COMMITMENT & INTEGRITY
DRIVE RESULTS

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March 30, 2021

Sudbury Conservation Department
275 Old Lancaster Road
Sudbury, MA 01776
Attn: Lori Capone, Conservation Coordinator

Re: Old Sudbury Road Culvert Replacements NOI
Response to Comments

Dear Ms. Capone:

Thank you for coordinating the review of the proposed culvert replacements on Old Sudbury Road in Sudbury. The following letter compiles responses to comments received from you via email on March 18, 2021. The comments received are provided below for your reference, and our response follows each comment:

Comment 1: *There is no discussion on how the project meets the Wetlands Bylaw. Unaltered Buffer Zone (Adjacent Upland Resource Area) is a resource area under the Bylaw. Impacts thereto should be mitigated or explain how functions provided by AURA are not being impacted.*

Please see section 4.1 of the updated Technical Memorandum for a discussion of impacts to the AURA.

Comment 2: *If the wetland scientist is deeming there is no stream associated with these crossing, how is the project altering 95 linear feet of bank? There are no Bank alteration called out on Figures 6 or 7.*

The bank alteration number was added in error and has been removed from the updated NOI form.

Comment 3: *Any cut and/or fill in BLSF for culvert 149 should be quantified, even if temporary . Is there any net increase in flood storage from proposed work?*

We have determined that relative to existing conditions, flood storage volume at Culvert 149 will increase by approximately 93 cubic feet.

Comment 4: *The extent of the edge of water at culvert 149 does not reflect current conditions. Currently the outlet is completed submerged.*

Please see Note 1 on the revised Sheet C-101.

Comment 5: *Figures 4 and 5 are missing from the NOI.*

In the original submission, the planset for Culverts 110 and 149 was intended to represent Figures 4 and 5. Please see the revised Technical Memorandum, which contains the planset as Figure 4.

Comment 6: *Erosion controls are not shown on the plan, except of the coffer dam and turbidity curtain.*

Please see the revised planset. Sediment barriers are shown at each culvert on sheets C-200 and C-201, and sedimentation barrier details are shown on sheet C-401.

Comment 7: *Can you provide detail on how this area is proposed to be excavated in the wet and how soils will be managed during excavation?*

The excavation and installation of Culvert 149 will be observed by a qualified geotechnical engineer. Refer to the geotechnical report included with the Technical Memorandum as Attachment C.

Comment 8: *Will the large tree directly adjacent to the inlet of culvert 149 need to be removed? If so this should be shown on the plan. Will the roots need to be removed?*

The tree and its root system will need to be removed. It will likely be removed during excavation and removal of the existing culvert. Please see the revised sheet C-201, which shows the approximate location of the tree called out and specifies removal of the tree and its roots.

Comment 9: *Will there be anything incorporated into the design for the management of beavers? It looks like the upstream screen was installed for beavers control.*

Per the discussion at the March 22nd meeting, the functionality of the existing rack/grating at the inlet of Culvert 149 is for debris control. While it was necessary to keep trash and debris out of the relatively small diameter existing pipe, the replacement box culvert will have a larger cross-sectional area that is less susceptible to clogging. Therefore, no grate is proposed for the replacement culvert.

Comment 10: *Where will the dirt bags be positioned? The note on the plan notes that it is to be discharged outside the buffer zone, but this would locate it outside the limit of work and the Town does not owned land on either side of the road at culvert 149.*

Please see the Dewatering Discharge Sediment Control Device detail and notes on revised sheet C-401. Per the discussion at the March 22nd meeting, it is anticipated the Contractor's staging area will be within the closed alternating one-way travel lane.

Comment 11: *Where will with the erosion control blanket be used?*

Note 1 of the Erosion Control Matting detail on sheet C-400 contains application instructions with minimum slopes where use of the matting will be required.

Comment 12: *What seed mix if being used to stabilize disturbed areas?*

Please see the attached seed mix specifications for the New England Conservation/Wildlife mix and the New England Erosion Control/Restoration Mix for Detention Basins and Moist Sites. The New England Conservation/Wildlife Mix will be used to stabilize disturbed upland areas. The New England Erosion Control/Restoration mix will be used to stabilize disturbed wetland areas above the waterline if incidental disturbances to such areas occur.

Comment 13: *Figures 6 and 7 are titled "Old Framingham Rd Sidewalk Extension"*

Please see the revised impact figures, re-numbered 5 and 6, with revised titles.

If you have any questions or require additional information, please do not hesitate to contact me at 781-613-0311 or email me at ssalvucci@woodardcurran.com.

Sincerely,

WOODARD & CURRAN INC.

Scott Salvucci, PE
Project Manager

Enclosures: Revised NOI Package

TECHNICAL MEMORANDUM

TO: Arthur Allen, EcoTec, Inc.

PREPARED BY: Daniel Pasquale & Kevin Trainor, Woodard & Curran

REVIEWED BY: Scott Salvucci, Woodard & Curran

DATE: February 18, 2021 (revised March 30, 2021)

RE: Old Sudbury Road Culvert Replacement (#110 & #149) – Hydraulic Analysis

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1. INTRODUCTION

Woodard & Curran has performed a hydraulic analysis of culverts crossing Old Sudbury Road (MA Route 27) in Sudbury, MA. The culverts are identified as Culvert #110 and Culvert #149 and are located approximately 0.4 miles and 200 feet northwest of the intersection of Old Sudbury Road and Water Row. Based on the results of culvert and bridge inspections documented in the "Crossing (Culvert & Bridge) Management Program," prepared by Tighe & Bond and updated April 30, 2019, these culverts have been identified for replacement. The purpose of this memorandum is to summarize Woodard & Curran's hydraulic evaluation of these culverts and support development of a Notice of Intent to file an application with the Conservation Commission for authorization to replace both culverts. Please refer to Figures 1 through 3 for Site Location Map and Project Area figures for each culvert location.

2. EXISTING CONDITIONS EVALUATION

Culvert #110 is an approximately six to eight-inch diameter corrugated metal equalization culvert built into the existing stacked stone wall that runs along Old Sudbury Road in the vicinity. The culvert does not convey a mapped stream; it allows roadway runoff and runoff from a small, wooded catchment to cross Old Sudbury Road, flowing from south to north generally toward Pantry Brook. This crossing was identified as a high priority for replacement due to complete pipe section loss and the potential for roadway materials to erode.

Culvert #149 is an approximately 3-foot diameter corrugated metal pipe equalization culvert with stacked stone headwalls at the inlet and outlet of the culvert. Culvert #149 does not convey a mapped stream; it allows exchange of surface water between wetlands on either side of Old Sudbury Road, generally flowing southwest to northeast toward the Sudbury River. This crossing was identified as a high priority for replacement due to severe pipe section loss and deteriorating headwalls.

2.1 Survey

An existing conditions survey of both culverts was performed by Chappell Engineering Associates in November 2020. Culvert #110 is 42.6 feet long, flowing south to north beneath Old Sudbury Road with maximum cover of approximately 4.3 feet. The inlet end of the culvert is located on land owned by the Augustina Sumito Trust, and the outlet end of the culvert is located on land owned by the Town of Sudbury.

Culvert #149 is 55.4 feet long with maximum cover of approximately 5.8 feet. The inlet end of the culvert is located on land owned by the United States of America, and the outlet end of the culvert is located on land owned by the Commonwealth of Massachusetts. The outlet pipe end is located on private property. Survey of both culverts is included as Attachment A.

2.2 Wetland Resource Evaluation

2.2.1 Culvert #110

A wetland resource evaluation was performed by EcoTec, Inc. on November 5, 2020 to evaluate the presence of resource areas within the project area. The crossing was identified as an "equalization culvert," with no streams in the project vicinity, based upon review of the current USGS map of the area; therefore, regulations pertaining to the Riverfront Area are not applicable to this site. Wetland flags were delineated for the boundary of bordering vegetated wetlands (BVW) associated with the wetland complexes located to the south and to the north of Old Sudbury Road, labeled A1-A9 and B1–B6, respectively. A 100-foot buffer zone extends horizontally from the A series and B series flags; the entire project area will be within the 100-foot buffer zone. Wetland Resource Evaluations for both culverts are included in Attachment B.

2.2.2 Culvert #149

A wetland resource evaluation was performed by EcoTec, Inc. on November 5, 2020 to evaluate the presence of resource areas within the project area. The crossing was identified as an "equalization culvert," with no streams in the project vicinity, based upon review of the current USGS map of the area; therefore, regulations pertaining to the Riverfront Area are not applicable to this site. Wetland flags were delineated for the boundary of bordering vegetated wetlands (BVW) associated with the wetland complexes located to the south and to the north of Old Sudbury Road, labeled A1-A8 and B1–B9, respectively. A 100-foot buffer zone extends horizontally from the A series and B series flags; the entire project area will be within the 100-foot buffer zone. In addition, the project site is within the AE flood zone; therefore, the project area is also within Bordering Land Subject to Flooding. Wetland Resource Evaluations for both culverts are included in Attachment B.

2.3 Channel Conditions

2.3.1 Culvert #110

The crossing at Culvert #110 is an equalization culvert connecting two wetlands on either side of Old Sudbury Road and is not considered a stream. The channel on both sides of Old Sudbury Road is not well defined and consists generally of wetland vegetation.

2.3.2 Culvert #149

The crossing at Culvert #149 is an equalization culvert connecting two wetlands on either side of Old Sudbury Road and is not considered a stream. The channel south of Old Sudbury Road is not well defined and consists generally of wetland vegetation. The channel north of Old Sudbury Road is controlled by the nearby crossing on Water Row. There is some evidence of scour on the outlet end of the culvert resulting from elevated discharge velocities.

2.4 Geotechnical Exploration

2.4.1 Culvert #110

GZA GeoEnvironmental, Inc. completed subsurface exploration and compiled a geotechnical memorandum dated January 7, 2021 presenting the subsurface findings. Boring B-3 was drilled on December 11, 2020 at Culvert #110. Subsurface conditions at the site consist of very dense sand fill overlying a thin layer of peat, over very dense sand. GZA recommends excavating the existing peat layer in the wet without dewatering the excavation) to prevent destabilization of adjacent soils. The geotechnical engineer will be on-site during removal of the existing culvert and installation of the new culvert. The geotechnical exploration report for both culverts is included as Attachment C.

2.4.2 Culvert #149

GZA GeoEnvironmental, Inc. completed subsurface exploration and compiled a geotechnical memorandum dated January 7, 2021 presenting the subsurface findings. Borings B-1 and B-2 were drilled on November 17, 2020 at Culvert #149. Subsurface conditions at the site consist of medium dense sand fill overlying peat, and medium dense silty fine sand, with no gravel. Soils generally became denser with depth. The groundwater level was found to be generally consistent with the surface water elevation in the vicinity of the crossing.

Geotechnical recommendations include overexcavating three feet of existing peat and installing the replacement culvert over approximately 3 feet of 1-1/4" crushed stone. The geotechnical report noted that excavation of the peat layer should occur in the wet as traditional dewatering may destabilize the surrounding soils. The geotechnical engineer will be on-site during removal of the existing culvert and installation of the new culvert. Footings for abutments and headwalls are recommended to extend to four feet below finished grade to provide frost protection. The geotechnical exploration report for both culverts is included as Attachment C.

2.5 FEMA FIRM Review

2.5.1 Culvert #110

Based on our review of Flood Insurance Rate Maps for the Town of Sudbury, Culvert #110 is not located in a mapped flood zone.

2.5.2 Culvert #149

Culvert #149 is located within an AE Zone with a base flood elevation (BFE) of 121 feet NAVD88. Culvert #149 is located on panel 25017C0369F, effective July 7, 2014. Flooding in this area is dominated by the Sudbury River. The Flood Insurance Study (FIS) for Middlesex County, MA, corrected April 4, 2017 was used to establish downstream boundary conditions for hydraulic analysis based on the Flood Profile on Panel 507P. The road elevation in the vicinity of Culvert #149 ranges between 120 and 121 feet NAVD88. The FIRM panel is included as Attachment D.

2.6 USGS Hydrology Review

2.6.1 Culvert #110

Culvert #110 does not convey a stream defined by the United States Geological Survey (USGS) StreamStats application for determining stream flow and basin characteristics. Approximately 500 feet to the northeast (of the Culvert #110 outlet, a stream channel is defined. This point was used to establish flows used for hydrologic and hydraulic analysis and design purposes. The StreamStats reports for both locations are attached as Appendix E.

2.6.2 Culvert #149

Culvert #149 crosses a wetland which drains to the Sudbury River, connecting wetlands on either side of Old Sudbury Road. The contributing area is primarily forested with limited development. The channel is defined by StreamStats, and USGS regression equations were used to establish flows used for hydrologic and hydraulic analysis and design purposes. The StreamStats reports for both locations are attached as Attachment E.

2.7 Hydrologic & Hydraulic Analysis

2.7.1 Culvert #110

The Crossing (Culvert & Bridge) Management Program recommended performing a hydrologic analysis of Culvert #110 to determine whether the crossing should be replaced or abandoned. Woodard & Curran reviewed topography data in the area using a 1-meter DEM. Culvert #110 is located near the low point of an approximately 400-foot long sag along the southwesterly edge of Old Sudbury Road with approximately 30 acres of contributing area. Abandoning the crossing could result in trapping water up to 1.5 feet deep on the southwest side of the road and potentially overtopping Old Sudbury Road before reaching another crossing. Maintaining an equalization culvert in this location is recommended.

Woodard & Curran performed a hydraulic analysis of Culvert #110 using hydrology data obtained from USGS. Flows for 4% annual-chance, 2% annual-chance, and 1% annual-chance precipitation events were simulated for the existing culvert and two replacement alternatives. The culvert was simulated using the Environmental Protection Agency (EPA) Storm Water Management Model, version 5.1.015 (SWMM5) on the PCSWMM v7.3.3095 platform based on field survey data. The boundary conditions simulated are summarized in Table 2-1 below.

Table 2-1: Culvert #110 Boundary Conditions

Storm Event	Flow (cfs)	Outfall Condition
4% Annual-Chance; 24-hour	11.8	Normal flow depth
2% Annual-Chance; 24-hour	14.6	Normal flow depth
1% Annual-Chance; 24-hour	17.6	Normal flow depth

2.7.2 Culvert #149

Woodard & Curran performed a hydraulic analysis of Culvert #149 using hydrology data obtained from USGS. Flows for 10% annual-chance, 4% annual-chance, 2% annual-chance, and 1% annual-chance precipitation events were simulated for the existing culvert and two replacement alternatives. The culvert was simulated using the Hydraulic Engineering Center-River Analysis System (HEC-RAS) version 5.07. The reach geometry was developed using field survey supplemented with a 1-meter digital elevation model (DEM) obtained from the National Map database. Boundary conditions simulated are summarized in Table 2-2 below.

Table 2-2: Culvert #149 Boundary Conditions

Storm Event	Flow (cfs)	Tailwater (NAVD88)
4% Annual-Chance; 24-hour	39.6	120.00
2% Annual-Chance; 24-hour	48.6	120.5
1% Annual-Chance; 24-hour	58.3	121.00

3. DESIGN CONSIDERATIONS

The purpose of this project is to replace structurally deficient crossings, while improving hydraulic capacity and habitat conditions at the crossing where possible. The design considerations of the culvert replacement concentrated on maintaining or improving on existing flood conditions for the 25-year, 50-year, and 100-year storm events. Hydraulic performance, potential for downstream flooding; effect on habitat on either side of Old Sudbury Road; potential for erosion and overall effect on stream stability were taken into consideration. We evaluated the following alternatives for each culvert location.

Culvert #110

- In-kind replacement of 8-inch (presumed) culvert matching existing invert elevations
- Replacement with 18-inch HDPE culvert matching existing invert elevations
- Replacement with 36-inch HDPE culvert embedded 12 inches

Culvert #149

- In-kind replacement of 36-inch diameter culvert matching existing invert elevations
- Replacement with 48-inch diameter culvert matching existing invert elevations
- Replacement with 60-inch wide by 84-inch tall box culvert, embedded 24 inches

Design considerations also included utility and roadway elevation constraints. Culvert #110 has a maximum cover of approximately 4.3 feet, and underground gas and water utilities cross the culvert at unknown depths. Assuming typical cover for underground gas utilities of 30-36 inches, the gas likely crosses over the Culvert #110. Assuming the underground water utility is below frost depth (four feet or greater), the water utility may pass underneath Culvert #110. Utility depths should be confirmed by test pit prior to project bidding. Increasing the culvert size may require limited utility relocation.

Survey of Culvert #149 did not indicate the presence of other underground utilities in the vicinity of the crossing. The existing culvert has a maximum cover of approximately 5.8 feet.

3.1 Hydraulic Analysis Results

The following tables summarize the results of hydraulic analysis. Only the 4%, 2%, and 1% annual-chance events are included, assuming the level of service for recommended replacements should equal or exceed what is considered the “25-year,” 24-hour design storm event. Detailed SWMM results for Culvert #110 and detailed HEC-RAS results for Culvert #149 are included in Attachment F.

Table 3-1: Culvert #110 Hydraulic Summary of Options

Alternative	Description	4% Annual-Chance Event WSE South of Old Sudbury Rd	2% Annual-Chance Event WSE South of Old Sudbury Rd	1% Annual-Chance Event WSE South of Old Sudbury Rd
1: In-Kind Replacement	8-inch Ductile Iron Pipe @ 0.1% slope	**232.87**	**232.87**	**232.91**
2: 18-inch HDPE	18-inch HDPE @ 0.1% slope	230.87	231.57	**232.49**
3: 30-inch Embedded HDPE	30-inch HDPE embedded 12 inches @ 0.0% slope	229.44	229.68	229.96

Note: Roadway elevation is approximately 232.5. Scenarios highlighted in yellow and bold result in roadway overtopping.

Table 3-2: Culvert #149 Hydraulic Summary of Options

Alternative	Description	4% Annual-Chance Event WSE South of Old Sudbury Rd	2% Annual-Chance Event WSE South of Old Sudbury Rd	1% Annual-Chance Event WSE South of Old Sudbury Rd
1: In-Kind Replacement	36-inch HDPE @ 0.4% slope	**120.60**	**120.71**	**121.00**
2: 48-inch HDPE	48-inch HDPE @ 0.4% slope	120.37	**120.65**	**121.00**
3: 60-inch by 84-inch Embedded Box Culvert	60-inch wide by 84-inch tall box embedded 24 inches @ 0.4% slope	120.05	**120.57**	**121.01**

Note: Roadway elevation is approximately 120.5. Scenarios highlighted in yellow and bold result in roadway overtopping.

3.2 Results Discussion

The following sections address the results in the context of hydraulic performance, effect on habitat on either side of Old Sudbury Road, and potential for erosion. Neither crossing is considered a stream crossing, and

Massachusetts Stream Crossing Standards are not applicable. However, where appropriate, goals of the Stream Crossing Standards are considered.

3.2.1 Culvert #110

3.2.1.1 Alternative 1

Alternative 1 will restore hydraulic performance associated with the existing crossing prior to deterioration during the 4%, 2%, and 1% annual-chance, 24-hour design storm event and will not change water levels on either side of Old Sudbury Road. Roadway overtopping remains a concern based on hydraulic analysis. Alternative 1 will also continue to separate habitat on either side of Old Sudbury Road. Material deposition south of Old Sudbury Road of the culvert and erosion north of Old Sudbury Road will likely continue. Erosion may be mitigated by construction of energy dissipation measures to prevent further scour.

3.2.1.2 Alternative 2

Alternative 2 is likely to reduce the water level south of Old Sudbury Road during the 4%, 2%, and 1% annual-chance, 24-hour design storm events and most lighter precipitation events, as well as during dry weather. Roadway overtopping is unlikely during the 4% and 2% annual-chance, 24-hour design storms, though minor overtopping may occur during the 1% annual-chance 24-hour design storm. Alternative 2 would not provide a habitat connection between the north and south sides of Old Sudbury Road; however, material deposition at the inlet end and erosion at the outlet end of the culvert will likely be mitigated by this option due to reduced ponding at the entrance and reduced velocity at the culvert exit.

3.2.1.3 Alternative 3

Alternative 3 is likely to reduce the water level south of Old Sudbury Road during the 4%, 2%, and 1% annual-chance, 24-hour design storm events and most lighter precipitation events, as well as during dry weather. Roadway overtopping is not expected during any of the scenarios simulated. Alternative 3 would provide an improved habitat connection between the two sides of Old Sudbury Road for small animals, and the embedment would provide additional natural substrate; however the length of the crossing and the height limitations due to shallow cover result in a low openness ratio, and the crossing may not ultimately be utilized by wildlife.

3.2.2 Culvert #149

3.2.2.1 Alternative 1

Alternative 1 will restore hydraulic performance associated with the existing crossing prior to deterioration during the 4%, 2%, and 1% annual-chance, 24-hour design storm event and will not change water levels on either side of Old Sudbury Road. Roadway overtopping will remain a concern during all scenarios simulated. Alternative 1 will also continue to separate habitat on either side of the culvert.

3.2.2.2 Alternative 2

Alternative 2 is likely to reduce the water level south of Old Sudbury Road during the 4%, 2%, and 1% annual-chance, 24-hour design storm events and most lighter precipitation events, as well as during dry weather. Roadway overtopping is not anticipated during the 4% annual-chance, 24-hour design storm; however, overtopping is still expected for greater storm events. Alternative 2 would not provide a significant habitat connection between the inlet and outlet ends of the culvert; however, material deposition at the inlet end and erosion at the outlet end of the culvert will likely be mitigated by this option due to reduced ponding at the entrance and reduced velocity at the culvert exit.

3.2.2.3 Alternative 3

Alternative 3 is likely to reduce the water level south of Old Sudbury Road during the 4%, 2%, and 1% annual-chance, 24-hour design storm events and most lighter precipitation events, as well as during dry weather. Roadway overtopping is not anticipated during the 4% annual-chance, 24-hour design storm, and minor overtopping may occur during the 2% annual-chance, 24-hour design storm. Flooding during the 1% annual-chance design storm in this location is controlled by the Sudbury River, and is likely to occur in any scenario that does not elevate the roadway. Alternative 3 would provide an improved habitat connection between the inlet and outlet ends of the culvert for small animals, and the embedment would provide additional natural substrate; however the length of the crossing and the height limitations due to shallow cover result in a low openness ratio, and the crossing may not ultimately be utilized by wildlife.

4. RECOMMENDED REPLACEMENT ALTERNATIVE

Based upon the design considerations and hydraulic calculations, and consideration for abutter concerns, the recommended replacement for Culvert #110 is Alternative 1 (replace in kind). The recommended replacement for Culvert #149 is Alternative 3. Please refer to Figure 4 for conceptual culvert sections.

4.1 Anticipated Impacts to Adjacent Upland Resource Areas (AURAs)

The Town of Sudbury Wetlands Administration Bylaw (Article XXII) and its associated Sudbury Wetlands Administration Bylaw Regulations (revised September 25, 2017) establishes jurisdictional Adjacent Upland Resource Areas (AURAs). The Bylaw defines AURAs as land within 100-feet of wetland resource areas, within 200-feet of top of bank, and with varying extent when adjacent to vernal pools, ponds <10,000 square feet in area, or isolated land subject to flooding. The proposed replacements of Culvert #110 and Culvert #149 include work within 100-feet of Bordering Vegetated Wetlands, considered an AURA under the Bylaw.

The project, which will replace two existing culverts, was designed to minimize the amount of disruption and alteration to the AURAs within the project limits of work. The new pipe culvert at crossing #110 will be the same size as the existing pipe. Hydraulic analysis of Culvert #149 predicted an enlarged crossing would reduce water levels surrounding the roadway during flood events, and a box culvert-style opening would provide easier wildlife passage through the crossing.

For both crossings, temporary land disturbances will be stabilized and restored to existing conditions. A native New England Conservation/Wildlife seed mix will be applied to temporarily disturbed areas within the AURAs. The blend of species will provide a permanent cover of grasses, forbs, wildflowers, and legumes to control soil erosion and enhance wildlife habitat. The roadway above both crossings will be replaced in the same footprint as the existing roadway. No new impervious area will be created within the AURA at Culvert #110. A small amount of new impervious area within the AURA will be constructed at Culvert #149—approximately 40 square feet of impervious area associated with the culvert headwalls is proposed. The new headwalls will reduce the potential for erosion of the embankment at the inlet and outlet ends of the culvert.

Both Culvert #110 and Culvert #149 are deteriorating and have been prioritized by the Town for replacement. Further deterioration of the culverts could result in their failure and failure of the roadway sections above them. There is no reasonable alternative that would reduce or eliminate the temporary and permanent impacts associated with the project. Figures 5 and 6 contain square footages of impacts to resource areas.

5. CONCEPTUAL SEQUENCE OF CONSTRUCTION

Plans depicting erosion control measures, proposed grading, and other features for the project are currently under development. It is expected that the replacements will occur in two phases to allow one-way traffic in alternating directions during construction. The anticipated sequence of construction is as follows:

1. Install temporary erosion and sedimentation control measures, including cofferdam, flow diffuser, and/or flow diversion;
2. Protection of existing utilities, including water, natural gas, and telecommunications;
3. Remove and dispose of the existing culvert, headwalls, and emergency repair gabions and riprap up to approximately the roadway centerline, maintaining alternating one-way traffic with flaggers;
4. Install new culvert and headwall;
5. Reconstruct road to approximate centerline;
6. Repeat steps 3 through 5 for the remaining side of the roadway;
7. Stabilize side slopes;
8. Install erosion control matting, loam, and seed on all disturbed areas; and
9. Remove temporary erosion and sedimentation control measures and cofferdam.

6. ATTACHMENTS

Figures

Figure 1 – Site Location Map, Culvert #110 & Culvert #149

Figure 2 – Project Area & Conceptual Hydraulic Model, Culvert #149

Figure 3 – Project Area & Conceptual Hydraulic Model, Culvert #110

Figure 4 – Replacement Culvert Concept Planset, Culvert #110 and Culvert #149

Figure 5 – Resource Area Impact Figure, Culvert #149

Figure 6 – Resource Area Impact Figure, Culvert #110

Attachments

Attachments A1 and A2 – Existing Conditions Surveys, Culvert #110 & Culvert #149

Attachments B1 and B2 – Wetland Resource Evaluation, Culvert #110 & Culvert #149

Attachment C – Geotechnical Evaluation, Culvert #110 & Culvert #149

Attachment D – FEMA FIRM Panel

Attachments E1 and E2 – StreamStats Reports, Culvert #110 & Culvert #149

Attachments F1 and F2 – Culvert Analysis Reports, Culvert #110 & Culvert #149

7. REFERENCES

USGS StreamStats Peak-Flow Statistics. Accessed electronically December 2020.

Environmental Protection Agency Storm Water Management Model User's Manual, Version 5.1. Revised September 2015.

Hydraulic Engineering Center – River Analysis System (HEC-RAS) Hydraulic Reference Manual, Version 5.0

Extreme Precipitation in New York & New England, Northeast Regional Climate Center, Extreme Precipitation Tables obtained December 2020

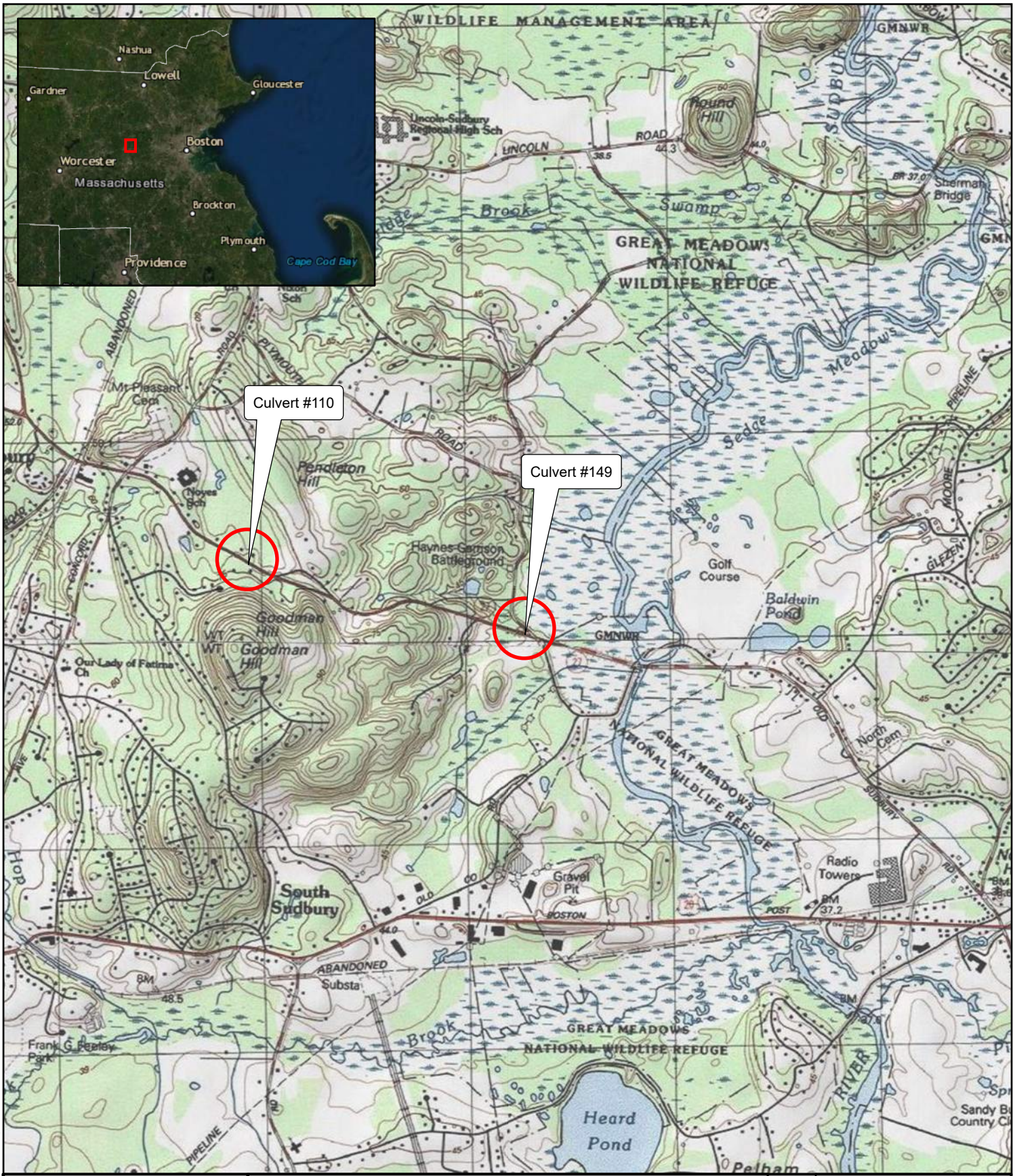
Soil Survey Geographic (SSURGO) database for Middlesex County, Massachusetts," Natural Resources Conservation Service Web Soil Survey, accessed online December 2020.

Concord River HUC 8 LiDAR FY 2010, Middlesex County, Massachusetts CID 25017C, Worcester County, Massachusetts CID 25027C. Federal Emergency Management Agency. DEM generated from LiDAR by MassGIS. Accessed electronically December, 2020.

