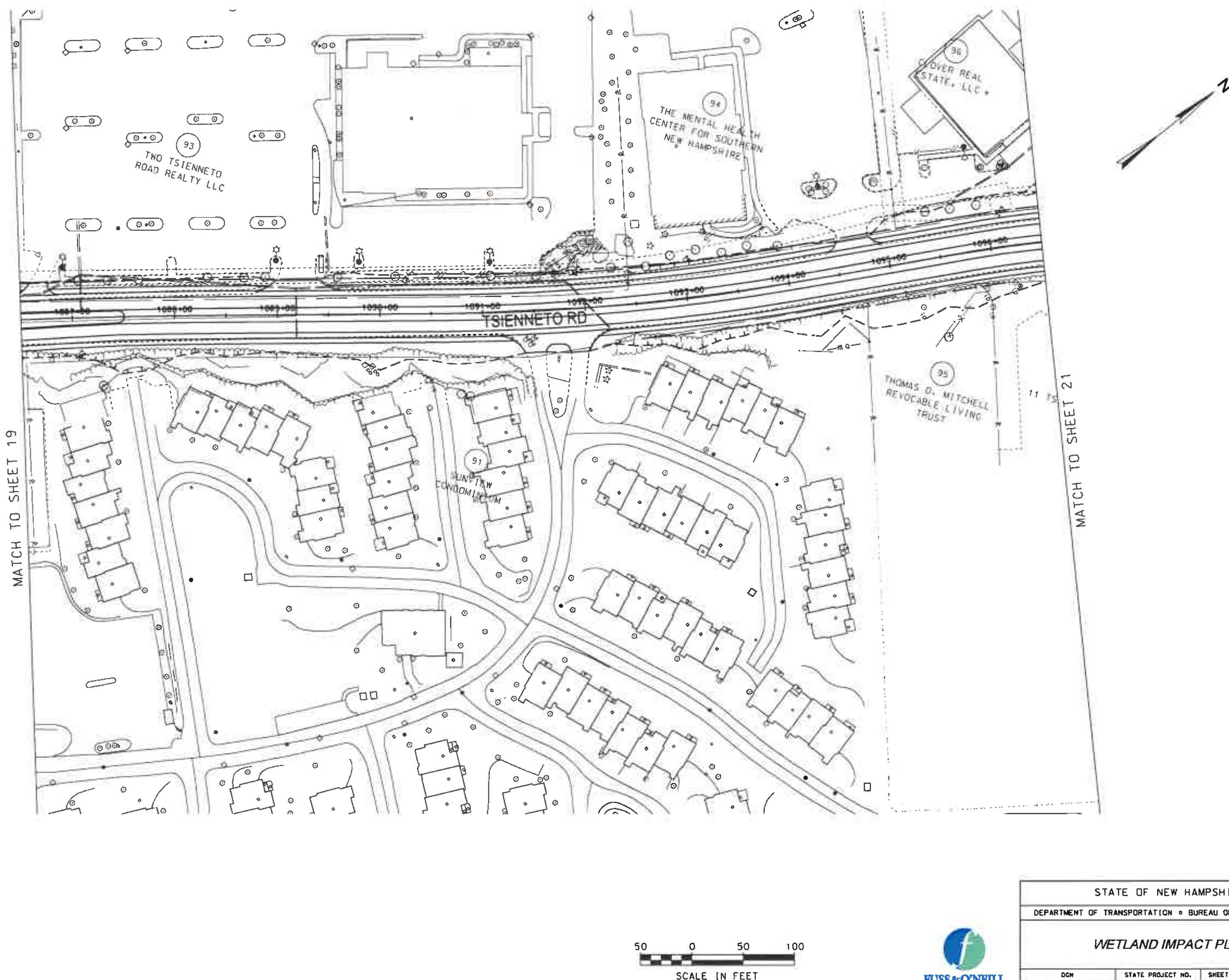

SCALE IN FEET: 50 0 50 100

FUSS & O'NEILL

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION • BUREAU OF HIGHWAY DESIGN

*WETLAND IMPACT PLAN*

| DGN | STATE PROJECT NO. | SHEET NO. | TOTAL SHEETS |
|---|---|---|---|
| 13065WETL | 13065 | 19 | 28 |




## LEGEND

| TYPE OF WETLAND IMPACT | SHADING/ HATCHING |
|---|---|
| WETLANDS - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
| VERNAL POOL - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
| NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (TEMPORARY WETLAND) | |

REVISIONS AFTER PROPOSAL

| NUMBER | DATE | STATION | STATION | DESCRIPTION |
|---|---|---|---|---|

| | | |
|---|---|---|
| SDR PROCESSED | | DATE |
| NEW DESIGN | EMM | DATE 2/6/2020 |
| SHEET CHECKED | NCF | DATE 2/6/2020 |
| AS BUILT DETAILS | | DATE |

FUSS&O'NEILL

STATE OF NEW HAMPSHIRE

DEPARTMENT OF TRANSPORTATION • BUREAU OF HIGHWAY DESIGN

*WETLAND IMPACT PLAN*

| DGN | STATE PROJECT NO. | SHEET NO. | TOTAL SHEETS |
|---|---|---|---|
| 13065WETL | 13065 | 20 | 28 |

| SDR PROCESSED | | DATE |
|---|---|---|
| NEW DESIGN | EMM | DATE 2/6/2020 |
| SHEET CHECKED | NCF | DATE 2/6/2020 |
| AS BUILT DETAILS | | DATE |

REVISIONS AFTER PROPOSAL

| NUMBER | DATE | STATION | STATION | DESCRIPTION |
|---|---|---|---|---|
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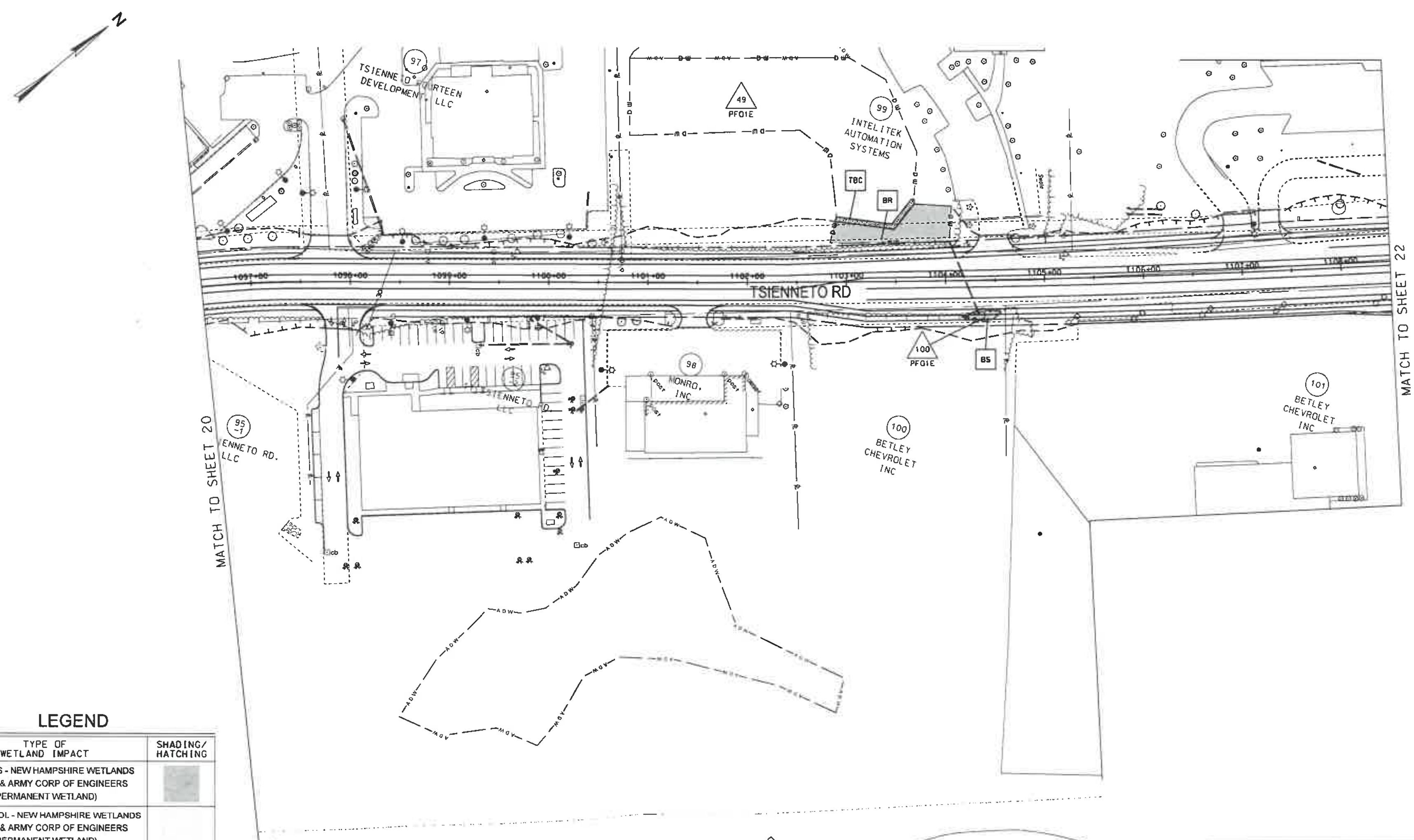



## LEGEND

| TYPE OF WETLAND IMPACT | SHADING/ HATCHING |
|---|---|
| WETLANDS - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
| VERNAL POOL - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
| NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (TEMPORARY WETLAND) | |

FUSS & O'NEILL

STATE OF NEW HAMPSHIRE

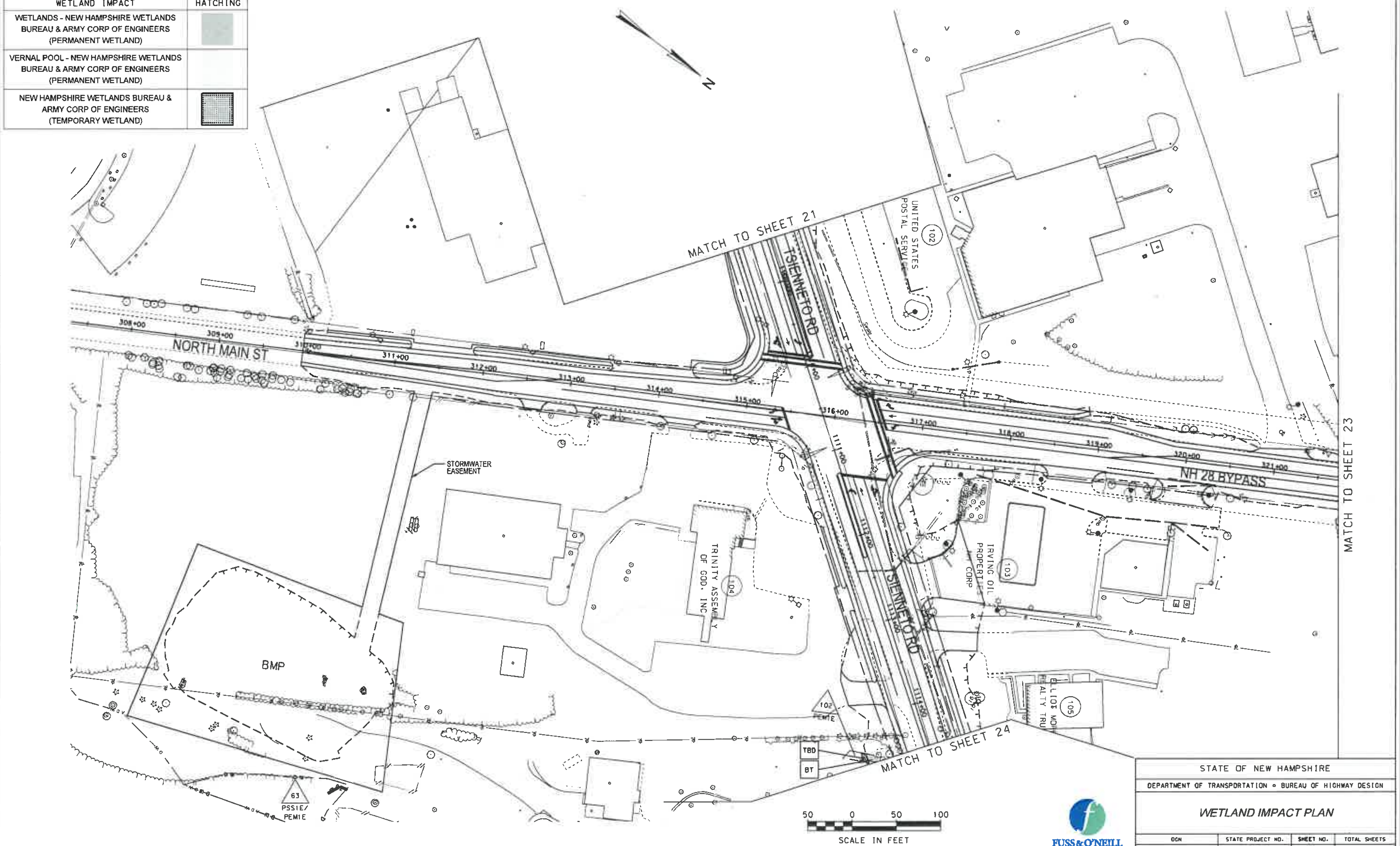
DEPARTMENT OF TRANSPORTATION • BUREAU OF HIGHWAY DESIGN

WETLAND IMPACT PLAN

| DGN | STATE PROJECT NO. | SHEET NO. | TOTAL SHEETS |
|---|---|---|---|
| 13065WETL | 13065 | 21 | 28 |

## LEGEND

| TYPE OF WETLAND IMPACT | SHADING/ HATCHING |
|---|---|
| WETLANDS - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
| VERNAL POOL - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
| NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (TEMPORARY WETLAND) | |




| SDR PROCESSED | | DATE | |
|---|---|---|---|
| NEW DESIGN | EMM | DATE | 2/6/2020 |
| SHEET CHECKED | NCF | DATE | 2/6/2020 |
| AS BUILT DETAILS | | DATE | |

REVISIONS AFTER PROPOSAL

| NUMBER | DATE | STATION | STATION | DESCRIPTION |
|---|---|---|---|---|
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STATE OF NEW HAMPSHIRE