FEMA FIRM Panel 25017C0369F, effective July 7, 2014

Massachusetts River and Stream Crossing Standards, River & Stream Continuity Partnership

Figure 1: Site Location Maps



0 0.1 0.2 0.3 0.4 0.5 Miles

OLD SUDBURY ROAD
CULVERT #110 & #149 REPLACEMENT

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WOODARD &CURRAN

SUDBURY, MA

FIGURE 1 - SITE LOCATION MAP

Project #: 0233335.00
Map Created: January 2021

Figure Exported: 1/27/2021 By: ktrainor Using: C:\Users\ktrainor\OneDrive - Woodard & Curran_PCFolders\Desktop\Project_Work\Sudbury_Culverts\Culvert_Figures\Culvert_Figures.aprx

Figures 2 & 3: Project Area & Conceptual Hydraulic Models

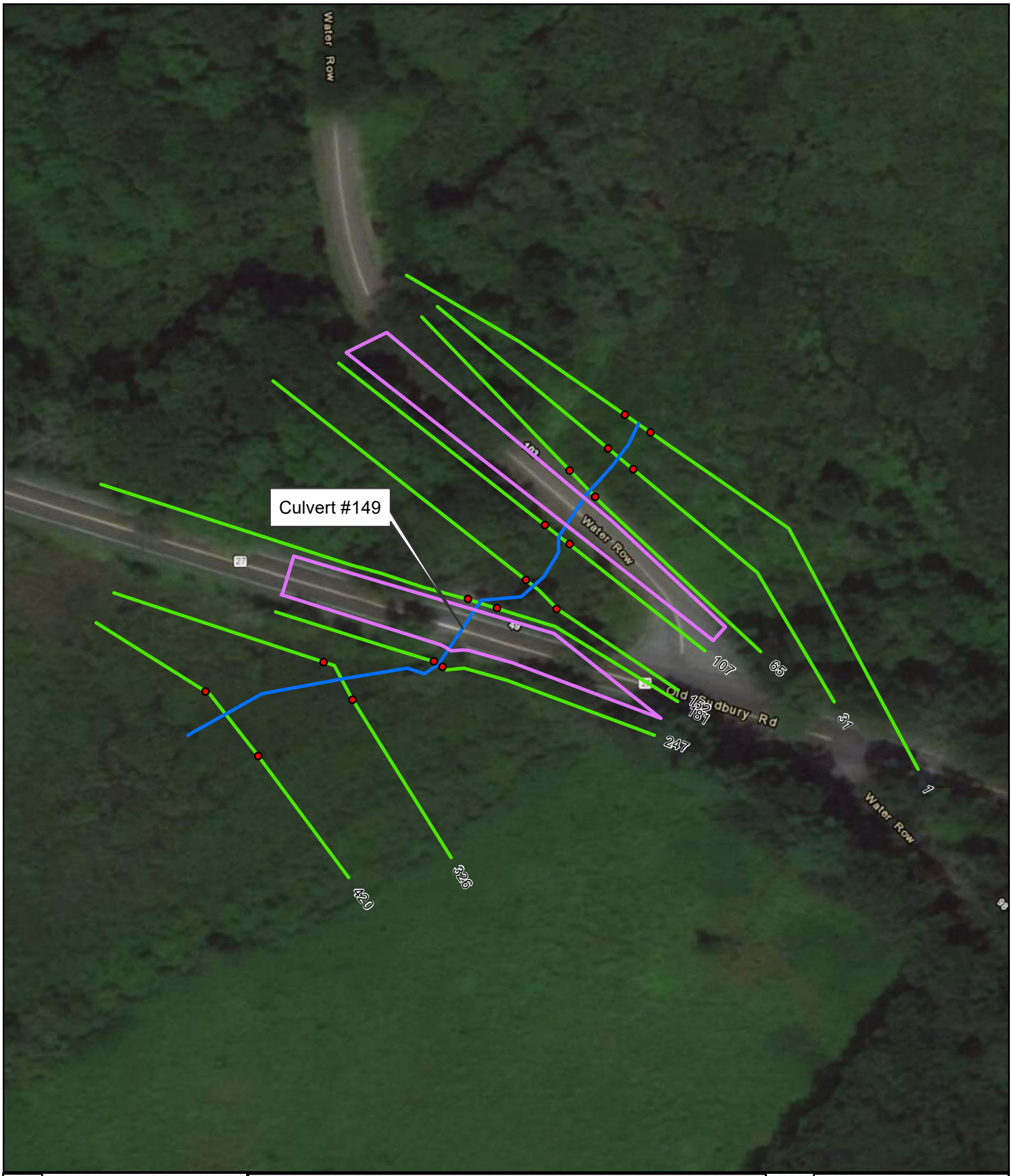

Figure Exported: 1/25/2021 By: dpasquale Using: C:\Users\dpasquale\OneDrive - Woodard & Curran_PCFolders\Documents\HH_Modeling\Washington Drive\GIS\Projects\OSR Figures.mxd

Legend

- Stream Bank Locations
- Structure
- Stream
- Cross-Section (Stationing in ft.)

0 0.0045 0.009 0.0135 0.018 0.0225 Miles

OLD SUDBURY ROAD
CULVERT #149 REPLACEMENT

SUDBURY, MA

FIGURE 2 - PROJECT AREA & CONCEPTUAL HYDRAULIC MODEL

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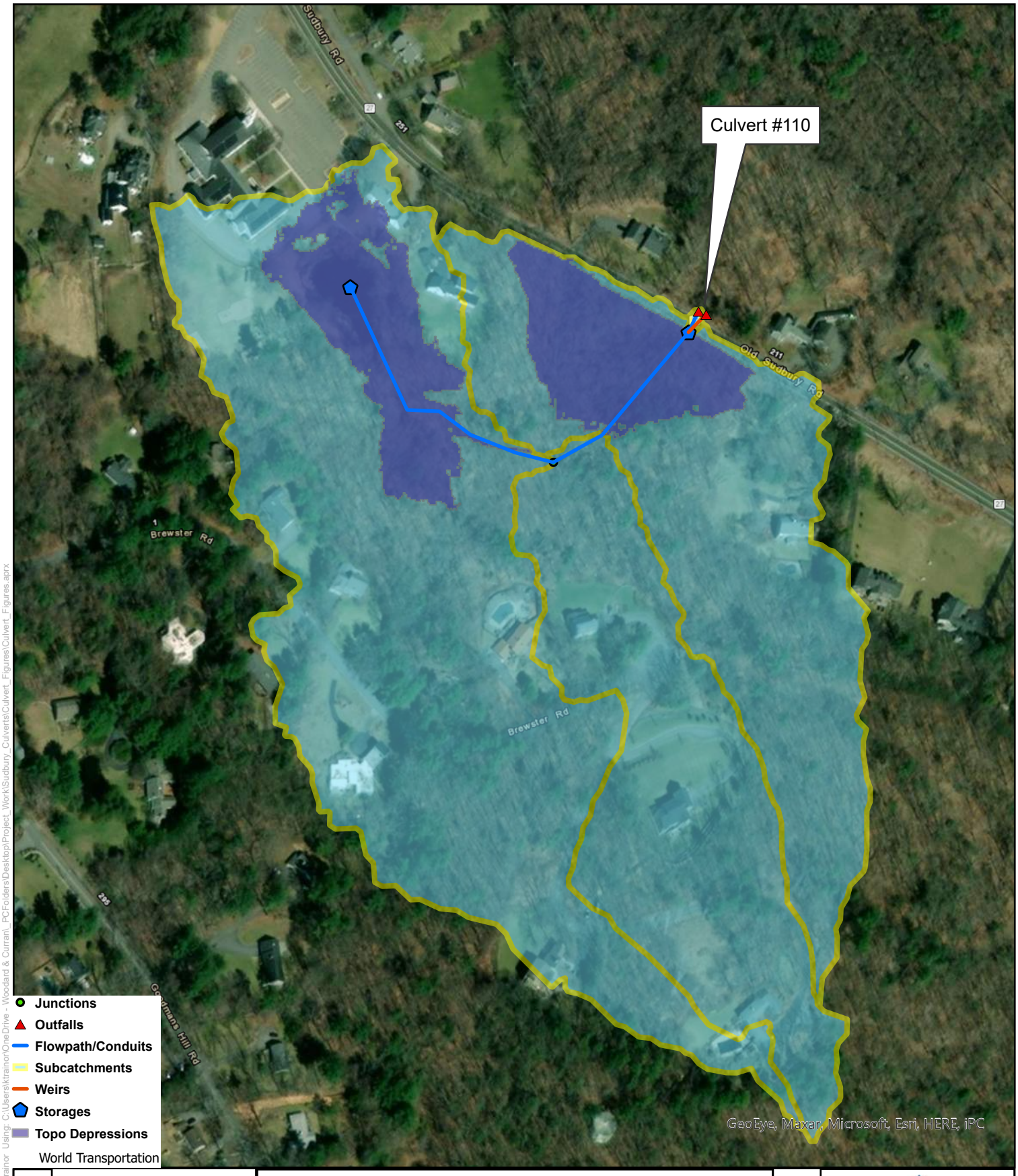
WOODARD &CURRAN

Project #: 0233335.00
Map Created: January 2021



Legend

- Junctions
- Outfalls
- Flowpath/Conduits
- Subcatchments
- Weirs
- Storages
- Topo Depressions
- World Transportation

0 50 100 150 200 250 Feet

OLD SUDBURY ROAD
CULVERT #110 REPLACEMENT

SUDBURY, MA

FIGURE 3 - PROJECT AREA & CONCEPTUAL HYDRAULIC MODEL

N

WOODARD &CURRAN

Project #: 0233335.00
Map Created: January 2021

Figure Exported: 1/27/2021 By: ktrainor Using: C:\Users\ktrainor\OneDrive - Woodard & Curran_PCFolders\Desktop\Project_Work\Sudbury_Culverts\Culvert_Figures\Culvert_Figures.aprx

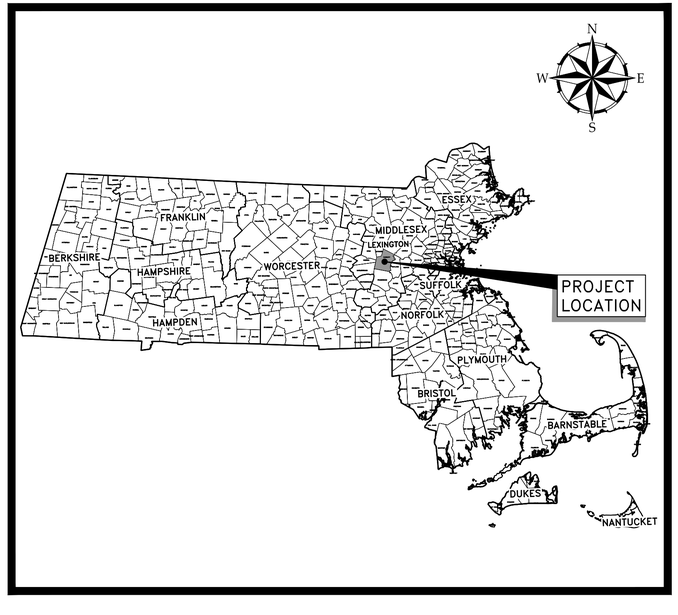
Figure 4: Replacement Culvert Concept Planset, Culvert #110 and Culvert #149

TOWN OF SUDBURY, MA
PUBLIC WORKS DEPARTMENT
OLD SUDBURY ROAD CULVERTS
110 AND 149 REPLACEMENT

PROJECT NO.
0233335.01

MARCH 2021

NOTICE OF INTENT
PERMITTING ONLY - NOT FOR CONSTRUCTION



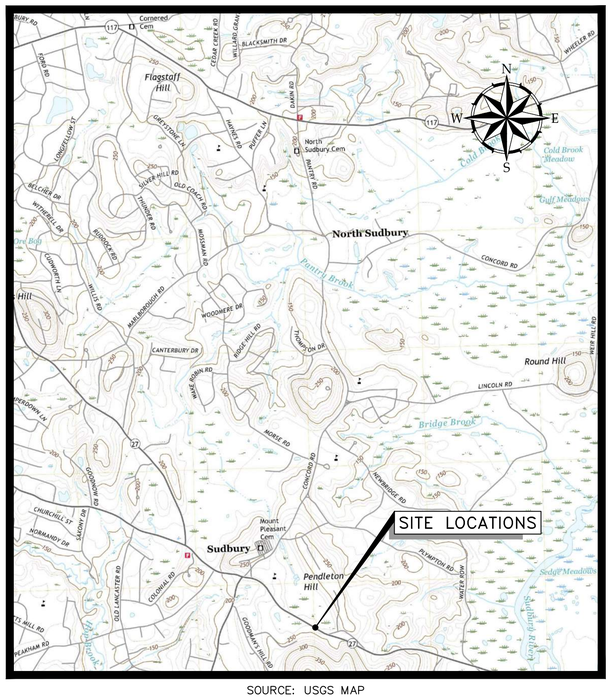
PROJECT LOCATION MAP

SUDBURY PUBLIC WORKS

WOODARD & CURRAN

250 Royall Street Suite 200E
Canton, Massachusetts 02021
800.446.5518 | www.woodardcurran.com

COMMITMENT & INTEGRITY DRIVE RESULTS



SOURCE: USGS MAP

SITE LOCATION MAP

scale 1 0 1 mile
scale 2000 0 2000 4000 feet

GENERAL NOTES:

1. EXISTING CONDITIONS ARE BASED ON SURVEYS PERFORMED BY CHAPPELL ENGINEERING ASSOCIATES, DATED JANUARY 19, 2021.
2. CHAPPELL ENGINEERING ASSOCIATES IS LOCATED AT THE FOLLOWING ADDRESS:
   201 BOSTON POST ROAD WEST, SUITE 101
   MARLBOROUGH, MA 01752
   (508) 481-7400 EXT. 18
3. CONTRACTOR SHALL INVESTIGATE EXISTING CONDITIONS AND FIELD VERIFY LOCATIONS, DEPTH, AND SIZE OF UTILITIES AND SUB-SURFACE STRUCTURES PRIOR TO CONSTRUCTION. CONTRACTOR SHALL NOTIFY ENGINEER OF ANY CONFLICTS OR DISCREPANCIES WITH THE EXISTING AND PROPOSED UTILITY LOCATIONS.
4. THE HORIZONTAL DATUM DEPICTED ON THE MAPS HEREON IS BASED ON THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, MAINLAND ZONE, REFERENCED TO THE NORTH AMERICAN DATUM OF 1983. THE VERTICAL DATUM IS BASED ON THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88).
5. ANY PROPERTY AND RIGHT OF WAY LOCATIONS THAT MAY BE SHOWN HEREON ARE APPROXIMATE AND DO NOT REPRESENT A PROPERTY BOUNDARY SURVEY.
6. WOODARD & CURRAN ASSUMES NO RESPONSIBILITY FOR DAMAGES INCURRED AS A RESULT OF UTILITIES OMITTED OR INACCURATELY SHOWN.
7. COORDINATE CONSTRUCTION ACTIVITY WITH UTILITY COMPANIES, EMERGENCY SERVICES AND TOWN. CONTRACTOR SHALL NOTIFY ALL UTILITIES PRIOR TO COMMENCING WORK, ALLOWING SUFFICIENT TIME TO LOCATE AND MARK THE LOCATION OF BURIED UTILITIES. CONTRACTOR SHALL CONTACT "DIG SAFE", TELEPHONE 811, PRIOR TO EXCAVATION.
8. RESTORE ALL AREAS DISTURBED BY CONTRACTOR'S OPERATIONS TO ORIGINAL FINISH (GRAVEL, PAVEMENT, GRASS, ETC.) UNLESS NOTED OTHERWISE ON THE PLANS. RESTORATION OF PAVED SURFACES, GRAVEL SURFACES, DRIVEWAYS, AND LAWNS DAMAGED BY CONSTRUCTION ACTIVITIES SHALL BE PERFORMED AT NO ADDITIONAL COST TO OWNER. ANY CURB DAMAGED BY CONSTRUCTION ACTIVITIES SHALL BE REPLACED IN KIND AND SHALL CONFORM TO TOWN OF SUDBURY AND MASSACHUSETTS DOT SPECIFICATIONS AT NO ADDITIONAL COST TO OWNER.
9. PROPERLY PROTECT AND DO NOT DISTURB PROPERTY IRONS AND MONUMENTS. IF DISTURBED, THE PROPERTY MONUMENT SHALL BE RESET AT THE CONTRACTOR'S EXPENSE BY A LICENSED LAND SURVEYOR ACCEPTABLE TO THE TOWN.
10. EXISTING FACILITIES (I.E. TREES, POLES, LIGHT POSTS, CATCH BASINS, STONE FROM CULVERT, ETC.) SHALL BE REMOVED AND/OR PROTECTED DURING CONSTRUCTION. THE TOWN RETAINS RIGHT TO KEEP ANY AND ALL REMOVED FACILITIES. CONTRACTOR SHALL DISPOSE OF ANY REMOVED FACILITY AT THE REQUEST OF THE TOWN AT NO ADDITIONAL COST TO OWNER.
11. ALL TREES NOT NOTED TO BE REMOVED OR RELOCATED SHALL BE PROTECTED BY CONTRACTOR DURING CONSTRUCTION.
12. RESTRICT ACCESS TO SITE THROUGH THE USE OF APPROPRIATE SIGNAGE, BARRIERS, FENCES, ETC. SITE SHALL BE LEFT WITH APPROPRIATE SAFETY MEASURES IN PLACE DURING NON-WORKING HOURS. SITE SAFETY IS THE RESPONSIBILITY OF CONTRACTOR, DURING BOTH WORKING AND NON-WORKING HOURS.
13. CONTRACTOR IS RESPONSIBLE FOR OBTAINING ALL NECESSARY CONSTRUCTION PERMITS INCLUDING "PERMIT TO CONSTRUCT WITHIN A PUBLIC WAY" FROM THE TOWN. PERMIT APPLICATIONS SHALL BE SUBMITTED WITH ADEQUATE TIME SO AS NOT TO DELAY CONSTRUCTION.
14. ALL WORK ASSOCIATED WITH THE PROJECT SHALL BE COMPLETED IN ACCORDANCE WITH THE TOWN OF SUDBURY BYLAW AND LOCAL REGULATIONS AND MASSACHUSETTS DOT STANDARD SPECIFICATIONS.
15. UPON COMPLETION OF CONSTRUCTION, A COMPLETE SET OF "RECORD" DRAWINGS SHALL BE SUBMITTED TO THE TOWN ENGINEER. THESE DRAWINGS SHALL BE SUBMITTED IN BOTH DIGITAL AND HARD COPY FORMAT AS DEFINED IN THE SPECIFICATIONS PRIOR TO PAYMENT OF FINAL RETAINAGE.
16. PROTECTION OF EXISTING UTILITIES DURING CONSTRUCTION SHALL BE PROVIDED AT NO ADDITIONAL COST.
17. CONTRACTOR SHALL BE RESPONSIBLE FOR SWEEPING OLD SUDBURY ROAD EVERY FRIDAY AND AS NECESSARY DURING THE DURATION OF THE WORK.
18. PRIOR TO CONSTRUCTION, CONTRACTOR SHALL ATTEND A PRE-CONSTRUCTION MEETING HELD AT THE PROJECT SITE WITH THE CONTRACTOR, ENGINEER, OWNER, AND CONSERVATION OFFICE TO REVIEW THE CONSTRUCTION SCHEDULE AND SEQUENCING, ORDER OF CONDITIONS, STOCKPILE LOCATIONS AND CRITICAL ASPECTS OF THE PROJECT.
19. ALL DISTURBED UPLAND AREAS SHALL BE BROUGHT TO FINAL GRADE AND SHALL BE PERMANENTLY STABILIZED WITHIN 30 DAYS AFTER DISTURBANCE. BARE GROUND AND DISTURBED AREAS THAT CANNOT BE PERMANENTLY VEGETATED WITHIN 30 DAYS SHALL BE TEMPORARY STABILIZED BY AN APPROVED METHOD.
20. CONTRACTOR SHALL DEMARCATE CONSTRUCTION EQUIPMENT AND MATERIAL STORAGE AREAS PRIOR TO CONSTRUCTION.
21. THE CONSTRUCTION SITE SHALL BE MAINTAINED IN CLEAN CONDITIONS AT ALL TIMES AND CONSTRUCTION REFUSE AND DEBRIS SHALL BE DISPOSED OF PROMPTLY AND IN A LEGAL MANNER.
22. STORING, SERVICING, OR CLEANING OF TRUCKS OR EQUIPMENT SHALL BE PERFORMED IN AN UPLAND AREA AT A HORIZONTAL DISTANCE GREATER THAN 100 FEET FROM THE WETLAND RESOURCE AREAS.
23. CONTRACTOR SHALL REFER TO SPECIFICATION XXX MASSACHUSETTS COVID ORDER AND CONSTRUCTION GUIDELINES AND EXECUTE CONSTRUCTION IN COMPLIANCE WITH APPLICABLE SOCIAL DISTANCING PROTOCOLS.
24. GEOTECHNICAL INVESTIGATION WAS CONDUCTED BY GZA GEOENVIRONMENTAL ON NOVEMBER 17, 2020 AND DECEMBER 11, 2020 AND DOCUMENTED IN A REPORT DATED JANUARY 7, 2021.
25. WETLAND DELINEATION WAS PREPARED BY ECOTEC, INC. 102 GROVE STREET, WORCESTER, MA 01605. THE WETLAND RESOURCE EVALUATION REPORT IS DATED XX XX, 2021 AND WETLAND FIELD INSPECTION WAS CONDUCTED ON NOVEMBER 4, 2020.
26. DO NOT PARK, IMPEDE ACCESS TO, OR STORE EQUIPMENT BEYOND LIMIT OF WORK, UNLESS PERMISSION HAS BEEN GRANTED IN WRITING BY TOWN AND/OR LAND OWNER.
27. PRIOR TO THE START OF WORK, CONTRACTOR SHALL CONFIRM EXISTING WETLAND FLAGS ARE IN PLACE AND SHALL BE MAINTAINED DURING CONSTRUCTION. MISSING FLAGS SHALL BE RESET PRIOR TO CONSTRUCTION. AN AUTOCAD FILE OF THE WETLAND FLAG LOCATIONS SHALL BE PROVIDED FOR CONTRACTOR'S USE IN RESETTING WETLAND FLAGS.
28. NO EQUIPMENT IS TO CROSS OR ENTER WETLAND RESOURCE AREAS AT ANY TIME UNLESS THE LOCATION OF DISTURBANCE IS MARKED ON THE PLANS REFERENCED IN THE ORDER OF CONDITIONS AND FLAGGED IN THE FIELD (DEP FILE #XXX-XXXX).
29. THE CONTRACTOR, SITE ENGINEER, OR OTHER INDIVIDUAL IN CHARGE OF WORK ON THE SITE SHALL HAVE A COPY OF THE ORDER OF CONDITIONS AT ALL TIMES (DEP FILE #XXX-XXXX).

EROSION CONTROL NOTES:

1. EROSION CONTROL DEVICES SHALL REMAIN IN PLACE, UNTIL ALL DISTURBED SURFACES HAVE BEEN STABILIZED WITH FINAL VEGETATION COVER OR THE COMMISSION HAS AUTHORIZED THEIR REMOVAL.
2. EROSION CONTROL MEASURES AND BARRIERS SHALL BE MONITORED DAILY AND MAINTAINED, OR REINFORCED AS NECESSARY TO ENSURE AND PREVENT EROSION AND SILTATION OF SOILS TO WETLAND RESOURCE AREAS. ADDITIONAL FILTER FABRIC AND STRAW WATTLES SHALL BE STORED ON SITE FOR EMERGENCY USE.
3. DURING ALL PHASES OF CONSTRUCTION, ALL DISTURBED OR EXPOSED AREAS OUTSIDE THE ROADWAY SHALL BE BROUGHT TO FINISHED GRADE AND EITHER A) LOAMED AND SEEDED FOR PERMANENT STABILIZATION, IN ACCORDANCE WITH U.S. SOIL CONSERVATION SERVICE PROCEDURES, OR B) STABILIZED IN ANOTHER WAY APPROVED BY THE COMMISSION. AREAS THAT CANNOT BE PERMANENTLY STABILIZED WITHIN 30 DAYS OF DISTURBANCE SHALL BE STABILIZED WITH HAY, STRAW, MULCH OR ANY OTHER PROTECTIVE COVERING AND/OR METHOD APPROVED BY THE U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE OR BY OTHER TEMPORARY MEASURES ACCEPTABLE TO THE COMMISSION.
4. PROJECT IS SUBJECT TO THE CONDITIONS SET FORTH IN PERMITS ISSUED BY THE US ARMY CORPS OF ENGINEERS, SUDBURY CONSERVATION COMMISSION, AND MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION, SPECIFICALLY RELATED TO LIMITS OF IMPACT, EROSION CONTROL MEASURES, RESTORATION ACTIVITIES, AND TIMEFRAME RESTRICTIONS. CONTRACTOR SHALL READ PERMIT DOCUMENTS FULLY AND CARRY OUT WORK IN ACCORDANCE WITH PERMIT DOCUMENTS. COPIES OF PERMIT DOCUMENTS ARE APPENDED TO THE PROJECT SPECIFICATIONS.
5. AN ADEQUATE STOCKPILE OF EROSION AND SEDIMENTATION CONTROL MATERIALS SHALL BE ON SITE AT ALL TIMES FOR EMERGENCY OR ROUTINE REPLACEMENT.
6. ANY DAMAGE CAUSED AS A DIRECT RESULT OF CONSTRUCTION TO THE WETLAND RESOURCE AREAS SHALL BE REPAIRED, RESTORED AND/OR REPLACED. SEDIMENTATION OR EROSION SHALL BE CONSIDERED DAMAGE TO THE WETLAND RESOURCE AREAS. IF SEDIMENTATION REACHES THESE AREAS, THE CONSERVATION COMMISSION SHALL BE CONTACTED AND A PLAN FOR THE PROPOSED RESTORATION SHALL BE SUBMITTED FOR APPROVAL.
7. THE SILT FENCE AND STRAW BALES MUST BE INSPECTED PRIOR TO THE START OF ANY WORK OR A $100 PER DAY FINE WILL BE LEVIED ON THE CONTRACTOR.

DEWATERING NOTES

1. LOCATE DISCHARGE SITE ON FLAT UPLAND AREAS AS FAR AWAY AS POSSIBLE FROM STREAMS, WETLANDS, OTHER RESOURCES AND POINTS OF CONCENTRATED FLOW.
2. NEVER DISCHARGE TO AREAS THAT ARE BARE OR NEWLY VEGETATED.
3. DIRT BAG MATERIAL BASED ON PARTICLE SIZE IN DIRTY WATER, I.E., FOR COARSE PARTICLES A WOVEN MATERIAL; FOR SILTS/CLAYS A NON-WOVEN MATERIAL.
4. DO NOT OVER PRESSURIZE DIRT BAG OR USE BEYOND CAPACITY.
5. CHANNELS DUG FOR DISCHARGING WATER FROM THE EXCAVATED AREA NEED TO BE STABLE. IF FLOW VELOCITIES CAUSE EROSION WITHIN THE CHANNEL THEN A DITCH LINING SHOULD BE USED.
6. BUCKETED WATER SHOULD BE DISCHARGED IN A STABLE MANNER TO THE SEDIMENT REMOVAL AREA. A SPLASH PAD OF RIPRAP UNDERLAIN WITH GEOTEXTILE MAY BE NECESSARY TO PREVENT SCOURING OF SOIL.
7. DEWATERING IN PERIODS OF INTENSE, HEAVY RAIN, WHEN THE INFILTRATIVE CAPACITY OF THE SOIL IS EXCEEDED, SHOULD BE AVOIDED.
8. INSTALL DIVERSION DITCHES OR BERMS TO MINIMIZE THE AMOUNT OF CLEAN STORMWATER RUNOFF ALLOWED INTO THE EXCAVATED AREA.
9. DURING THE ACTIVE DEWATERING PROCESS, INSPECTION OF THE DEWATERING FACILITY SHOULD BE REVIEWED FREQUENTLY. SPECIAL ATTENTION SHOULD BE PAID TO THE BUFFER AREA FOR ANY SIGN OF EROSION AND CONCENTRATION OF FLOW THAT MAY COMPROMISE THE BUFFER AREA. OBSERVE WHERE POSSIBLE THE VISUAL QUALITY OF THE EFFLUENT AND DETERMINE IF ADDITIONAL TREATMENT CAN BE PROVIDED.
10. EROSION CONTROL REQUIRED AROUND DEWATERING DISCHARGE SEDIMENT CONTROL DEVICE.

ABBREVIATIONS

&	AND
A.G.	ABOVE GROUND
BIT	BITUMINOUS
B/W	BETWEEN
BVW	BORDERING VEGETATED WETLAND
CB	CATCH BASIN
CBDH	CONCRETE BOUND DRILL HOLE
CI	CAST IRON
CMP	CORRUGATED METAL PIPE
CONC	CONCRETE
D	STORM DRAIN
DI	DUCTILE IRON
DIA.	DIAMETER
DIP	DUCTILE IRON PIPE
DMH	DRAIN MANHOLE
DOT	DEPARTMENT OF TRANSPORTATION
DTL.	DETAIL
E	UNDERGROUND ELECTRICAL
EMH	ELECTRIC HAND HOLE
EL.	ELEVATION
E.O.P.	EDGE OF PAVEMENT
EXIST.	EXISTING
FF	FINISH FLOOR
FT	FOOT/FEET
G	GAS MAIN
GS	GAS SERVICE
GALV.	GALVANIZED
GRAN.	GRANITE
HDPE	HIGH DENSITY POLYETHYLENE
HDPP	HIGH DENSITY POLYPROPYLENE
HYD	HYDRANT
INV.	INVERT
LF	LINEAR FEET
MASSDEP	MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION
MADOT	MASSACHUSETTS DEPARTMENT OF TRANSPORTATION
MAX.	MAXIMUM
MB	MAILBOX
MIN.	MINIMUM
MON	MONUMENT
N.I.C.	NOT IN CONTRACT
NO.	NUMBER
NR	NO REFUSAL
N.T.S.	NOT TO SCALE
OE	OVERHEAD ELECTRIC
OH	OVERHEAD
±	PLUS OR MINUS
LLS	LICENSED LAND SURVEYOR
PROP.	PROPOSED
PT.	POINT
PVC	POLYVINYL CHLORIDE
R.O.W.	RIGHT-OF-WAY
RCP	REINFORCED CONCRETE PIPE
REINF.	REINFORCED
REQ'D	REQUIRED
RPP	RIBBED PLASTIC PIPE
S	SLOPE (FT./FT.)
S	SEWER
SBDH	STONE BOUND DRILL HOLE
SMH	SEWER MANHOLE
SCH	SCHEDULE
STA.	STATION
TOWN	TOWN OF SUDBURY
TYP.	TYPICAL
UNO	UNLESS NOTED OTHERWISE
UP	UTILITY POLE
VC	VITRIFIED CLAY
VIT.	VITRIFIED CLAY
W	WEST
W	WATER
W/	WITH
W	WATERMAIN
WS	WATER SERVICE
WV	WATER VALVE

SYMBOLS

DESCRIPTION	EXISTING
UTILITY POLE	○
CATCH BASIN	▦
WETLAND FLAG LOCATION	WF #B-X
BENCHMARK	◔
MANHOLE	Ⓓ
TREE	24" ●

SHEET INDEX

RESOURCE AREA LEGEND

BORDERING VEGETATED WETLAND (BVW)

EDGE OF WATER/FLOW PATH

NATURAL HERITAGE & ENDANGERED SPECIES PROGRAM (NHESP) PRIORITY HABITATS OF RARE SPECIES

COFFERDAM — CD —

LIMIT OF WORK — LW —

SEDIMENT BARRIER

TURBIDITY CURTAIN

NOTE:

1. CULVERT 110 AND CULVERT 149 PROJECT AREAS ENTIRELY WITHIN BORDERING VEGETATED WETLAND (BVW) BUFFER (ADJACENT UPLAND RESOURCE AREA).
2. CULVERT 149 PROJECT AREA ENTIRELY WITHIN BORDERING LAND SUBJECT TO FLOODING (100-YEAR FLOOD ZONE).