DEPARTMENT OF TRANSPORTATION • BUREAU OF HIGHWAY DESIGN

FUSS & O'NEILL

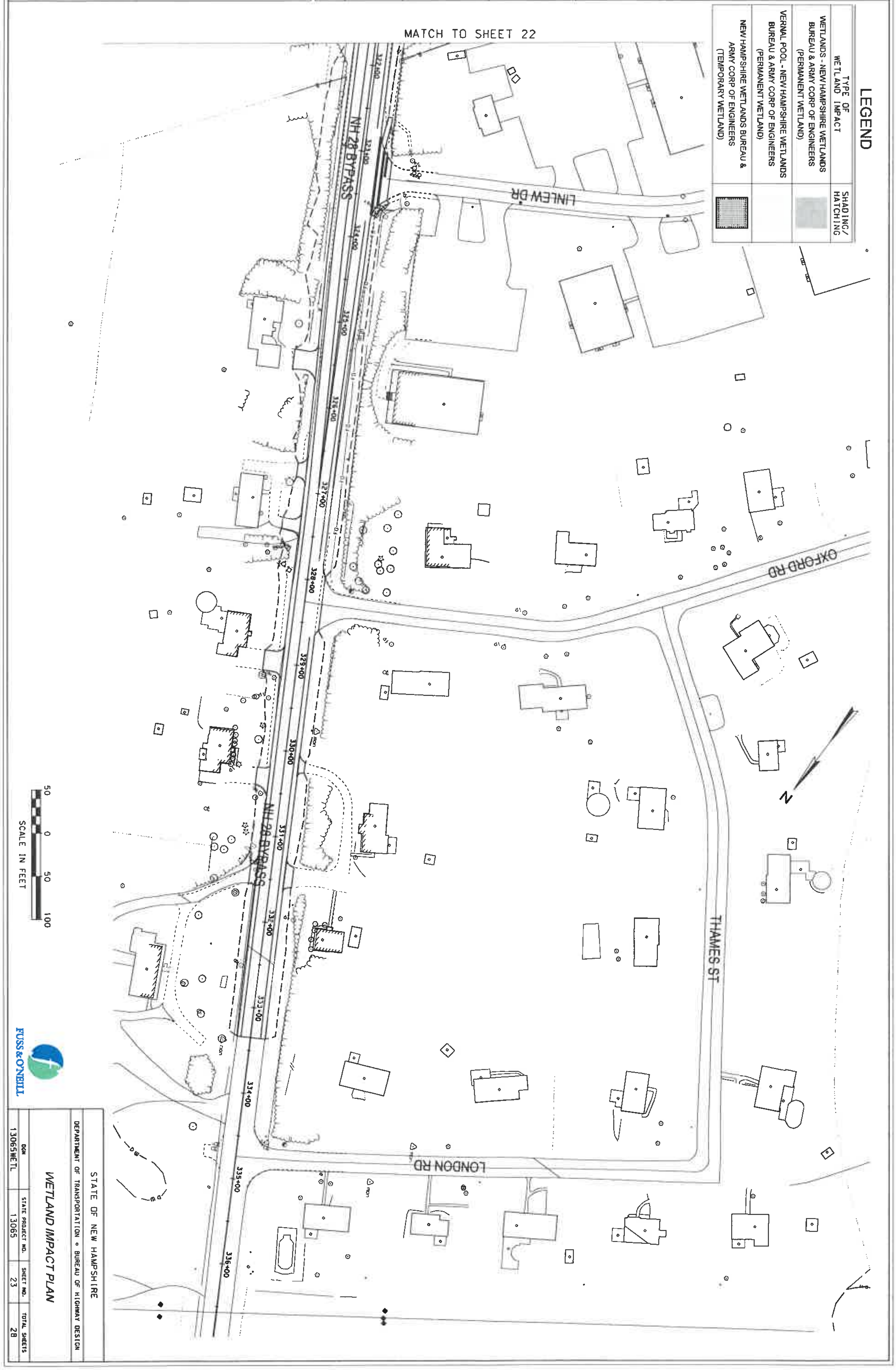
*WETLAND IMPACT PLAN*

| DGN | STATE PROJECT NO. | SHEET NO. | TOTAL SHEETS |
|---|---|---|---|
| 13065WETL | 13065 | 22 | 28 |

| | | |
|---|---|---|
| SDR PROCESSED | | DATE |
| NEW DESIGN | EMM | DATE 2/6/2020 |
| SHEET CHECKED | NCF | DATE 2/6/2020 |
| | | |
| AS BUILT DETAILS | | DATE |

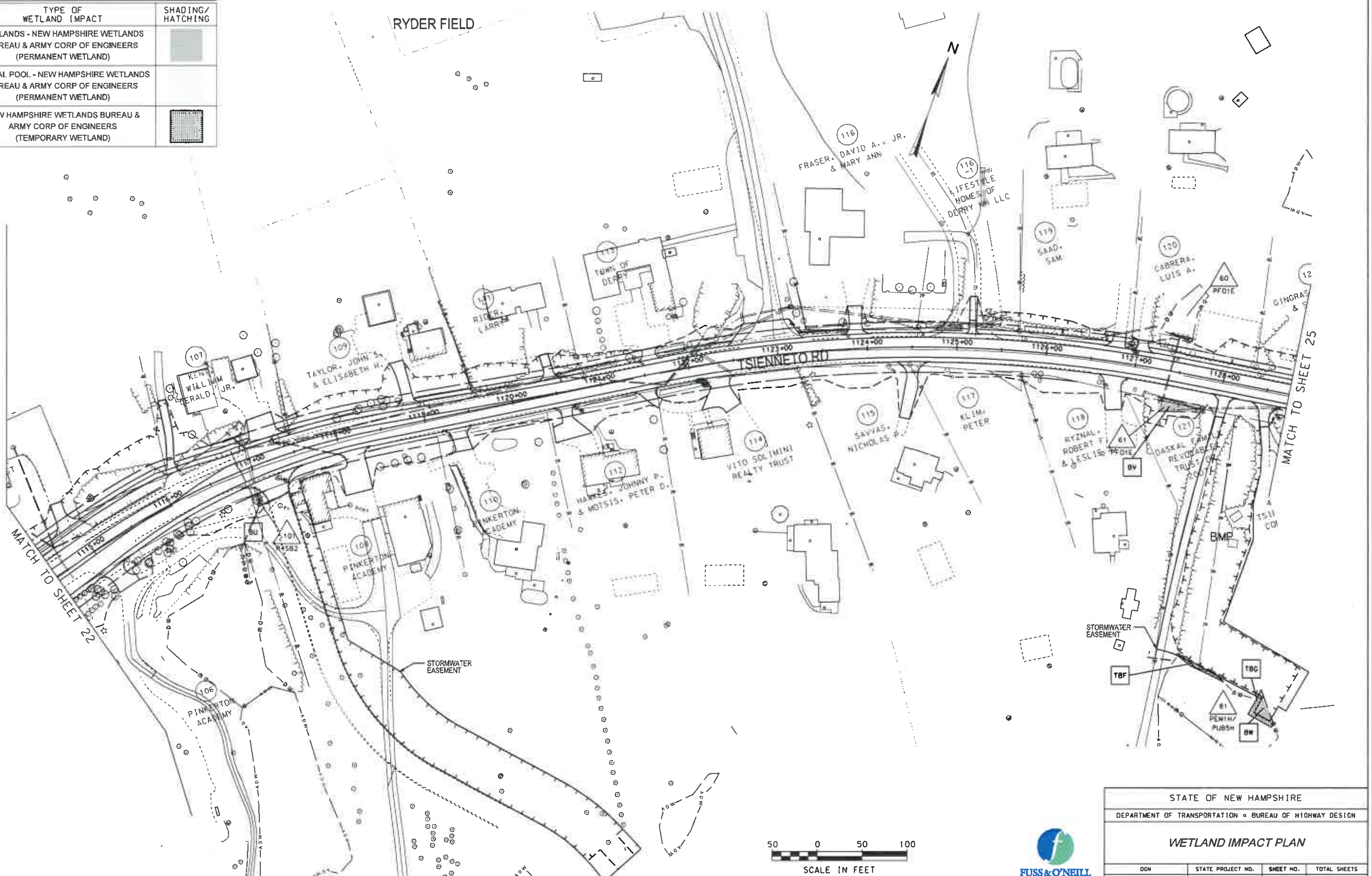
REVISIONS AFTER PROPOSAL

| NUMBER | DATE | STATION | STATION | DESCRIPTION |
|---|---|---|---|---|
| | | | | |



## LEGEND

| TYPE OF WETLAND IMPACT | SHADING/ HATCHING |
|---|---|
| WETLANDS - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
| VERNAL POOL - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
| NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (TEMPORARY WETLAND) | |

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|---|---|
| REVISIONS AFTER PROPOSAL | |
| NUMBER / DATE / STATION / STATION / DESCRIPTION | |
| SDR PROCESSED | DATE |
| NEW DESIGN EMM | DATE 2/6/2020 |
| SHEET CHECKED NCF | DATE 2/6/2020 |
| AS BUILT DETAILS | DATE |

FUSS & O'NEILL

STATE OF NEW HAMPSHIRE

DEPARTMENT OF TRANSPORTATION • BUREAU OF HIGHWAY DESIGN

*WETLAND IMPACT PLAN*

| DGN | STATE PROJECT NO. | SHEET NO. | TOTAL SHEETS |
|---|---|---|---|
| 13065WETL | 13065 | 24 | 28 |

| SDR PROCESSED | | DATE |
|---|---|---|
| NEW DESIGN | EMM | DATE 2/6/2020 |
| SHEET CHECKED | NCF | DATE 2/6/2020 |
| AS BUILT DETAILS | | DATE |

REVISIONS AFTER PROPOSAL

| NUMBER | DATE | STATION | STATION | DESCRIPTION |
|---|---|---|---|---|
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## LEGEND

| TYPE OF WETLAND IMPACT | SHADING/ HATCHING |
|---|---|
| WETLANDS - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
| VERNAL POOL - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
| NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (TEMPORARY WETLAND) | |

50 0 50 100
SCALE IN FEET

FUSS & O'NEILL

STATE OF NEW HAMPSHIRE

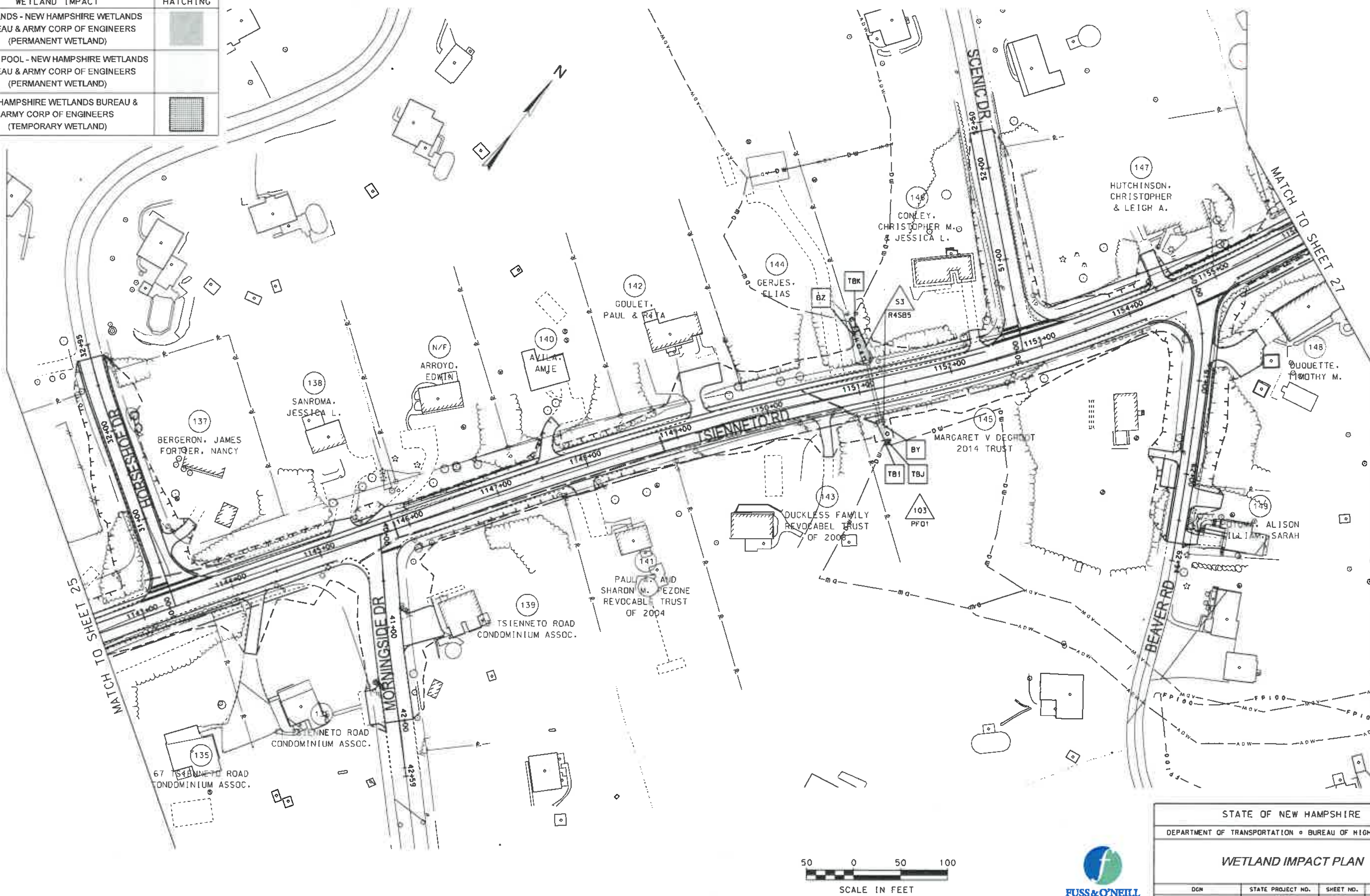
DEPARTMENT OF TRANSPORTATION • BUREAU OF HIGHWAY DESIGN

*WETLAND IMPACT PLAN*

| DGN | STATE PROJECT NO. | SHEET NO. | TOTAL SHEETS |
|---|---|---|---|
| 13065WETL | 13065 | 25 | 28 |

# LEGEND

| TYPE OF WETLAND IMPACT | SHADING/ HATCHING |
|---|---|
| WETLANDS - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
| VERNAL POOL - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
| NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (TEMPORARY WETLAND) | |




| SDR PROCESSED | | DATE | |
|---|---|---|---|
| NEW DESIGN | EMM | DATE | 2/6/2020 |
| SHEET CHECKED | NCF | DATE | 2/6/2020 |
| AS BUILT DETAILS | | DATE | |

REVISIONS AFTER PROPOSAL

| NUMBER | DATE | STATION | STATION | DESCRIPTION |
|---|---|---|---|---|
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STATE OF NEW HAMPSHIRE

DEPARTMENT OF TRANSPORTATION • BUREAU OF HIGHWAY DESIGN

*WETLAND IMPACT PLAN*

| DGN | STATE PROJECT NO. | SHEET NO. | TOTAL SHEETS |
|---|---|---|---|
| 13065WETL | 13065 | 26 | 28 |

FUSS&O'NEILL

| SDR PROCESSED | | DATE | |
|---|---|---|---|
| NEW DESIGN | EMM | DATE | 2/6/2020 |
| SHEET CHECKED | NCF | DATE | 2/6/2020 |
| AS BUILT DETAILS | | DATE | |

REVISIONS AFTER PROPOSAL

| NUMBER | DATE | STATION | STATION | DESCRIPTION |
|---|---|---|---|---|
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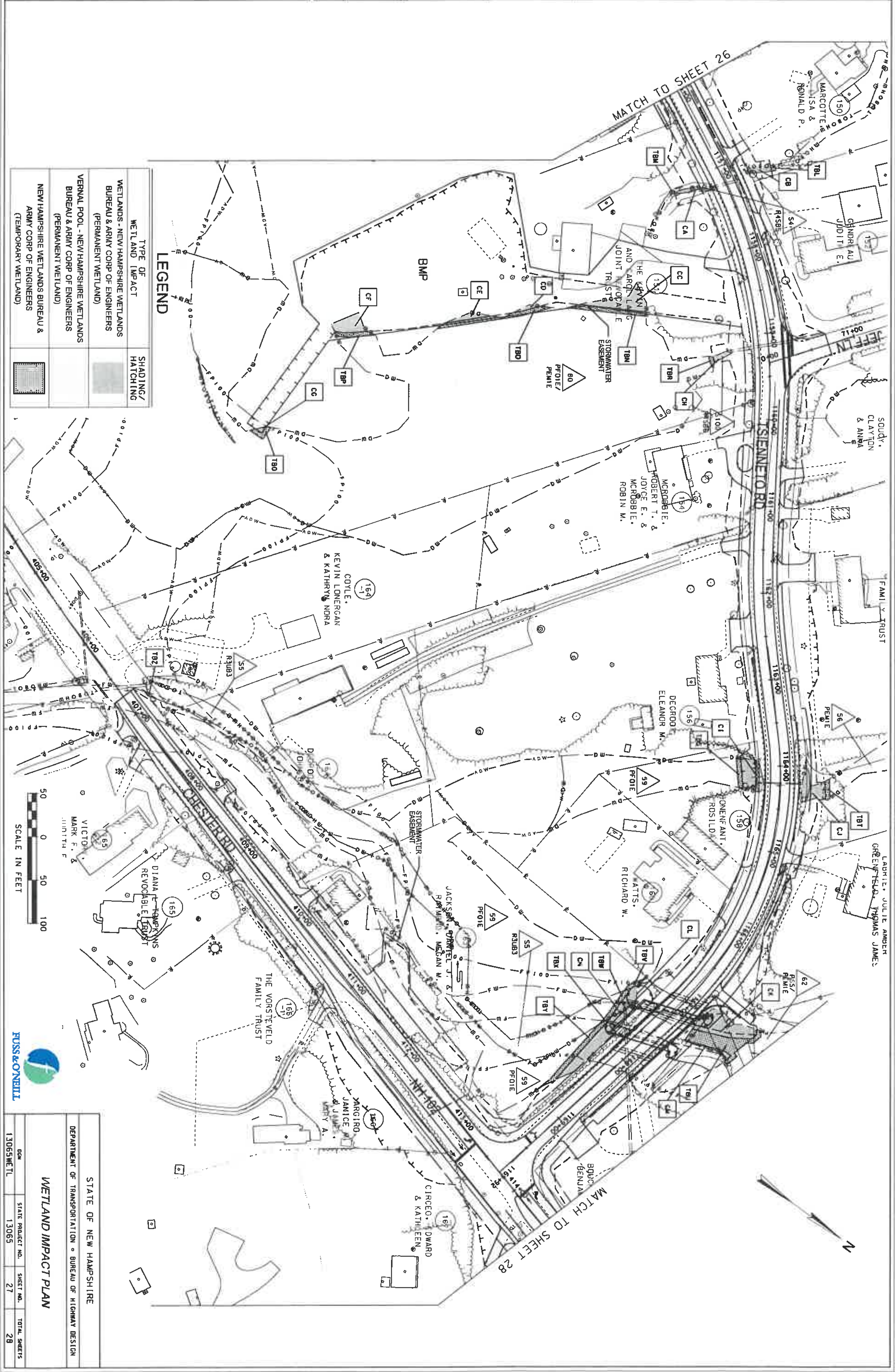


LEGEND

| TYPE OF WETLAND IMPACT | SHADING/ HATCHING |
|---|---|
| WETLANDS - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
| VERNAL POOL - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
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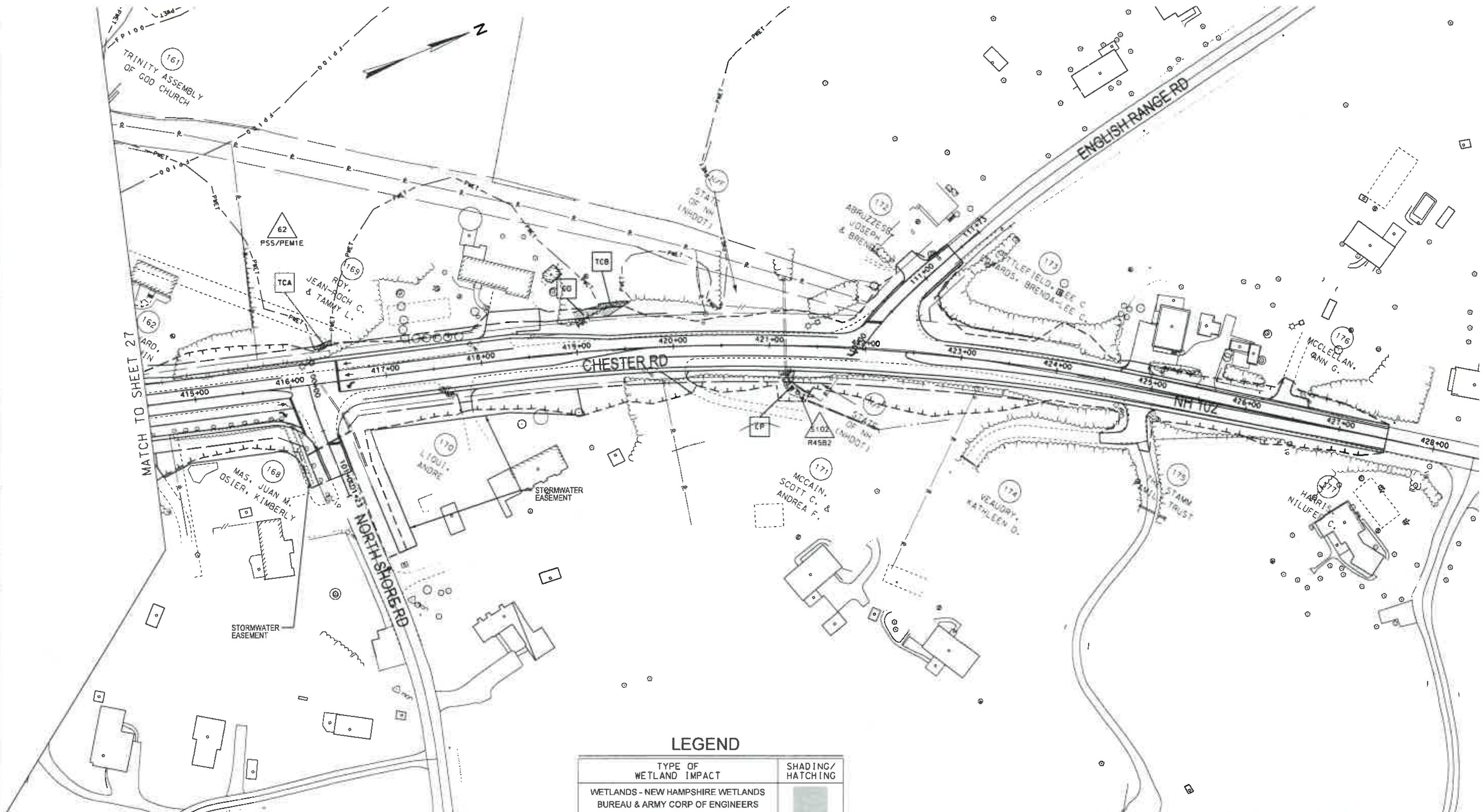
FUSS & O'NEILL

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION • BUREAU OF HIGHWAY DESIGN

**WETLAND IMPACT PLAN**

| DGN | STATE PROJECT NO. | SHEET NO. | TOTAL SHEETS |
|---|---|---|---|
| 13065WETL | 13065 | 27 | 28 |




## LEGEND

| TYPE OF WETLAND IMPACT | SHADING/ HATCHING |
|---|---|
| WETLANDS - NEW HAMPSHIRE WETLANDS BUREAU & ARMY CORP OF ENGINEERS (PERMANENT WETLAND) | |
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SCALE IN FEET

FUSS & O'NEILL

STATE OF NEW HAMPSHIRE

DEPARTMENT OF TRANSPORTATION • BUREAU OF HIGHWAY DESIGN

### WETLAND IMPACT PLAN

| DGN | STATE PROJECT NO. | SHEET NO. | TOTAL SHEETS |
|---|---|---|---|
| 13065WETL | 13065 | 28 | 28 |

| REVISIONS AFTER PROPOSAL | | | | |
|---|---|---|---|---|
| NUMBER | DATE | STATION | STATION | DESCRIPTION |

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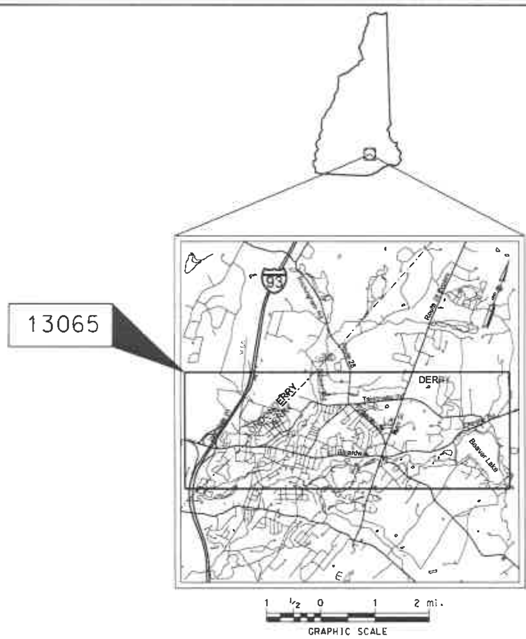
|---|---|---|---|
| SDR PROCESSED | | DATE | |
| NEW DESIGN | EMM | DATE | 2/6/2020 |
| SHEET CHECKED | NCF | DATE | 2/6/2020 |
| AS BUILT DETAILS | | DATE | |

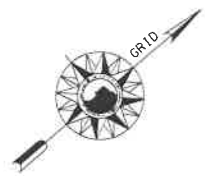
| | | |
|---|---|---|
| DRAWN BY MGS | DATE | 2/6/2020 |
| CHECKED BY KAH | DATE | 2/6/2020 |

# STATE OF NEW HAMPSHIRE
# DEPARTMENT OF TRANSPORTATION

# EROSION & SEDIMENT CONTROL PLANS

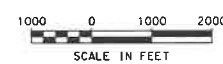
## I-93 EXIT 4A DERRY-LONDONDERRY
## FEDERAL PROJECT IM-0931(201)
## NH PROJECT 13065





**TOWNS OF LONDONDERRY & DERRY**
**COUNTY OF ROCKINGHAM**
**SCALE : 1" = 1000'**




**NHDOT** THE STATE OF NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION

RECOMMENDED FOR APPROVAL:

DIRECTOR OF PROJECT DEVELOPMENT — DATE

APPROVED:

ASSISTANT COMMISSIONER AND CHIEF ENGINEER — DATE

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

APPROVED:

DIVISION ADMINISTRATOR — DATE

| FEDERAL PROJECT NO. | STATE PROJECT NO. | SHEET NO. | TOTAL SHEETS |
|---|---|---|---|
| IM-0931(201) | 13065 | 1 | 28 |

2/7/2020

## GENERAL

| | PROPOSED ROADWAY | existing roadway | (pavement removed outside slope lines) |
|---|---|---|---|
| EDGE OF PAVEMENT | | | |
| TRAVELED WAY | | | |

- DRIVEWAYS — (label surface type)
- BUILDINGS — (label house or type of building); (building to be removed)
- FOUNDATION — (label type)
- LEACH FIELD — leach field
- BRIDGE CROSSINGS — STREAM; OVERPASS
- STEPS AND WALK — (label type)
- INTERMITTENT WATER COURSE
- SHORE LINE — river/stream; pond (label name of water body)
- POTENTIAL WET AREA SYMBOL
- BRUSH OR WOODS LINE
- TREES (PLANS) — (deciduous) (coniferous) (stump)
- TREE OR STUMP (CROSS-SECTIONS) — (show station, circumference in feet & type)
- HEDGE — (label type)
- MONITORING WELL — mon
- WELL
- FLAG POLE — fp

- ORIGINAL GROUND (TYPICALS)
- ROCK OUTCROP
- ROCK LINE (TYPICALS & SECTIONS ONLY)

| | existing | PROPOSED |
|---|---|---|
| GUARDRAIL (label type) | bgr / cgr | |
| JERSEY BARRIER | | |
| CURB (LABEL TYPE) | | |
| STONE WALL | | |
| RETAINING WALL (LABEL TYPE) | | (points toward retained ground) |
| FENCE (LABEL TYPE) | | |

- SIGNS — (single post); (double post)
- GAS PUMP — gp
- FUEL TANK (ABOVE GROUND) — ft (label size & type)
- STORAGE TANK FILLER CAP — fc
- SEPTIC TANK — S
- GRAVE — gr
- MAILBOX — mb
- VENT PIPE — vp
- SATELLITE DISH ANTENNA — da
- PHONE — ph
- GROUND LIGHT/LAMP POST — gl; lp
- BORING LOCATION — B
- TEST PIT — TP
- INTERSTATE NUMBERED HIGHWAY — 293
- UNITED STATES NUMBERED HIGHWAY — 3
- STATE NUMBERED HIGHWAY — 102

## SHORELAND - WETLAND

| | |
|---|---|
| WETLAND DESIGNATION AND TYPE | 2 PUB2E |
| DELINEATED WETLAND | DW |
| AERIAL DELINEATED WETLAND | ADW |
| ORDINARY HIGH WATER | OHW |
| TOP OF BANK | TOB |
| TOP OF BANK & ORDINARY HIGH WATER | TOBOHW |
| NORMAL HIGH WATER | NHW |
| WIDTH AT BANK FULL | WBF |
| PRIME WETLAND | PWET |
| PRIME WETLAND 100' BUFFER | PWET100 |
| NON-JURISDICTIONAL DRAINAGE AREA | NJDA |
| COWARDIN DISTINCTION LINE | CDL |
| TIDAL BUFFER ZONE | TBZ |
| DEVELOPED TIDAL BUFFER ZONE | DTBZ |
| HIGHEST OBSERVABLE TIDE LINE | HOTL |
| MEAN HIGH WATER | MHW |
| MEAN LOW WATER | MLW |
| VERNAL POOL | VP |
| SPECIAL AQUATIC SITE | SAS |
| REFERENCE LINE | REF |
| WATER FRONT BUFFER | WB50 |
| NATURAL WOODLAND BUFFER | NWB150 |
| PROTECTED SHORELAND | PS250 |
| INVASIVE SPECIES LABEL | I.S. I; I.S. II |
| INVASIVE SPECIES | INV |

## FLOODPLAIN / FLOODWAY

| | |
|---|---|
| 500 YEAR FLOODPLAIN BOUNDARY | FP500 |
| 100 YEAR FLOODPLAIN BOUNDARY | FP100 |
| FLOODWAY | FW |

## ENGINEERING

- CONSTRUCTION BASELINE — 30 31 32
- PC, PT, POT (ON CONST BASELINE)
- PI (IN CONSTRUCTION BASELINES)
- INTERSECTION OR EQUATION OF TWO LINES
- ORIGINAL GROUND LINE (PROFILES AND CROSS-SECTIONS)
- PROFILE GRADE LINE (PROFILES AND CROSS-SECTIONS)
- CLEARING LINE — SLOPE LINE; CLEARING LINE
- SLOPE LINE
- SLOPE LINE (FILL)
- SLOPE LINE (CUT)
- PROFILES AND CROSS SECTIONS: ORIGINAL GROUND ELEVATION (LEFT) FINISHED GRADE ELEVATION (RIGHT) — 72.5 79.14

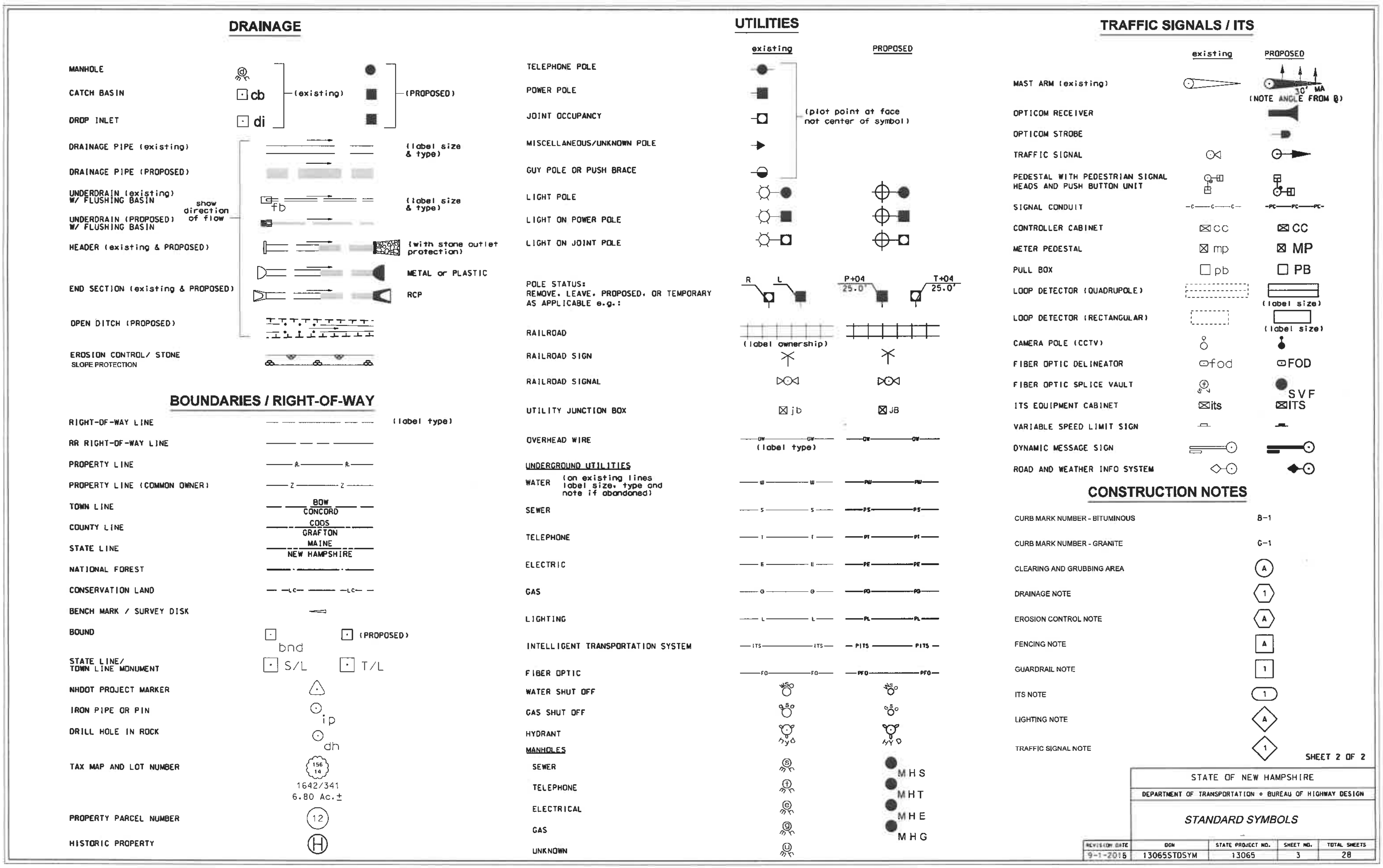
SHEET 1 OF 2

STATE OF NEW HAMPSHIRE

DEPARTMENT OF TRANSPORTATION • BUREAU OF HIGHWAY DESIGN

*STANDARD SYMBOLS*

| REVISION DATE | DGN | STATE PROJECT NO. | SHEET NO. | TOTAL SHEETS |
|---|---|---|---|---|
| 11-21-2014 | 13065STDSYM | 13065 | 2 | 28 |