LINE TYPES & HATCHES

DESCRIPTION	EXISTING	PROPOSED
RIGHT OF WAY/PROPERTY LINE		
CONTOUR (2' INTERVAL)	201	
CONTOUR (INDEX)	200	
BITUMINOUS CURB		
EDGE OF PAVEMENT		
STORM DRAIN LINE	SD	
UNDERGROUND GAS	G	
WATER LINE	W	
GUARDRAIL		
LIMIT OF WORK		LW
SEDIMENT BARRIER/COFFERDAM		
SEDIMENT BARRIER/SILTSOXX/ SILT FENCE		
SAWCUT		
RETAINING WALL		
STONE WALL		
RIPRAP		
BITUMINOUS PAVEMENT		
MILL AND OVERLAY		
PAVEMENT TO BE REMOVED		

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Canton, MA 02021
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COMMITMENT & INTEGRITY DRIVE RESULTS

REV	DESCRIPTION	DATE	DESIGNED BY: MB/DLP	CHECKED BY: HCP/SS
1	PER MARCH 24 CONSERVATION COMMISSION MEETING	03/30/2021	DRAWN BY: MB	0233335.01-GXXX.dwg
2	NOI PERMIT SUBMISSION	04/08/2021		

GENERAL NOTES, LEGEND AND ABBREVIATIONS

TOWN OF SUDBURY, MA
PUBLIC WORKS DEPARTMENT

OLD SUDBURY ROAD
CULVERTS 110 AND 149
REPLACEMENT

JOB NO: 0233335.01
DATE: MARCH 2021
SCALE: N.T.S.
SHEET: 2 OF 9

G-002

PERMITTING ONLY - NOT FOR CONSTRUCTION

230 OLD SUDBURY ROAD
N/F
JAMES E & JEVON FRANCIS
BK. 49535 PG. 17
MAP 10 LOT 23

0 OLD SUDBURY ROAD
N/F
TOWN OF SUDBURY
BK. 11595 PG. 496
MAP 10 LOT 20

218 OLD SUDBURY ROAD
N/F
RICHARD P & CANDACE MANDEL
BK. 13096 PG. 105
MAP 10 LOT 19

71 BREWSTER ROAD
N/F
AGUSTINA SUMITO TRUST
BK. 47283 PG. 413
MAP 10 LOT 9

213 OLD SUDBURY ROAD
N/F
BENJAMIN & SUSAN CHISHOLM
BK. 68208 PG. 531
MAP 10 LOT 5

CBLP

BLP FOUND AND HELD

389.33'
N63°35'29"W

BENCHMARK: BONNETBOLT
EL=233.96'

BENCHMARK: MAGNAIL IN UTILITY POLE
EL=233.23'

8" DRAIN OPENING
IN STONE WALL
ELEV.=228.05'

1
N: 2963281.930'
E: 681399.610'
EL: 232.602'
MAGNAIL

6" DRAIN OPENING
IN STONE WALL
ELEV.=227.86'

IP 1

IP 2" OLD

WOODS

FLOW PATH

UPL

UG GAS

UG WATER

UG DRAIN

SD

EOP

DH

WF#TP-U
WF#TP-W
WF#A-1
WF#A-2
WF#A-3
WF#A-4
WF#A-5
WF#A-6
WF#A-7
WF#A-8
WF#A-9
WF#B-1
WF#B-2
WF#B-3
WF#B-4
WF#B-5
WF#B-6

225 226 227 228 229 230 231 232

OLD SUDBURY ROAD (ROUTE 27)
(PUBLIC - VARIABLE WIDTH)

RESOURCE AREA LEGEND

BORDERING VEGETATED WETLAND (BVW)

EDGE OF WATER/FLOW PATH

NOTE:

1. CULVERT 110 PROJECT AREA ENTIRELY WITHIN BORDERING VEGETATED WETLAND (BVW) BUFFER (ADJACENT UPLAND RESOURCE AREA).

BAR SCALE
1" = 30'
CHECK GRAPHIC SCALE BEFORE USING

PERMITTING ONLY - NOT FOR CONSTRUCTION

\\woodardcurran.net\shared\Projects\0233335.01 sudbury ma old sudbury rd culvert replacement\wip\Dtawings\Civil\0233335.01-C-100-101.dwg, Mar 26, 2021 - 11:01am SJUNG

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WOODARD & CURRAN
COMMITMENT & INTEGRITY DRIVE RESULTS

REV	DESCRIPTION	DATE
1	NOI PERMIT SUBMISSION	03/02/2021
2	PER MARCH 24 CONSERVATION COMMISSION MEETING	03/30/2021

DESIGNED BY: DLP/MB
DRAWN BY: MB
CHECKED BY: HCP/SS
0233335.01-C-100-101.dwg

EXISTING CONDITIONS PLAN - CULVERT 110

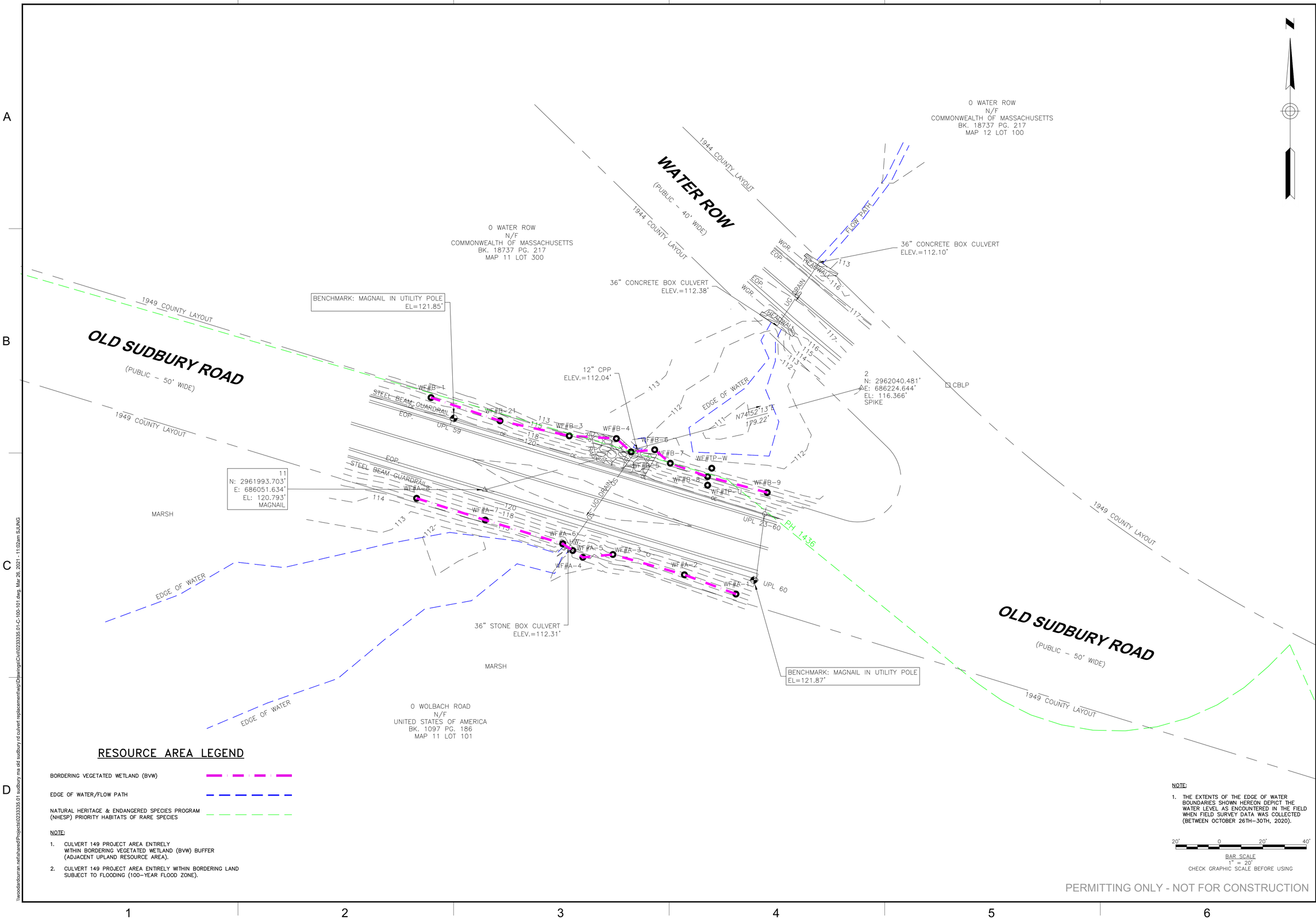
TOWN OF SUDBURY, MA
PUBLIC WORKS DEPARTMENT

OLD SUDBURY ROAD
CULVERTS 110 AND 149
REPLACEMENT

JOB NO:	0233335.01
DATE:	MARCH 2021
SCALE:	AS SHOWN
SHEET:	3 OF 9

C-100

22x34 SHEET
1:1



RESOURCE AREA LEGEND

BORDERING VEGETATED WETLAND (BVW)

EDGE OF WATER/FLOW PATH

NATURAL HERITAGE & ENDANGERED SPECIES PROGRAM (NHESP) PRIORITY HABITATS OF RARE SPECIES

NOTE:

1. CULVERT 149 PROJECT AREA ENTIRELY WITHIN BORDERING VEGETATED WETLAND (BVW) BUFFER (ADJACENT UPLAND RESOURCE AREA).
2. CULVERT 149 PROJECT AREA ENTIRELY WITHIN BORDERING LAND SUBJECT TO FLOODING (100-YEAR FLOOD ZONE).

NOTE:

1. THE EXTENTS OF THE EDGE OF WATER BOUNDARIES SHOWN HEREON DEPICT THE WATER LEVEL AS ENCOUNTERED IN THE FIELD WHEN FIELD SURVEY DATA WAS COLLECTED (BETWEEN OCTOBER 26TH–30TH, 2020).

20' 0 20' 40'

BAR SCALE
1" = 20'
CHECK GRAPHIC SCALE BEFORE USING

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COMMITMENT & INTEGRITY DRIVE RESULTS

REV.	DESCRIPTION	DATE
2	PER MARCH 24 CONSERVATION COMMISSION MEETING	03/30/2021
1	NOI PERMIT SUBMISSION	03/26/2021

DESIGNED BY: DLP/MB
DRAWN BY: MB
CHECKED BY: HCP/SS
0233335.01-C-105-101.dwg

EXISTING CONDITIONS PLAN - CULVERT 149

TOWN OF SUDBURY, MA
PUBLIC WORKS DEPARTMENT

OLD SUDBURY ROAD
CULVERTS 149 AND 150
REPLACEMENT

JOB NO:	0233335.01
DATE:	MARCH 2021
SCALE:	AS SHOWN
SHEET:	4 OF 9

C-101

230 OLD SUDBURY ROAD
N/F
JAMES E & JEVON FRANCIS
BK. 49535 PG. 17
MAP 10 LOT 23

0 OLD SUDBURY ROAD
N/F
TOWN OF SUDBURY
BK. 11595 PG. 496
MAP 10 LOT 20

218 OLD SUDBURY ROAD
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MAP 10 LOT 5

71 BREWSTER ROAD
N/F
AGUSTINA SUMITO TRUST
BK. 47283 PG. 413
MAP 10 LOT 9

OLD SUDBURY ROAD (ROUTE 27)
(PUBLIC - VARIABLE WIDTH)

CBLP FOUND AND HELD

389.33'
N63°35'29"W

WOODS

8" DRAIN OPENING
IN STONE WALL
ELEV.=228.05'

6" DRAIN OPENING
IN STONE WALL
ELEV.=227.86'

REMOVE AND REPLACE
DRAINAGE PIPE

PROVIDE TURBIDITY CURTAIN
(SEE NOTE 1 THIS SHEET)

SAWCUT
PAVEMENT

SEDIMENT BARRIER
(TYP.)

PROVIDE COFFERDAM
(SEE NOTE 1 THIS SHEET)

FLOW PATH

WF#B-1
WF#B-2
WF#B-3
WF#B-4
WF#B-5
WF#B-6
WF#TP-U
WF#TP-W
WF#A-1
WF#A-2
WF#A-3
WF#A-4
WF#A-5
WF#A-6
WF#A-7
WF#A-8
WF#A-9

IP 1

NOTES:

1. FOR CULVERT 110 ONLY, IN LIEU OF PROVIDING COFFERDAM AND TURBIDITY CURTAIN, CONTRACTOR MAY CONSTRUCT TEMPORARY SANDBAG BARRIERS AT THE INLET AND OUTLET ENDS OF THE CULVERT. THE CONTRACTOR SHALL BE RESPONSIBLE FOR PROTECTING THE WORK FROM FLOW AT ALL TIMES DURING THE COURSE OF CONSTRUCTION.

30' 0 30' 60'

BAR SCALE
1" = 30'
CHECK GRAPHIC SCALE BEFORE USING

PERMITTING ONLY - NOT FOR CONSTRUCTION

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2	PER MARCH 24 CONSERVATION COMMISSION MEETING	03/30/2021
1	NOI PERMIT SUBMISSION	03/26/2021

DESIGNED BY: DLP/MB
DRAWN BY: MB
CHECKED BY: HCP/SS
0233335.01-C-200-201.dwg

EROSION CONTROL AND DEMOLITION PLAN - CULVERT 110

TOWN OF SUDBURY, MA
PUBLIC WORKS DEPARTMENT

OLD SUDBURY ROAD
CULVERTS 110 AND 149
REPLACEMENT

JOB NO:	0233335.01
DATE:	MARCH 2021
SCALE:	AS SHOWN
SHEET:	5 OF 9

C-200

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REV.	DESCRIPTION	DATE
1	NOI PERMIT SUBMISSION	03/02/2021
2	PER MARCH 24 CONSERVATION COMMISSION MEETING	03/30/2021

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DRAWN BY: MB | 0233335.01-C-200-201.dwg

EROSION CONTROL AND DEMOLITION PLAN - CULVERT 149

TOWN OF SUDBURY, MA
PUBLIC WORKS DEPARTMENT

OLD SUDBURY ROAD
CULVERTS 110 AND 149
REPLACEMENT

JOB NO:	0233335.01
DATE:	MARCH 2021
SCALE:	AS SHOWN
SHEET:	6 OF 9

C-201

BAR SCALE
1" = 20'
CHECK GRAPHIC SCALE BEFORE USING

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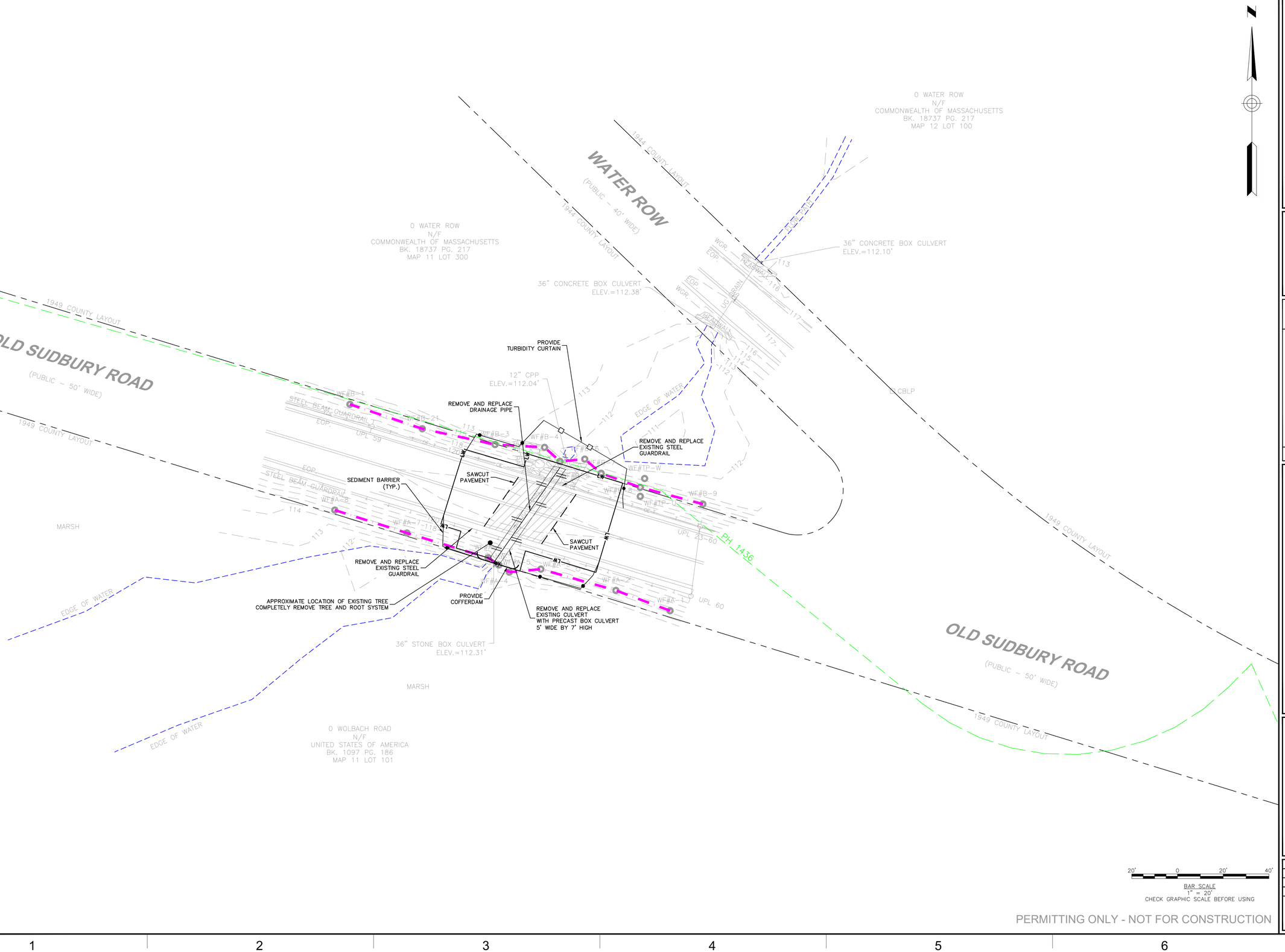

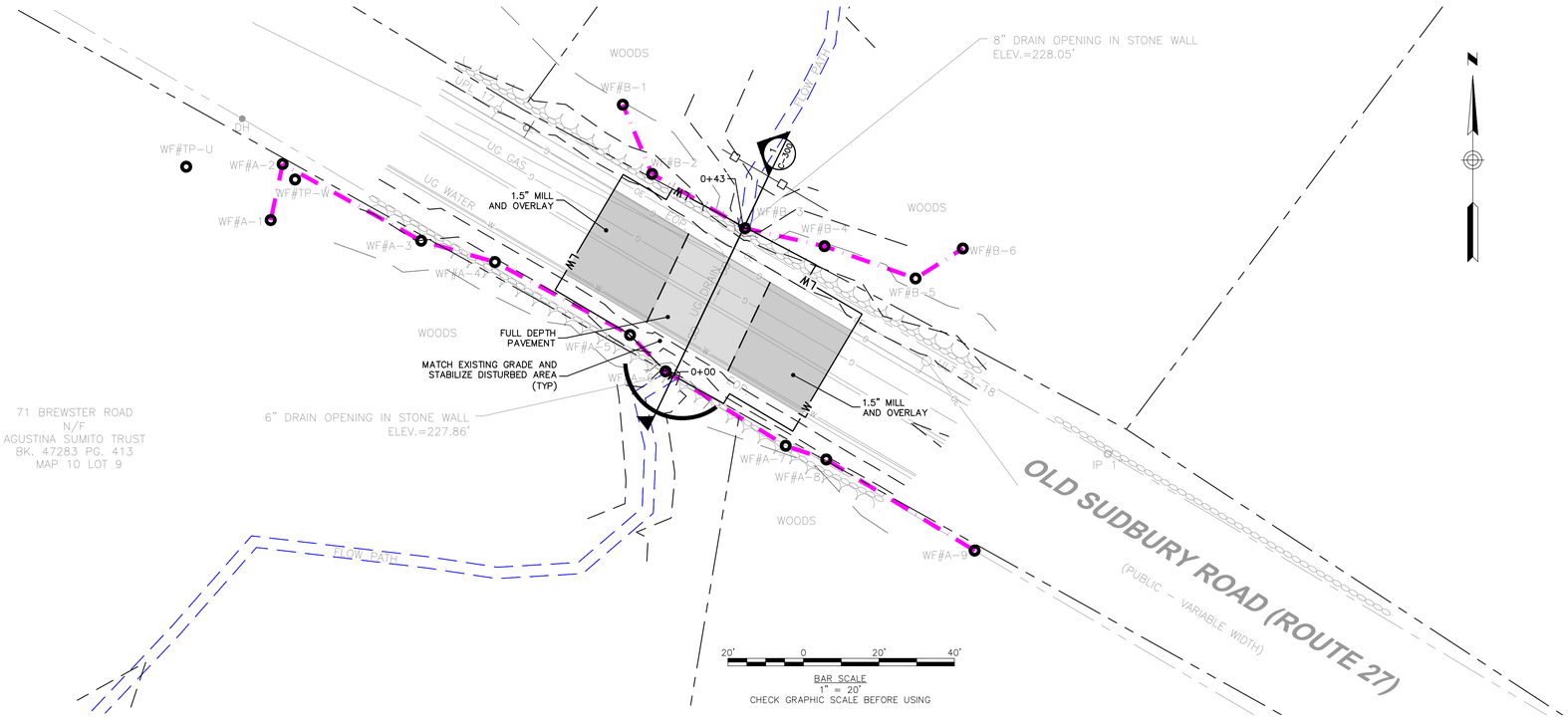

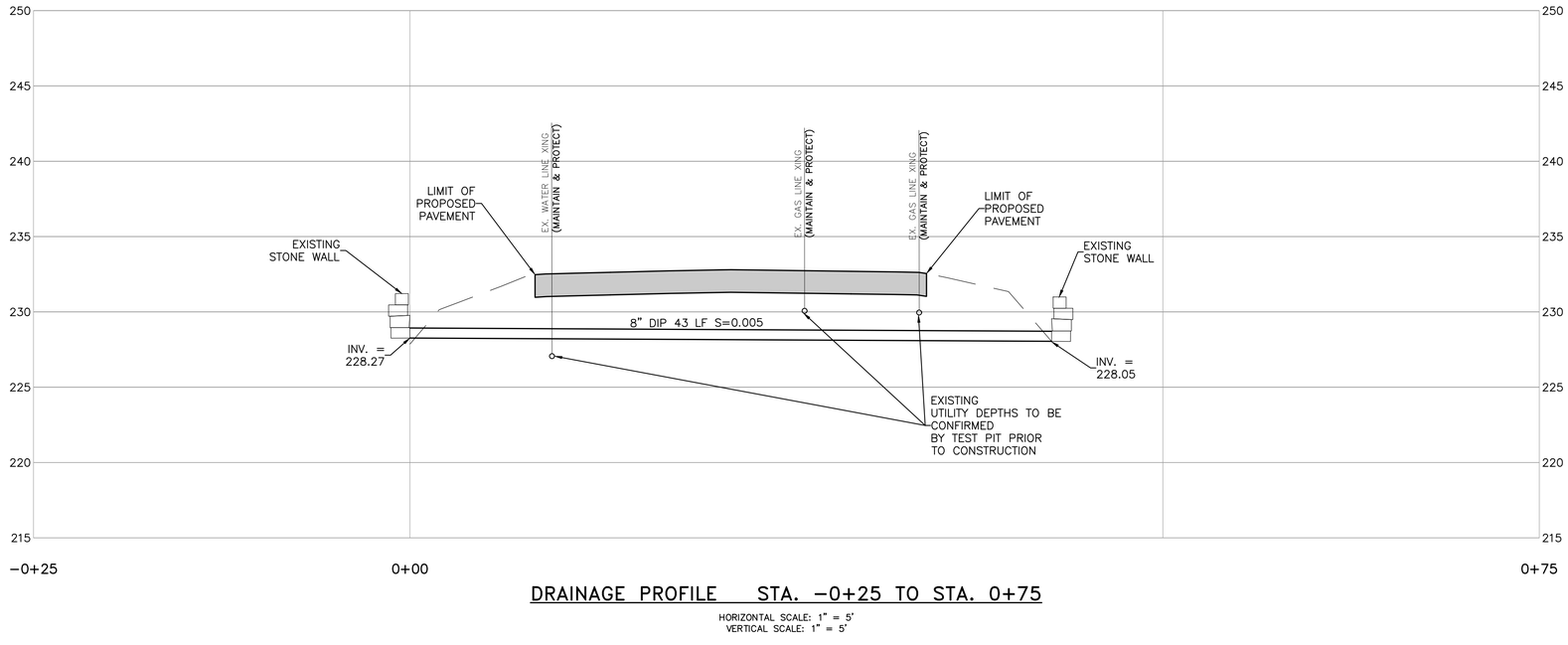

DRAINAGE PROFILE STA. −0+25 TO STA. 0+75

HORIZONTAL SCALE: 1" = 5'
VERTICAL SCALE: 1" = 5'

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COMMITMENT & INTEGRITY DRIVE RESULTS

REV	DESCRIPTION	DATE
2	PER MARCH 24 CONSERVATION COMMISSION MEETING	03/30/2021
1	NOI PERMIT SUBMISSION	03/26/2021

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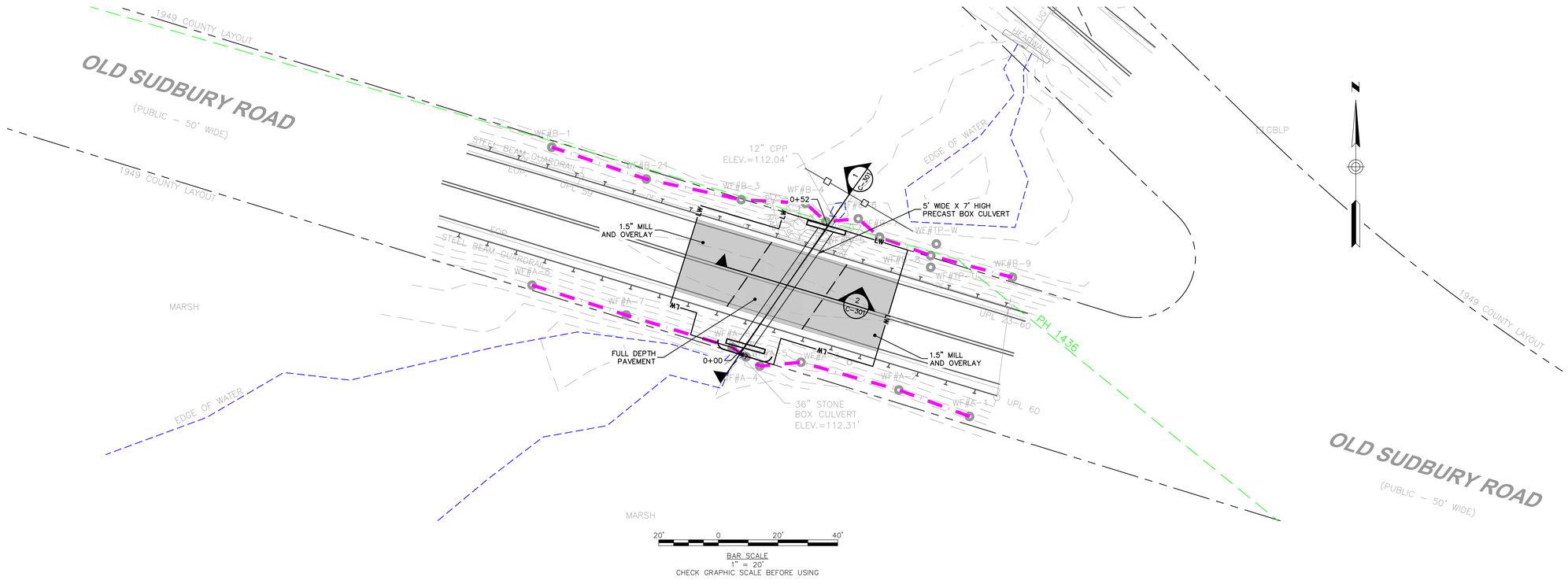
SITE PLAN AND PROFILE - CULVERT 110

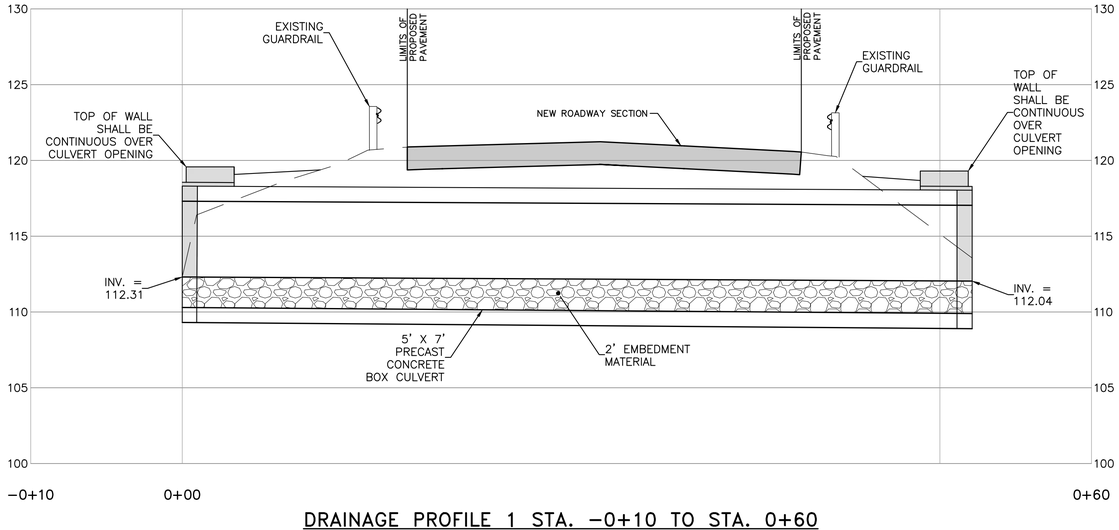
TOWN OF SUDBURY, MA
PUBLIC WORKS DEPARTMENT

OLD SUDBURY ROAD
CULVERTS A AND 149
REPLACEMENT

JOB NO: 0233335.01
DATE: MARCH 2021
SCALE: AS SHOWN
SHEET: 7 OF 9

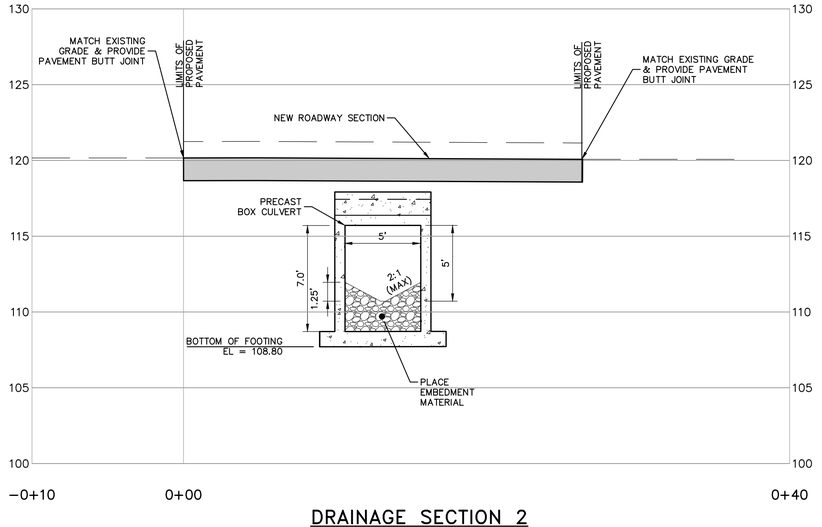
C-300





DRAINAGE PROFILE 1 STA. −0+10 TO STA. 0+60

HORIZONTAL SCALE: 1" = 5'
VERTICAL SCALE: 1" = 5'



DRAINAGE SECTION 2

HORIZONTAL SCALE: 1" = 5'
VERTICAL SCALE: 1" = 5'

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SITE PLAN AND PROFILE - CULVERT 149

TOWN OF SUDBURY, MA
PUBLIC WORKS DEPARTMENT

OLD SUDBURY ROAD
CULVERTS 1 AND 149
REPLACEMENT

JOB NO: 0233335.01
DATE: MARCH 2021
SCALE: AS SHOWN
SHEET: 8 OF 9

C-301

EROSION AND SEDIMENT CONTROL NOTES

Temporary Erosion Control

Measure	Dates For Use	Timing, Activity, and Location
Sedimentation Barrier	ALL	Before soil disturbance, install downhill of areas to be disturbed and around material stockpiles.
Up-slope Diversion	ALL	Before soil disturbance, install uphill of areas to be disturbed and material stockpiles.
Catch Basin Protection	ALL	Before soil or pavement disturbance, install ACF Environmental, Inc. High Flow Siltsack, Siltsaver Inlet Filter. or equal, installed per manufacturer's requirements.
Dust Control	ALL	During dry weather, apply water and calcium chloride to control dust.
Temporary Seeding	April 15 to Oct. 15	Soil stockpiles that are not covered and disturbed areas that will not be disturbed again within 14 days. If grass growth provides less than 95% soil coverage by Nov. 1, apply mulch and anchor with erosion control blanket.
Mulch	April 15 to Sept. 15	On all areas of exposed soil prior to rain events apply 100-150 lbs (2.5 bales) per 1,000 sq ft. by mechanical blower.
Winter Mulch	Sept. 16 to Oct. 31	On all areas of exposed soil prior to precipitation apply 150 to 170 lbs. mulch (4 bales) per 1,000 sq. ft. by mechanical blower. Erosion control blanket may be used as a substitute for winter mulch.
	Nov. 1 to April 14	On all areas of exposed soil, apply 150 to 170 lbs. mulch (4 bales) per 1,000 sq. ft. and anchor with netting at the end of each working day. Erosion control blanket may be used as a substitute for winter mulch.
Inspections	Until site is permanently stabilized	Inspect the erosion and sedimentation control measures daily, and after rainfall of half inch or greater in a 24-hour period, and maintain and repair as necessary.

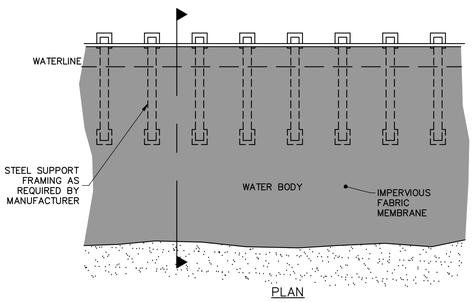
Permanent Erosion Control:

Measure	Dates For Use	Timing, Activity, and Location
Pavement – Base Course – Final Course	When no frost is in ground	Install only in areas shown on the plan, shortly after pavement base is brought to final grade. Install near completion of project.
Permanent Seeding	April 15 to Sept. 15	On final grade areas, within 7 days of grade preparation, prepare topsoil, followed by seed and mulch application.
Dormant Seeding	Sept. 16 to April 15	On final grade areas, with prepared topsoil. Apply seed at double the specified rate on bare soil, and follow with an application of winter mulch.
Ground Cover, Trees, Shrubs	April 15 to Nov. 1	Install with final landscaping.
Permanent Mulch	ALL	Install with final landscaping.

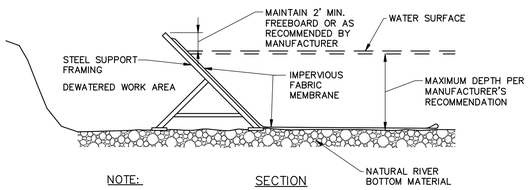
Inspections:

Regular inspections of all erosion and sedimentation controls shall be made at least weekly and prior to and following storm events. Minimum inspections shall be made as listed in the table below.

Inspected Item	Look For
Mulched Surfaces	Thin mulch or inadequate application. Wind movement.
Seeded Surfaces	Poor seed germination. Loss of mulch. Development of rivulets.
Sediment Barrier	Sediment build-up to one half the height of the barrier. Undermining of the barrier. Supporting stakes loose, toppled, or unmarked. Breaks in barrier.
Perimeter Diversion	Discharge is to stabilized area. Erosion or breaks in barrier. Supporting stakes loose, toppled or unmarked.
Catch Basin Protection	Sediment build-up and structure blockages. Slow flow/Ponding water. Breaks in fabric or voids in barrier.
Site Roadways	Sedimentation of roadways. Off-site dust complaints.