DRAINAGE
MANHOLE
CATCH BASIN
DROP INLET
cb
di
(existing)
(PROPOSED)
DRAINAGE PIPE (existing)
DRAINAGE PIPE (PROPOSED)
(label size & type)
UNDERDRAIN (existing) W/ FLUSHING BASIN
UNDERDRAIN (PROPOSED) W/ FLUSHING BASIN
show direction of flow
fb
(label size & type)
HEADER (existing & PROPOSED)
(with stone outlet protection)
END SECTION (existing & PROPOSED)
METAL or PLASTIC
RCP
OPEN DITCH (PROPOSED)
EROSION CONTROL/ STONE SLOPE PROTECTION
BOUNDARIES / RIGHT-OF-WAY
RIGHT-OF-WAY LINE
(label type)
RR RIGHT-OF-WAY LINE
PROPERTY LINE
PROPERTY LINE (COMMON OWNER)
TOWN LINE
BOW
CONCORD
COUNTY LINE
COOS
GRAFTON
STATE LINE
MAINE
NEW HAMPSHIRE
NATIONAL FOREST
CONSERVATION LAND
BENCH MARK / SURVEY DISK
BOUND
bnd
(PROPOSED)
STATE LINE/ TOWN LINE MONUMENT
S/L
T/L
NHDOT PROJECT MARKER
IRON PIPE OR PIN
ip
DRILL HOLE IN ROCK
dh
TAX MAP AND LOT NUMBER
156 14
1642/341
6.80 Ac.±
PROPERTY PARCEL NUMBER
12
HISTORIC PROPERTY
H
UTILITIES
existing
PROPOSED
TELEPHONE POLE
POWER POLE
JOINT OCCUPANCY
(plot point at face not center of symbol)
MISCELLANEOUS/UNKNOWN POLE
GUY POLE OR PUSH BRACE
LIGHT POLE
LIGHT ON POWER POLE
LIGHT ON JOINT POLE
POLE STATUS: REMOVE, LEAVE, PROPOSED, OR TEMPORARY AS APPLICABLE e.g.:
R
L
P+04 25.0'
T+04 25.0'
RAILROAD
(label ownership)
RAILROAD SIGN
RAILROAD SIGNAL
UTILITY JUNCTION BOX
jb
JB
OVERHEAD WIRE
(label type)
UNDERGROUND UTILITIES
(on existing lines label size, type and note if abandoned)
WATER
SEWER
TELEPHONE
ELECTRIC
GAS
LIGHTING
INTELLIGENT TRANSPORTATION SYSTEM
FIBER OPTIC
WATER SHUT OFF
GAS SHUT OFF
HYDRANT
MANHOLES
SEWER
TELEPHONE
ELECTRICAL
GAS
UNKNOWN
MHS
MHT
MHE
MHG
TRAFFIC SIGNALS / ITS
existing
PROPOSED
MAST ARM (existing)
30' MA
(NOTE ANGLE FROM ℄)
OPTICOM RECEIVER
OPTICOM STROBE
TRAFFIC SIGNAL
PEDESTAL WITH PEDESTRIAN SIGNAL HEADS AND PUSH BUTTON UNIT
SIGNAL CONDUIT
CONTROLLER CABINET
cc
CC
METER PEDESTAL
mp
MP
PULL BOX
pb
PB
LOOP DETECTOR (QUADRUPOLE)
(label size)
LOOP DETECTOR (RECTANGULAR)
(label size)
CAMERA POLE (CCTV)
FIBER OPTIC DELINEATOR
fod
FOD
FIBER OPTIC SPLICE VAULT
SVF
ITS EQUIPMENT CABINET
its
ITS
VARIABLE SPEED LIMIT SIGN
DYNAMIC MESSAGE SIGN
ROAD AND WEATHER INFO SYSTEM
CONSTRUCTION NOTES
CURB MARK NUMBER - BITUMINOUS
B-1
CURB MARK NUMBER - GRANITE
G-1
CLEARING AND GRUBBING AREA
A
DRAINAGE NOTE
1
EROSION CONTROL NOTE
A
FENCING NOTE
A
GUARDRAIL NOTE
1
ITS NOTE
1
LIGHTING NOTE
A
TRAFFIC SIGNAL NOTE
1
SHEET 2 OF 2
STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION • BUREAU OF HIGHWAY DESIGN
STANDARD SYMBOLS
REVISION DATE
9-1-2016
DGN
13065STDSYM
STATE PROJECT NO.
13065
SHEET NO.
3
TOTAL SHEETS
28

# EROSION CONTROL PLAN LEGEND

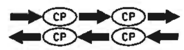
PERIMETER CONTROL


SILT FENCE
EROSION CONTROL MIX BERM
EROSION CONTROL MIX SOX
TURBIDITY CURTAIN
SHEET PILE
COFFER DAM

NATURAL BUFFER/PERIMETER CONTROL

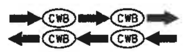

SILT FENCE
EROSION CONTROL MIX BERM
EROSION CONTROL MIX SOX
TURBIDITY CURTAIN
SHEET PILE
COFFER DAM

CHANNEL PROTECTION




STONE CHECK DAMS
STRAW WATTLES
CHANNEL MATTING
CLASS D EROSION STONE
CLASS C STONE

CLEAN WATER BYPASS




PUMP THROUGH PIPE
DRAIN THROUGH PIPE OR CHANNEL

| STATE OF NEW HAMPSHIRE | | | | |
|---|---|---|---|---|
| DEPARTMENT OF TRANSPORTATION ◦ BUREAU OF HIGHWAY DESIGN | | | | |
| *EROSION CONTROL SYMBOLS* | | | | |
| REVISION DATE | DGN | STATE PROJECT NO. | SHEET NO. | TOTAL SHEETS |
| 1-17-2020 | 13065STDSYMERO | 13065 | 4 | 28 |

# EROSION CONTROL STRATEGIES

1. ENVIRONMENTAL COMMITMENTS:
   - 1.1. THESE GUIDELINES DO NOT RELIEVE THE CONTRACTOR FROM COMPLIANCE WITH ANY CONTRACT PROVISIONS, OR APPLICABLE FEDERAL, STATE, AND LOCAL REGULATIONS.
   - 1.2. THIS PROJECT WILL BE SUBJECT TO THE US EPA'S NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) STORM WATER CONSTRUCTION GENERAL PERMIT AS ADMINISTERED BY THE ENVIRONMENTAL PROTECTION AGENCY (EPA). THIS PROJECT IS SUBJECT TO REQUIREMENTS IN THE MOST RECENT CONSTRUCTION GENERAL PERMIT (CGP).
   - 1.3. THE CONTRACTOR'S ATTENTION IS DIRECTED TO THE NHDES WETLAND PERMIT, THE US ARMY CORPS OF ENGINEERS PERMIT, WATER QUALITY CERTIFICATION AND THE SPECIAL ATTENTION ITEMS INCLUDED IN THE CONTRACT DOCUMENTS.
   - 1.4. ALL STORM WATER, EROSION AND SEDIMENT CONTROL MEASURES SHALL BE INSTALLED AND MAINTAINED IN ACCORDANCE WITH THE NEW HAMPSHIRE STORMWATER MANUAL, VOLUME 3, EROSION AND SEDIMENT CONTROLS DURING CONSTRUCTION (DECEMBER 2008) (BMP MANUAL) AVAILABLE FROM THE NEW HAMPSHIRE DEPARTMENT OF ENVIRONMENTAL SERVICES (NHDES).
   - 1.5. THE CONTRACTOR SHALL COMPLY WITH RSA 485-A:17, AND ALL, PUBLISHED NHDES ALTERATION OF TERRAIN ENV-WQ 1500 REQUIREMENTS (HTTP://DES.NH.GOV/ORGANIZATION/COMMISSIONER/LEGAL/RULES/INDEX.HTM)
   - 1.6. THE CONTRACTOR IS DIRECTED TO REVIEW AND COMPLY WITH SECTION 107.1 OF THE CONTRACT AS IT REFERS TO SPILLAGE, AND ALSO WITH REGARDS TO EROSION, POLLUTION, AND TURBIDITY PRECAUTIONS.

2. STANDARD EROSION CONTROL SEQUENCING APPLICABLE TO ALL CONSTRUCTION PROJECTS:
   - 2.1. PERIMETER CONTROLS SHALL BE INSTALLED PRIOR TO EARTH DISTURBING ACTIVITIES. PERIMETER CONTROLS AND STABILIZED CONSTRUCTION EXITS SHALL BE INSTALLED AS SHOWN IN THE BMP MANUAL AND AS DIRECTED BY THE STORMWATER POLLUTION PREVENTION PLAN (SWPPP) PREPARER.
   - 2.2. EROSION, SEDIMENTATION CONTROL MEASURES AND INFILTRATION BASINS SHALL BE CLEANED, REPLACED AND AUGMENTED AS NECESSARY TO PREVENT SEDIMENTATION BEYOND PROJECT LIMITS THROUGHOUT THE PROJECT DURATION.
   - 2.3. EROSION AND SEDIMENT CONTROL MEASURES SHALL BE INSPECTED IN ACCORDANCE WITH THE CONSTRUCTION GENERAL PERMIT AND SECTION 645 OF THE NHDOT SPECIFICATIONS FOR ROAD AND BRIDGES CONSTRUCTION.
   - 2.4. AN AREA SHALL BE CONSIDERED STABLE IF ONE OF THE FOLLOWING HAS OCCURRED:
     - (A) BASE COURSE GRAVELS HAVE BEEN INSTALLED IN AREAS TO BE PAVED;
     - (B) A MINIMUM OF 85% VEGETATED GROWTH HAS BEEN ESTABLISHED;
     - (C) A MINIMUM OF 3" OF NON-EROSIVE MATERIAL SUCH AS STONE OR RIP-RAP HAS BEEN INSTALLED;
     - (D) TEMPORARY SLOPE STABILIZATION CONFORMING TO TABLE 1 HAS BEEN PROPERLY INSTALLED
   - 2.5. ALL STOCKPILES SHALL BE CONTAINED WITH A PERIMETER CONTROL. IF THE STOCKPILE IS TO REMAIN UNDISTURBED FOR MORE THAN 14 DAYS, MULCHING WILL BE REQUIRED.
   - 2.6. A WATER TRUCK SHALL BE AVAILABLE TO CONTROL EXCESSIVE DUST AT THE DIRECTION OF THE CONTRACT ADMINISTRATOR.
   - 2.7. TEMPORARY EROSION AND SEDIMENTATION CONTROL MEASURES SHALL REMAIN UNTIL THE AREA HAS BEEN PERMANENTLY STABILIZED.
   - 2.8. CONSTRUCTION PERFORMED ANY TIME BETWEEN NOVEMBER 30ᵗʰ AND MAY 1ˢᵗ OF ANY YEAR SHALL BE CONSIDERED WINTER CONSTRUCTION AND SHALL CONFORM TO THE FOLLOWING REQUIREMENTS.
     - (A) ALL PROPOSED VEGETATED AREAS WHICH DO NOT EXHIBIT A MINIMUM OF 85% VEGETATIVE GROWTH BY OCTOBER 15ᵗʰ, OR WHICH ARE DISTURBED AFTER OCTOBER 15ᵗʰ, SHALL BE STABILIZED IN ACCORDANCE WITH TABLE 1.
     - (B) ALL DITCHES OR SWALES WHICH DO NOT EXHIBIT A MINIMUM OF 85% VEGETATIVE GROWTH BY OCTOBER 15ᵗʰ, OR WHICH ARE DISTURBED AFTER OCTOBER 15ᵗʰ, SHALL BE STABILIZED TEMPORARILY WITH STONE OR IN ACCORDANCE WITH TABLE 1.
     - (C) AFTER NOVEMBER 30ᵗʰ INCOMPLETE ROAD SURFACES, WHERE WORK HAS STOPPED FOR THE SEASON, SHALL BE PROTECTED IN ACCORDANCE WITH TABLE 1.
     - (D) WINTER EXCAVATION AND EARTHWORK SHALL BE DONE SUCH THAT NO MORE THAN 1 ACRE OF THE PROJECT IS WITHOUT STABILIZATION AT ONE TIME, UNLESS A WINTER CONSTRUCTION PLAN HAS BEEN APPROVED BY NHDOT THAT MEETS THE REQUIREMENTS OF ENV-WQ 1505.02 AND ENV-WQ 1505.05.
     - (E) A SWPPP AMENDMENT SHALL BE SUBMITTED TO THE DEPARTMENT, FOR APPROVAL, ADDRESSING COLD WEATHER STABILIZATION (ENV-WQ 1505.05) AND INCLUDING THE REQUIREMENTS OF NO LESS THAN 30 DAYS PRIOR TO THE COMMENCEMENT OF WORK SCHEDULED AFTER NOVEMBER 30ᵗʰ.

GENERAL CONSTRUCTION PLANNING AND SELECTION OF STRATEGIES TO CONTROL EROSION AND SEDIMENT ON HIGHWAY CONSTRUCTION PROJECTS

3. PLAN ACTIVITIES TO ACCOUNT FOR SENSITIVE SITE CONDITIONS:
   - 3.1. CLEARLY FLAG AREAS TO BE PROTECTED IN THE FIELD AND PROVIDE CONSTRUCTION BARRIERS TO PREVENT TRAFFICKING OUTSIDE OF WORK AREAS.
   - 3.2. CONSTRUCTION SHALL BE SEQUENCED TO LIMIT THE DURATION AND AREA OF EXPOSED SOILS.
   - 3.3. PROTECT AND MAXIMIZE EXISTING NATIVE VEGETATION AND NATURAL FOREST BUFFERS BETWEEN CONSTRUCTION ACTIVITY AND SENSITIVE AREAS.
   - 3.4. WHEN WORK IS PERFORMED IN AND NEAR WATER COURSES, STREAM FLOW DIVERSION METHODS SHALL BE IMPLEMENTED PRIOR TO ANY EXCAVATION OR FILLING.
   - 3.5. WHEN WORK IS PERFORMED WITHIN 50 FEET OF SURFACE WATERS (WETLAND, OPEN WATER OR FLOWING WATER), PERIMETER CONTROL SHALL BE ENHANCED CONSISTENT WITH SECTION 2.1.2.1. OF THE 2012 NPDES CONSTRUCTION GENERAL PERMIT.

4. MINIMIZE THE AMOUNT OF EXPOSED SOIL:
   - 4.1. CONSTRUCTION SHALL BE SEQUENCED TO LIMIT THE DURATION AND AREA OF EXPOSED SOILS. MINIMIZE THE AREA OF EXPOSED SOIL AT ANY ONE TIME. PHASING SHALL BE USED TO REDUCE THE AMOUNT AND DURATION OF SOIL EXPOSED TO THE ELEMENTS AND VEHICLE TRACKING.
   - 4.2. UTILIZE TEMPORARY MULCHING OR PROVIDE ALTERNATE TEMPORARY STABILIZATION ON EXPOSED SOILS IN ACCORDANCE WITH TABLE 1.
   - 4.3. THE MAXIMUM AMOUNT OF DISTURBED EARTH SHALL NOT EXCEED A TOTAL OF 5 ACRES FROM MAY 1ˢᵗ THROUGH NOVEMBER 30ᵗʰ, OR EXCEED ONE ACRE DURING WINTER MONTHS, UNLESS THE CONTRACTOR DEMONSTRATES TO THE DEPARTMENT THAT THE ADDITIONAL AREA OF DISTURBANCE IS NECESSARY TO MEET THE CONTRACTORS CRITICAL PATH METHOD SCHEDULE (CPM), AND THE CONTRACTOR HAS ADEQUATE RESOURCES AVAILABLE TO ENSURE THAT ENVIRONMENTAL COMMITMENTS WILL BE MET.

5. CONTROL STORMWATER FLOWING ONTO AND THROUGH THE PROJECT:
   - 5.1. DIVERT OFF SITE RUNOFF OR CLEAN WATER AWAY FROM THE CONSTRUCTION ACTIVITY TO REDUCE THE VOLUME THAT NEEDS TO BE TREATED ON SITE.
   - 5.2. DIVERT STORM RUNOFF FROM UPSLOPE DRAINAGE AREAS AWAY FROM DISTURBED AREAS, SLOPES, AND AROUND ACTIVE WORK AREAS AND TO A STABILIZED OUTLET LOCATION.
   - 5.3. CONSTRUCT IMPERMEABLE BARRIERS AS NECESSARY TO COLLECT OR DIVERT CONCENTRATED FLOWS FROM WORK OR DISTURBED AREAS.
   - 5.4. STABILIZE, TO APPROPRIATE ANTICIPATED VELOCITIES, CONVEYANCE CHANNELS OR PUMPING SYSTEMS NEEDED TO CONVEY CONSTRUCTION STORMWATER TO BASINS AND DISCHARGE LOCATIONS PRIOR TO USE.
   - 5.5. DIVERT OFF-SITE WATER THROUGH THE PROJECT IN AN APPROPRIATE MANNER SO NOT TO DISTURB THE UPSTREAM OR DOWNSTREAM SOILS, VEGETATION OR HYDROLOGY BEYOND THE PERMITTED AREA.

6. PROTECT SLOPES:
   - 6.1. INTERCEPT AND DIVERT STORM RUNOFF FROM UPSLOPE DRAINAGE AREAS AWAY FROM UNPROTECTED AND NEWLY ESTABLISHED AREAS AND SLOPES TO A STABILIZED OUTLET OR CONVEYANCE.
   - 6.2. CONSIDER HOW GROUNDWATER SEEPAGE ON CUT SLOPES MAY IMPACT SLOPE STABILITY AND INCORPORATE APPROPRIATE MEASURES TO MINIMIZE EROSION.
   - 6.3. CONVEY STORMWATER DOWN THE SLOPE IN A STABILIZED CHANNEL OR SLOPE DRAIN.
   - 6.4. THE OUTER FACE OF THE FILL SLOPE SHOULD BE IN A LOOSE RUFFLED CONDITION PRIOR TO TURF ESTABLISHMENT. TOPSOIL OR HUMUS LAYERS SHALL BE TRACKED UP AND DOWN THE SLOPE, DISKED, HARROWED, DRAGGED WITH A CHAIN OR MAT, MACHINE-RAKED, OR HAND-WORKED TO PRODUCE A RUFFLED SURFACE.

7. ESTABLISH STABILIZED CONSTRUCTION EXITS:
   - 7.1. INSTALL AND MAINTAIN CONSTRUCTION EXITS, ANYWHERE TRAFFIC LEAVES A CONSTRUCTION SITE ONTO A PUBLIC RIGHT-OF-WAY.
   - 7.2. SWEEP ALL CONSTRUCTION RELATED DEBRIS AND SOIL FROM THE ADJACENT PAVED ROADWAYS AS NECESSARY.

8. PROTECT STORM DRAIN INLETS:
   - 8.1. DIVERT SEDIMENT LADEN WATER AWAY FROM INLET STRUCTURES TO THE EXTENT POSSIBLE.
   - 8.2. INSTALL SEDIMENT BARRIERS AND SEDIMENT TRAPS AT INLETS TO PREVENT SEDIMENT FROM ENTERING THE DRAINAGE SYSTEM.
   - 8.3. CLEAN CATCH BASINS, DRAINAGE PIPES, AND CULVERTS IF SIGNIFICANT SEDIMENT IS DEPOSITED.
   - 8.4. DROP INLET SEDIMENT BARRIERS SHOULD NEVER BE USED AS THE PRIMARY MEANS OF SEDIMENT CONTROL AND SHOULD ONLY BE USED TO PROVIDE AN ADDITIONAL LEVEL OF PROTECTION TO STRUCTURES AND DOWN-GRADIENT SENSITIVE RECEPTORS.

9. SOIL STABILIZATION:
   - 9.1. WITHIN THREE DAYS OF THE LAST ACTIVITY IN AN AREA, ALL EXPOSED SOIL AREAS, WHERE CONSTRUCTION ACTIVITIES ARE COMPLETE, SHALL BE STABILIZED.
   - 9.2. IN ALL AREAS, TEMPORARY SOIL STABILIZATION MEASURES SHALL BE APPLIED IN ACCORDANCE WITH THE STABILIZATION REQUIREMENTS (SECTION 2.2) OF THE 2012 CGP. (SEE TABLE 1 FOR GUIDANCE ON THE SELECTION OF TEMPORARY SOIL STABILIZATION MEASURES.)
   - 9.3. EROSION CONTROL SEED MIX SHALL BE SOWN IN ALL INACTIVE CONSTRUCTION AREAS THAT WILL NOT BE PERMANENTLY SEEDED WITHIN TWO WEEKS OF DISTURBANCE AND PRIOR TO SEPTEMBER 15, OF ANY GIVEN YEAR, IN ORDER TO ACHIEVE VEGETATIVE STABILIZATION PRIOR TO THE END OF THE GROWING SEASON.
   - 9.4. SOIL TACKIFIERS MAY BE APPLIED IN ACCORDANCE WITH THE MANUFACTURER'S SPECIFICATIONS AND REAPPLIED AS NECESSARY TO MINIMIZE SOIL AND MULCH LOSS UNTIL PERMANENT VEGETATION IS ESTABLISHED.

10. RETAIN SEDIMENT ON-SITE AND CONTROL DEWATERING PRACTICES:
    - 10.1. TEMPORARY SEDIMENT BASINS (CGP-SECTION 2.1.3.2) OR SEDIMENT TRAPS (ENV-WQ 1506.10) SHALL BE SIZED TO RETAIN, ON SITE, THE VOLUME OF A 2-YEAR 24-HOUR STORM EVENT FOR ANY AREA OF DISTURBANCE OR 3,600 CUBIC FEET OF STORMWATER RUNOFF PER ACRE OF DISTURBANCE, WHICHEVER IS GREATER. TEMPORARY SEDIMENT BASINS USED TO TREAT STORMWATER RUNOFF FROM AREAS GREATER THAN 5-ACRES OF DISTURBANCE SHALL BE SIZED TO ALSO CONTROL STORMWATER RUNOFF FROM A 10-YEAR 24 HOUR STORM EVENT. ON-SITE RETENTION OF THE 10-YEAR 24-HOUR EVENT IS NOT REQUIRED.
    - 10.2. CONSTRUCT AND STABILIZE DEWATERING INFILTRATION BASINS PRIOR TO ANY EXCAVATION THAT MAY REQUIRE DEWATERING.
    - 10.3. TEMPORARY SEDIMENT BASINS OR TRAPS SHALL BE PLACED AND STABILIZED AT LOCATIONS WHERE CONCENTRATED FLOW (CHANNELS AND PIPES) DISCHARGE TO THE SURROUNDING ENVIRONMENT FROM AREAS OF UNSTABILIZED EARTH DISTURBING ACTIVITIES.

11. ADDITIONAL EROSION AND SEDIMENT CONTROL GENERAL PRACTICES:
    - 11.1. USE TEMPORARY MULCHING, PERMANENT MULCHING, TEMPORARY VEGETATIVE COVER, AND PERMANENT VEGETATIVE COVER TO REDUCE THE NEED FOR DUST CONTROL. USE MECHANICAL SWEEPERS ON PAVED SURFACES WHERE NECESSARY TO PREVENT DUST BUILDUP. APPLY WATER, OR OTHER DUST INHIBITING AGENTS OR TACKIFIERS, AS APPROVED BY THE NHDES.
    - 11.2. ALL STOCKPILES SHALL BE CONTAINED WITH TEMPORARY PERIMETER CONTROLS. INACTIVE SOIL STOCKPILES SHOULD BE PROTECTED WITH SOIL STABILIZATION MEASURES (TEMPORARY EROSION CONTROL SEED MIX AND MULCH, SOIL BINDER) OR COVERED WITH ANCHORED TARPS.
    - 11.3. EROSION AND SEDIMENT CONTROL MEASURES WILL BE INSPECTED IN ACCORDANCE WITH SECTION 645 OF NHDOT SPECIFICATIONS, WEEKLY AND WITHIN 24 HOURS AFTER ANY STORM EVENT GREATER THAN 0.25 IN. OF RAIN PER 24-HOUR PERIOD. EROSION AND SEDIMENT CONTROL MEASURES WILL ALSO BE INSPECTED IN ACCORDANCE WITH THE GUIDANCE MEMO FROM THE NHDES CONTAINED WITHIN THE CONTRACT PROPOSAL AND THE EPA CONSTRUCTION GENERAL PERMIT.
    - 11.4. THE CONTRACTOR SHOULD UTILIZE STORM DRAIN INLET PROTECTION TO PREVENT SEDIMENT FROM ENTERING A STORM DRAINAGE SYSTEM PRIOR TO THE PERMANENT STABILIZATION OF THE CONTRIBUTING DISTURBED AREA.
    - 11.5. PERMANENT STABILIZATION MEASURES WILL BE CONSTRUCTED AND MAINTAINED IN LOCATIONS AS SHOWN ON THE CONSTRUCTION PLANS TO STABILIZE AREAS. VEGETATIVE STABILIZATION SHALL NOT BE CONSIDERED PERMANENTLY STABILIZED UNTIL VEGETATIVE GROWTH COVERS AT LEAST 85% OF THE DISTURBED AREA. THE CONTRACTOR SHALL BE RESPONSIBLE FOR EROSION AND SEDIMENT CONTROL FOR ONE YEAR AFTER PROJECT COMPLETION.
    - 11.6. CATCH BASINS: CARE SHALL BE TAKEN TO ENSURE THAT SEDIMENTS DO NOT ENTER ANY EXISTING CATCH BASINS DURING CONSTRUCTION. THE CONTRACTOR SHALL PLACE TEMPORARY STONE INLET PROTECTION OVER INLETS IN AREAS OF SOIL DISTURBANCE THAT ARE SUBJECT TO SEDIMENT CONTAMINATION.
    - 11.7. TEMPORARY AND PERMANENT DITCHES SHALL BE CONSTRUCTED, STABILIZED AND MAINTAINED IN A MANNER THAT WILL MINIMIZE SCOUR. TEMPORARY AND PERMANENT DITCHES SHALL BE DIRECTED TO DRAIN TO SEDIMENT BASINS OR STORM WATER COLLECTION AREAS.
    - 11.8. WINTER EXCAVATION AND EARTHWORK ACTIVITIES NEED TO BE LIMITED IN EXTENT AND DURATION, TO MINIMIZE POTENTIAL EROSION AND SEDIMENTATION IMPACTS. THE AREA OF EXPOSED SOIL SHALL BE LIMITED TO ONE ACRE, OR THAT WHICH CAN BE STABILIZED AT THE END OF EACH DAY UNLESS A WINTER CONSTRUCTION PLAN, DEVELOPED BY A QUALIFIED ENGINEER OR A CPESC SPECIALIST, IS REVIEWED AND APPROVED BY THE DEPARTMENT.
    - 11.9. CHANNEL PROTECTION MEASURES SHALL BE SUPPLEMENTED WITH PERIMETER CONTROL MEASURES WHEN THE DITCH LINES OCCUR AT THE BOTTOM OF LONG FILL SLOPES. THE PERIMETER CONTROLS SHALL BE INSTALLED ON THE FILL SLOPE TO MINIMIZE THE POTENTIAL FOR FILL SLOPE SEDIMENT DEPOSITS IN THE DITCH LINE.

BEST MANAGEMENT PRACTICES (BMP) BASED ON AMOUNT OF OPEN CONSTRUCTION AREA

12. STRATEGIES SPECIFIC TO OPEN AREAS LESS THAN 5 ACRES:
    - 12.1. THE CONTRACTOR SHALL COMPLY WITH RSA 485:A:17 AND ENV-WQ 1500: ALTERATION OF TERRAIN FOR CONSTRUCTION AND USE ALL CONVENTIONAL BMP STRATEGIES.
    - 12.2. SLOPES STEEPER THAN 3:1 WILL RECEIVE TURF ESTABLISHMENT WITH MATTING.
    - 12.3. SLOPES 3:1 OR FLATTER WILL RECEIVE TURF ESTABLISHMENT ALONE.
    - 12.4. AREAS WHERE HAUL ROADS ARE CONSTRUCTED AND STORMWATER CANNOT BE TREATED THE DEPARTMENT WILL CONSIDER INFILTRATION.
    - 12.5. FOR HAUL ROADS ADJACENT TO SENSITIVE ENVIRONMENTAL AREAS OR STEEPER THAN 5%, THE DEPARTMENT WILL CONSIDER USING EROSION STONE, CRUSHED GRAVEL, OR CRUSHED STONE BASE TO HELP MINIMIZE EROSION ISSUES.
    - 12.6. ALL AREAS THAT CAN BE STABILIZED SHALL BE STABILIZED PRIOR TO OPENING UP NEW TERRITORY.
    - 12.7. DETENTION BASINS SHALL BE DESIGNED AND CONSTRUCTED TO ACCOMMODATE A 2 YEAR STORM EVENT.

13. STRATEGIES SPECIFIC TO OPEN AREAS BETWEEN 5 AND 10 ACRES:
    - 13.1. THE CONTRACTOR SHALL COMPLY WITH RSA 485:A:17 AND ENV-WQ 1500 ALTERATION OF TERRAIN AND SHALL USE CONVENTIONAL BMP STRATEGIES AND ALL TREATMENT OPTIONS USED FOR UNDER 5 ACRES WILL BE UTILIZED.
    - 13.2. DETENTION BASINS WILL BE CONSTRUCTED TO ACCOMMODATE THE 2-YEAR 24-HOUR STORM EVENT AND CONTROL A 10-YEAR 24-HOUR STORM EVENT.
    - 13.3. SLOPES STEEPER THAN A 3:1 WILL RECEIVE TURF ESTABLISHMENT WITH MATTING OR OTHER TEMPORARY SOIL STABILIZATION MEASURES DETAILED IN TABLE 1. THE CONTRACTOR MAY ALSO CONSIDER A SOIL BINDER IN ACCORDANCE WITH THE NHDES APPROVALS OR REGULATIONS. OTHER ALTERNATIVE MEASURES, SUCH AS BONDED FIBER MATRIXES (BFMS) OR FLEXIBLE GROWTH MEDIUMS (FGMS) MAY BE UTILIZED, IF MEETING THE NHDES APPROVALS AND REGULATIONS.
    - 13.4. SLOPES 3:1 OR FLATTER WILL RECEIVE TURF ESTABLISHMENT OR OTHER TEMPORARY SOIL STABILIZATION MEASURES DETAILED IN TABLE 1. THE CONTRACTOR MAY ALSO CONSIDER A SOIL BINDER IN ACCORDANCE WITH THE NHDES APPROVALS OR REGULATIONS.