PLAN



NOTE:

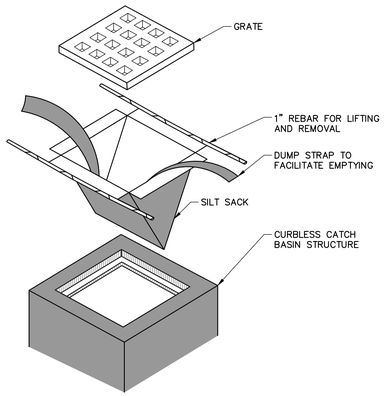
SECTION

COFFERDAM DETAIL SHOWN FOR REFERENCE PURPOSES. CONTRACTOR SHALL PROVIDE DESIGN OF TEMPORARY COFFERDAMS, STAMPED BY A LICENSED PROFESSIONAL ENGINEER IN THE COMMONWEALTH OF MASSACHUSETTS.

COFFER DAM DETAIL

N.T.S.

TO BE INSTALLED AROUND WORK AREA IN ACCORDANCE WITH CONTRACTOR'S WORK PLAN

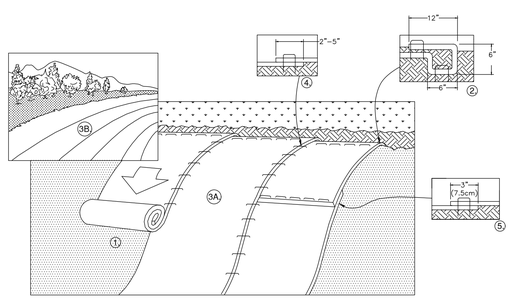


NOTES:

1. INSTALL SILTSACK PER MANUFACTURER'S INSTRUCTIONS AND RECOMMENDATIONS.
2. EMPTY OR REMOVE SEDIMENT FROM SILTSACK WHEN RESTRAINT CORD IS NO LONGER VISIBLE. CLEAN, RINSE, AND REPLACE AS NEEDED.
3. SILT SACKS TO BE INSTALLED WHEN THE POTENTIAL FOR SEDIMENT TO ENTER EXISTING & PROPOSED BASINS EXISTS.

SILTSACK– CURBLESS INLET

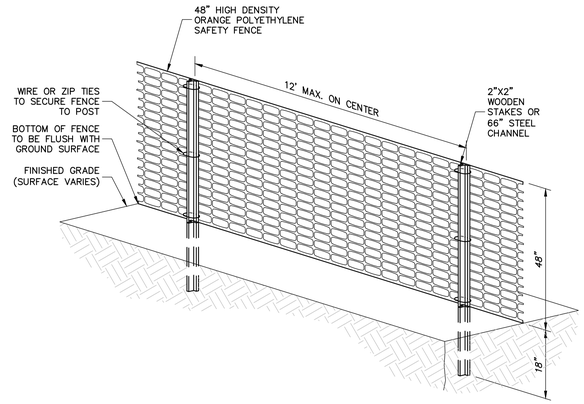
NOT TO SCALE



1. PREPARE SOIL BEFORE INSTALLING ROLLED EROSION CONTROL PRODUCTS (RECP's), INCLUDING ANY NECESSARY APPLICATION OF LIME, FERTILIZER, AND SEED AS WELL AS REMOVING ANY PROTRUDING ROCKS, STUMPS OR ROOTS. DURING THE GROWING SEASON (APRIL 15 – SEPTEMBER 15) USE RECP'S ON SLOPES HAVING A GRADE GREATER THAT 15%, OR ANYWHERE WHERE HAY MULCH HAS PROVEN TO BE INEFFECTIVE AT CONTROLLING SHEET EROSION. RECP'S ARE A MANUFACTURED COMBINATION OF MULCH AND NETTING DESIGNED TO PREVENT EROSION AND RETAIN SOIL MOISTURE. FOR OVER WINTER PROTECTION, APPLY RECP'S ON SLOPES STEEPER THAN AN 8% GRADE.
2. BEGIN AT THE TOP OF THE SLOPE BY ANCHORING THE RECP's IN A 6" DEEP X 6" WIDE TRENCH WITH APPROXIMATELY 12" OF RECP's EXTENDED BEYOND THE UP-SLOPE PORTION OF THE TRENCH. ANCHOR THE RECP's WITH A ROW OF STAPLES/STAKES APPROXIMATELY 12" APART IN THE BOTTOM OF THE TRENCH (USE OF METAL STAPLES IS PROHIBITED). BACKFILL AND COMPACT THE TRENCH AFTER STAPLING. APPLY SEED TO COMPACTED SOIL AND FOLD REMAINING 12" PORTION OF RECP's BACK OVER SEED AND COMPACTED SOIL. SECURE RECP's OVER COMPACTED SOIL WITH A ROW OF STAPLES/STAKES SPACED APPROXIMATELY 12" APART ACROSS THE WIDTH OF THE RECP's.
3. ROLL THE RECP's (A.) DOWN OR (B.) HORIZONTALLY ACROSS THE SLOPE. RECP's WILL UNROLL WITH APPROPRIATE SIDE AGAINST THE SOIL SURFACE. ALL RECP's MUST BE SECURELY FASTENED TO SOIL SURFACE BY PLACING STAPLES/STAKES IN APPROPRIATE LOCATIONS AS SHOWN IN THE STAPLE PATTERN GUIDE. WHEN USING THE DOT SYSTEM, STAPLES/STAKES SHOULD BE PLACED THROUGH EACH OF THE COLORED DOTS CORRESPONDING TO THE APPROPRIATE STAPLE PATTERN.
4. THE EDGES OF PARALLEL RECP's MUST BE STAPLED WITH APPROXIMATELY 2" – 5" OVERLAP DEPENDING ON RECP's TYPE.
5. CONSECUTIVE RECP's SPLICED DOWN THE SLOPE MUST BE PLACED END OVER END (SHINGLE STYLE) WITH AN APPROXIMATE 3" OVERLAP. STAPLE THROUGH OVERLAPPED AREA, APPROXIMATELY 12" APART ACROSS ENTIRE RECP's WIDTH. NOTE: *IN LOOSE SOIL CONDITIONS, THE USE OF STAPLE OR STAKE LENGTHS GREATER THAN 6" MAY BE NECESSARY TO PROPERLY SECURE THE RECP's.
6. UNTIL GRASS HAS GOOD COVERAGE, INSPECT PERIODICALLY AND AFTER EACH RAINSTORM TO CHECK FOR EROSION. IMMEDIATELY REPAIR AND ADD MORE MULCH UNTIL GRASSES ARE FIRMLY ESTABLISHED. DO NOT MOW THE FIRST YEAR.
7. EROSION CONTROL MATTING AND GROUND FASTENERS SHALL BE 100% BIODEGRADABLE.

EROSION CONTROL MATTING

N.T.S.

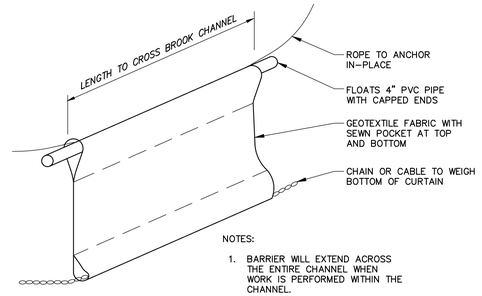


NOTE:

1. MAINTAIN TENSION ACROSS FULL HEIGHT AND LENGTH OF FENCE.
2. PROVIDE PERIODIC INSPECTION AND MAINTENANCE OF FENCE.
3. FENCE SHALL BE HIGH DENSITY ORANGE POLYETHYLENE SAFETY FENCE AS MANUFACTURED BY EROSION RUNNER® OR APPROVED EQUAL.

PLASTIC CONSTRUCTION SAFETY FENCE

N.T.S.

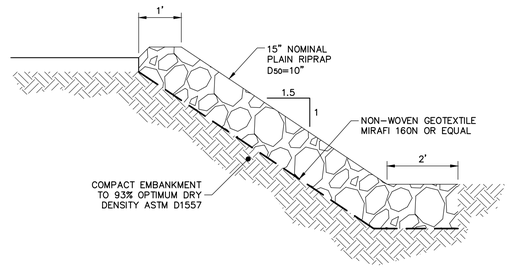


NOTES:

1. BARRIER WILL EXTEND ACROSS THE ENTIRE CHANNEL WHEN WORK IS PERFORMED WITHIN THE CHANNEL.
2. ROPE SHALL BE 1/2" NYLON OR MANILA.

FLOATING TURBIDITY BARRIER

N.T.S.



RIPRAP SLOPE DETAIL

N.T.S.

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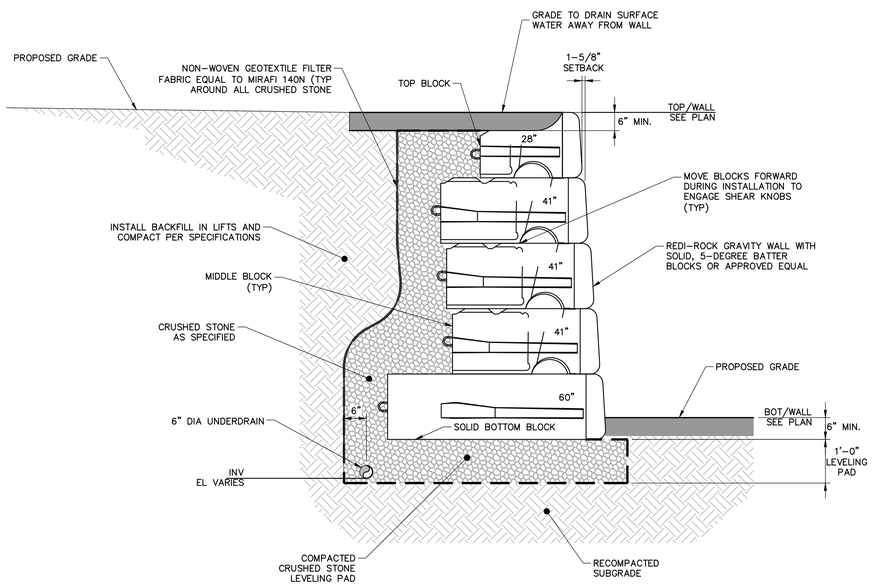
CIVIL DETAILS 1

TOWN OF SUDBURY, MA
PUBLIC WORKS DEPARTMENT

OLD SUDBURY ROAD
CULVERTS 150 AND 149
REPLACEMENT

JOB NO: 0233335.01
DATE: MARCH 2021
SCALE: AS SHOWN
SHEET: 9 OF 9

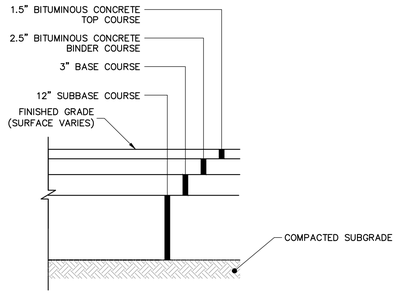
C-400



NOTES:

1. RETAINING WALL SECTIONS ARE CONCEPTUAL IN NATURE AND FOR REFERENCE PURPOSES TO AID IN THE LAYOUT AND DEVELOPMENT OF WALL DESIGN (BY OTHERS). GRAVITY WALL ENGINEER SHALL PROVIDE FINAL WALL DESIGN AND CALCULATIONS, STAMPED AND SIGNED BY A PROFESSIONAL ENGINEER LICENSED IN THE STATE OF MASSACHUSETTS SUBJECT TO REVIEW OF THE ENGINEER.
2. REFER TO SHEET C-102 FOR PLAN VIEW AND LIMITS OF PROPOSED RETAINING WALL.
3. REFER TO SPECIFICATION SECTION 31 00 00 FOR MATERIAL GRADATIONS AND REQUIREMENTS.
4. ELEVATIONS SHOWN ARE APPROXIMATE AND SHALL BE FIELD VERIFIED.
5. REFER TO SECTIONS AND PLANS FOR BACK FILL INFORMATION.

RETAINING WALL DETAIL
N.T.S.



BITUMINOUS PAVEMENT SECTION
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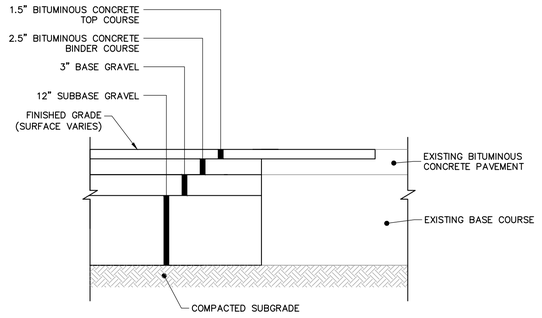
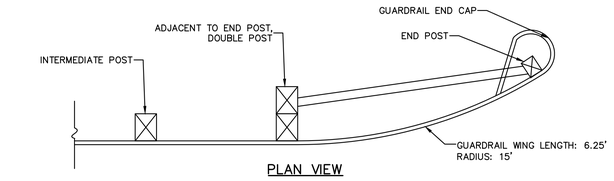
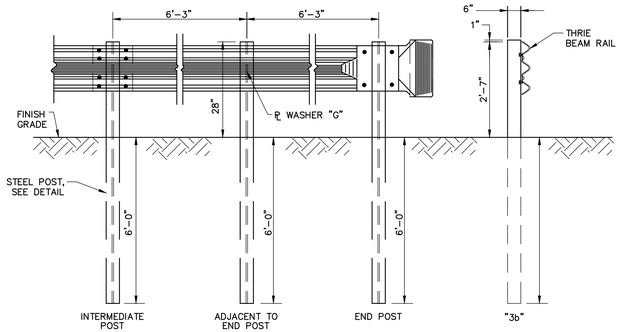


BITUMINOUS PAVEMENT BUTT JOINT
N.T.S.



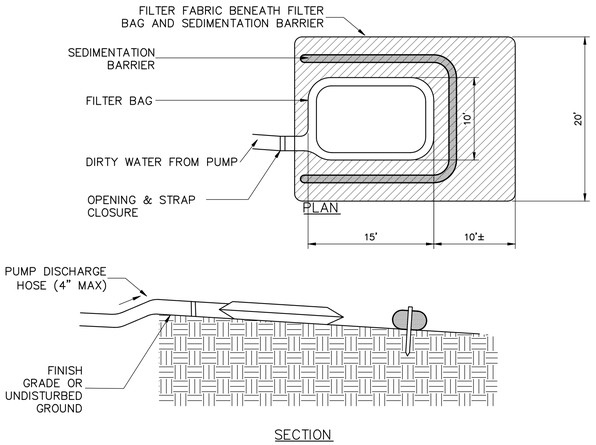
PLAN VIEW



NOTES:

- ALL POST SPACING SHALL BE 6'-3" UNLESS OTHERWISE DIRECTED BY ENGINEER.
- GUARDRAIL SHALL MEET ALL MASSDOT SPECIFICATIONS
- ALL HOLES IN BEAM SHALL BE SHOP-PUNCHED BEFORE GALVANIZING.
- GUARD RAIL SHALL MEET NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM (NCHRP) 350

GUARDRAIL DETAILS
N.T.S.

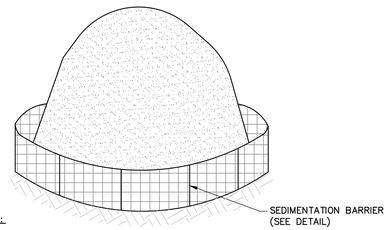


SECTION

DEWATERING DISCHARGE SEDIMENT CONTROL DEVICE
NOT TO SCALE

DEWATERING NOTES

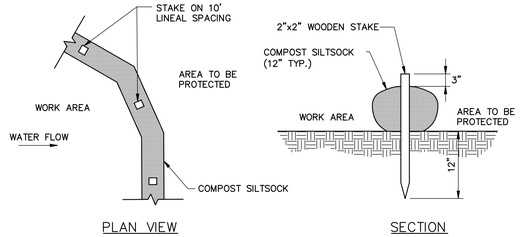
1. LOCATE DISCHARGE SITE ON FLAT UPLAND AREAS AS FAR AWAY AS POSSIBLE FROM STREAMS, WETLANDS, OTHER RESOURCES AND POINTS OF CONCENTRATED FLOW.
2. DOWNGRADIENT RECEIVING AREA MUST BE WELL VEGETATED OR OTHERWISE STABLE FROM EROSION, I.E. FOREST FLOOR OR COARSE GRAVEL/STONE.
3. NEVER DISCHARGE TO AREAS THAT ARE BARE OR NEWLY VEGETATED.
4. DIRT BAG MATERIAL BASED ON PARTICLE SIZE IN DIRTY WATER, I.E., FOR COARSE PARTICLES A WOVEN MATERIAL; FOR SILTS/CLAYS A NON-WOVEN MATERIAL.
5. DO NOT OVER PRESSURIZE DIRT BAG OR USE BEYOND CAPACITY.
6. CHANNELS DUG FOR DISCHARGING WATER FROM THE EXCAVATED AREA NEED TO BE STABLE. IF FLOW VELOCITIES CAUSE EROSION WITHIN THE CHANNEL THEN A DITCH LINING SHOULD BE USED.
7. BUCKETED WATER SHOULD BE DISCHARGED IN A STABLE MANNER TO THE SEDIMENT REMOVAL AREA. A SPLASH PAD OF RIPRAP UNDERLAIN WITH GEOTEXTILE MAY BE NECESSARY TO PREVENT SCOURING OF SOIL.
8. DEWATERING IN PERIODS OF INTENSE, HEAVY RAIN, WHEN THE INFILTRATIVE CAPACITY OF THE SOIL IS EXCEEDED, SHOULD BE AVOIDED.
9. INSTALL DIVERSION DITCHES OR BERMS TO MINIMIZE THE AMOUNT OF CLEAN STORMWATER RUNOFF ALLOWED INTO THE EXCAVATED AREA.
10. DURING THE ACTIVE DEWATERING PROCESS, INSPECTION OF THE DEWATERING FACILITY SHOULD BE REVIEWED FREQUENTLY. SPECIAL ATTENTION SHOULD BE PAID TO THE BUFFER AREA FOR ANY SIGN OF EROSION AND CONCENTRATION OF FLOW THAT MAY COMPROMISE THE BUFFER AREA. OBSERVE WHERE POSSIBLE THE VISUAL QUALITY OF THE EFFLUENT AND DETERMINE IF ADDITIONAL TREATMENT CAN BE PROVIDED.
11. EROSION CONTROL REQUIRED AROUND DEWATERING DISCHARGE SEDIMENT CONTROL DEVICE.



NOTES:

1. STOCKPILES SHALL BE SURROUNDED BY SEDIMENTATION BARRIER.
2. STOCKPILES SHALL HAVE A MAXIMUM 2:1 (H:V) SIDE SLOPE.
3. REPAIR OR REPLACE DAMAGED SEDIMENTATION BARRIER DUE TO CONSTRUCTION ACTIVITIES OR STOCKPILE MITIGATION.
4. STOCKPILE SHALL BE LOCATED IN AREAS AS SHOWN ON THE DRAWINGS OR APPROVED BY THE ENGINEER.

TEMPORARY SOIL STOCK PILE AREA
NOT TO SCALE



PLAN VIEW SECTION

NOTE:

WHEN STAKING IS NOT POSSIBLE, HEAVY CONCRETE BLOCKS SHALL BE USED BEHIND THE SEDIMENT CONTROL TO HELP STABILIZE DURING RAINFALL/RUNOFF EVENTS.

SEDIMENTATION BARRIER – SILTSOCK
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CIVIL DETAILS 2

TOWN OF SUDBURY, MA
PUBLIC WORKS DEPARTMENT

OLD SUDBURY ROAD
CULVERTS 140 AND 149
REPLACEMENT

JOB NO: 0233335.01
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C-401

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Figures 5 & 6: Resource Area Impact Figures

TOWN OF SUDBURY
BK. 11595 PG. 496
MAP 10 LOT 20

WOODS

WF#B-1

WF#B-2

WF#B-3

WF#B-4

WF#B-5

WF#B-6

WF#A-1

WF#A-2

WF#TP-W

WF#A-3

WF#A-4

WF#A-5

WF#A-6

WF#A-7

WF#A-8

WF#A-9

FLOW PATH

UG GAS

UG WATER

UPL 17

ULT 23-18

EOP

DH

227

228

229

230

231

232

RESOURCE AREA IMPACT TABLE

	PERMANENT	TEMPORARY
100' BORDERING VEGETATED WETLAND (BVW) BUFFER (ADJACENT UPLAND RESOURCE AREA)	1,895 S.F.	993 S.F.

RESOURCE AREA LEGEND

- BORDERING VEGETATED WETLAND (BVW)
- EDGE OF WATER/FLOW PATH
- PERMANENT IMPACT
- TEMPORARY IMPACT

NOTE:

1. CULVERT 110 PROJECT AREA ENTIRELY WITHIN BORDERING VEGETATED WETLAND (BVW) BUFFER (ADJACENT UPLAND RESOURCE AREA).

10' 0 10' 20'

BAR SCALE
1" = 10'
CHECK GRAPHIC SCALE BEFORE USING

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22x34 SHEET
1:1

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CHECKED BY: HCP/SS
0233335.01-IMPACT AREAS1.dwg

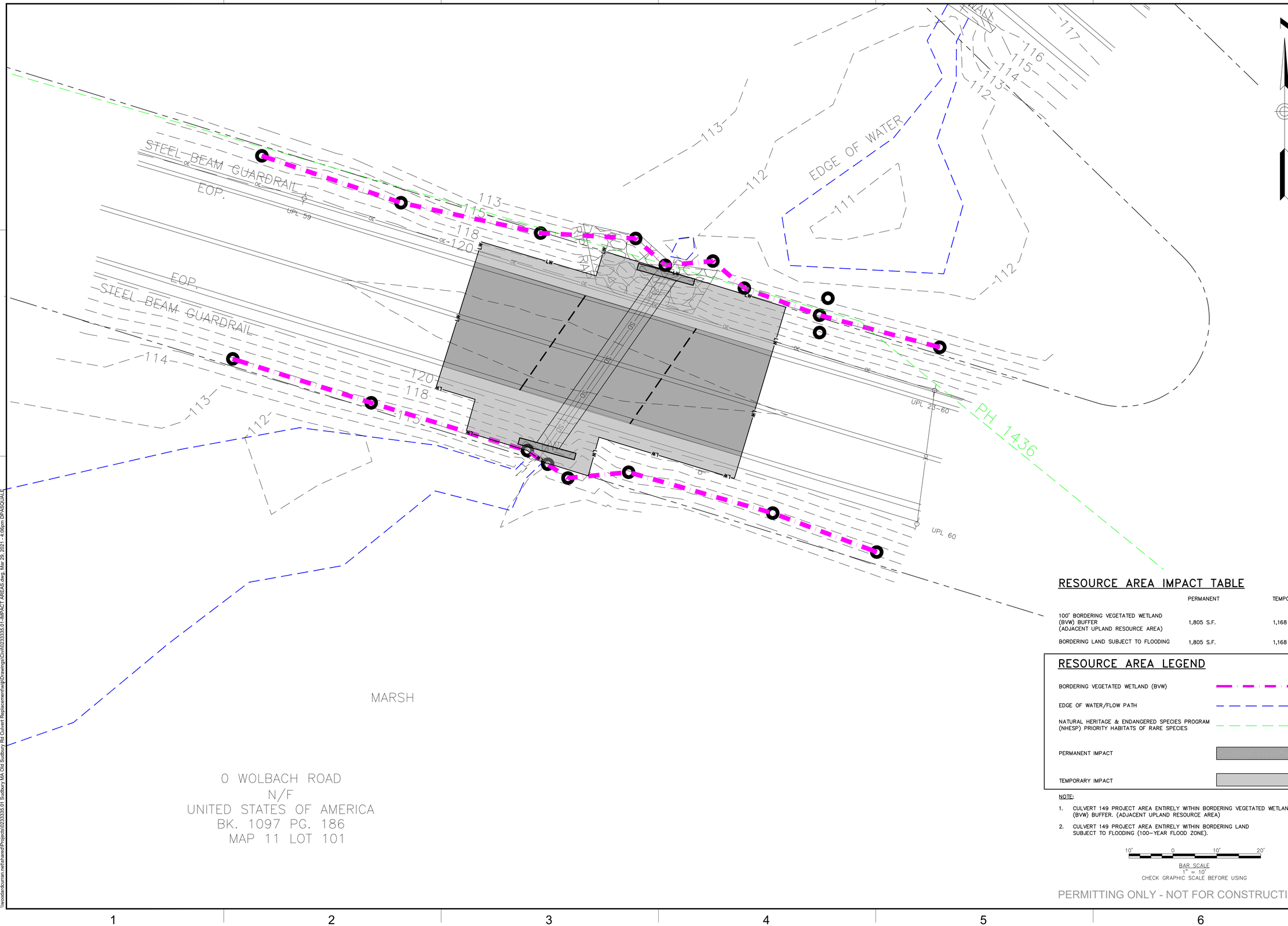
IMPACT AREAS FIGURE
CULVERT 110

TOWN OF SUDBURY, MA
PUBLIC WORKS DEPARTMENT

OLD SUDBURY ROAD
CULVERTS 110 AND 149
REPLACEMENT

JOB NO: 0233350.00
DATE: FEBRUARY 2021
SCALE: AS SHOWN
SHEET: ---- OF

FIG-5



RESOURCE AREA IMPACT TABLE

	PERMANENT	TEMPORARY
100' BORDERING VEGETATED WETLAND (BVW) BUFFER (ADJACENT UPLAND RESOURCE AREA)	1,805 S.F.	1,168 S.F.
BORDERING LAND SUBJECT TO FLOODING	1,805 S.F.	1,168 S.F.

RESOURCE AREA LEGEND

- BORDERING VEGETATED WETLAND (BVW)
- EDGE OF WATER/FLOW PATH
- NATURAL HERITAGE & ENDANGERED SPECIES PROGRAM (NHESP) PRIORITY HABITATS OF RARE SPECIES
- PERMANENT IMPACT
- TEMPORARY IMPACT

NOTE:

1. CULVERT 149 PROJECT AREA ENTIRELY WITHIN BORDERING VEGETATED WETLAND (BVW) BUFFER. (ADJACENT UPLAND RESOURCE AREA)
2. CULVERT 149 PROJECT AREA ENTIRELY WITHIN BORDERING LAND SUBJECT TO FLOODING (100-YEAR FLOOD ZONE).

10' 0 10' 20'

BAR SCALE
1" = 10'
CHECK GRAPHIC SCALE BEFORE USING

PERMITTING ONLY - NOT FOR CONSTRUCTION

WOODARD & CURRAN
250 Royall Street, Suite 200E
Canton, MA 02021
800.426.4262 | www.woodardcurran.com

COMMITMENT & INTEGRITY DRIVE RESULTS

REV	DESCRIPTION	DATE
2	PER MARCH 24 CONSERVATION COMMISSION MEETING	03/30/2021
1	NOI PERMIT SUBMISSION	03/29/2021

DESIGNED BY: DLP/MB
DRAWN BY: MB
CHECKED BY: HCP/SS
0233335.01-IMPACT AREAS7.dwg

IMPACT AREAS FIGURE CULVERT 149

TOWN OF SUDBURY, MA
PUBLIC WORKS DEPARTMENT

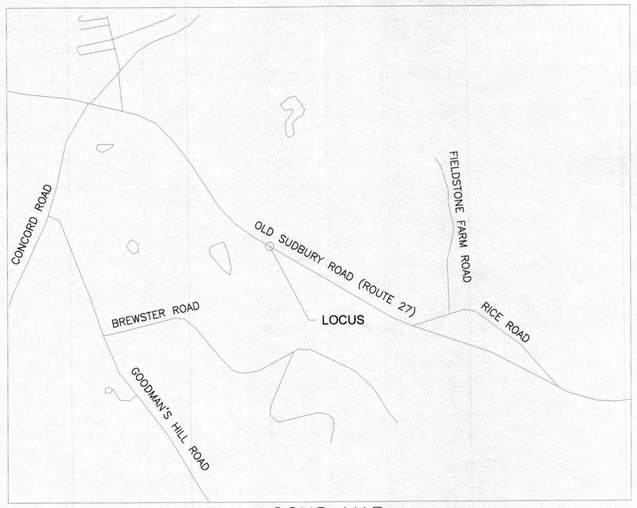
OLD SUDBURY ROAD
CULVERTS 150 AND 149
REPLACEMENT

JOB NO: 0233350.00
DATE: FEBRUARY 2021
SCALE: AS SHOWN
SHEET: ---- OF

FIG-6

22x34 SHEET
1:1

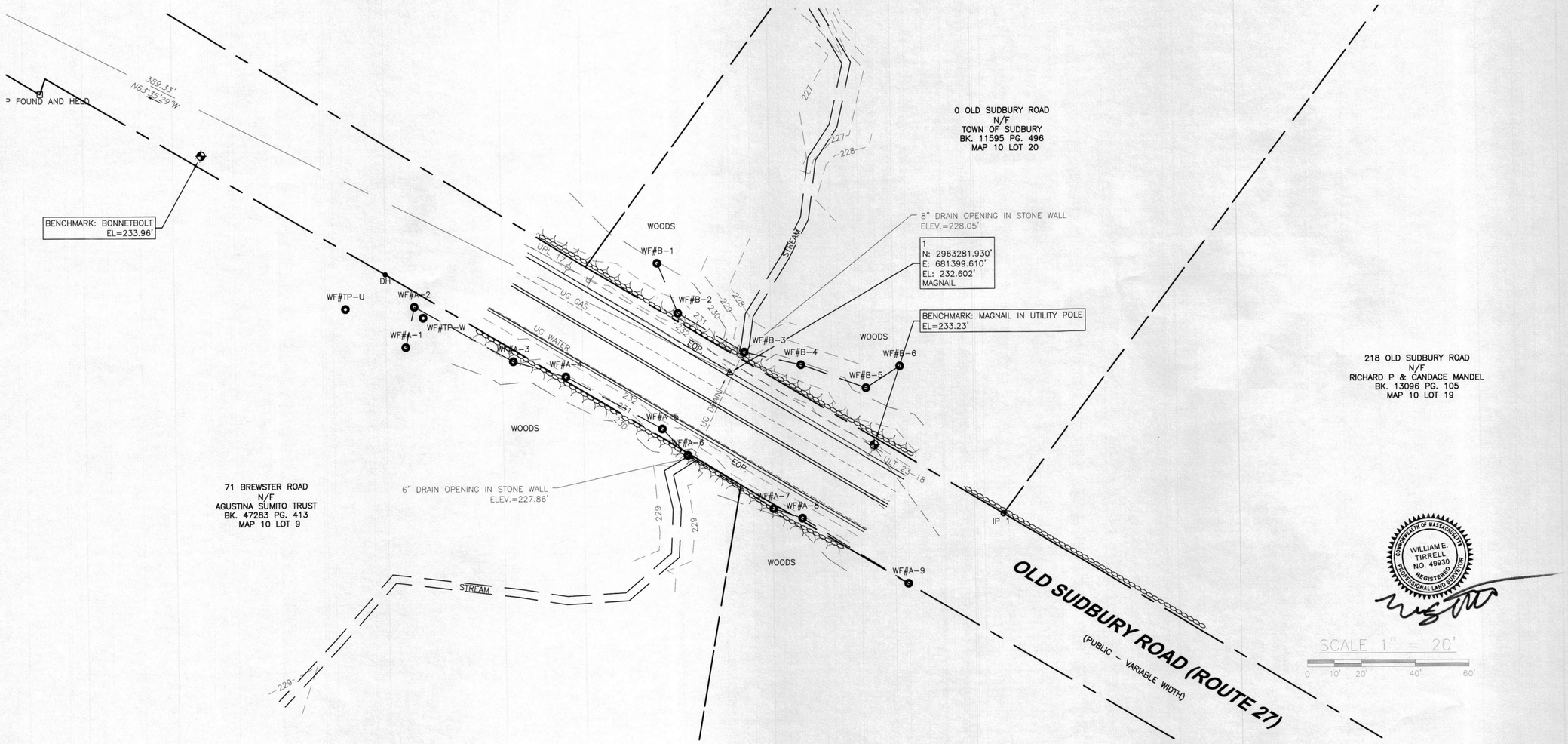
ATTACHMENTS A1 AND A2 – EXISTING CONDITIONS SURVEYS, CULVERT #110 & CULVERT #149



LOCUS MAP

GENERAL NOTES:

1. THE EXISTING CONDITIONS INFORMATION SHOWN HEREON IS THE RESULT OF AN ON-THE-GROUND SURVEY PERFORMED BY CHAPPELL ENGINEERING ASSOCIATES, LLC., BETWEEN OCTOBER 26TH – 30TH, 2020.
2. ALL DEED/PLAN REFERENCES ARE TO MIDDLESEX REGISTRY OF DEEDS SOUTHERN DISTRICT.
3. THE PROJECT AREA IS LOCATED IN FLOOD ZONE "X" AS SHOWN ON FLOOD INSURANCE RATE MAP FOR THE TOWN OF SUDBURY, COMMUNITY PANEL NUMBER 25017C 0369F, EFFECTIVE DATE JULY 7, 2014.
4. PROPERTY DOES NOT RESIDE IN A WATER RESOURCE PROTECTION DISTRICT.
5. ZONING DISTRICT RESIDENCE A.
6. LOCATION OF SUBSURFACE UTILITIES SHOWN HEREON ARE APPROXIMATE AND ADDITIONAL UTILITIES MAY EXIST THAT ARE NOT SHOWN ON THIS PLAN. LOCATIONS ARE COMPILED FROM UTILITY PLANS OF RECORD AND DIG-SAFE FIELD MARKINGS. RIM AND INVERT INFORMATION HAS BEEN FIELD VERIFIED WHERE POSSIBLE. THIS INFORMATION IS NOT TO BE USED FOR CONSTRUCTION. PRIOR TO ANY CONSTRUCTION, CONTACT DIG-SAFE (1-800-344-7233) TO FIELD VERIFY LOCATION OF ALL UTILITIES.
7. PLAN REFERENCES: (PLAN NO, / PLAN YEAR)
   9063-449 227 OF 1947 1501 OF 1962 1181 OF 1996 620 OF 2002
8. BORDERING WETLAND LOCATION FLAGS SET BY ECOTEC, LLC. ON OCTOBER 15TH, 2020.
9. HORIZONTAL DATUM: NAD 83 MASS STATE PLANE MAINLAND ZONE HORIZONTAL CONTROL SYSTEM.
10. VERTICAL DATUM: NAVD 88 VERTICAL CONTROL SYSTEM.



SCALE 1" = 20'

0 10' 20' 40' 60'

NAD 83

LEGEND

- STREET R.O.W. LINE
- ABUTTER PROPERTY LINE
- EASEMENT LINES
- EDGE OF PAVEMENT
- VGC VERT. GRAN. CURB
- IRON HAND RAIL
- CHAIN-LINK FENCE
- PAINTED TRAFFIC LINES
- OVERHEAD WIRES
- GUARD RAIL
- DRAIN MANHOLE
- SEWER MANHOLE
- CATCH BASIN
- FIRE HYDRANT
- WATER GATE
- GAS VALVE
- GUY WIRE
- LIGHT POLE
- UTILITY POLE
- 24" TREE
- CBDH MONUMENT
- BENCHMARK
- SIGN
- C CONCRETE
- WF#A-14 BORDERING VEGETATIVE WETLAND FLAG
- DH DRILL HOLE OR IRON ROD
- STONE OR CONC. BOUND
- TRAVERSE POINT

CHAPPELL ENGINEERING ASSOCIATES, LLC
Civil Structural Land Surveying
201 BOSTON POST ROAD WEST-SUITE 101
MARLBOROUGH, MA 01752
TEL (508) 481-7400
WWW.CHAPPELLENGINEERING.COM

REVISIONS		
1		
0		
REV. #	DATE	DESCRIPTION

PROJECT NO.	DRAWN BY: MLT	SCALE:
XXXXX	CHECK'D BY: TPC	1" = 20'

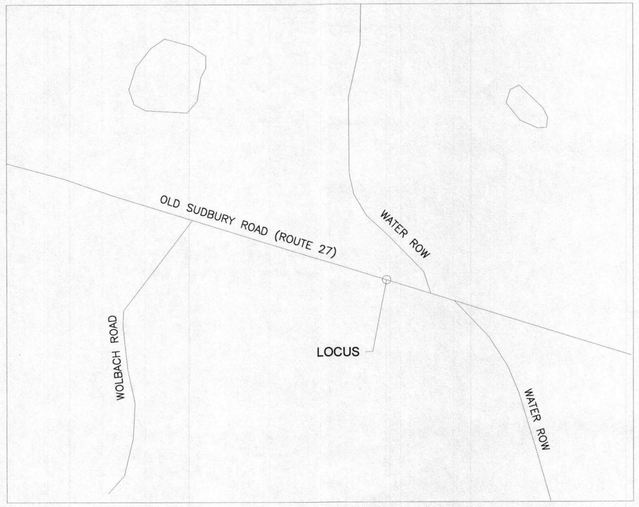
COMMONWEALTH OF MASSACHUSETTS
WILLIAM E. TIRRELL
NO. 49930
REGISTERED PROFESSIONAL LAND SURVEYOR

EXISTING CONDITIONS SURVEY

CULVERT #110
OLD SUDBURY ROAD,
SUDBURY, MASSACHUSETTS

JANUARY 19, 2021

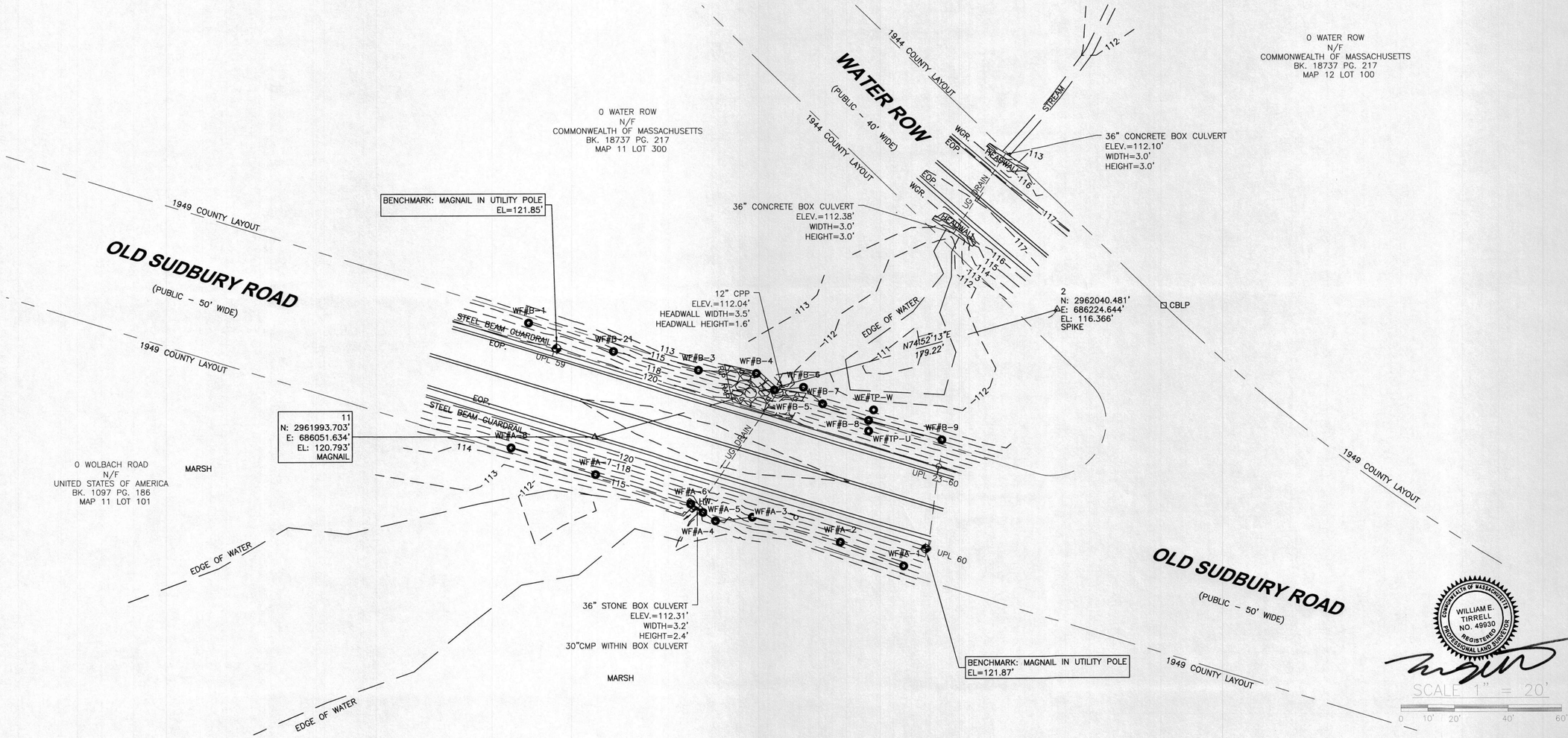
SHEET 1 OF 1



LOCUS MAP

GENERAL NOTES:

1. THE EXISTING CONDITIONS INFORMATION SHOWN HEREON IS THE RESULT OF AN ON-THE-GROUND SURVEY PERFORMED BY CHAPPELL ENGINEERING ASSOCIATES, LLC., BETWEEN OCTOBER 26TH - 30TH, 2020.
2. ALL DEED/PLAN REFERENCES ARE TO MIDDLESEX REGISTRY OF DEEDS SOUTHERN DISTRICT.
3. THE ENTIRE PROJECT AREA IS LOCATED IN FLOOD ZONE "AE" AS SHOWN ON FLOOD INSURANCE RATE MAP FOR THE TOWN OF SUDBURY, COMMUNITY PANEL NUMBER 25017C 0369F, EFFECTIVE DATE JULY 7, 2014.
4. PROPERTY DOES NOT RESIDE IN A WATER RESOURCE PROTECTION DISTRICT.
5. ZONING DISTRICT RESIDENCE C.
6. LOCATION OF SUBSURFACE UTILITIES SHOWN HEREON ARE APPROXIMATE AND ADDITIONAL UTILITIES MAY EXIST THAT ARE NOT SHOWN ON THIS PLAN. LOCATIONS ARE COMPILED FROM UTILITY PLANS OF RECORD AND DIG-SAFE FIELD MARKINGS. RIM AND INVERT INFORMATION HAS BEEN FIELD VERIFIED WHERE POSSIBLE. THIS INFORMATION IS NOT TO BE USED FOR CONSTRUCTION. PRIOR TO ANY CONSTRUCTION, CONTACT DIG-SAFE (1-800-344-7233) TO FIELD VERIFY LOCATION OF ALL UTILITIES.
7. PLAN REFERENCES:
   436-35 OF 1949
8. BORDERING WETLAND LOCATION FLAGS SET BY ECOTEC, LLC. ON OCTOBER 15TH, 2020.
9. HORIZONTAL DATUM: NAD 83 MASS STATE PLANE MAINLAND ZONE HORIZONTAL CONTROL SYSTEM.
10. VERTICAL DATUM: NAVD 88 VERTICAL CONTROL SYSTEM.



SCALE: 1" = 20'
0 10' 20' 40' 60'

LEGEND

- STREET R.O.W. LINE
- ABUTTER PROPERTY LINE
- EASEMENT LINES
- EDGE OF PAVEMENT
- VGC VERT. GRAN. CURB
- IRON HAND RAIL
- CHAIN-LINK FENCE
- PAINTED TRAFFIC LINES
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MARLBOROUGH, MA 01752
TEL (508) 481-7400
WWW.CHAPPELLENGINEERING.COM

REVISIONS		
1		
0		
REV. #	DATE	DESCRIPTION

PROJECT NO.	DRAWN BY: MLT	SCALE:
XXXXX	CHECK'D BY: TPC	1" = 20'

EXISTING CONDITIONS SURVEY

CULVERT #149
OLD SUDBURY ROAD,
SUDBURY, MASSACHUSETTS

JANUARY 19, 2021

SHEET 1 OF 1

COMMONWEALTH OF MASSACHUSETTS
WILLIAM E. TIRRELL
NO. 49930
REGISTERED PROFESSIONAL LAND SURVEYOR

ATTACHMENTS B1 AND B2 – WETLAND RESOURCE EVALUATION, CULVERT #110 & CULVERT #149

EcoTec, Inc.

ENVIRONMENTAL CONSULTING SERVICES
102 Grove Street
Worcester, MA 01605-2629
508-752-9666 – Fax: 508-752-9494

November 9, 2020

Scott Salvucci, P.E.
Woodard & Curran, Inc.
980 Washington St., Suite 325
Dedham, MA 02026

RE: Wetland Resource Evaluation, Culvert #110, Old Sudbury Road, Sudbury, MA

Dear Scott:

On November 4, 2020, EcoTec, Inc. inspected the above-referenced property for the presence of wetland resources as defined by: (1) the Massachusetts Wetlands Protection Act (M.G.L. Ch. 131, § 40; the "Act") and its implementing regulations (310 CMR 10.00 *et seq.*; the "Regulations"); and (2) the U.S. Clean Water Act (i.e., Section 404 and 401 wetlands). Arthur Allen, CPSS, CWS conducted the inspection.

The subject site consists of the vicinity of an existing culvert equalizing flood flows under Old Sudbury Road. The upland portions of the site consist of a public roadway and vegetated side slopes. The wetland resources observed on the site are described below.

Methodology

The site was inspected, and areas suspected to qualify as wetland resources were identified. The boundary of Bordering Vegetated Wetlands was delineated in the field in accordance with the definition set forth in the regulations at 310 CMR 10.55(2)(c). Section 10.55(2)(c) states that "The boundary of Bordering Vegetated Wetlands is the line within which 50% or more of the vegetational community consists of wetland indicator plants and saturated or inundated conditions exist." The methodology used to delineate Bordering Vegetated Wetlands is further described in: (1) the BVW Policy "*BVW: Bordering Vegetated Wetlands Delineation Criteria and Methodology*," issued March 1, 1995; and (2) "*Delineating Bordering Vegetated Wetlands Under the Massachusetts Wetlands Protection Act: A Handbook*," produced by the Massachusetts Department of Environmental Protection, dated March 1995. The plant taxonomy used in this report is based on the *National List of Plant Species that Occur in Wetlands: Massachusetts* (Fish and Wildlife Service, U.S. Department of the Interior, 1988). Federal wetlands were presumed to have boundaries conterminous with the delineated Bordering Vegetated Wetlands. One set of DEP Bordering Vegetated Wetland Delineation Field Data Forms completed for observation plots located in the wetlands and uplands near flag A-1

is attached. The table below provides the Flag Numbers, Flag Type, and Wetland Types and Locations for the delineated wetland resources.

Flag Numbers	Flag Type	Wetland Types and Locations
A-1 to A-9 (Test Plots at A-1)	Blue Flags	Boundary of Bordering Vegetated Wetlands located on the south side of Old Sudbury Road. Flag A-6 connects to equalization culvert.
B-1 to B-6	Blue Flags	Boundary of Bordering Vegetated Wetlands located on the north side of Old Sudbury Road. Flag B-3 connects to equalization culvert.

Findings

Wetland A/B consists of a wooded swamp that is associated with on off-site, intermittent stream. Plant species observed include red maple (*Acer rubrum*) and American elm (*Ulmus americana*) trees and/or saplings; highbush blueberry (*Vaccinium corymbosum*), common winterberry (*Ilex verticillata*), arrow-wood (*Viburnum dentatum*), withe-rod (*Viburnum cassinoides*), swamp rose (*Rosa palustris*), speckled alder (*Alnus rugosa*), maleberry (*Lyonia ligustrina*), glossy buckthorn (*Rhamnus frangula*), and American elderberry (*Sambucus canadensis*) shrubs; and sheep-laurel (*Kalmia angustifolia*), bristly blackberry (*Rubus hispidus*), cinnamon fern (*Osmunda cinnamomea*), royal fern (*Osmunda regalis*), sensitive fern (*Onoclea sensibilis*), subarctic lady fern (*Athyrium filix-femina*), marsh fern (*Thelypteris thelypteroides*), Massachusetts fern (*Thelypteris simulata*), spinulose woodfern (*Dryopteris spinulosa*), skunk-cabbage (*Symplocarpus foetidus*), swamp Jack-in-the-pulpit (*Arisaema triphyllum*), spotted touch-me-not (*Impatiens capensis*) and sphagnum moss (*Sphagnum sp*.) ground cover. Evidence of wetland hydrology, including hydric soils, high groundwater, saturated soils, pore linings, evidence of flooding, and drainage patterns, was observed within the delineated wetland. This vegetated wetland borders an intermittent stream; accordingly, the vegetated wetlands would be regulated as Bordering Vegetated Wetlands under the Act. A 100-foot Buffer Zone extends horizontally outward from the edge of Bordering Vegetated Wetlands under the Act.

Bordering Land Subject to Flooding is an area that floods due to a rise in floodwaters from a bordering waterway or water body. Where flood studies have been completed, the boundary of Bordering Land Subject to Flooding is based upon flood profile data prepared by the National Flood Insurance Program. Section 10.57(2)(a)3. states that “The boundary of Bordering Land Subject to Flooding is the estimated maximum lateral extent of flood water which will theoretically result from the statistical 100-year frequency storm.” The project engineer should evaluate the most recent National Flood Insurance Program flood profile data to confirm the absence of Bordering Land Subject to Flooding on the site. Bordering Land Subject to Flooding would occur in areas where the 100-year flood elevation is located outside of or upgradient of the delineated Bordering Vegetated Wetlands boundary. Bordering Land Subject to Flooding does not have a Buffer Zone under the Act.

The Massachusetts Rivers Protection Act amended the Act to establish an additional wetland resource area: Riverfront Area. Based upon a review of the current USGS Map (attached), there are no streams within 200-feet of the project site. Furthermore, based upon observations made during the site inspection, there are no unmapped streams located within 200 feet of the site. Accordingly, except as noted above, Riverfront Area would not occur on the site. Riverfront Area does not have a Buffer Zone under the Act, but may overlap other wetland resources and their Buffer Zones.

The Regulations require that no project may be permitted that will have any adverse effect on specified habitat sites of rare vertebrate or invertebrate species, as identified by procedures set forth at 310 CMR 10.59. Based upon a review of the *Massachusetts Natural Heritage Atlas*, 14th edition, Priority Habitats and Estimated Habitats from the NHESP Interactive Viewer, valid from August 1, 2017, and Certified Vernal Pools from MassGIS, there is no Estimated Habitat [for use with the Act and Regulations (310 CMR 10.00 *et seq*.)] and no Priority Habitat [for use with Massachusetts Endangered Species Act (M.G.L. Ch. 131A; "MESA") and MESA Regulations (321 CMR 10.00 *et seq*.)]. There are no Certified Vernal Pools on or in the immediate vicinity of the site. A copy of this map is attached.

The reader should be aware that the regulatory authority for determining wetland jurisdiction rests with local, state, and federal authorities. A brief description of my experience and qualifications is attached. If you have any questions, please feel free to contact me at any time.

Cordially,
ECOTEC, INC.

Arthur Allen, CWS, CPSS
Vice President

Attachments (5, 8 pages)

AA/NOI/Sudbury Old Sudbury 110 EcoTec Wet Report 1.12.2021

EcoTec, Inc.

ENVIRONMENTAL CONSULTING SERVICES
102 Grove Street
Worcester, MA 01605-2629
508-752-9666 / Fax: 508-752-9494

Arthur Allen, CPSS, CWS, CESSWI
Vice President
Soil & Wetland Scientist

Arthur Allen is the Vice President of EcoTec, Inc. and has been a senior environmental scientist there since 1995. His work with EcoTec has involved wetland delineation, wildlife habitat evaluation, environmental permitting (federal, state and local), environmental monitoring, expert testimony, peer reviews, contaminated site assessment and the description, mapping and interpretation of soils. His clients have included private landowners, developers, major corporations and regulatory agencies. Prior to joining EcoTec, Mr. Allen mapped and interpreted soils in Franklin County, MA for the U.S.D.A. Natural Resources Conservation Service (formerly Soil Conservation Service) and was a research soil scientist at Harvard University's Harvard Forest. Since 1994, Mr. Allen has assisted the Massachusetts Department of Environmental Protection and the Massachusetts Association of Conservation Commissions as an instructor in the interpretation of soils for wetland delineation and for the Title V Soil Evaluator program.

Mr. Allen has a civil service rating as a soil scientist, an undergraduate degree in Natural Resource Studies and a graduate certificate in Soil Studies. His work on the Franklin County soil survey involved interpretation of landscape-soil-water relationships, classifying soils and drainage, and determining use and limitation of the soil units that he delineated. As a soil scientist at the Harvard Forest, Mr. Allen was involved in identifying the legacies of historical land-use in modern soil and vegetation at a number of study sites across southern New England. He has a working knowledge of the chemical and physical properties of soil and water and how these properties interact with the plants that grow on a given site. While at Harvard Forest he authored and presented several papers describing his research results which were later published. In addition to his aforementioned experience, Mr. Allen was previously employed by the Trustees of Reservations as a land manager and by the Town of North Andover, MA as a conservation commission intern.

Education:
1993-Graduate Certificate in Soil Studies, University of New Hampshire
1982-Bachelor of Science in Natural Resource Studies, University of Massachusetts

Professional Affiliations:
Certified Professional Soil Scientist (ARCPACS CPSS #22529)
New Hampshire Certified Wetland Scientist (#19)
Registered Professional Soil Scientist – Society of Soil Scientists of SNE [Board Member (2000-2006)]
Certified Erosion, Sediment & Stormwater Inspector (#965)
Massachusetts Approved Soil Evaluator (#13764)
Massachusetts Arborists Association-Certified Arborist (1982 – 1998)
New England Hydric Soils Technical Committee member
Massachusetts Association of Conservation Commissions member
Society of Wetland Scientists member

Refereed Publications:
Soil Science and Survey at Harvard Forest. A.Allen. *In*: Soil Survey Horizons. Vol. 36, No. 4, 1995, pp. 133-142.
Controlling Site to Evaluate History: Vegetation Patterns of a New England Sand Plain. G.Motzkin, D.Foster, A.Allen, J.Harrod, & R.Boone. *In*: Ecological Monographs 66(3), 1996, pp. 345-365.
Vegetation Patterns in Heterogeneous Landscapes: The Importance of History and Environment. G.Motzkin, P.Wilson, D.R.Foster & A.Allen. In: Journal of Vegetation Science 10, 1999, pp. 903-920.

DEP Bordering Vegetated Wetland (310 CMR 10.55) Delineation Field Form

Applicant | Prepared by: EcoTec, Inc | Project Location: Old Sudbury Rd. (110), Sudbury | DEP File #

Section I. Vegetation | Number: TPU | Transect # A1 | Date of Delin: 11/4/2020

A. Sample layer and plant species (Enter largest to smallest % cover by layer)			Percent Cover (or basal area)	Percent Dominance	Dominant Plant?	Wetland Indicator Category	
Tree	Red Oak	Quercus rubra	20	20.0	YES	FACU-	
	Red Maple	Acer rubrum	60	60.0	YES	FAC	*
	White Pine	Pinus strobus	20	20.0	YES	FACU	
Sapling	White Pine	Pinus strobus	20	100.0	YES	FACU	
Shrub	White Pine	Pinus strobus	10	20.0	YES	FACU	
	Speckled Alder	Alnus rugosa	15	30.0	YES	FACW+	*
	Highbush Blueberry	Vaccinium corymbosum	15	30.0	YES	FACW-	*
	Glossy Buckthorn	Rhamnus frangula	10	20.0	YES	FAC	*
Ground	Bracken Fern	Pteridium aquilinum	20	100.0	YES	FACU	
Vine							

Vegetation Conclusions

Number of dominant wetland indicator plants **4** | Number of dominant non-wetland indicator plants **5**

Is the number of dominant wetland plants equal or greater than the number of dominant non-wetland plants? NO

DEP Bordering Vegetated Wetland (310 CMR 10.55) Delineation Field Form

Applicant | Prepared by: EcoTec, Inc | Project Location: Old Sudbury Rd. (110), Sudbury | DEP File #

Section II. Indicators of Hydrology | Number: TPU | Transect # A1 | Date of Delin: 11/4/2020

1. Soil Survey

Is there a published soil survey for this site?

- title/date
- map number
- soil type mapped
- hydric soil inclusions

Are field observarions consistent with soil survey?

Remarks:

2. Soil Description

Horizon	Depth (inches)	Matrix Color	Mottle Color
Litter	2		
O	2-0		
A	0-6	10YR 3/2	
Bw	6-15	10YR 4/6	

Remarks Fine Sandy Loams

3. Other

Conclusion: Is the soil hydric? No

Other Indicators of hydrology (check all that apply):

- ☐ Site Inundated
- ☐ Depth to free water in observation hole
- ☐ Depth to soil saturation in observation hole
- ☐ Water marks
- ☐ Drift lines
- ☐ Sediment Deposits
- ☐ Drainage patterns in BVWs
- ☐ Oxidized rhizospheres
- ☐ Water stained leaves
- ☐ Recorded data (stream, lake, or tidal gauge; aerial photo; other):
- ☐ Other:

Vegetation and Hydrology Conclusion

	Yes	No
Number of wetland indicator plants ≥ number of non-wetland indicator plants	☐	☑
Wetland hydrology present:		
Hydric soil present	☐	☑
Other indicators of hydrology present	☐	☑
Sample Location is in a BVW	☐	☑

DEP Bordering Vegetated Wetland (310 CMR 10.55) Delineation Field Form

Applicant | Prepared by: EcoTec, Inc | Project Location: Old Sudbury Rd. (110), Sudbury | DEP File #

Section I. Vegetation | Number: TPW | Transect # A1 | Date of Delin: 11/4/2020

A. Sample layer and plant species (Enter largest to smallest % cover by layer)			Percent Cover (or basal area)	Percent Dominance	Dominant Plant?	Wetland Indicator Category	
Tree	American Elm	Ulmus americana	10	10.0	YES	FACW-	*
	Red Maple	Acer rubrum	90	90.0	YES	FAC	*
Sapling	American Elm	Ulmus americana	10	50.0	YES	FACW-	*
	Red Oak	Quercus rubra	10	50.0	YES	FACU-	
Shrub	Winterberry	Ilex verticillata	20	33.3	YES	FACW+	*
	Maleberry	Lyonia ligustrina	30	50.0	YES	FACW	*
	Highbush Blueberry	Vaccinium corymbosum	10	16.7	NO	FACW-	*
Ground	Sheep Laurel	Kalmia angustifolia	10	100.0	YES	FAC	*
Vine							

Vegetation Conclusions

Number of dominant wetland indicator plants **6** | Number of dominant non-wetland indicator plants **1**

Is the number of dominant wetland plants equal or greater than the number of dominant non-wetland plants? YES

DEP Bordering Vegetated Wetland (310 CMR 10.55) Delineation Field Form

Applicant | Prepared by: EcoTec, Inc | Project Location: Old Sudbury Rd. (110), Sudbury | DEP File #

Section II. Indicators of Hydrology | Number: TPW | Transect # A1 | Date of Delin: 11/4/2020

1. Soil Survey

Is there a published soil survey for this site?

title/date

map number

soil type mapped

hydric soil inclusions

Are field observarions consistent with soil survey?

Remarks:

2. Soil Description

Horizon	Depth (inches)	Matrix Color	Mottle Color
Litter	2		
O	1-0		
A	0-8	10YR 2/1	
Bs	8-16	7.5YR 4/4	10% 5YR 4/6

Remarks Fine Sandy Loams

3. Other

Conclusion: Is the soil hydric?

Yes

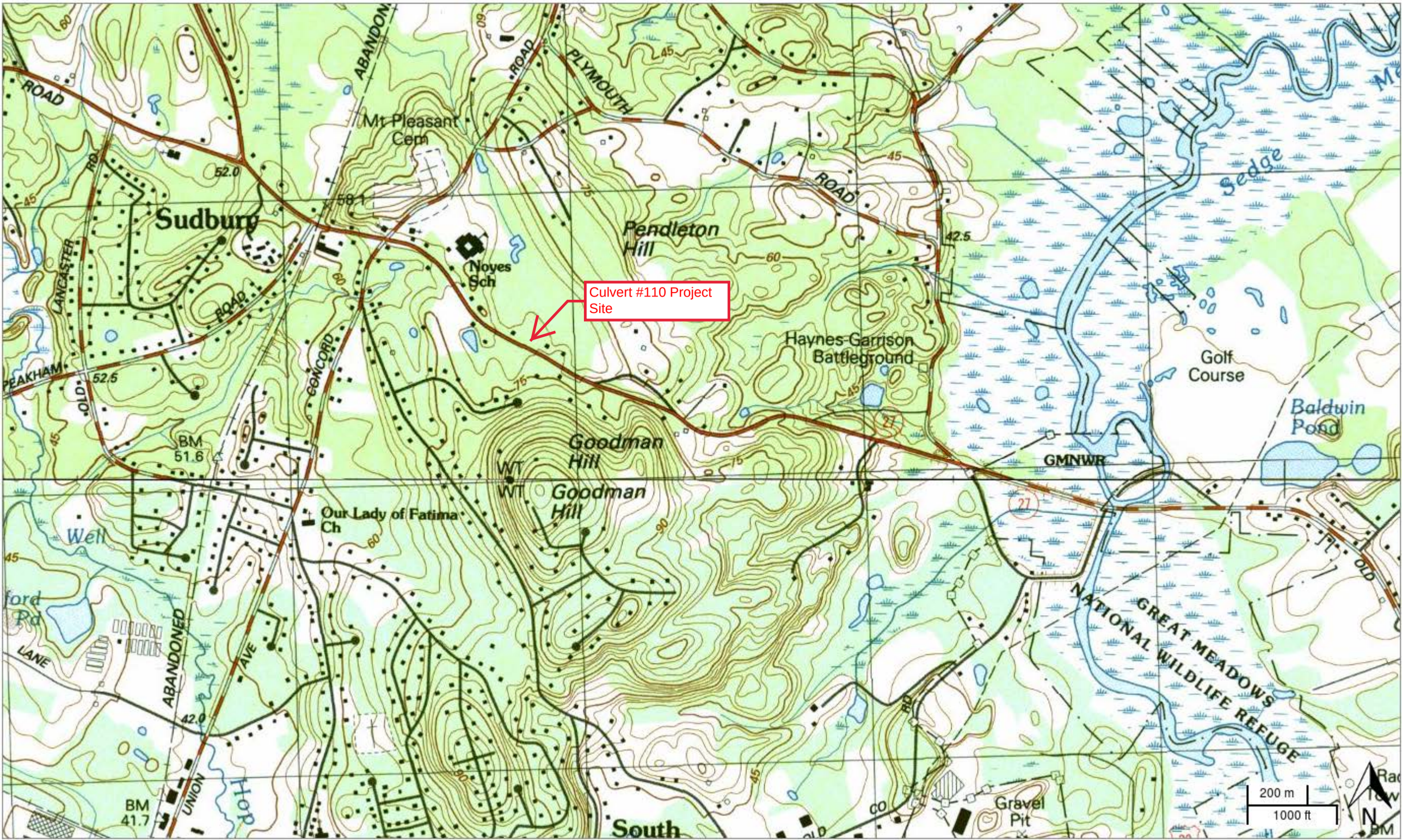
Other Indicators of hydrology (check all that apply):

- ☐ Site Inundated
- ☐ Depth to free water in observation hole
- ☐ Depth to soil saturation in observation hole
- ☐ Water marks
- ☐ Drift lines
- ☐ Sediment Deposits
- ☑ Drainage patterns in BVWs
- ☐ Oxidized rhizospheres
- ☐ Water stained leaves
- ☐ Recorded data (stream, lake, or tidal gauge; aerial photo; other):
- ☐ Other:

Vegetation and Hydrology Conclusion

	Yes	No
Number of wetland indicator plants ≥ number of non-wetland indicator plants	☑	☐
Wetland hydrology present:		
Hydric soil present	☑	☐
Other indicators of hydrology present	☑	☐
Sample Location is in a BVW	☑	☐

USGS - Sudbury, MA



National Flood Hazard Layer FIRMette

FEMA

71°24'44"W 42°23'N

71°24'6"W 42°22'34"N

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

1:6,000

Legend

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

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

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

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

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

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

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

N

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 11/3/2020 at 5:21 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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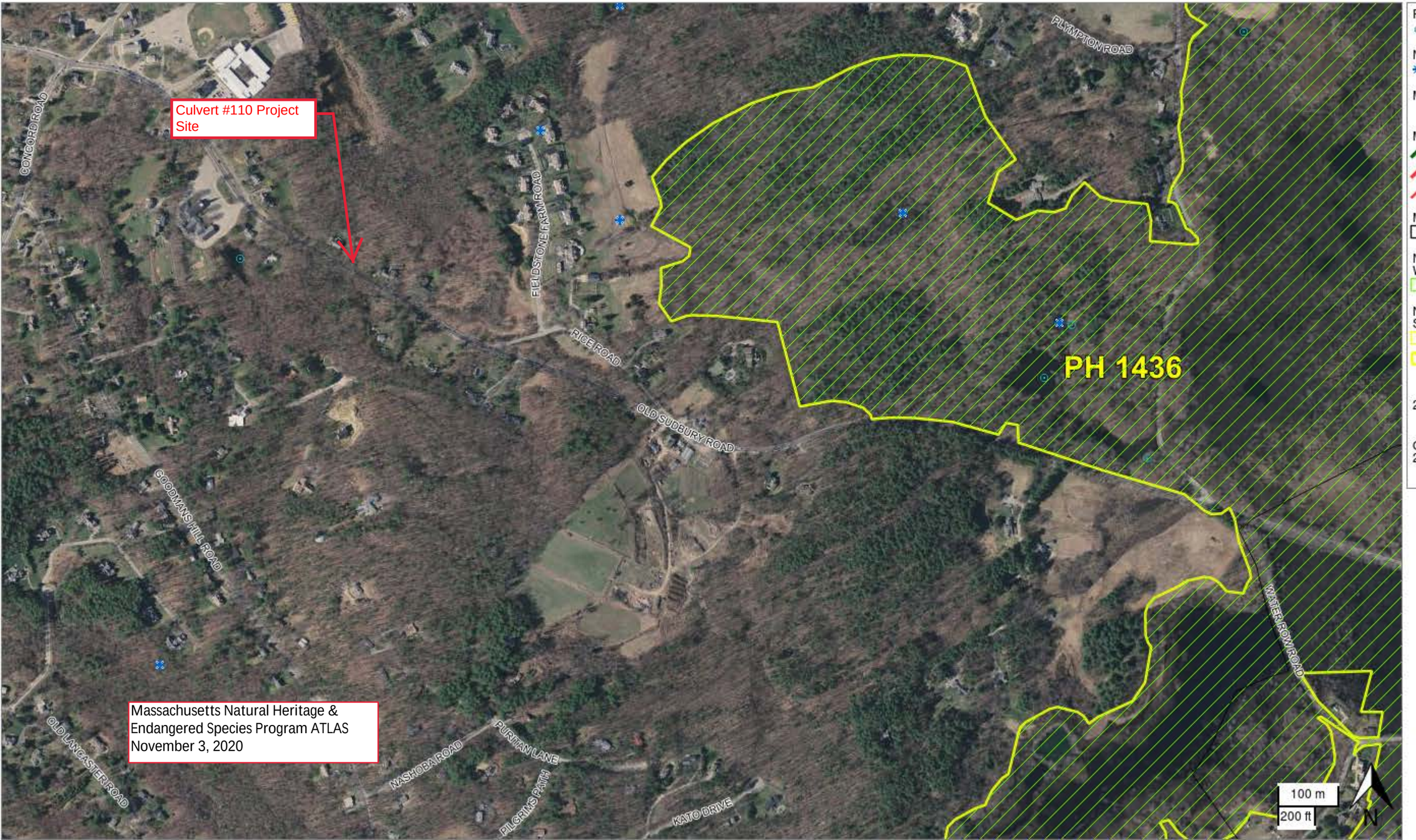
NHESP - 11.3.2020



Potential Vernal Pools

NHESP Certified Vernal Pools

MassDOT Roads Street Names

Major MassDOT Routes
- Interstate Highways
- US Roads
- State

Massachusetts Towns

NHESP Estimated Habitats of Rare Wildlife

NHESP Priority Habitats of Rare Species

2013-2014 Color Orthos (USGS)

Orthos 2019
2019 Color Orthos (USGS)

EcoTec, Inc.