14. STRATEGIES SPECIFIC TO OPEN AREAS OVER 10 ACRES:
    - 14.1. THE CONTRACTOR SHALL COMPLY WITH RSA 485:A:17 AND ENV-WQ 1500 ALTERATION OF TERRAIN AND SHALL USE CONVENTIONAL BMP STRATEGIES AND ALL TREATMENT OPTIONS USED FOR UNDER 5 ACRES AND BETWEEN 5 AND 10 ACRES WILL BE UTILIZED.
    - 14.2. THE DEPARTMENT ANTICIPATES THAT SOIL BINDERS WILL BE NEEDED ON ALL SLOPES STEEPER THAN 3:1, IN ORDER TO MINIMIZE EROSION AND REDUCE THE AMOUNT OF SEDIMENT IN THE STORMWATER TREATMENT BASINS.
    - 14.3. THE CONTRACTOR WILL BE REQUIRED TO HAVE AN APPROVED DESIGN IN ACCORDANCE WITH ENV-WQ 1506.12 FOR AN ACTIVE FLOCCULANT TREATMENT SYSTEM TO TREAT AND RELEASE WATER CAPTURED IN STORM WATER BASINS. THE CONTRACTOR SHALL ALSO RETAIN THE SERVICES OF AN ENVIRONMENTAL CONSULTANT WHO HAS DEMONSTRATED EXPERIENCE IN THE DESIGN OF FLOCCULANT TREATMENT SYSTEMS. THE CONSULTANT WILL ALSO BE RESPONSIBLE FOR THE IMPLEMENTATION AND MONITORING OF THE SYSTEM.

TABLE 1

GUIDANCE ON SELECTING TEMPORARY SOIL STABILIZATION MEASURES

| APPLICATION AREAS | DRY MULCH METHODS | | | | HYDRAULICALLY APPLIED MULCHES[2] | | | | ROLLED EROSION CONTROL BLANKETS[3] | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | HMT | WC | SG | CB | HM | SMM | BFM | FRM | SNSB | DNSB | DNSCB | DNCB |
| SLOPES[1] | | | | | | | | | | | | |
| STEEPER THAN 2:1 | NO | NO | YES | NO | NO | NO | NO | YES | NO | NO | NO | YES |
| 2:1 SLOPE | YES[1] | YES[1] | YES | YES | NO | NO | YES | YES | NO | YES | YES | YES |
| 3:1 SLOPE | YES | YES | YES | YES | NO | YES | YES | YES | YES | YES | YES | NO |
| 4:1 SLOPE | YES | YES | YES | YES | YES | YES | YES | YES | YES | YES | NO | NO |
| WINTER STABILIZATION | 4T/AC | YES | YES | YES | NO | NO | YES | YES | YES | YES | YES | YES |
| CHANNELS | | | | | | | | | | | | |
| LOW FLOW CHANNELS | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | YES | YES |
| HIGH FLOW CHANNELS | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | YES |

| ABBREV. | STABILIZATION MEASURE | ABBREV. | STABILIZATION MEASURE | ABBREV. | STABILIZATION MEASURE |
|---|---|---|---|---|---|
| HMT | HAY MULCH & TACK | HM | HYDRAULIC MULCH | SNSB | SINGLE NET STRAW BLANKET |
| WC | WOOD CHIPS | SMM | STABILIZED MULCH MATRIX | DNSB | DOUBLE NET STRAW BLANKET |
| SG | STUMP GRINDINGS | BFM | BONDED FIBER MATRIX | DNSCB | 2 NET STRAW-COCONUT BLANKET |
| CB | COMPOST BLANKET | FRM | FIBER REINFORCED MEDIUM | DNCB | 2 NET COCONUT BLANKET |

NOTES:
1. ALL SLOPE STABILIZATION OPTIONS ASSUME A SLOPE LENGTH ≤10 TIMES THE HORIZONTAL DISTANCE COMPONENT OF THE SLOPE, IN FEET.
2. PRODUCTS CONTAINING POLYACRYLAMIDE (PAM) SHALL NOT BE APPLIED DIRECTLY TO OR WITHIN 100 FEET OF ANY SURFACE WATER WITHOUT PRIOR WRITTEN APPROVAL FROM THE NH DEPARTMENT OF ENVIRONMENTAL SERVICES.
3. ALL EROSION CONTROL BLANKETS SHALL BE MADE WITH WILDLIFE FRIENDLY BIODEGRADABLE NETTING.

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*EROSION CONTROL STRATEGIES AND STABILIZATION MATRIX*

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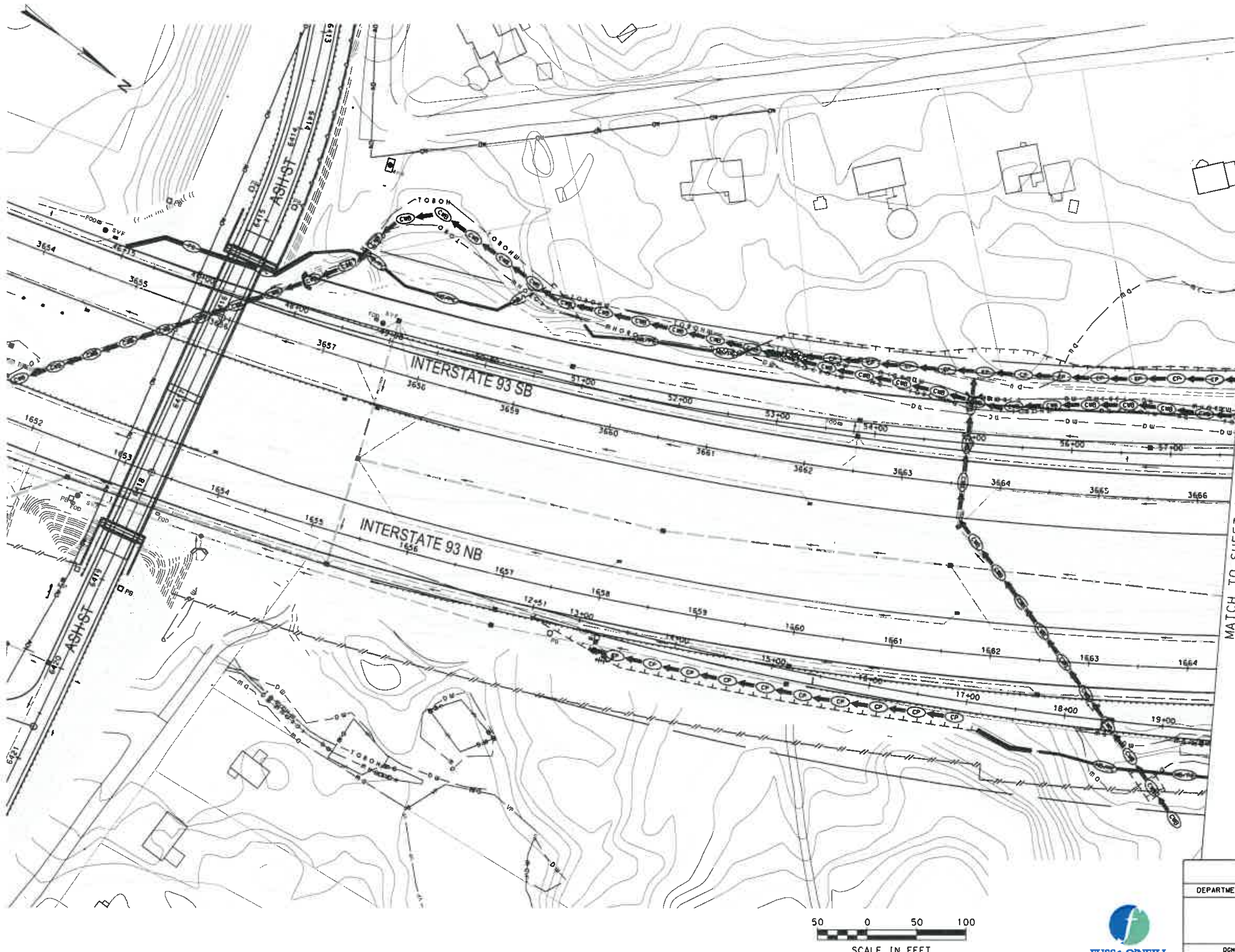


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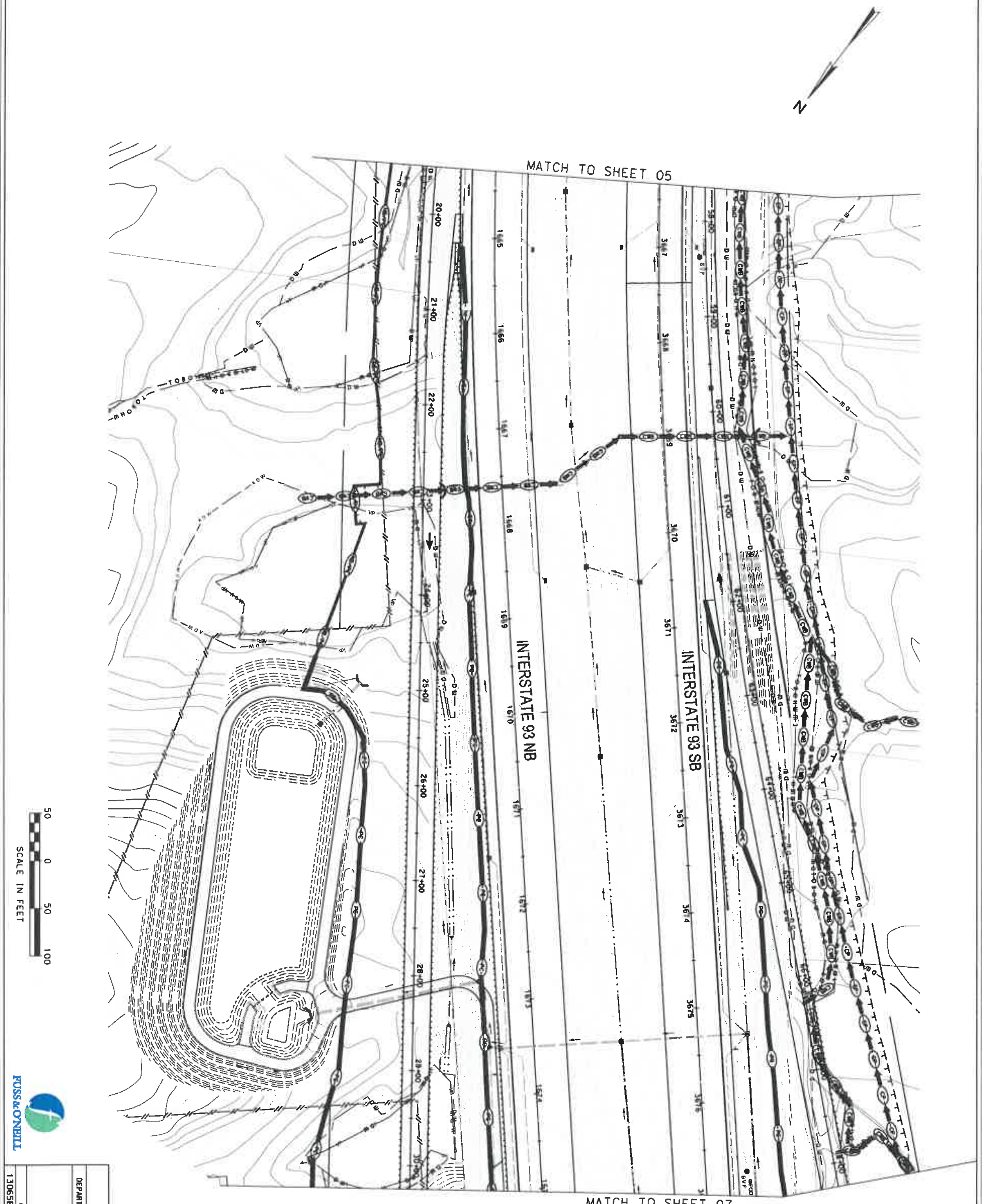


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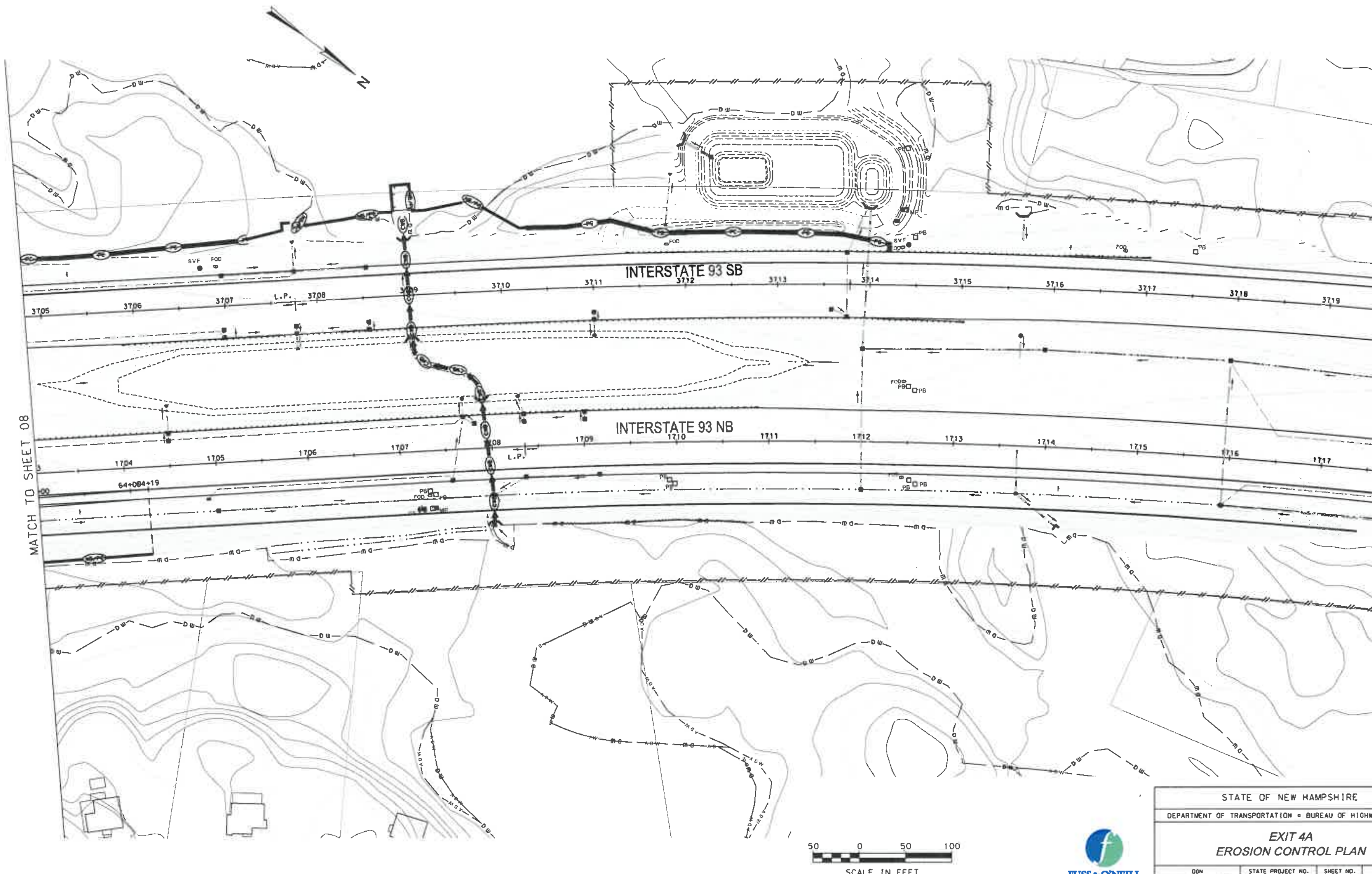