ENVIRONMENTAL CONSULTING SERVICES
102 Grove Street
Worcester, MA 01605-2629
508-752-9666 – Fax: 508-752-9494

November 5, 2020

Scott Salvucci, P.E.
Woodard & Curran, Inc.
980 Washington St., Suite 325
Dedham, MA 02026

RE: Wetland Resource Evaluation, Culvert 149 Old Sudbury Road, Sudbury, MA

Dear Scott:

On November 4, 2020, EcoTec, Inc. inspected the above-referenced property for the presence of wetland resources as defined by: (1) the Massachusetts Wetlands Protection Act (M.G.L. Ch. 131, § 40; the "Act") and its implementing regulations (310 CMR 10.00 *et seq.*; the "Regulations"); and (2) the U.S. Clean Water Act (i.e., Section 404 and 401 wetlands). Arthur Allen, CPSS, CWS conducted the inspection.

The subject site consists of the vicinity of an existing culvert equalizing flood flows under Old Sudbury Road. The upland portions of the site consist of a public roadway and vegetated side slopes. The wetland resources observed on the site are described below.

Methodology

The site was inspected, and areas suspected to qualify as wetland resources were identified. The boundary of Bordering Vegetated Wetlands was delineated in the field in accordance with the definition set forth in the regulations at 310 CMR 10.55(2)(c). Section 10.55(2)(c) states that "The boundary of Bordering Vegetated Wetlands is the line within which 50% or more of the vegetational community consists of wetland indicator plants and saturated or inundated conditions exist." The methodology used to delineate Bordering Vegetated Wetlands is further described in: (1) the BVW Policy "*BVW: Bordering Vegetated Wetlands Delineation Criteria and Methodology*," issued March 1, 1995; and (2) "*Delineating Bordering Vegetated Wetlands Under the Massachusetts Wetlands Protection Act: A Handbook*," produced by the Massachusetts Department of Environmental Protection, dated March 1995. The plant taxonomy used in this report is based on the *National List of Plant Species that Occur in Wetlands: Massachusetts* (Fish and Wildlife Service, U.S. Department of the Interior, 1988). Federal wetlands were presumed to have boundaries conterminous with the delineated Bordering Vegetated Wetlands. One set of DEP Bordering Vegetated Wetland Delineation Field Data Forms completed for observation plots located in the wetlands and uplands near flag B-8

is attached. The table below provides the Flag Numbers, Flag Type, and Wetland Types and Locations for the delineated wetland resources.

Flag Numbers	Flag Type	Wetland Types and Locations
A-1 to A-8	Blue Flags	Boundary of Bordering Vegetated Wetlands located on the south side of Old Sudbury Road. Flags A-5 & A-6 connect to equalization culvert.
B-1 to B-9 (Test Plots at B-8)	Blue Flags	Boundary of Bordering Vegetated Wetlands located on the north side of Old Sudbury Road. Flags B-5 & B-6 connect to equalization culvert.

Findings

Wetland A/B consists of shrub swamp that is associated with the floodplain of the Sudbury River. Plant species observed include red maple (*Acer rubrum*) and swamp white oak (*Quercus bicolor*) trees and/or saplings; buttonbush (*Cephalanthus occidentalis*), highbush blueberry (*Vaccinium corymbosum*), common winterberry (*Ilex verticillata*), arrow-wood (*Viburnum dentatum*), withe-rod (*Viburnum cassinoides*), swamp rose (*Rosa palustris*), speckled alder (*Alnus rugosa*), maleberry (*Lyonia ligustrina*), glossy buckthorn (*Rhamnus frangula*), and American elderberry (*Sambucus canadensis*) shrubs; and sheep-laurel (*Kalmia angustifolia*), bristly blackberry (*Rubus hispidus*), cinnamon fern (*Osmunda cinnamomea*), royal fern (*Osmunda regalis*), sensitive fern (*Onoclea sensibilis*), subarctic lady fern (*Athyrium filix-femina*), marsh fern (*Thelypteris thelypteroides*), Massachusetts fern (*Thelypteris simulata*), spinulose woodfern (*Dryopteris spinulosa*), skunk-cabbage (*Symplocarpus foetidus*), swamp Jack-in-the-pulpit (*Arisaema triphyllum*), spotted touch-me-not (*Impatiens capensis*) and sphagnum moss (*Sphagnum sp*.) ground cover. Evidence of wetland hydrology, including hydric soils, high groundwater, saturated soils, pore linings, evidence of flooding, and drainage patterns, was observed within the delineated wetland. This vegetated wetland borders a perennial stream floodplain; accordingly, the vegetated wetlands would be regulated as Bordering Vegetated Wetlands under the Act. A 100-foot Buffer Zone extends horizontally outward from the edge of Bordering Vegetated Wetlands under the Act.

Bordering Land Subject to Flooding is an area that floods due to a rise in floodwaters from a bordering waterway or water body. Where flood studies have been completed, the boundary of Bordering Land Subject to Flooding is based upon flood profile data prepared by the National Flood Insurance Program. Section 10.57(2)(a)3. states that "The boundary of Bordering Land Subject to Flooding is the estimated maximum lateral extent of flood water which will theoretically result from the statistical 100-year frequency storm." The project engineer should evaluate the most recent National Flood Insurance Program flood profile data to confirm the extent and elevation of Bordering Land Subject to Flooding on the site. Bordering Land Subject to Flooding would occur in areas where the 100-year flood elevation is located outside of or upgradient of the delineated Bordering Vegetated Wetlands boundary. Bordering Land Subject to Flooding does not have a Buffer Zone under the Act.

The Massachusetts Rivers Protection Act amended the Act to establish an additional wetland resource area: Riverfront Area. Based upon a review of the current USGS Map (attached), there are no streams within 200-feet of the project site. Furthermore, based upon observations made during the site inspection, there are no unmapped streams located within 200 feet of the site. Accordingly, except as noted above, Riverfront Area would not occur on the site. Riverfront Area does not have a Buffer Zone under the Act, but may overlap other wetland resources and their Buffer Zones.

The Regulations require that no project may be permitted that will have any adverse effect on specified habitat sites of rare vertebrate or invertebrate species, as identified by procedures set forth at 310 CMR 10.59. Based upon a review of the *Massachusetts Natural Heritage Atlas*, 14th edition, Priority Habitats and Estimated Habitats from the NHESP Interactive Viewer, valid from August 1, 2017, and Certified Vernal Pools from MassGIS, there is Estimated Habitat [for use with the Act and Regulations (310 CMR 10.00 *et seq*.)] and Priority Habitat [for use with Massachusetts Endangered Species Act (M.G.L. Ch. 131A; "MESA") and MESA Regulations (321 CMR 10.00 *et seq*.)]. The habitat area is labeled as PH 1436. There are no Certified Vernal Pools on or in the immediate vicinity of the site. A copy of this map is attached.

The reader should be aware that the regulatory authority for determining wetland jurisdiction rests with local, state, and federal authorities. A brief description of my experience and qualifications is attached. If you have any questions, please feel free to contact me at any time.

Cordially,
ECOTEC, INC.

Arthur Allen, CWS, CPSS
Vice President

Attachments (5, 8 pages)

AA/NOI/Sudbury Old Sudbury 149 EcoTec Wet Report 1.7.2021

EcoTec, Inc.

ENVIRONMENTAL CONSULTING SERVICES
102 Grove Street
Worcester, MA 01605-2629
508-752-9666 / Fax: 508-752-9494

Arthur Allen, CPSS, CWS, CESSWI
Vice President
Soil & Wetland Scientist

Arthur Allen is the Vice President of EcoTec, Inc. and has been a senior environmental scientist there since 1995. His work with EcoTec has involved wetland delineation, wildlife habitat evaluation, environmental permitting (federal, state and local), environmental monitoring, expert testimony, peer reviews, contaminated site assessment and the description, mapping and interpretation of soils. His clients have included private landowners, developers, major corporations and regulatory agencies. Prior to joining EcoTec, Mr. Allen mapped and interpreted soils in Franklin County, MA for the U.S.D.A. Natural Resources Conservation Service (formerly Soil Conservation Service) and was a research soil scientist at Harvard University's Harvard Forest. Since 1994, Mr. Allen has assisted the Massachusetts Department of Environmental Protection and the Massachusetts Association of Conservation Commissions as an instructor in the interpretation of soils for wetland delineation and for the Title V Soil Evaluator program.

Mr. Allen has a civil service rating as a soil scientist, an undergraduate degree in Natural Resource Studies and a graduate certificate in Soil Studies. His work on the Franklin County soil survey involved interpretation of landscape-soil-water relationships, classifying soils and drainage, and determining use and limitation of the soil units that he delineated. As a soil scientist at the Harvard Forest, Mr. Allen was involved in identifying the legacies of historical land-use in modern soil and vegetation at a number of study sites across southern New England. He has a working knowledge of the chemical and physical properties of soil and water and how these properties interact with the plants that grow on a given site. While at Harvard Forest he authored and presented several papers describing his research results which were later published. In addition to his aforementioned experience, Mr. Allen was previously employed by the Trustees of Reservations as a land manager and by the Town of North Andover, MA as a conservation commission intern.

Education:
1993-Graduate Certificate in Soil Studies, University of New Hampshire
1982-Bachelor of Science in Natural Resource Studies, University of Massachusetts

Professional Affiliations:
Certified Professional Soil Scientist (ARCPACS CPSS #22529)
New Hampshire Certified Wetland Scientist (#19)
Registered Professional Soil Scientist – Society of Soil Scientists of SNE [Board Member (2000-2006)]
Certified Erosion, Sediment & Stormwater Inspector (#965)
Massachusetts Approved Soil Evaluator (#13764)
Massachusetts Arborists Association-Certified Arborist (1982 – 1998)
New England Hydric Soils Technical Committee member
Massachusetts Association of Conservation Commissions member
Society of Wetland Scientists member

Refereed Publications:
Soil Science and Survey at Harvard Forest. A.Allen. *In*: Soil Survey Horizons. Vol. 36, No. 4, 1995, pp. 133-142.
Controlling Site to Evaluate History: Vegetation Patterns of a New England Sand Plain. G.Motzkin, D.Foster, A.Allen, J.Harrod, & R.Boone. *In*: Ecological Monographs 66(3), 1996, pp. 345-365.
Vegetation Patterns in Heterogeneous Landscapes: The Importance of History and Environment. G.Motzkin, P.Wilson, D.R.Foster & A.Allen. In: Journal of Vegetation Science 10, 1999, pp. 903-920.

DEP Bordering Vegetated Wetland (310 CMR 10.55) Delineation Field Form

Applicant | Prepared by: EcoTec, Inc | Project Location: Old Sudbury Rd. (149), Sudbury | DEP File #

Section I. Vegetation | Number: TPU | Transect # B8 | Date of Delin: 11/4/2020

A. Sample layer and plant species (Enter largest to smallest % cover by layer)			Percent Cover (or basal area)	Percent Dominance	Dominant Plant?	Wetland Indicator Category	
Tree	none						
Sapling	American Elm	Ulmus americana	10	100.0	YES	FACW-	*
Shrub	Red Maple	Acer rubrum	10	50.0	YES	FAC	*
	Swamp White Oak	Quercus bicolor	10	50.0	YES	FACW	*
Ground	Asiatic Dayflower	Commelina communis	20	28.6	YES	FAC-	
	timothy gras	Phleum pretense	50	71.4	YES	FACU	
Vine							

Vegetation Conclusions

Number of dominant wetland indicator plants **3** | Number of dominant non-wetland indicator plants **2**

Is the number of dominant wetland plants equal or greater than the number of dominant non-wetland plants? YES

DEP Bordering Vegetated Wetland (310 CMR 10.55) Delineation Field Form

Applicant | Prepared by: EcoTec, Inc | Project Location: Old Sudbury Rd. (149), Sudbury | DEP File #

Section II. Indicators of Hydrology | Number: TPU | Transect # B8 | Date of Delin: 11/4/2020

1. Soil Survey

Is there a published soil survey for this site?

title/date

map number

soil type mapped

hydric soil inclusions

Are field observarions consistent with soil survey?

Remarks:

2. Soil Description

Horizon	Depth (inches)	Matrix Color	Mottle Color
Litter	1		
A	0-8	10YR 3/2	
C	8-16	10YR 5/4	

Remarks Gravely loamy sands

3. Other

Conclusion: Is the soil hydric? No

Other Indicators of hydrology (check all that apply):

- ☐ Site Inundated
- ☐ Depth to free water in observation hole
- ☐ Depth to soil saturation in observation hole
- ☐ Water marks
- ☐ Drift lines
- ☐ Sediment Deposits
- ☐ Drainage patterns in BVWs
- ☐ Oxidized rhizospheres
- ☐ Water stained leaves
- ☐ Recorded data (stream, lake, or tidal gauge; aerial photo; other):
- ☐ Other:

Vegetation and Hydrology Conclusion

	Yes	No
Number of wetland indicator plants ≥ number of non-wetland indicator plants	☑	☐
Wetland hydrology present:		
Hydric soil present	☐	☑
Other indicators of hydrology present	☐	☑
Sample Location is in a BVW	☐	☑

DEP Bordering Vegetated Wetland (310 CMR 10.55) Delineation Field Form

Applicant | Prepared by: EcoTec, Inc | Project Location: Old Sudbury Rd. (149), Sudbury | DEP File #

Section I. Vegetation | Number: TPW | Transect # B8 | Date of Delin: 11/4/2020

A. Sample layer and plant species (Enter largest to smallest % cover by layer)			Percent Cover (or basal area)	Percent Dominance	Dominant Plant?	Wetland Indicator Category	
Tree	none						
Sapling	American Elm	Ulmus americana	10	100.0	YES	FACW-	*
Shrub	Buttonbush	Cephalanthus occidentalis	30	50.0	YES	OBL	*
	Silky Dogwood	Cornus amomum	30	50.0	YES	FACW	*
Ground	Purple Loosestrife	Lythrum salicaria	20	100.0	YES	FACW+	*
Vine							

Vegetation Conclusions

Number of dominant wetland indicator plants **4** | Number of dominant non-wetland indicator plants **0**

Is the number of dominant wetland plants equal or greater than the number of dominant non-wetland plants? YES

DEP Bordering Vegetated Wetland (310 CMR 10.55) Delineation Field Form

Applicant | Prepared by: EcoTec, Inc | Project Location: Old Sudbury Rd. (149), Sudbury | DEP File #

Section II. Indicators of Hydrology | Number: TPW | Transect # B8 | Date of Delin: 11/4/2020

1. Soil Survey

Is there a published soil survey for this site?

title/date

map number

soil type mapped

hydric soil inclusions

Are field observarions consistent with soil survey?

Remarks:

2. Soil Description

Horizon	Depth (inches)	Matrix Color	Mottle Color
Litter	1		
Oa	0-10	10YR 2/1	

Remarks Oa - Muck

3. Other

Conclusion: Is the soil hydric? Yes

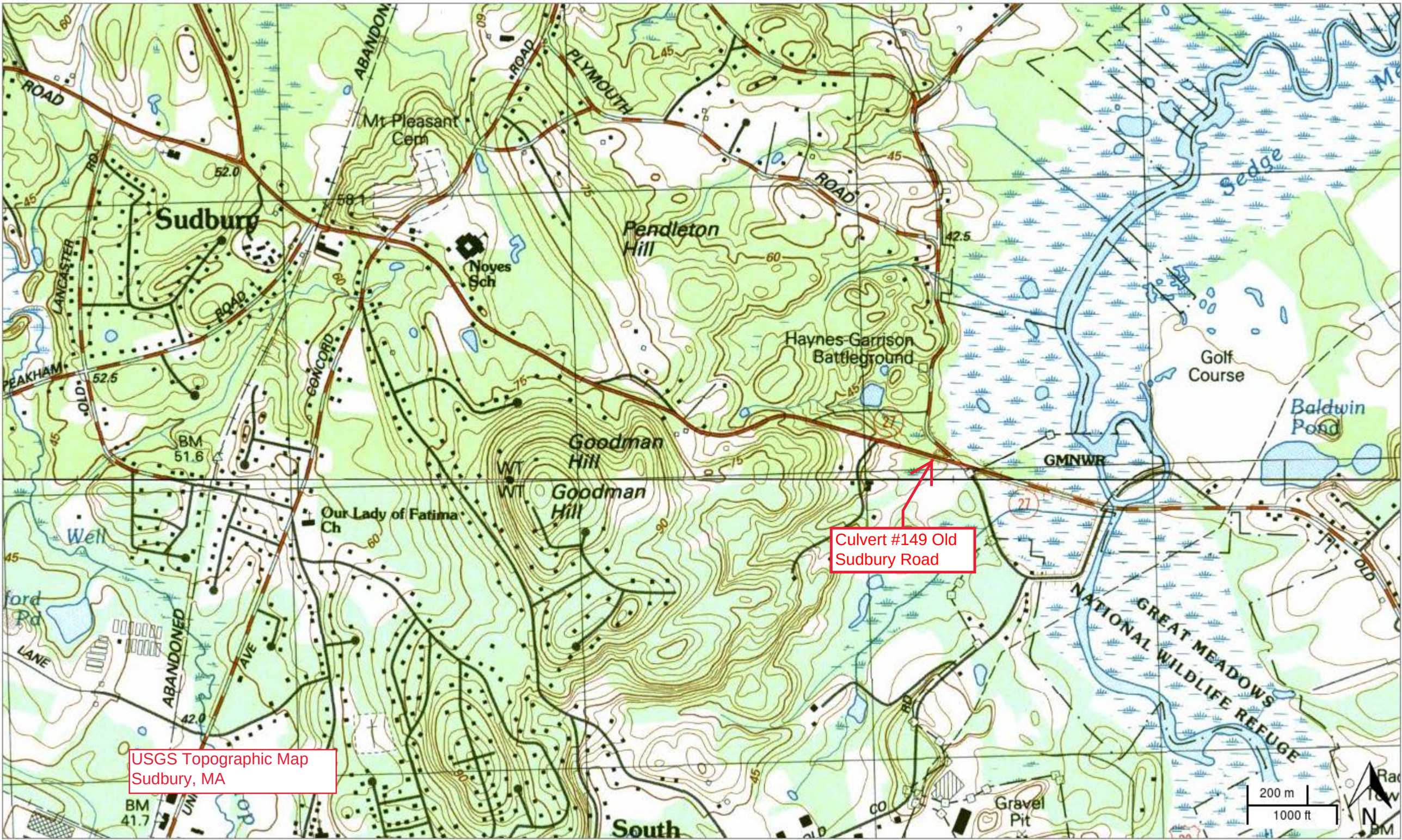
Other Indicators of hydrology (check all that apply):

- [x] Site Inundated 2"
- [ ] Depth to free water in observation hole
- [ ] Depth to soil saturation in observation hole
- [ ] Water marks
- [ ] Drift lines
- [ ] Sediment Deposits
- [ ] Drainage patterns in BVWs
- [ ] Oxidized rhizospheres
- [x] Water stained leaves
- [ ] Recorded data (stream, lake, or tidal gauge; aerial photo; other):
- [ ] Other:

Vegetation and Hydrology Conclusion

	Yes	No
Number of wetland indicator plants ≥ number of non-wetland indicator plants	☑	☐
Wetland hydrology present:		
Hydric soil present	☑	☐
Other indicators of hydrology present	☑	☐
Sample Location is in a BVW	☑	☐

USGS - Sudbury, MA

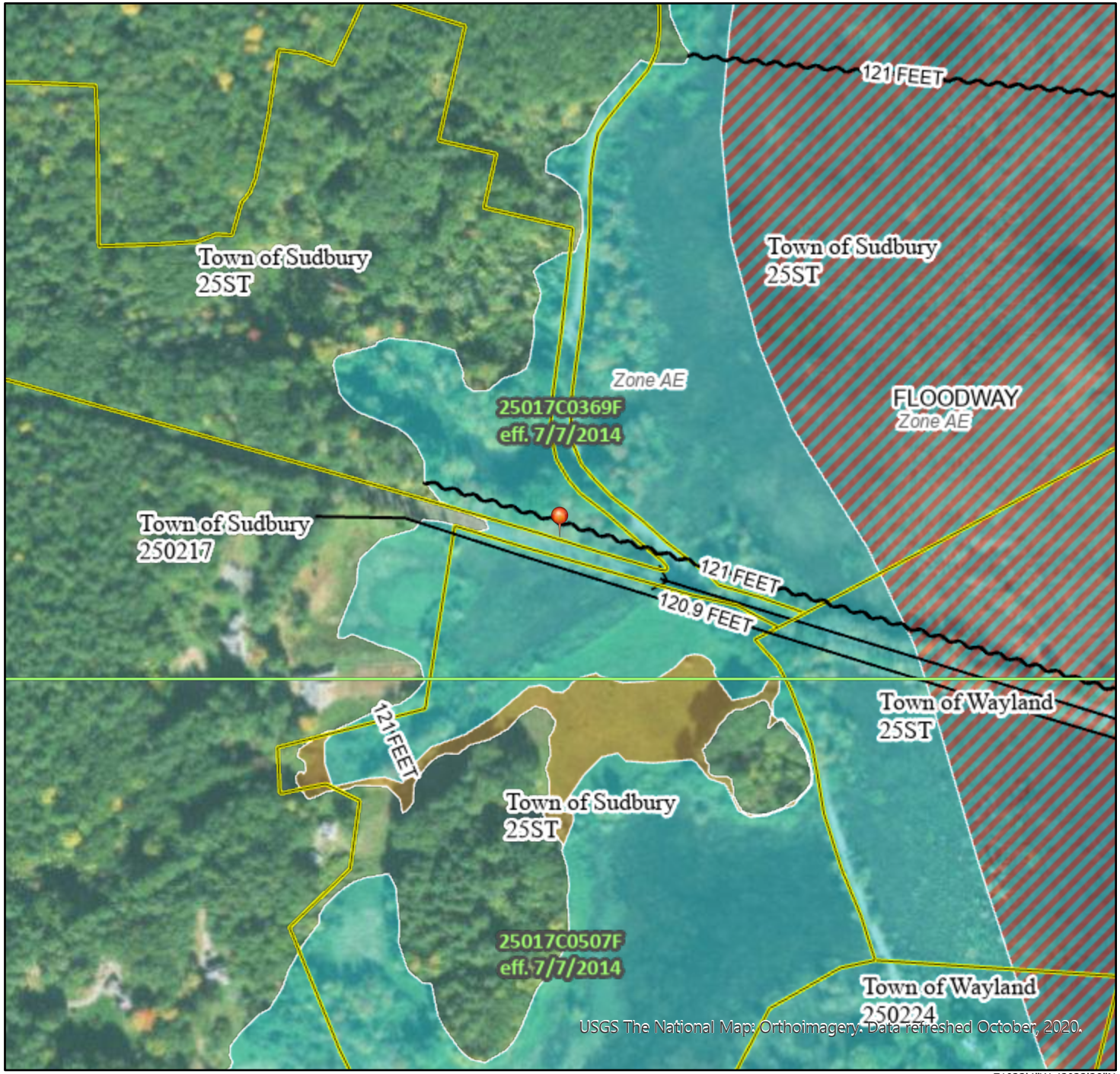


USGS Topographic Map
Sudbury, MA

National Flood Hazard Layer FIRMette

FEMA

71°23'41"W 42°22'47"N



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

1:6,000

71°23'4"W 42°22'20"N

Legend

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

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

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

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

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

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

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

N

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

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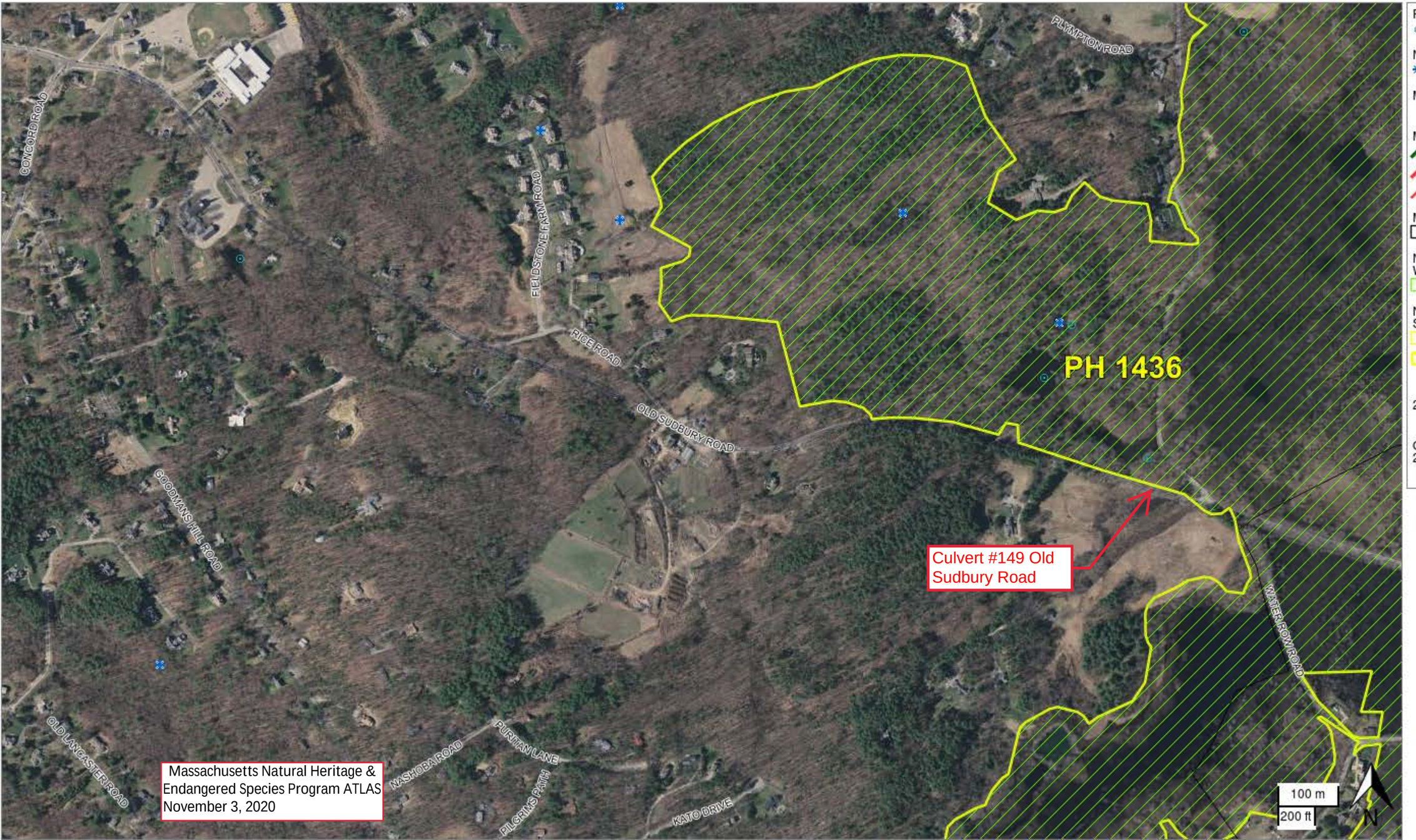
NHESP - 11.3.2020



Potential Vernal Pools

NHESP Certified Vernal Pools

MassDOT Roads Street Names

Major MassDOT Routes
Interstate Highways
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Massachusetts Towns

NHESP Estimated Habitats of Rare Wildlife

NHESP Priority Habitats of Rare Species

2013-2014 Color Orthos (USGS)

Orthos 2019
2019 Color Orthos (USGS)

ATTACHMENT C: GEOTECHNICAL EVALUATION, CULVERT #110 & CULVERT #149

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MEMORANDUM

To: Mr. Scott Salvucci
Woodard & Curran, Inc. (W&C)

From: Mirsad Alihodzic and Bruce W. Fairless, P.E.
GZA GeoEnvironmental, Inc. (GZA)

Date: January 7, 2021

File No.: 04.0191167.00

Re: Geotechnical Engineering Memorandum
Old Sudbury Road Culverts #110 and #149
Sudbury, Massachusetts

This memorandum presents the results of the subsurface exploration program performed at the above-referenced sites by GZA. The subsurface exploration program was completed in accordance with GZA's Proposal for Geotechnical Services dated October 7, 2020. GZA's objectives were to evaluate subsurface conditions and provide geotechnical recommendations for the proposed culvert replacements. The contents of this report are subject to the **Limitations** contained in **Appendix A** and the Terms and Conditions of our agreement. Note that elevations in this memorandum are in feet referenced to the North American Vertical Datum of 1988 (NAVD 88).

BACKGROUND/SITE DESCRIPTION

Based on discussions with you, we understand that the existing Culvert #110, located near 230 Old Sudbury Road, and Culvert #149, located near the intersection of Old Sudbury Road and Water Row, need to be replaced because of their current undersized hydraulic capacities and the historic flooding conditions which occur at Culvert #149. See **Figure 1, Locus Plan** for relative culvert locations.

CULVERT #110

The existing Culvert #110 allows an unnamed stream to pass under the roadway and flow downstream to the south. The current culvert is approximately 43 feet long and spans the width of the roadway and slopes down from the north to the south.

Based on the survey plan provided to us by W&C on November 17, 2020, the typical water elevation of the stream upstream is about Elevation 228 feet, with the pipe invert on the north (inlet) side at about Elevation 228 and the south (outlet) side at about Elevation 227.8 feet. Based on a review of the plans provided and our visual observations in the field, an approximately 2-foot-wide, 6-foot-long, 2-foot-tall stacked stone headwall with an 8-inch-diameter drain opening (drain pipe was not observed) located at the inlet side of the culvert, while at the outlet side the culvert is incorporated into an approximately 2-foot-wide, 5-foot-long, 2-foot-tall stacked stone headwall, with a 6-inch drain opening (drain pipe was not observed).

The 8-inch-diameter inlet opening and stone stacked headwall at the upstream (north) side of the culvert can be seen on **Photograph 1** below, while the 6-inch-diameter outlet opening and stone stacked headwall at the downstream (south) is shown in **Photograph 2** below.

The roadway at this culvert area currently slopes from the northwest to the southeast with stone walls on each side of the road. Based on the plans and information provided by W&C, it is our understating that multiple utilities are present under Old Sudbury Road in the area of Culvert #110, including an 8-inch-diameter water main on the south side of the roadway and a 2-inch-diameter gas main on the north side of the roadway. An overhead utility is also present on the north side of the roadway.


Photograph 1 – Stone headwall Culvert # 110 inlet


Photograph 2 – Stone headwall Culvert #110 outlet

At this time, the proposed culvert replacement being considered for Culvert #110 is a single 18-inch-diameter Reinforced Concrete Pipe (RCP) culvert at approximately the same elevation as the existing culvert, or a 30-inch-diameter RCP culvert that would be embedded approximately 1 foot. The new culvert would be in the same approximate alignment as the existing culvert. The existing stacked stone headwalls would be rebuilt on both sides.

CULVERT #149

The existing Culvert #149, located near the intersection of Old Sudbury Road and Water Row, connects the wetlands of the Bay Circuit Trail by allowing an unnamed stream to pass under the roadway and flow downstream to the north towards the Sudbury River. The current culvert, which is approximately 56 feet long, spans the width of the roadway and slopes down from the south to the north. Based on information provided by W&C, it is our understanding that flooding occurs in this area due to the fluctuating levels of the Sudbury River which is located approximately 1,500 feet to the northeast.

Based on the survey plan provided to us by W&C on November 17, 2020, the typical water elevation of the stream/wetland area upstream is about Elevation 113 feet, with the pipe invert on the south (inlet) side at about Elevation 112.3 and the north (outlet) side at about Elevation 112 feet. Based on our review of the plans provided and our visual observations in the field, a 2-foot-wide, 6-foot-long, 3-foot-tall stone headwall with an approximately 3-foot-wide stone box culvert opening is located at the inlet side of the culvert, while the outlet side of the culvert is incorporated into an approximately 2-foot-wide, 12-foot-long, 2-foot-tall stacked stone headwall, with a 6-inch corrugated plastic pipe at the outlet side of the culvert which discharges into the wetland area at the north side of the road. The 3-foot-wide stone box culvert opening with a metal grate screen grate at

the upstream side (south) of the culvert can be seen on **Photograph 3** below, while the 6-inch-diameter storm drain pipe outlet opening with the headwall at the downstream side (north) of the culvert to the east is shown in **Photograph 4** below.

The roadway in this area currently slopes from the west to the east with steel beam guard rail on each side of the road. An overhead utility is present on the north side of the roadway and based on the plans and information provided by the Town of Sudbury and W&C, underground utilities are not present in this section of the Old Sudbury Road.

Photograph 3 – Stone headwall Culvert # 149 inlet

Photograph 4 – Stacked stone headwall Culvert #149 outlet

Based on our communications with you, we understand that the proposed culvert replacement being considered for Culvert #149 is a single 5-foot-wide, 7-foot-tall, 4-sided concrete box culvert with a 5-foot opening and 2-foot embedment and would be installed at approximately elevation 109, and in the same approximate alignment as the existing culvert. The stacked stone walls would be replaced with block stone headwalls on both the inlet and outlet sides.

SUBSURFACE EXPLORATIONS

GZA performed a subsurface exploration program to evaluate subsurface conditions in the vicinity of the proposed culverts. New England Boring Contractors of Derry, New Hampshire coordinated utility clearance and drilled test borings B-1 and B-2 on November 17, 2020, and test boring B-3 on December 11, 2020. Boring B-1 was drilled in the roadway to the northwest of the existing Culvert #149 and extended to a depth of about 31 feet below ground surface (bgs). Boring B-2 was drilled in the roadway to the southeast of the existing Culvert # 149 and extended to a depth of about 25 feet bgs. Boring B-3 was drilled in the roadway to the northwest of the existing Culvert #110 to a depth of about 15 feet bgs. GZA field personnel located the test borings by tape measurements from prominent site features. The approximate locations of the test borings are shown on **Figure 2 – Exploration Location Plan at Culvert #149** and **Figure 3 – Exploration Location Plan at Culvert #110**.

Borings B-1 and B-2 were drilled using a truck-mounted drill rig with 4-inch-inside-diameter (ID), flush-joint casing and drive-and-wash drilling methods. Standard Penetration Testing and split spoon sampling were performed generally at 5-foot intervals.

Boring B-3 was drilled using a truck-mounted drill rig with 2.25-inch-ID, hollow stem augers. Standard Penetration Testing and split spoon sampling were performed continuously for the first 10 feet and then at 5-foot intervals thereafter.

Samples were classified in accordance with the Modified Burmister System. The test borings were backfilled with drill cuttings upon the completion of the drilling and repaired at the surface with asphalt cold-patch. GZA field personnel monitored the drilling and prepared the test boring logs which are included in **Appendix B**.

GEOTECHNICAL LABORATORY TESTING

Four soil samples obtained from test borings were submitted to GZA's geotechnical laboratory subcontractor, Thielsch Engineering, for grain size distribution analyses and organic content. Laboratory test results for these samples are attached as **Appendix C** and are summarized in the table below.

Test Boring No.	Sample ID	Depth Below Grade (ft)	Stratum	Soil Description	Test Performed
B-1	S-2	4-6	Fill	Brown, fine to coarse SAND, some Clayey Silt, little fine Gravel.	Index (Gradation, Moisture)
B-1	S-4	14-16	Sand	Gray, fine SAND, some Silt	Index (Gradation, Moisture)
B-2	S-3B	9-11	Peat	Black, fine grained PEAT	Organic Content, Moisture
B-2	S-5	19-21	Sand	Brown, fine SAND, some Silt.	Index (Gradation, Moisture)

GENERALIZED SUBSURFACE CONDITIONS

Based on the completed test borings, subsurface conditions at the site consisted of very loose to very dense sand fill over natural peat over sand, with the soils encountered generally becoming denser with depth. Descriptions of the geologic units encountered are as follows, in general order of occurrence below ground surface at each culvert location.

GENERALIZED SUBSURFACE CONDITIONS NEAR CULVERT 110 (Boring B-3)		
Soil Unit	**Approx. Depth Range (feet)**	**Generalized Description**
Asphalt	0 to 0.8	10 inches of bituminous asphalt pavement was encountered at the ground surface in boring B-3.
Fill (Silty Sand)	0.8 to 4.0	Approximately 3 feet of Sand was encountered directly below the asphalt in boring B-3. The material generally consisted of very dense, gray, fine to coarse SAND, with up to about 35 percent Silt and up to 20 percent Gravel.
Peat	4 to 5	Approximately 1 foot of PEAT was encountered directly below the Fill in boring B-3. The PEAT consisted of dense, black fine-grained PEAT, with up to 35 percent sand.
Sand	9.5 to 28.5	Approximately 10 feet of Sand was encountered at a depth of 5 feet bgs in boring B-3; the Sand was not fully penetrated as the boring was terminated in the Sand. The Sand generally consisted of dense to very dense, gray, fine to coarse SAND, with up to 35 percent Silt and up to 20 percent of Gravel. Based on drilling observations, cobbles and/or boulders were encountered from approximately 5 to 15 feet bgs in boring B-3.

GENERALIZED SUBSURFACE CONDITIONS NEAR CULVERT 149 (Borings B-1 and B-2)		
Soil Unit	**Approx. Depth Range (feet)**	**Generalized Description**
Asphalt	0 to 0.8	8 to 10 inches of bituminous asphalt pavement was encountered at the ground surface in borings B-1 and B-2.
Fill (Silty Sand)	0.8 to 10.9	Approximately 10 and 11 feet of Fill was encountered directly below the asphalt in borings B-1 and B-2, respectively. The Fill generally consisted of medium dense to very dense, brown to gray, fine to coarse SAND, with up to about 35 percent Silt and/or Gravel.
Peat	1.9 to 2	Approximately 2 feet of PEAT was encountered directly below the Fill in borings B-1 and B-2. The PEAT consisted of medium dense, black fine-grained PEAT, with more than 50 percent fine sand/ and or silt. Laboratory testing indicated a PEAT moisture content of 110 percent and an organic content of 19.1 percent by weight.
Sand	12.5 to 18	Sand was encountered below the Peat at a depth of about 13 feet bgs in borings B-1 and B-2. The material generally consisted of loose to medium dense, gray or brown, fine SAND, with up to 35 percent Silt.

Detailed descriptions of the materials encountered are presented on the boring logs in **Appendix B**.

GROUNDWATER

Groundwater was measured in test borings B-1 and B-2 at approximately 9 and 8 feet bgs (corresponding to Elevations 111.6 and 112.4), respectively, as shown on the boring logs included in **Appendix B**. Groundwater depths and elevations are approximate representations of the hydrostatic groundwater level, as the drive-and-wash method of drilling introduces drill water to stabilize the borehole and remove drill spoils. Therefore, the groundwater level observed in the test borings B-1 and B-2 may not represent stabilized groundwater levels. The stream/wetland level at the time the borings were completed in this area was at approximately Elevation ±112.

Groundwater was measured in test boring B-3 at approximately 7.4 feet bgs (corresponding to Elevation 224.6) as shown on the boring logs included in **Appendix B**. This depth and elevation are an approximate groundwater level observed at the time the test boring was performed. Therefore, the groundwater level observed in the test boring B-3 may not represent stabilized groundwater levels. The stream level at the time the boring was completed in this area was at approximately Elevation ±228.

Water level readings were made in the borings at the time and under conditions stated on the logs. Note that fluctuations in the level of the groundwater will occur due to variations in season, rainfall, temperature, construction, and other factors occurring since the time measurements were made.

BEDROCK

Bedrock was not encountered beneath the sand in borings B-1 and B-2. Based on observed drill action including auger and split spoon refusal, probable bedrock may have been encountered in test boring B-3 at approximately 15.1 feet bgs, corresponding to approximately elevation 216.9. No split spoon samples were retrieved, and rock coring was not attempted. Bedrock underlying each site area is mapped as quartzite, schist, calc-silicate quartzite, and amphibolite which are part of the Westboro Formation.

IMPLICATIONS OF SUBSURFACE CONDITIONS

CULVERT #110

The subsurface conditions at Culvert #110 site, based on boring B-3, generally consist of very dense sand fill overlying a thin layer of peat, over very dense sand. Based on plans provided by W&C, the estimated elevation of the bottom of the proposed culvert at this site will be about Elevation ±226 feet or ±228 feet. Based on the test boring, soils at this elevation are likely to be within the peat stratum with an estimated bottom of peat elevation of 227.

CULVERT #149

The subsurface conditions at the Culvert #149 site generally consist of medium dense sand fill overlying peat, and medium dense silty fine sand, with no gravel. Based on plans provided by W&C, the estimated elevation of the bottom of the proposed culvert at this site will be about Elevation ±110 feet. Based on the borings, soils at this elevation are likely to be within the peat stratum with an estimated bottom of peat elevation of 108.

GENERAL

Supporting the new culverts over compressible peat will cause the culverts to settle over time. Thus, if peat is observed to be present along the culvert alignment during construction, over-excavation to remove the peat is recommended at both proposed culvert alignments. Backfill with crushed stone to the culvert subgrade elevations.

Based on the borings, the anticipated over-excavation depth to remove peat will be up to about 3 feet. Dewatering to remove the peat "in the dry" may be difficult. It is likely to be more practical to attempt to remove the peat along the culvert alignments "in the wet" to mitigate (but not eliminate) the settlement risk. The excavation process and excavated subgrade, before backfilling, should be observed by a qualified geotechnical engineer to confirm that the subgrade is suitable for placement of crushed stone, bearing the pipe or proposed concrete box culvert.

RECOMMENDATIONS

The following recommendations are based on the assumption that the peat stratum will be removed at Culvert #110 in the wet. In addition, the proposed 5-foot-wide, 7-foot-tall concrete box culvert at Culvert #149 will be installed at about Elevation 110 feet on about 3 feet of 1¼-inch crushed stone placed in the wet following overexcavation of the peat.

DEWATERING

Based on the survey plans provided to GZA on November 17, 2020, the typical water elevation of the brook at Culvert #149 upstream is about Elevation ±112 feet. Temporary construction dewatering to control groundwater seepage, precipitation, and surface inflow in excavations, to maintain the integrity of soil bearing surfaces, and allow construction in-the-dry will be difficult without utilizing steel sheeting. The anticipated excavated sand subgrade can become unstable if exposed to high dewatering gradients. Excavation in the wet is recommended with careful construction protocols established with the contractor.

FROST PROTECTION

Typical frost depth in the Commonwealth of Massachusetts is 4 feet bgs. We recommend that spread footings for abutments and wingwalls be supported a minimum of 4 feet below the lowest adjacent ground surface to provide frost protection.

BEARING PRESSURE

The proposed RCP at Culvert #110 and the concrete box culvert at Culvert #149 can be supported over the natural undisturbed Sand, once the peat is removed, and replaced with 1¼-inch crushed stone, assuming up to about 3 feet of over excavation. Recommended maximum net allowable bearing pressure for the proposed abutments and wingwalls bearing on at least 1 foot of dense-graded crushed stone over the 1¼-inch crushed stone is 2,000 pounds per square foot. Potential settlement is difficult to estimate as there may be limited peat remaining below the crushed stone, even after the over-excavation process in the wet.

CONCLUSION

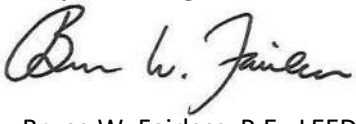
We appreciate the opportunity to work with Woodard & Curran, Inc. on this project. If you have any questions regarding this memorandum, please contact Mirsad Alihodzic at 603-232-8755 or Bruce Fairless at 781-603-2254.

Very truly yours,

GZA GEOENVIRONMENTAL, INC.

Mirsad Alihodzic
Project Manager

David G. Lamothe, P.E.
Consultant/Reviewer



Bruce W. Fairless, P.E., LEED AP
Associate Principal

MA/BWF/DGL:tmd
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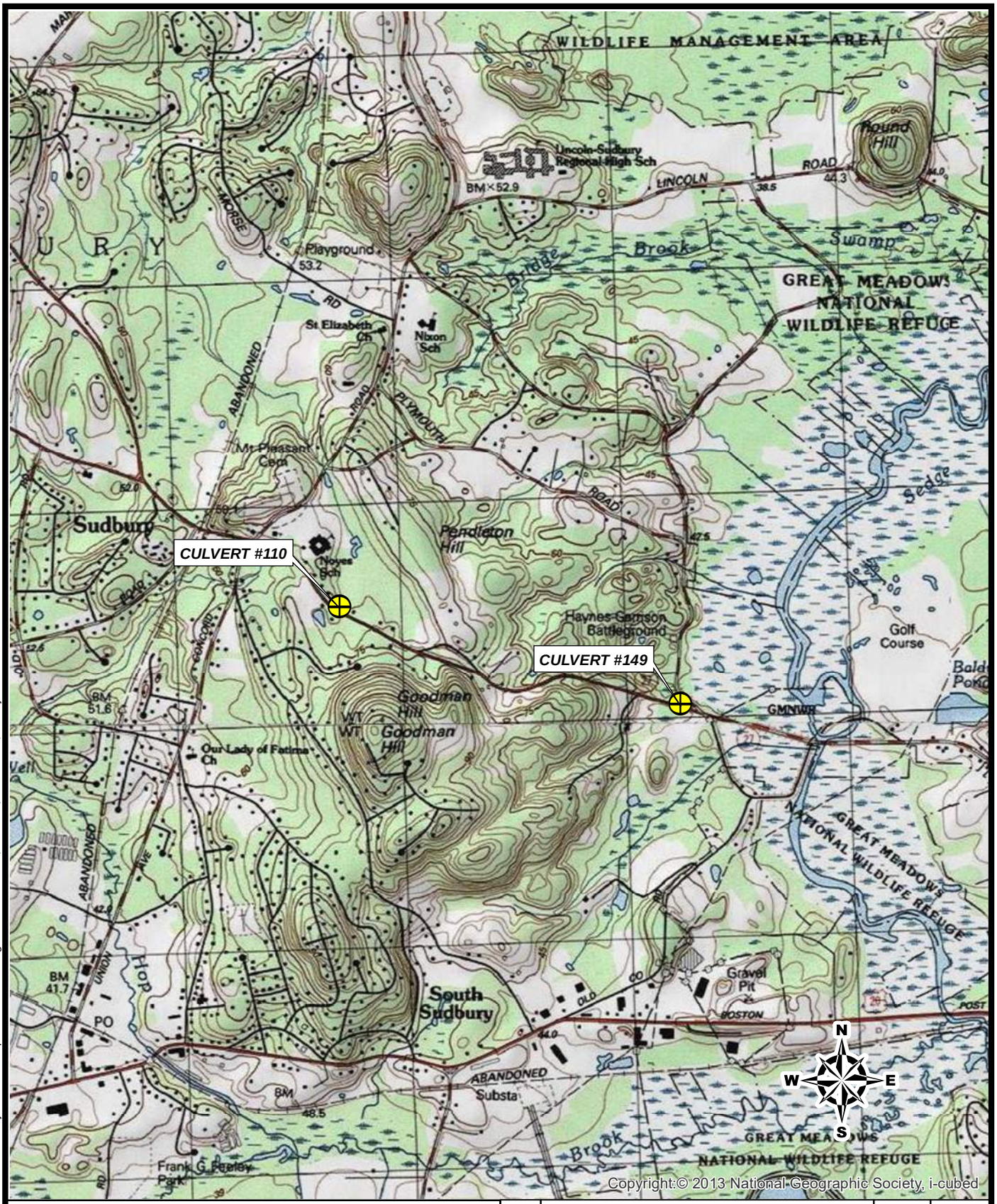
Attachments: Figure 1 – Locus Plan
Figure 2 – Exploration Location Plan at Culvert #149
Figure 3 – Exploration Location Plan at Culvert #110
Appendix A – Limitations
Appendix B – Boring Logs
Appendix C – Laboratory Test Results

Figures



NO.	ISSUE / DESCRIPTION	BY	DATE

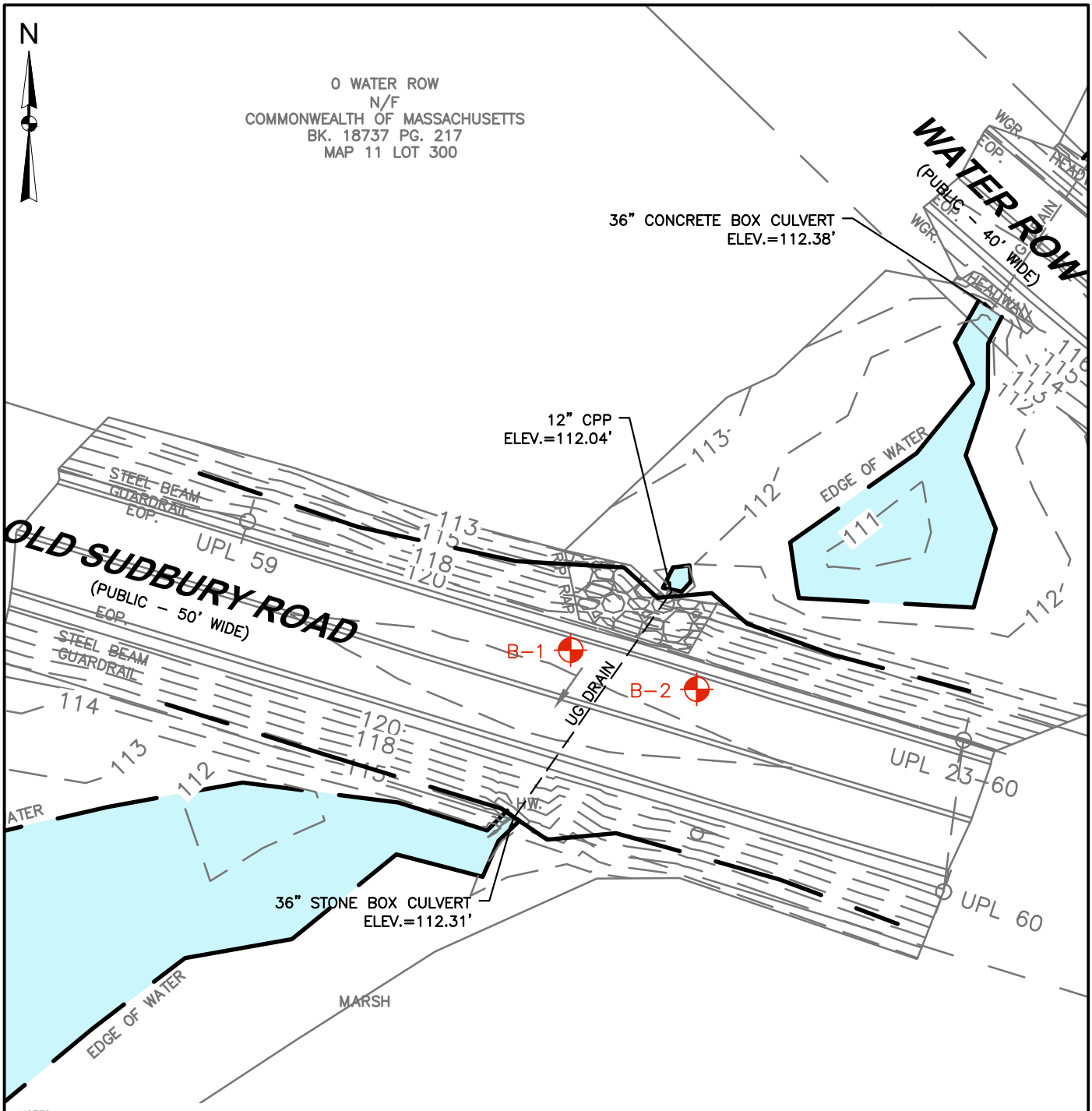
OLD SUDBURY ROAD
CULVERTS #110 AND #149

LOCUS PLAN

PREPARED BY:
GZA GeoEnvironmental, Inc.
Engineers and Scientists
www.gza.com

PREPARED FOR:
WOODARD & CURRAN, INC.

PROJ MGR: MA	REVIEWED BY: BF	CHECKED BY: DL	FIGURE 1
DESIGNED BY: MA	DRAWN BY: LW	SCALE: 1 in = 2,000 ft	
DATE: JANUARY 2021	PROJECT NO. 04.0191167.00	REVISION NO.	



NOTES:

1. BASE PLAN WAS DEVELOPED FROM AN ELECTRONIC BASE PLAN ENTITLED "CULVERT 149" DATED NOVEMBER 17, 2020; PREPARED BY CHAPPELL ENGINEERING ASSOCIATES, LLC OF MARLBOROUGH, MASSACHUSETTS PROVIDED BY WOODARD AND CURRAN VIA EMAIL ON NOVEMBER 18, 2020.
2. TEST BORINGS B-1 AND B-2 WERE PERFORMED BY NEW ENGLAND BORING CONTRACTORS OF DERRY, NEW HAMPSHIRE ON NOVEMBER 17, 2020 AND WERE OBSERVED AND LOGGED BY GZA PERSONNEL.
3. TEST BORING B-1 AND B-2 LOCATIONS WERE DETERMINED BY GZA USING TAPE MEASUREMENTS FROM EXISTING TOPOGRAPHIC FEATURES. THESE LOCATIONS SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.

LEGEND:

B-1 APPROXIMATE BORING LOCATION AND DESIGNATION

0 30' 60' 90'

SCALE IN FEET

NO.	ISSUE/DESCRIPTION	BY	DATE

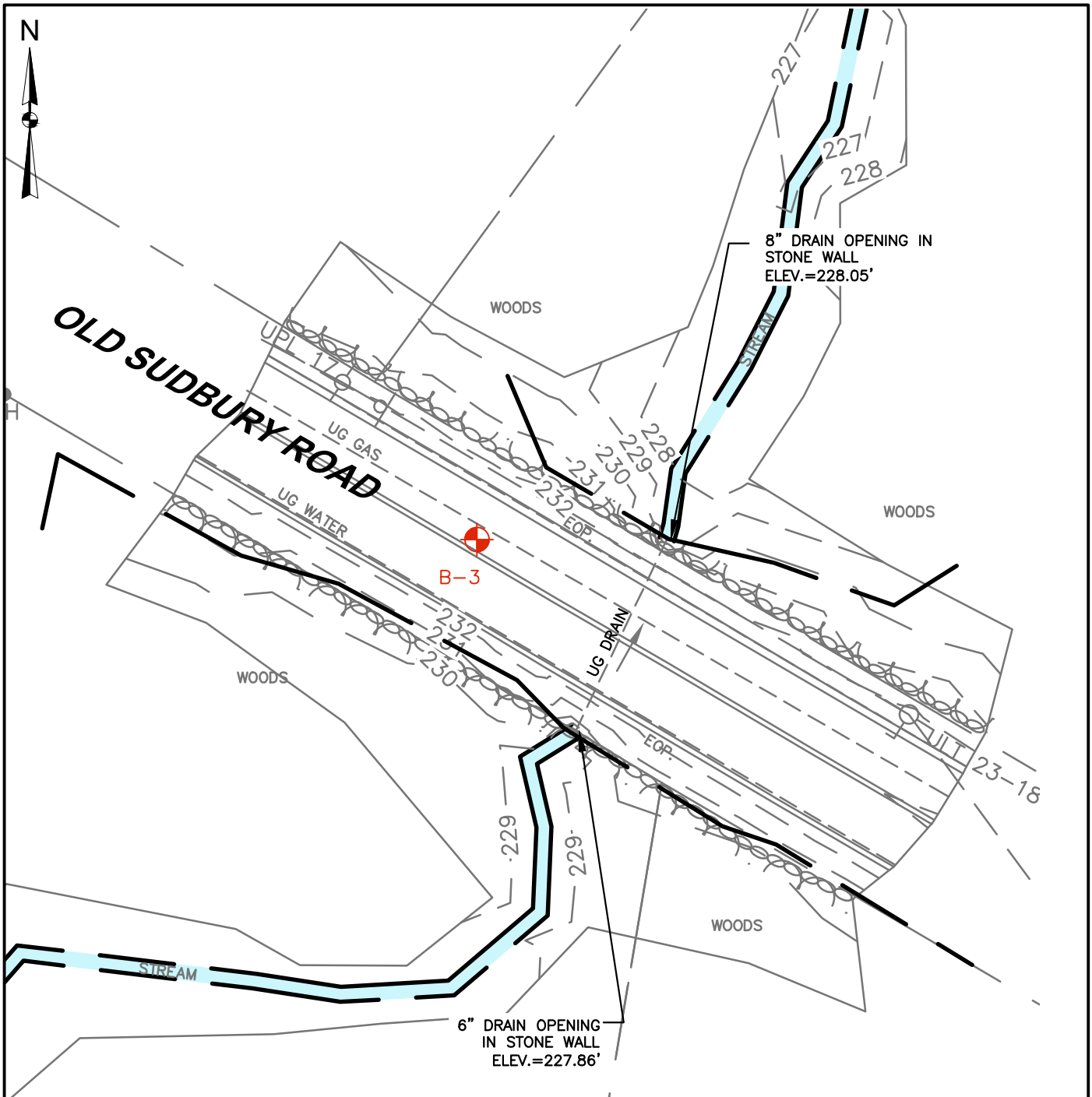
OLD SUDBURY ROAD CULVERT #149
SUDBURY, MA

EXPLORATION LOCATION PLAN

PREPARED BY:
GZA GeoEnvironmental, Inc.
Engineers and Scientists
www.gza.com

PREPARED FOR:
WOODARD & CURRAN, INC

PROJ MGR: MA	REVIEWED BY: BWF	CHECKED BY: DGL	FIGURE 2
DESIGNED BY: MA	DRAWN BY: MA	SCALE: AS SHOWN	
DATE: JANUARY, 2021	PROJECT NO. 04.0191167.00	REVISION NO.	SHEET NO.



NOTES:

1. BASE PLAN WAS DEVELOPED FROM AN ELECTRONIC BASE PLAN ENTITLED "CULVERT 110" DATED NOVEMBER 17, 2020; PREPARED BY CHAPPELL ENGINEERING ASSOCIATES, LLC OF MARLBOROUGH, MASSACHUSETTS PROVIDED BY WOODARD AND CURRAN VIA EMAIL ON NOVEMBER 18, 2020.
2. TEST BORING B-3 WAS PERFORMED BY NEW ENGLAND BORING CONTRACTORS OF DERRY, NEW HAMPSHIRE ON DECEMBER 11, 2020 AND WERE OBSERVED AND LOGGED BY GZA PERSONNEL.
3. TEST BORING B-3 LOCATION WAS DETERMINED BY GZA USING TAPE MEASUREMENTS FROM EXISTING TOPOGRAPHIC FEATURES. THIS LOCATION SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.

LEGEND:

B-3 APPROXIMATE BORING LOCATION AND DESIGNATION

0 30' 60' 90'

SCALE IN FEET

NO.	ISSUE/DESCRIPTION	BY	DATE

OLD SUDBURY ROAD CULVERT #110
SUDBURY, MA

EXPLORATION LOCATION PLAN

PREPARED BY:
GZA GeoEnvironmental, Inc.
Engineers and Scientists
www.gza.com

PREPARED FOR:
WOODARD & CURRAN, INC

PROJ MGR: MA	REVIEWED BY: BWF	CHECKED BY: DGL	FIGURE 3
DESIGNED BY: MA	DRAWN BY: MA	SCALE: AS SHOWN	
DATE: JANUARY, 2021	PROJECT NO. 04.0191167.00	REVISION NO.	SHEET NO.

Appendix A – Limitations

USE OF REPORT

1. GZA GeoEnvironmental, Inc. (GZA) prepared this report on behalf of, and for the exclusive use of our Client for the stated purpose(s) and location(s) identified in the Proposal for Services and/or Report. Use of this report, in whole or in part, at other locations, or for other purposes, may lead to inappropriate conclusions; and we do not accept any responsibility for the consequences of such use(s). Further, reliance by any party not expressly identified in the contract documents, for any use, without our prior written permission, shall be at that party's sole risk, and without any liability to GZA.

STANDARD OF CARE

2. GZA's findings and conclusions are based on the work conducted as part of the Scope of Services set forth in Proposal for Services and/or Report, and reflect our professional judgment. These findings and conclusions must be considered not as scientific or engineering certainties, but rather as our professional opinions concerning the limited data gathered during the course of our work. If conditions other than those described in this report are found at the subject location(s), or the design has been altered in any way, GZA shall be so notified and afforded the opportunity to revise the report, as appropriate, to reflect the unanticipated changed conditions .

3. GZA's services were performed using the degree of skill and care ordinarily exercised by qualified professionals performing the same type of services, at the same time, under similar conditions, at the same or a similar property. No warranty, expressed or implied, is made.

4. In conducting our work, GZA relied upon certain information made available by public agencies, Client and/or others. GZA did not attempt to independently verify the accuracy or completeness of that information. Inconsistencies in this information which we have noted, if any, are discussed in the Report.

SUBSURFACE CONDITIONS

5. The generalized soil profile(s) provided in our Report are based on widely-spaced subsurface explorations and are intended only to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized, and were based on our assessment of subsurface conditions. The composition of strata, and the transitions between strata, may be more variable and more complex than indicated. For more specific information on soil conditions at a specific location refer to the exploration logs. The nature and extent of variations between these explorations may not become evident until further exploration or construction. If variations or other latent conditions then become evident, it will be necessary to reevaluate the conclusions and recommendations of this report.

6. In preparing this report, GZA relied on certain information provided by the Client, state and local officials, and other parties referenced therein which were made available to GZA at the time of our evaluation. GZA did not attempt to independently verify the accuracy or completeness of all information reviewed or received during the course of this evaluation.

7. Water level readings have been made in test holes (as described in this Report) and monitoring wells at the specified times and under the stated conditions. These data have been reviewed and interpretations have been made in this Report. Fluctuations in the level of the groundwater however occur due to temporal or spatial variations in areal recharge rates, soil heterogeneities, the presence of subsurface utilities, and/or natural or artificially induced perturbations. The water table encountered in the course of the work may differ from that indicated in the Report.

8. GZA's services did not include an assessment of the presence of oil or hazardous materials at the property. Consequently, we did not consider the potential impacts (if any) that contaminants in soil or groundwater may have on construction activities, or the use of structures on the property.

9. Recommendations for foundation drainage, waterproofing, and moisture control address the conventional geotechnical engineering aspects of seepage control. These recommendations may not preclude an environment that allows the infestation of mold or other biological pollutants.

COMPLIANCE WITH CODES AND REGULATIONS

10. We used reasonable care in identifying and interpreting applicable codes and regulations. These codes and regulations are subject to various, and possibly contradictory, interpretations. Compliance with codes and regulations by other parties is beyond our control.

COST ESTIMATES

11. Unless otherwise stated, our cost estimates are only for comparative and general planning purposes. These estimates may involve approximate quantity evaluations. Note that these quantity estimates are not intended to be sufficiently accurate to develop construction bids, or to predict the actual cost of work addressed in this Report. Further, since we have no control over either when the work will take place or the labor and material costs required to plan and execute the anticipated work, our cost estimates were made by relying on our experience, the experience of others, and other sources of readily available information. Actual costs may vary over time and could be significantly more, or less, than stated in the Report.

ADDITIONAL SERVICES

12. GZA recommends that we be retained to provide services during any future: site observations, design, implementation activities, construction and/or property development/redevelopment. This will allow us the opportunity to: i) observe conditions and compliance with our design concepts and opinions; ii) allow for changes in the event that conditions are other than anticipated; iii) provide modifications to our design; and iv) assess the consequences of changes in technologies and/or regulations.

Appendix B – Boring Logs

TEST BORING LOG

GZA GeoEnvironmental, Inc.
Engineers and Scientists

Woodard and Curran
Old Sudbury Road Culverts
Sudbury, MA

EXPLORATION NO.: B-1 (Culvert 149)
SHEET: 1 of 1
PROJECT NO: 04.0191167.00
REVIEWED BY: MA

Logged By: D. Shaffer
Drilling Co.: New England Boring Contractors
Foreman: P. Schofield

Type of Rig: Truck
Rig Model: MB-48
Drilling Method: Drive & Wash

Boring Location: See Plan
Ground Surface Elev. (ft.): 120.5
Final Boring Depth (ft.): 31
Date Start - Finish: 11/17/2020 - 11/17/2020

H. Datum: NAD83
V. Datum: NAVD88

Hammer Type: Automatic Hammer
Hammer Weight (lb.): 140
Hammer Fall (in.): 30
Auger or Casing O.D./I.D Dia (in.): 4

Sampler Type: SS
Sampler O.D. (in.): 2
Sampler Length (in.): 24
Rock Core Size: None

Groundwater Depth (ft.)