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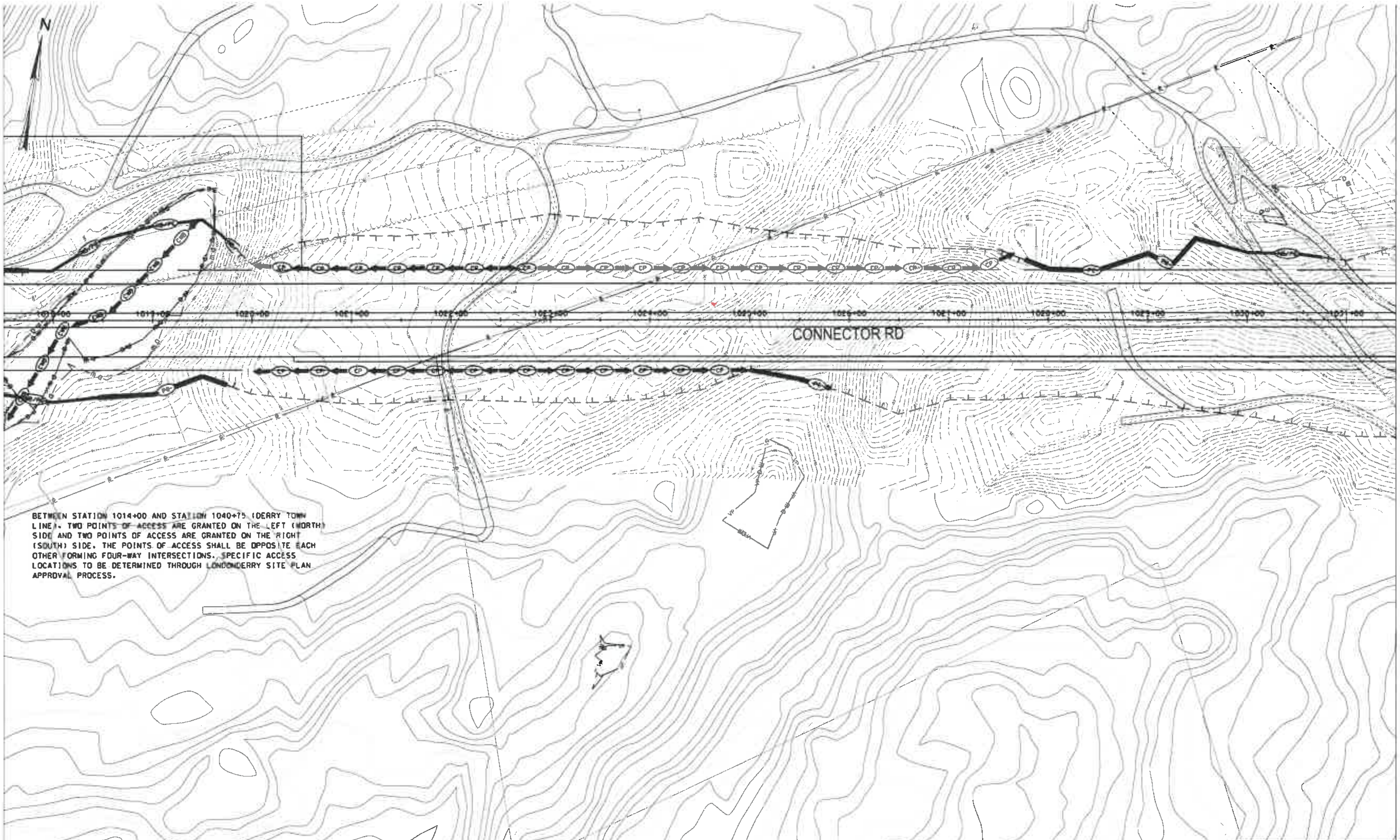


BETWEEN STATION 1014+00 AND STATION 1040+75 (DERRY TOWN LINE). TWO POINTS OF ACCESS ARE GRANTED ON THE LEFT (NORTH) SIDE AND TWO POINTS OF ACCESS ARE GRANTED ON THE RIGHT (SOUTH) SIDE. THE POINTS OF ACCESS SHALL BE OPPOSITE EACH OTHER FORMING FOUR-WAY INTERSECTIONS. SPECIFIC ACCESS LOCATIONS TO BE DETERMINED THROUGH LONDONDERRY SITE PLAN APPROVAL PROCESS.

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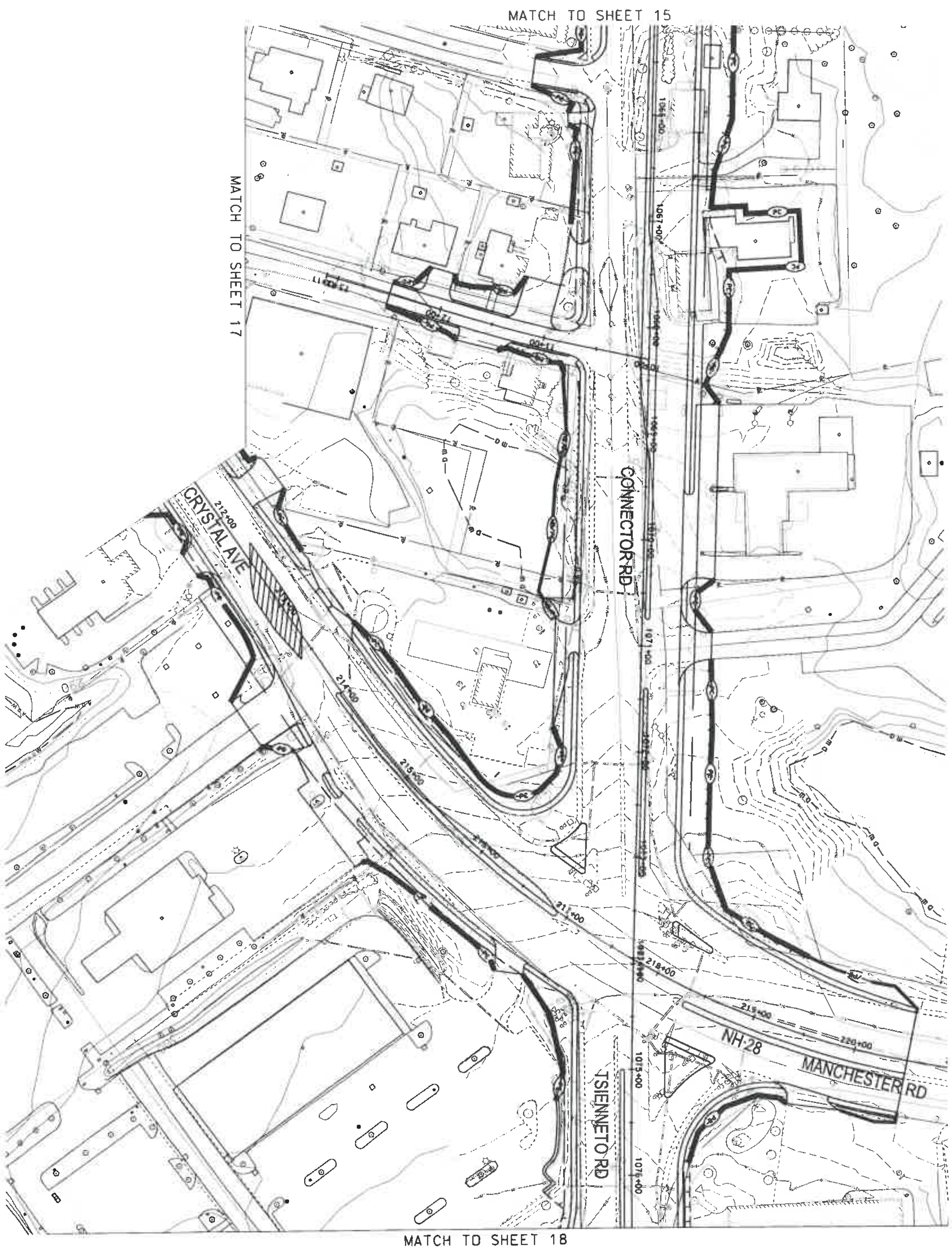


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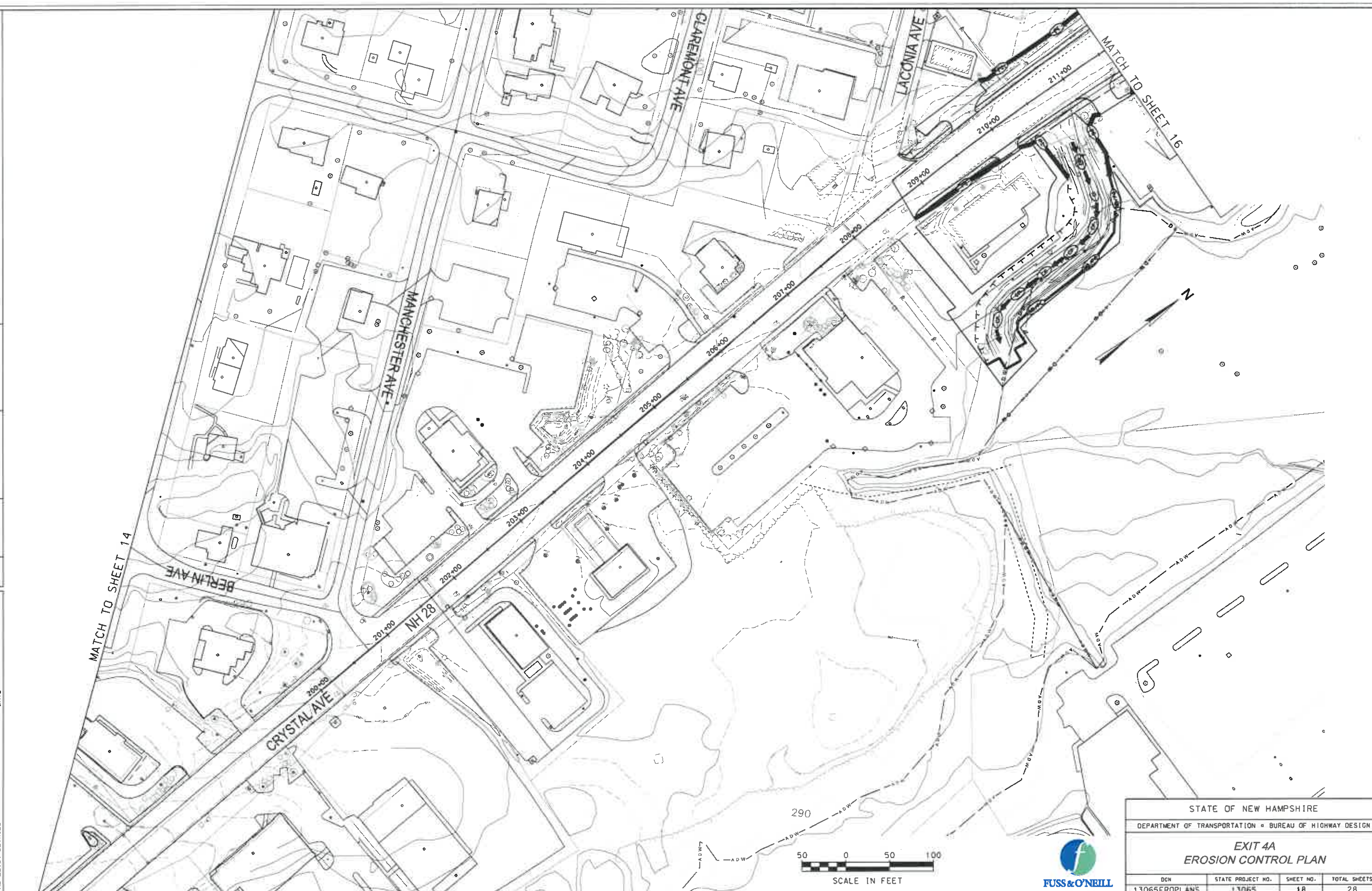


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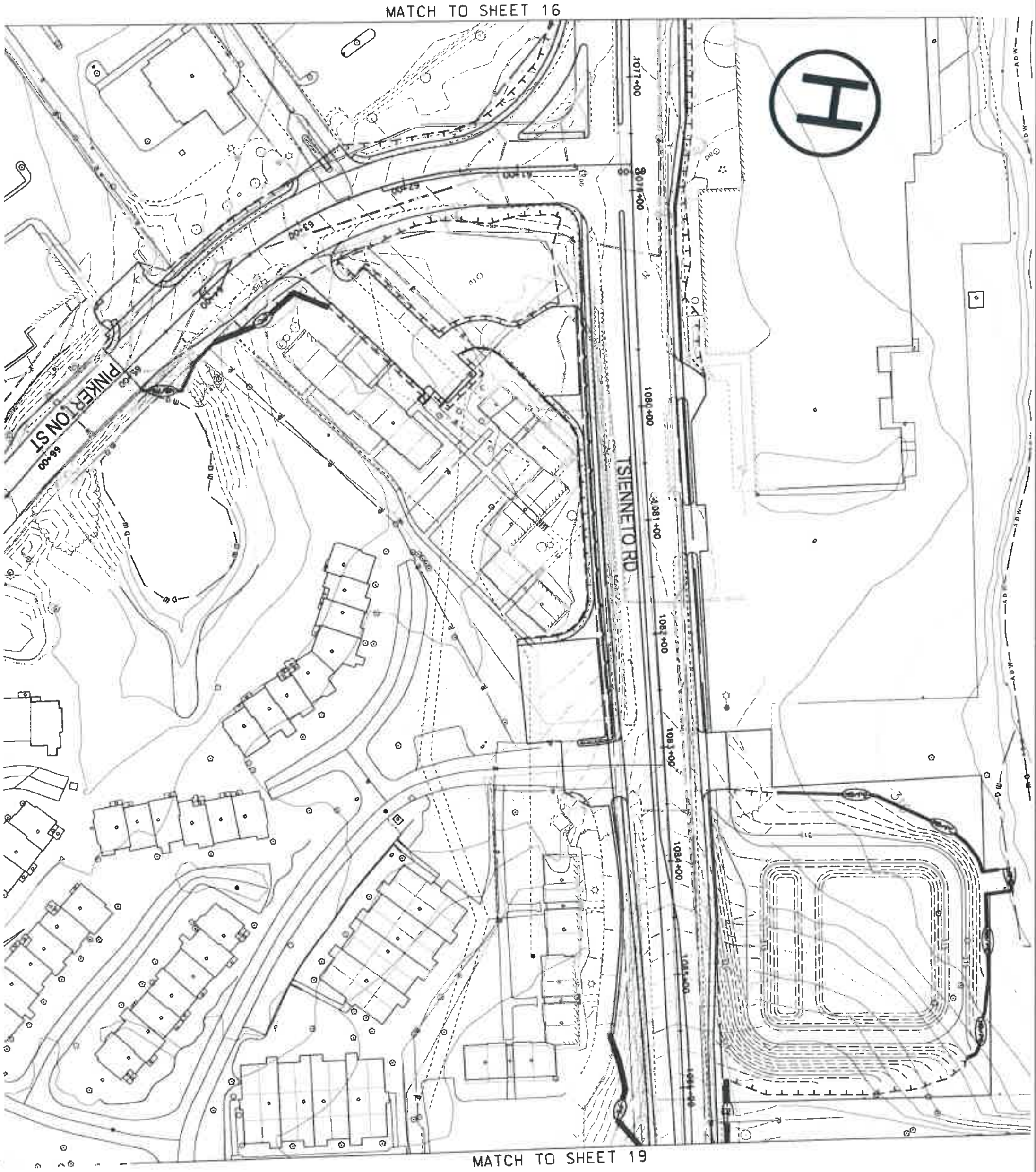


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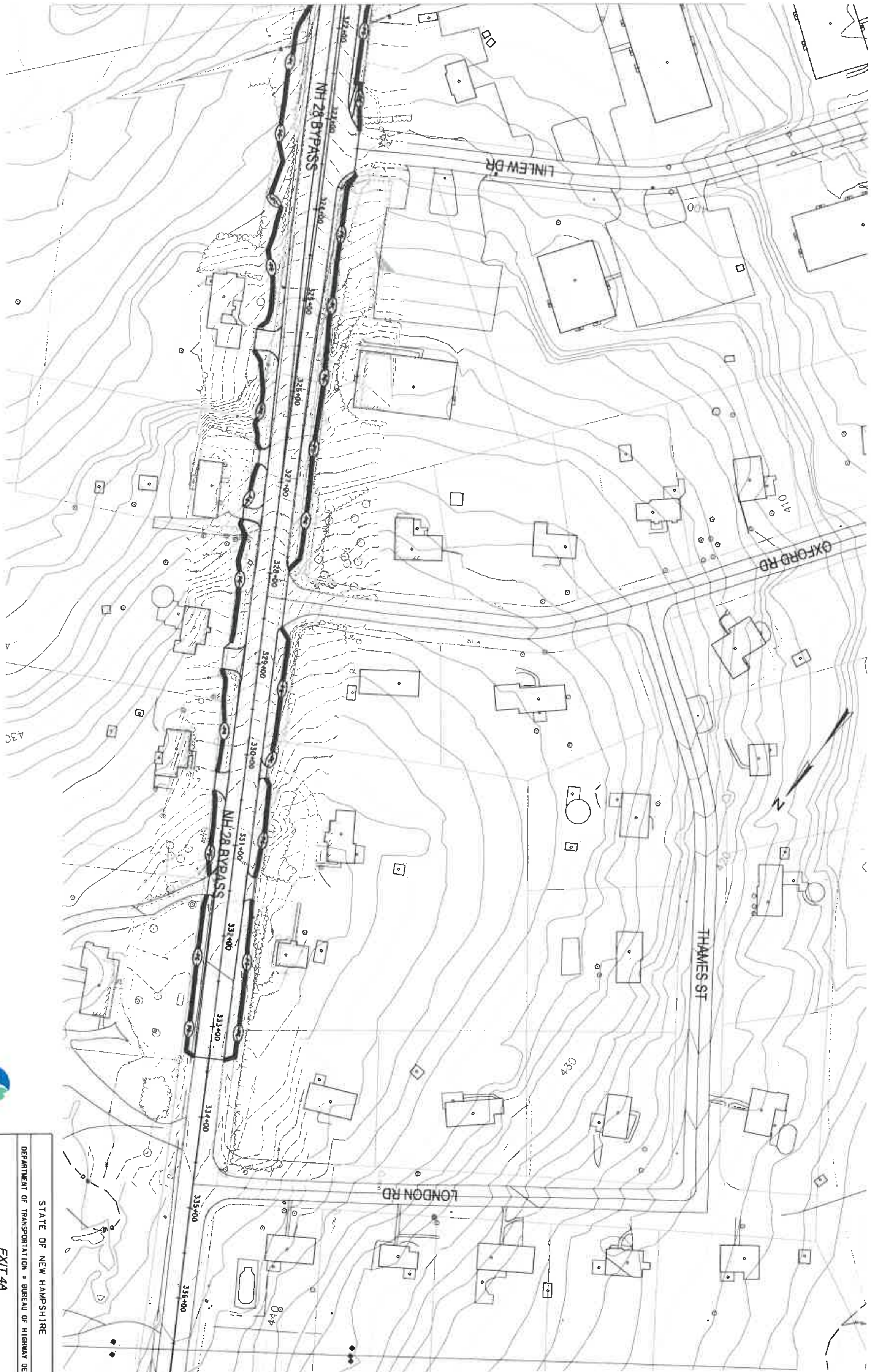


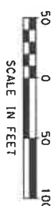


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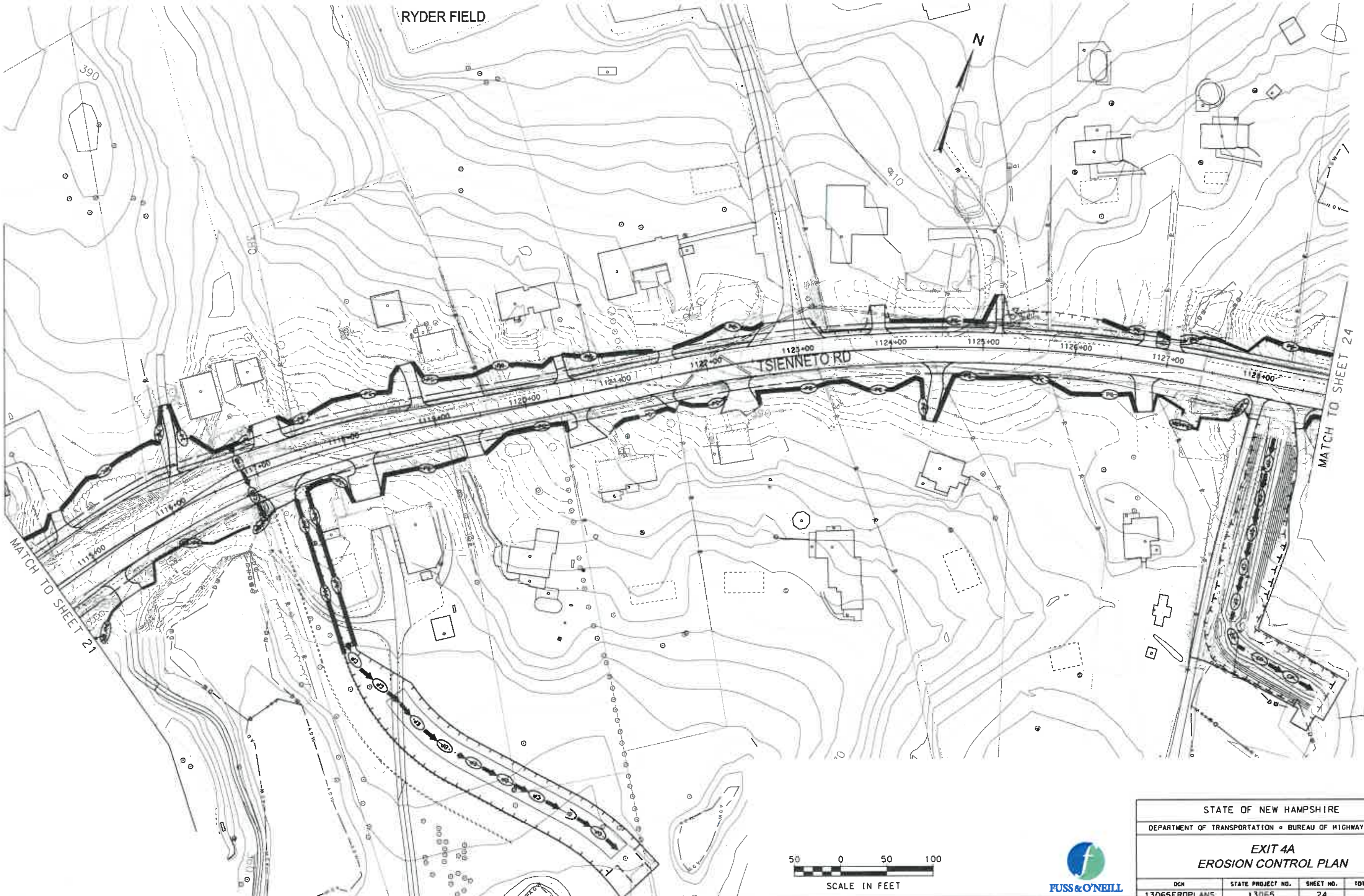


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| REVISIONS AFTER PROPOSAL | |
| NUMBER | |
| DATE | |
| STATION | |
| STATION | |
| DESCRIPTION | |

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| SDR PROCESSED | | DATE |
| NEW DESIGN | EMM | DATE 11/01/2019 |
| SHEET CHECKED | KAH | DATE 01/17/2020 |
| AS BUILT DETAILS | | DATE |

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SCALE IN FEET

FUSS & O'NEILL

STATE OF NEW HAMPSHIRE

DEPARTMENT OF TRANSPORTATION ◦ BUREAU OF HIGHWAY DESIGN

EXIT 4A
EROSION CONTROL PLAN

| DGN | STATE PROJECT NO. | SHEET NO. | TOTAL SHEETS |
|---|---|---|---|
| 13065EROPLANS | 13065 | 26 | 28 |

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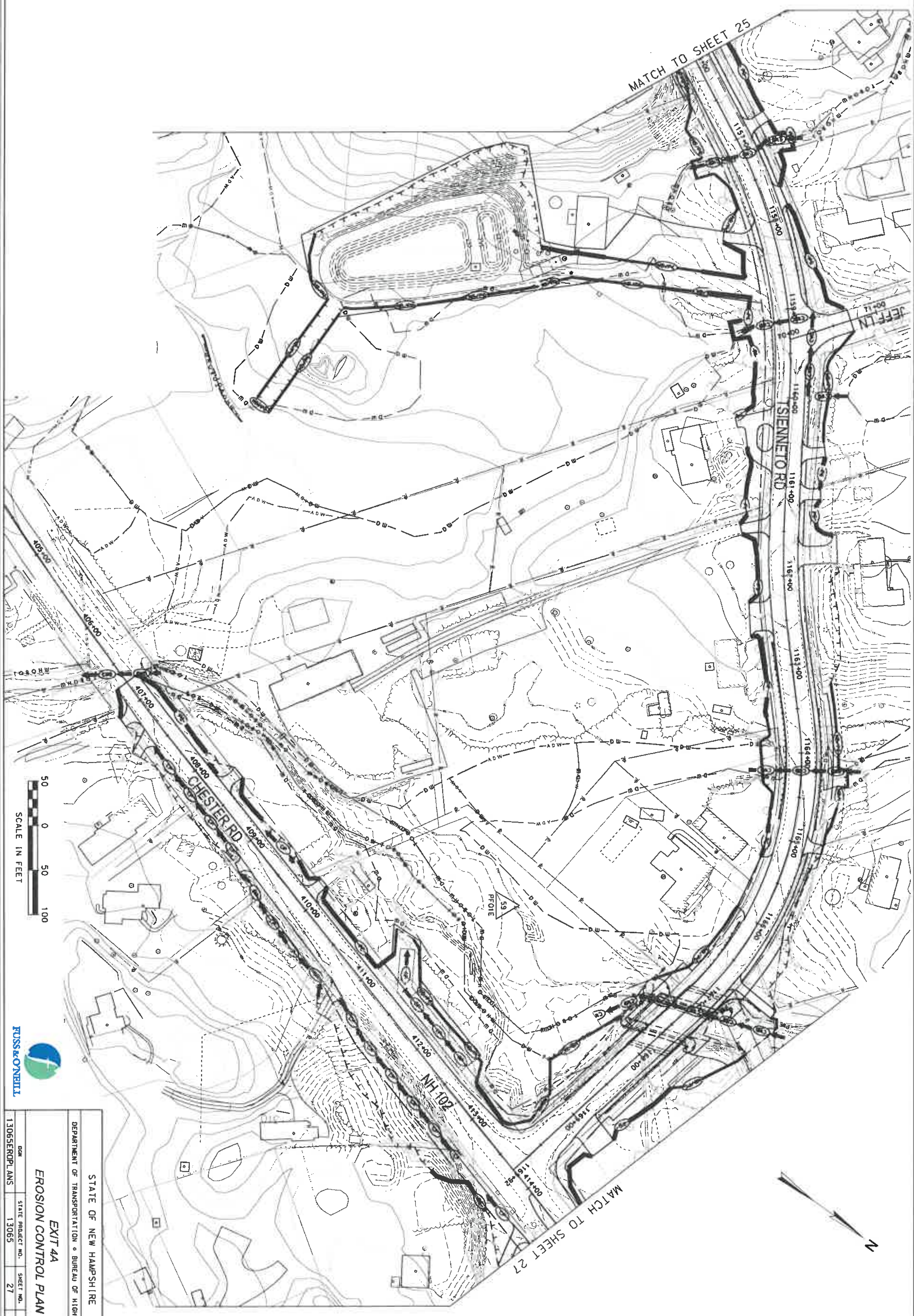
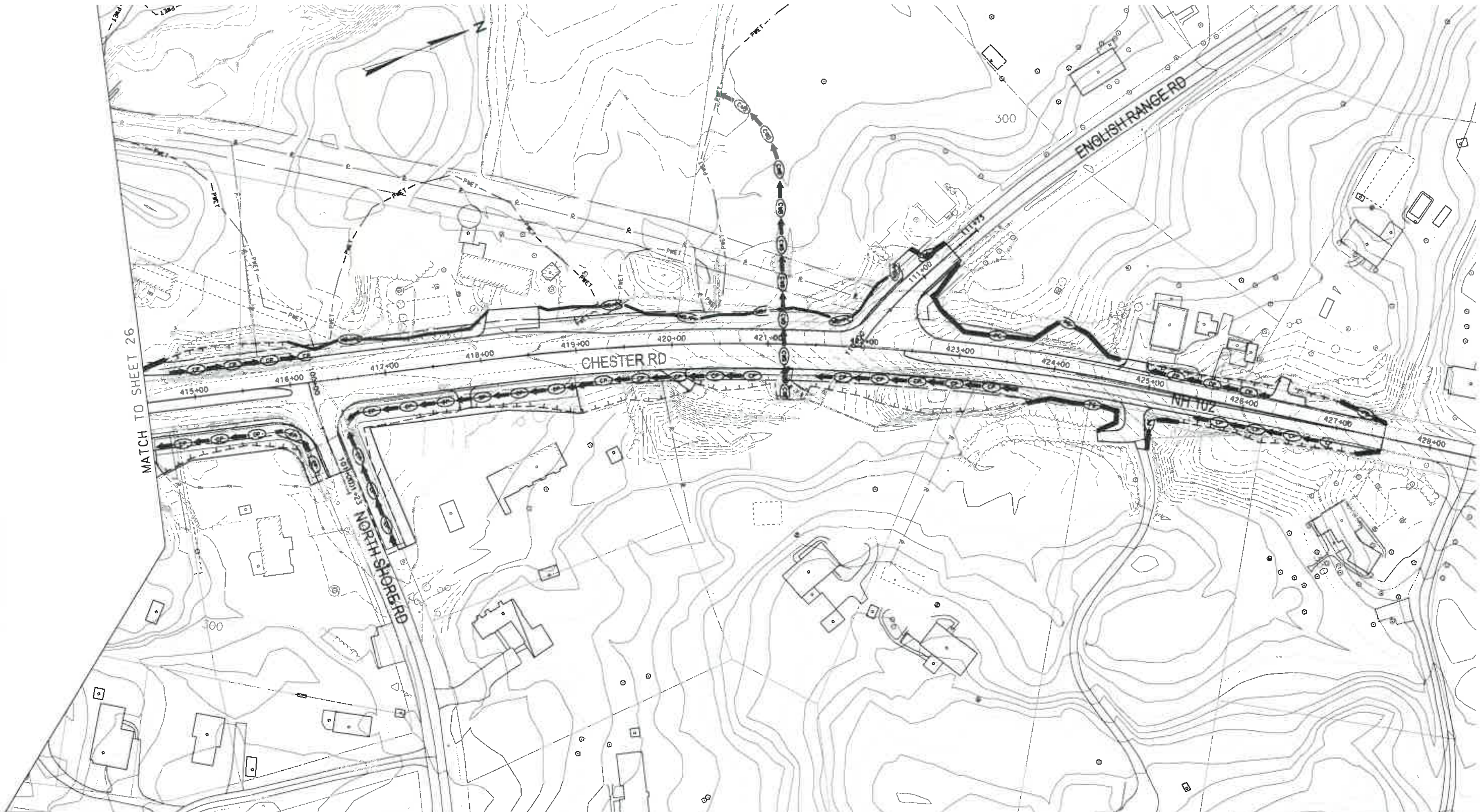
| SDR PROCESSED | | DATE | | REVISIONS AFTER PROPOSAL | | | | |
| NEW DESIGN | EMM | DATE | 11/01/2019 | NUMBER | DATE | STATION | STATION | DESCRIPTION |
| SHEET CHECKED | KAH | DATE | 01/17/2020 | | | | | |
| AS BUILT DETAILS | | DATE | | | | | | |




STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION • BUREAU OF HIGHWAY DESIGN

EXIT 4A
EROSION CONTROL PLAN

| DGN | STATE PROJECT NO. | SHEET NO. | TOTAL SHEETS |
|---|---|---|---|
| 13065EROPLANS | 13065 | 27 | 28 |




| STATE OF NEW HAMPSHIRE | | | |
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| DEPARTMENT OF TRANSPORTATION • BUREAU OF HIGHWAY DESIGN | | | |
| EXIT 4A<br>EROSION CONTROL PLAN | | | |
| DGN | STATE PROJECT NO. | SHEET NO. | TOTAL SHEETS |
| 13065EROPLANS | 13065 | 28 | 28 |

FUSS & O'NEILL

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| SDR PROCESSED | DATE |
| NEW DESIGN EMM | DATE 11/01/2019 |
| SHEET CHECKED KAH | DATE 01/17/2020 |
| AS BUILT DETAILS | DATE |

REVISIONS AFTER PROPOSAL

| NUMBER | DATE | STATION | STATION | DESCRIPTION |
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