Date	Time	Water Depth	Stab. Time
11/17/2020	1:12 p.m.	8.96	10 min.
11/17/2020	1:27 p.m.	9.19	25 min

Depth (ft)	Casing Blows/ Core Rate	Sample No.	Sample Depth (ft.)	Sample Pen. (in)	Sample Rec. (in)	Sample Blows (per 6 in.)	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Stratum Depth (ft.)	Stratum Description	Stratum Elev. (ft.)
										0.8	ASPHALT	119.7
		S-1	0.8-2.0	15	13	26 37	S-1: Very dense, brown, fine to coarse SAND, some Clayey Silt, little Gravel, moist.					
		S-2	2-4	24	14	50/3"		1				
						15 15	S-2: Medium dense, brown, fine to coarse SAND, some Silt, trace Gravel, moist.					
5						7 5					FILL	
10		S-3	9-11	24	12	4 2	S-3: Very loose, gray, fine SAND, some Silt, little Gravel, wet.					
						1 1		2		11.2		109.3
											POSSIBLE PEAT	
										13		107.5
15		S-4	14-16	24	12	5 9	S-4: Medium dense, gray, fine SAND, some Silt, wet.					
						7 7		3				
20		S-5	19-21	24	14	7 10	S-5: Medium dense, brown, fine SAND, some Silt, wet.					
						12 13					SAND	
25		S-6	24-26	24	15	3 5	S-6: Medium dense, gray, fine SAND, some Silt, wet.					
						5 6						
30		S-7	29-31	24	12	5 6	S-7: Medium dense, gray, fine SAND, some Silt, wet.	4				
						7 11				31		89.5
							End of exploration at 31 feet.					

REMARKS

1 - The ground surface elevation at the this test boring location is based on interpolation of topographic contours shown on Figure 2 - Exploration Location Plan. Elevations shown are in feet and refer to NAVD 1988 from the provided site plans.
2 - A color change from gray to black was observed during drilling in wash water between 11.2 feet and 13 feet below ground surface (b.g.s).
3 - Drilling difficulty increased at approximately 15 feet b.g.s.
4 - Test boring was terminated at approximately 31 feet b.g.s. Borehole was backfilled with drill cuttings upon completion.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

Exploration No.: B-1 (Culvert 149)

TEST BORING LOG

GZA GeoEnvironmental, Inc.
Engineers and Scientists

Woodard and Curran
Old Sudbury Road Culverts
Sudbury, MA

EXPLORATION NO.: B-2 (Culvert 149)
SHEET: 1 of 1
PROJECT NO: 04.0191167.00
REVIEWED BY: MA

Logged By: D. Shaffer
Drilling Co.: New England Boring Contractors
Foreman: P. Schofield

Type of Rig: Truck
Rig Model: MB-48
Drilling Method: Drive & Wash

Boring Location: See Plan
Ground Surface Elev. (ft.): 120.5
Final Boring Depth (ft.): 25
Date Start - Finish: 11/17/2020 - 11/17/2020

H. Datum: NAD83
V. Datum: NAVD88

Hammer Type: Automatic Hammer
Hammer Weight (lb.): 140
Hammer Fall (in.): 30
Auger or Casing O.D./I.D Dia (in.): 4

Sampler Type: SS
Sampler O.D. (in.): 2
Sampler Length (in.): 24
Rock Core Size: None

Groundwater Depth (ft.)

Date	Time	Water Depth	Stab. Time
11/17/2020	3:38 p.m.	8.08	10 min.

Depth (ft)	Casing Blows/ Core Rate	Sample No.	Sample Depth (ft.)	Sample Pen. (in)	Sample Rec. (in)	Sample Blows (per 6 in.)	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Stratum Depth (ft.)	Stratum Description	Stratum Elev. (ft.)
										0.7	ASPHALT	119.8
		S-1	0.7-2.1	17	11	28 35 50/5"	S-1: Very dense, brown, fine to coarse SAND, some Clayey Silt, little Gravel, moist.	1				
5		S-2	4-6	24	5	12 10 6 3	S-2: Medium dense, brown, fine to coarse SAND, some Gravel, some Silt, moist.				FILL	
10		S-3	9-11	24	5	19 6 5 5	S-3: A: (Top 3-inches) Medium dense, brown, fine to coarse SAND, some Silt, little Gravel, wet. S-3 B: (Bottom 2-inches) Medium dense, black, fine grained PEAT, wet.			10.6		109.9
										12.5	PEAT	108.0
15		S-4	14-16	24	13	7 9 12 12	S-4: Medium dense, gray, fine SAND, some Silt, wet.				SAND	
20		S-5	19-21	24	13	5 8 10 10	S-5: Medium dense, gray, fine SAND, some Silt, wet.					
		S-6	21-23	24	19	11 9 10 10	S-6: Medium dense, gray, fine SAND, some Silt, wet.	2				
25		S-7	23-25	24	22	5 4 5 6	S-7: Loose, gray, fine SAND, some Silt, wet.			25		95.5
							End of exploration at 25 feet.					
30												

REMARKS

1 - The ground surface elevation at the this test boring location is based on interpolation of topographic contours shown on Figure 2 - Exploration Location Plan. Elevations shown are in feet and refer to NAVD 1988 from the provided site plans.
2 - Test boring was terminated at approximately 25 feet below ground surface (b.g.s). Borehole was backfilled with drill cuttings upon completion.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

Exploration No.: B-2 (Culvert 149)

TEST BORING LOG

GZA GeoEnvironmental, Inc.
Engineers and Scientists

Woodard and Curran
Old Sudbury Road Culverts
Sudbury, MA

EXPLORATION NO.: B-3 (Culvert 110)
SHEET: 1 of 1
PROJECT NO: 04.0191167.00
REVIEWED BY: MA

Logged By: M. Alihodzic
Drilling Co.: New England Boring Contractors
Foreman: P. Schofield

Type of Rig: Truck
Rig Model: MB-48
Drilling Method: HSA

Boring Location: See Plan
Ground Surface Elev. (ft.): 232.0
Final Boring Depth (ft.): 15.1
Date Start - Finish: 12/11/2020 - 12/11/2020

H. Datum: NAD83
V. Datum: NAVD88

Hammer Type: Automatic Hammer
Hammer Weight (lb.): 140
Hammer Fall (in.): 30
Auger or Casing O.D./I.D Dia (in.): 2.25

Sampler Type: SS
Sampler O.D. (in.): 2
Sampler Length (in.): 24
Rock Core Size: None

Groundwater Depth (ft.)

Date	Time	Water Depth	Stab. Time
12/11/2020	10:37 a.m.	7.41	15 min.

Depth (ft)	Casing Blows/ Core Rate	Sample No.	Sample Depth (ft.)	Sample Pen. (in)	Sample Rec. (in)	Sample Blows (per 6 in.)	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Stratum Depth (ft.)	Stratum Description	Stratum Elev. (ft.)
										0.8	ASPHALT	231.2
		S-1	1-3	24	20	24 22 23 24	S-1: Very dense, gray fine to coarse SAND, some Silt, little Gravel, dry.	1			FILL	
										4		228.0
5		S-2	4-6	24	12	70 10 12 14	S-2: A: (Top 6-inches) Dense, black, fine grained PEAT, some Sand, wet.	2		5	PEAT	227.0
		S-3	6-8	24	20	12 21 21 23	S-2 B: (Bottom 6-inches) Dense, gray, fine to medium SAND, some Silt, wet. S-3: Dense, gray, fine to coarse SAND, some Silt, little Gravel, wet.					
		S-4	8-10	24	24	15 24 66 36	S-4: Very dense, gray, fine to coarse SAND, some Silt, little Gravel, wet.				SAND	
10												
15		S-5	14-14.7	8	8	23 50/2"	S-5: Very dense, gray, fine to coarse SAND, some Silt, little Gravel, wet.	3		15.1		216.9
							End of exploration at 15.1 feet.	4				
20												
25												
30												

REMARKS

1 - The ground surface elevation at the this test boring location is based on interpolation of topographic contours shown on Figure 3 - Exploration Location Plan. Elevations shown are in feet and refer to NAVD 1988 from the provided site plans.
2 - Cobbles and/or boulders were encoutered during drilling from approximately 5 to 15 feet b.g.s.
3 - Test boring was terminated at approximately 15.1 feet below ground surface (b.g.s).
4 - Auger refusal encoutered at approximately 15.1 feet b.g.s. Borehole was backfilled with drill cuttings upon completion.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

Exploration No.: B-3 (Culvert 110)

Appendix C – Laboratory Test Results

THIELSCH ENGINEERING
195 Frances Avenue
Cranston RI, 02910
Phone: (401)-467-6454
Fax: (401)-467-2398
thielsch.com
Let's Build a Solid Foundation

Client Information:
GZA GeoEnvironmental
Bedford, NH
PM: Mirsad Alihodzic
Assigned By: Mirsad Alihodzic
Collected By: Dylan S.

Project Information:
Old Sudbury Rd. Culvert
Sudbury, MA
GZA Project Number: 04.0191167.00
Summary Page: 1 of 1
Report Date: 12.15.2020

LABORATORY TESTING DATA SHEET, Report No.: 7420-L-169, Rev.1

Boring No.	Sample No.	Depth (Ft)	Laboratory No.	Identification Tests								Proctor / CBR / Permeability Tests								Laboratory Log and Soil Description
				As Received Water Content %	LL %	PL %	Gravel %	Sand %	Fines %	Org. %	G_s	Dry unit wt. pcf	Test Water Content %	γ_d MAX (pcf) W_{opt} (%)	γ_d MAX (pcf) W_{opt} (%) (Corr.)	Target Test Setup as % of Proctor	CBR @ 0.1"	CBR @ 0.2"	Permeability cm/sec	
				D2216	D4318		D6913			D2974	D854			D1557						
B-1	S-2	4-6	20-S-3594	15.4			10.6	60.4	29.0											Brown f-c SAND, some Clayey Silt, little fine Gravel
B-1	S-4	14-16	20-S-3595	21.1			0.0	69.7	30.3											Gray fine SAND, some Silt
B-2	S-3B	9-11	20-S-3596	110						19.1										Fine Grained Peat
B-2	S-5	19-21	20-S-3597	27.1			0.0	70.9	29.1											Light Brown fine SAND, some Silt

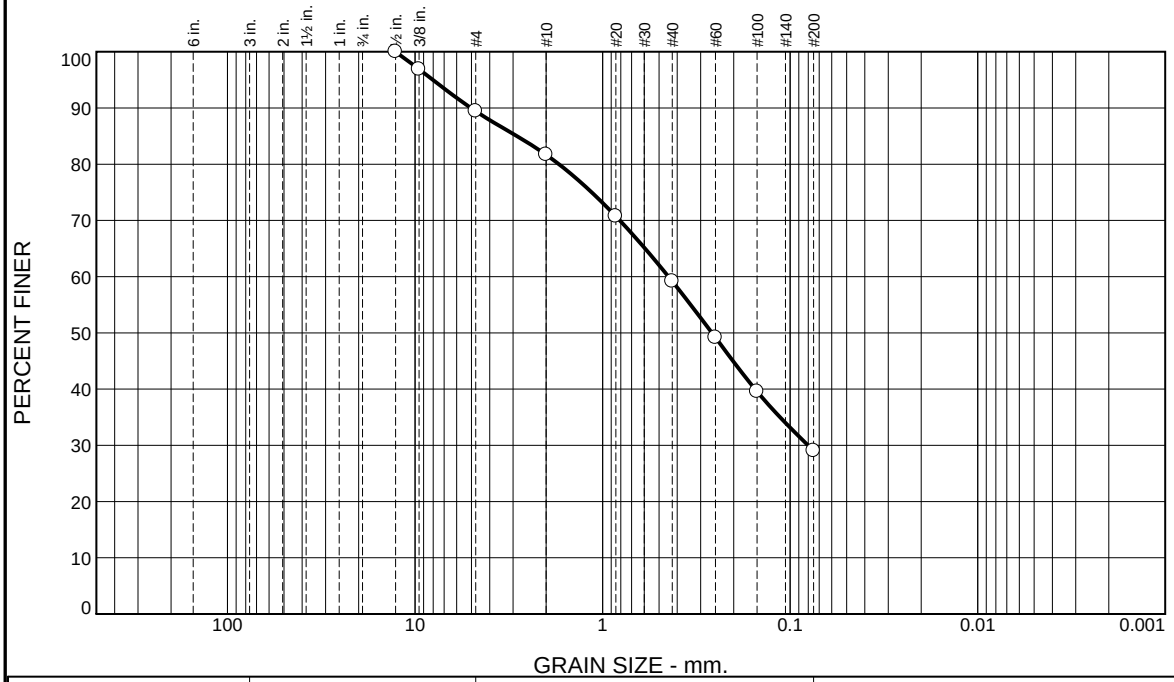
Organic Content test completed by JM on 11.25.2020.

Date Received: *11.23.2020*

Reviewed By:

Date Reviewed: *12.15.2020*

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	10.6	7.7	22.5	30.2	29.0	

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
0.5"	100.0		
0.375"	96.9		
#4	89.4		
#10	81.7		
#20	70.7		
#40	59.2		
#60	49.2		
#100	39.6		
#200	29.0		

* (no specification provided)

Material Description

Brown f-c SAND, some Clayey Silt, little fine Gravel

Atterberg Limits (ASTM D 4318)

PL= **LL=** **PI=**

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 5.0301 D_{85}= 2.8658 D_{60}= 0.4453
D_{50}= 0.2611 D_{30}= 0.0803 D_{15}=
D_{10}= C_u= C_c=

Remarks

Sample visually classified as plastic. Sample rolled to 1/4".

Date Received: 11.23.2020 **Date Tested:** 11.30.2020

Tested By: JM

Checked By: Steven Accetta

Title: Laboratory Coordinator

Source of Sample: Boring **Depth:** 4-6' **Date Sampled:**
Sample Number: B-1 / S-2

Thielsch Engineering Inc.

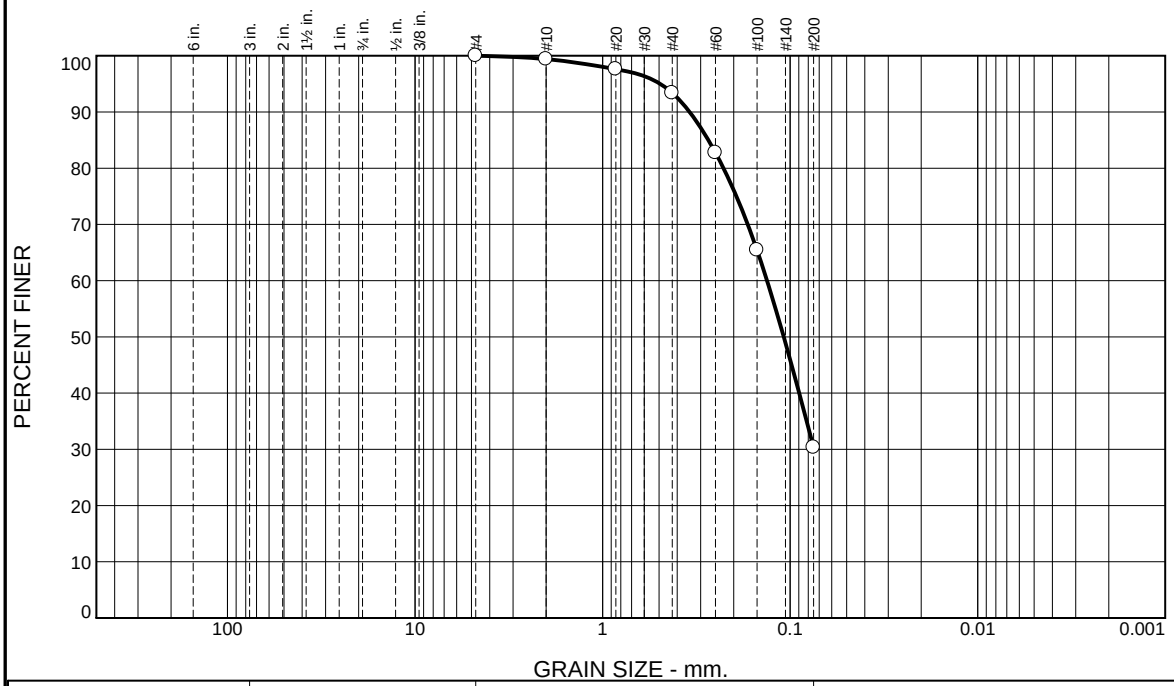
Cranston, RI

Client: GZA GeoEnvironmental

Project: Old Sudbury Rd Culvert
Sudbury, MA

Project No: 04.0191167.00 **Figure** 20-S-3594

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.6	6.0	63.1	30.3	

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100.0		
#10	99.4		
#20	97.6		
#40	93.4		
#60	82.8		
#100	65.4		
#200	30.3		

* (no specification provided)

Material Description

Gray fine SAND, some Silt

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 0.3432 D_{85}= 0.2728 D_{60}= 0.1327
D_{50}= 0.1082 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Sample visually classified as non-plastic.

Date Received: 11.23.2020 **Date Tested:** 11.30.2020

Tested By: JM

Checked By: Steven Accetta

Title: Laboratory Coordinator

Source of Sample: Boring **Depth:** 14-16' **Date Sampled:**
Sample Number: B-1 / S-4

Thielsch Engineering Inc.

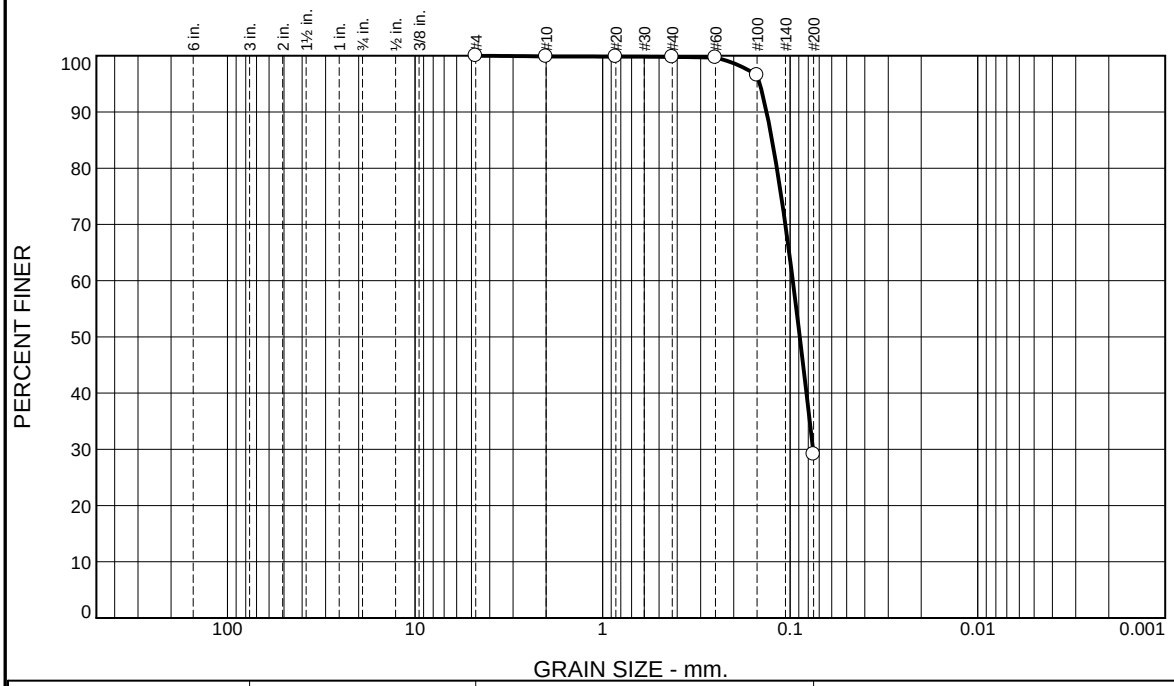
Cranston, RI

Client: GZA GeoEnvironmental

Project: Old Sudbury Rd Culvert
Sudbury, MA

Project No: 04.0191167.00 **Figure** 20-S-3595

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	0.1	70.7	29.1	

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100.0		
#10	99.9		
#20	99.8		
#40	99.8		
#60	99.7		
#100	96.5		
#200	29.1		

* (no specification provided)

Material Description

Light Brown fine SAND, some Silt

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 0.1334 D_{85}= 0.1247 D_{60}= 0.0968
D_{50}= 0.0889 D_{30}= 0.0755 D_{15}=
D_{10}= C_u= C_c=

Remarks

Sample visually classified as non-plastic.

Date Received: 11.23.2020 **Date Tested:** 11.30.2020

Tested By: JM

Checked By: Steven Accetta

Title: Laboratory Coordinator

Source of Sample: Boring **Depth:** 19-21' **Date Sampled:**
Sample Number: B-2 / S-5

Thielsch Engineering Inc.

Cranston, RI

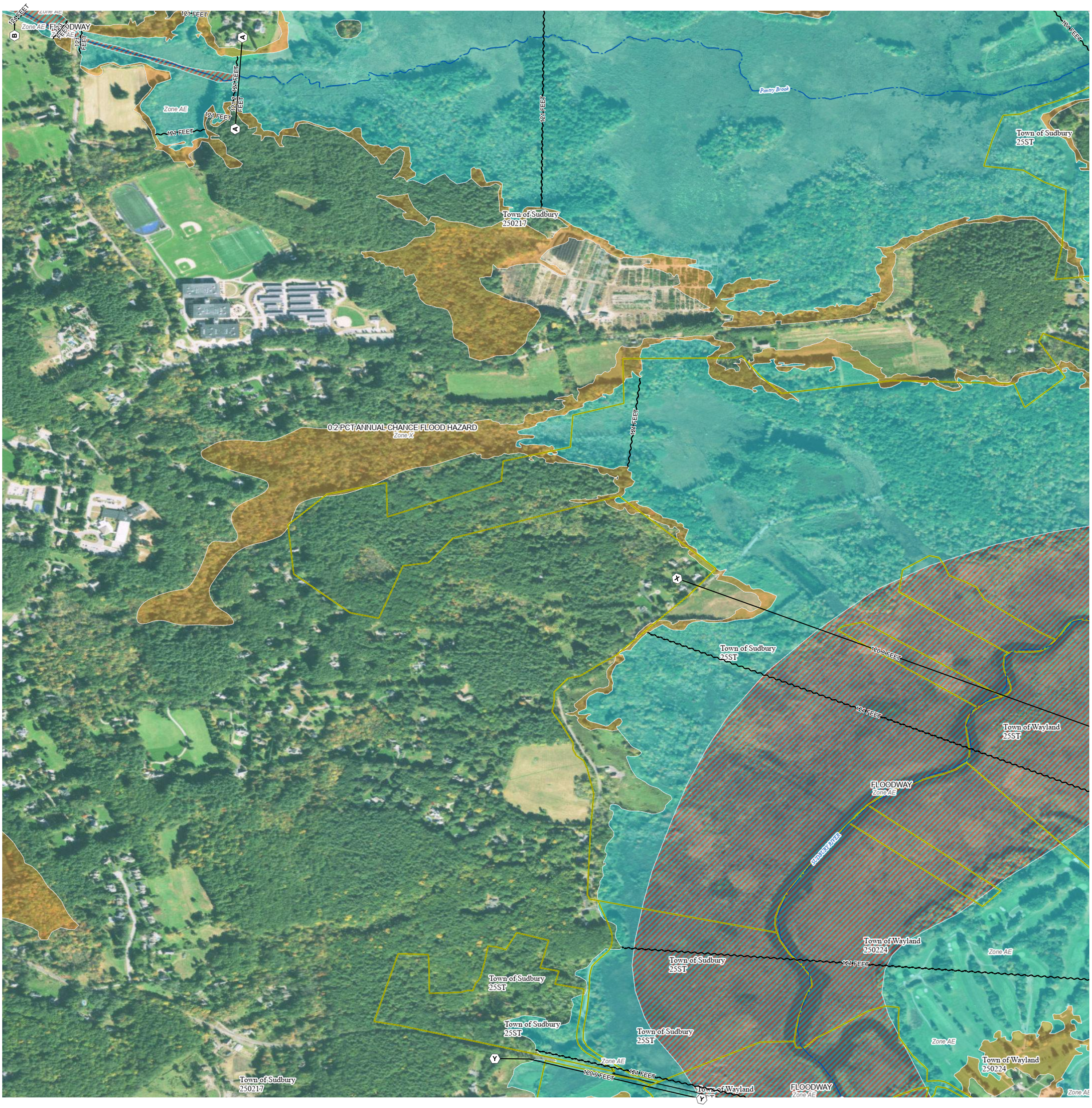
Client: GZA GeoEnvironmental

Project: Old Sudbury Rd Culvert
Sudbury, MA

Project No: 04.0191167.00 **Figure** 20-S-3597

ATTACHMENT D: FEMA FIRM PANEL

71°24'22.93"W 42°24'29.12"N



USGS The National Map: Orthoimagery. Data refreshed October, 2020.

71°22'29.58"W 42°22'23.44"N

FLOOD HAZARD INFORMATION

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

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

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

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

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

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

NOTES TO USERS

For information and questions about this Flood Insurance Rate Map (FIRM), available products associated with this FIRM, including historic versions, the current map date for each FIRM panel, how to order products, or the National Flood Insurance Program (NFIP) in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Flood Map Service Center website at https://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Flood Map Service Center at the number listed above.

For community and countywide map dates, refer to the Flood Insurance Study Report for this jurisdiction.

To determine if flood insurance is available in this community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

Basemap information shown on this FIRM was provided in digital format by USDA, Farm Service Agency (FSA). This information was derived from NAIP, dated April 11, 2018.

This map was exported from FEMA's National Flood Hazard Layer (NFHL) on **12/6/2020 5:13 PM** and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time. For additional information, please see the Flood Hazard Mapping Updates Overview Fact Sheet at https://www.fema.gov/media-library/assets/documents/118418

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards. This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date.

SCALE

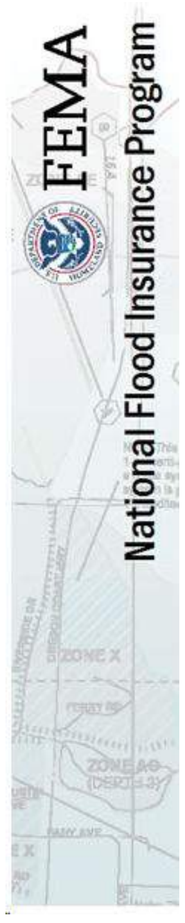
Map Projection:
GCS, Geodetic Reference System 1980;
Vertical Datum: NAVD88
For information about the specific vertical datum for elevation features, datum conversions, or vertical monuments used to create this map, please see the Flood Insurance Study (FIS) Report for your community at https://msc.fema.gov

N

1 inch = 500 feet 1:6,000

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

0 50 100 200 300 400 Meters



NATIONAL FLOOD INSURANCE PROGRAM

FLOOD INSURANCE RATE MAP

MIDDLESEX COUNTY, MASSACHUSETTS ALL JURISDICTIONS

PANEL 369 OF 654

Panel Contains:

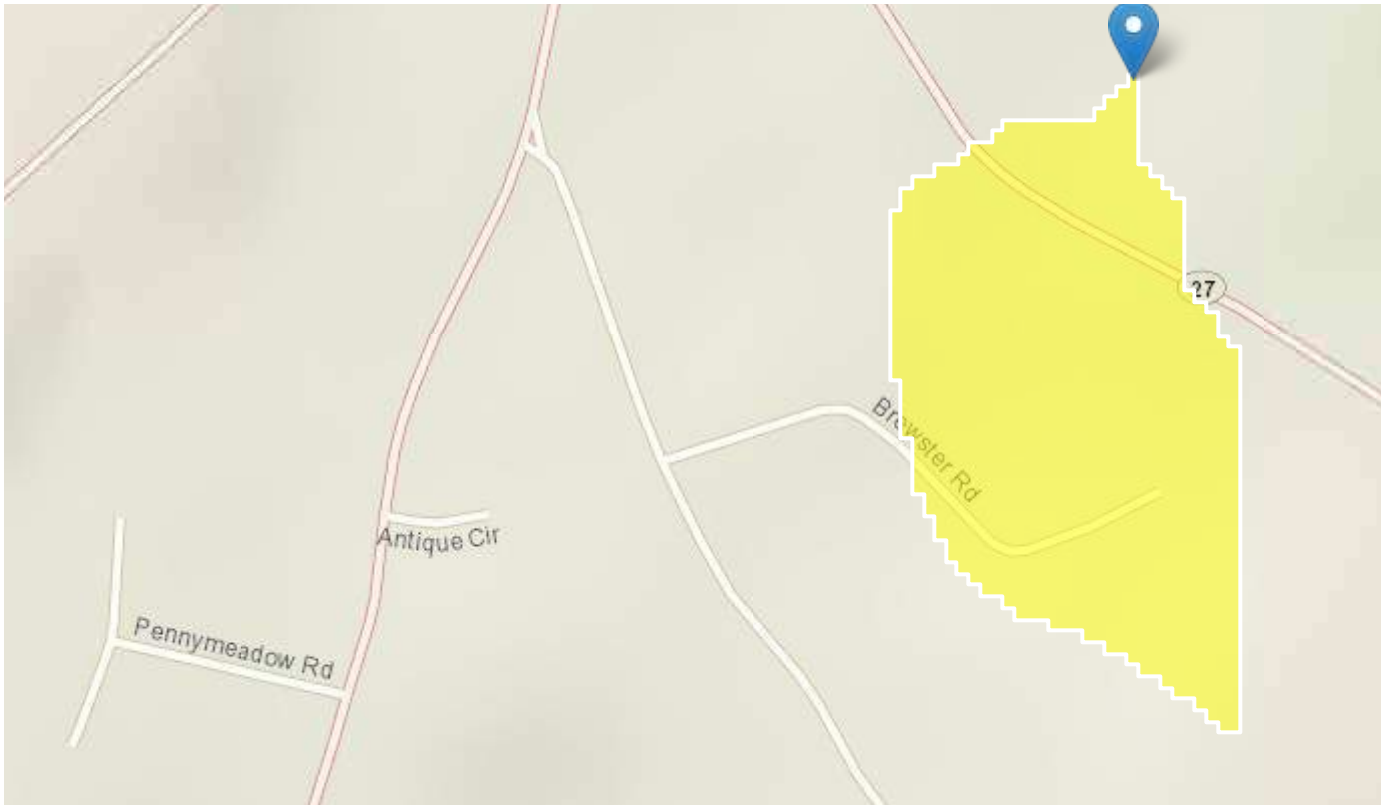
COMMUNITY	NUMBER	PANEL
TOWN OF SUDBURY	250217	0369
TOWN OF WAYLAND	250224	0369

MAP NUMBER
25017C0369F
EFFECTIVE DATE
July 07, 2014

ATTACHMENTS E1 AND E2 – STREAMSTATS REPORTS, CULVERT #110 & CULVERT #149

StreamStats Report

Region ID: MA
Workspace ID: MA20201216183229601000
Clicked Point (Latitude, Longitude): 42.38085, -71.40703
Time: 2020-12-16 13:32:45 -0500



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	0.0474	square miles
PCTSNDGRV	Percentage of land surface underlain by sand and gravel deposits	0	percent
FOREST	Percentage of area covered by forest	65.64	percent
MAREGION	Region of Massachusetts 0 for Eastern 1 for Western	0	dimensionless
ELEV	Mean Basin Elevation	253	feet
LC06STOR	Percentage of water bodies and wetlands determined from the NLCD 2006	4.89	percent

Parameter Code	Parameter Description	Value	Unit
BSLDEM10M	Mean basin slope computed from 10 m DEM	7.16	percent

Probability Statistics Parameters[Perennial Flow Probability]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.0474	square miles	0.01	1.99
PCTSNDGRV	Percent Underlain By Sand And Gravel	0	percent	0	100
FOREST	Percent Forest	65.64	percent	0	100
MAREGION	Massachusetts Region	0	dimensionless	0	1

Probability Statistics Flow Report[Perennial Flow Probability]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PC
Probability Stream Flowing Perennially	0.15	dim	71

Probability Statistics Citations

Bent, G.C., and Steeves, P.A.,2006, A revised logistic regression equation and an automated procedure for mapping the probability of a stream flowing perennially in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2006–5031, 107 p. (http://pubs.usgs.gov/sir/2006/5031/pdfs/SIR_2006-5031rev.pdf)

Peak-Flow Statistics Parameters[Peak Statewide 2016 5156]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.0474	square miles	0.16	512
ELEV	Mean Basin Elevation	253	feet	80.6	1948
LC06STOR	Percent Storage from NLCD2006	4.89	percent	0	32.3

Peak-Flow Statistics Disclaimers[Peak Statewide 2016 5156]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Peak-Flow Statistics Flow Report[Peak Statewide 2016 5156]

Statistic	Value	Unit
2 Year Peak Flood	3.63	ft^3/s
5 Year Peak Flood	6.31	ft^3/s
10 Year Peak Flood	8.53	ft^3/s
25 Year Peak Flood	11.8	ft^3/s
50 Year Peak Flood	14.6	ft^3/s
100 Year Peak Flood	17.6	ft^3/s
200 Year Peak Flood	20.9	ft^3/s
500 Year Peak Flood	25.7	ft^3/s

Peak-Flow Statistics Citations

Zarriello, P.J.,2017, Magnitude of flood flows at selected annual exceedance probabilities for streams in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2016–5156, 99 p. (https://dx.doi.org/10.3133/sir20165156)

Bankfull Statistics Parameters[Bankfull Statewide SIR2013 5155]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.0474	square miles	0.6	329
BSLDEM10M	Mean Basin Slope from 10m DEM	7.16	percent	2.2	23.9

Bankfull Statistics Disclaimers[Bankfull Statewide SIR2013 5155]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Bankfull Statistics Flow Report[Bankfull Statewide SIR2013 5155]

Statistic	Value	Unit
Bankfull Width	4.53	ft
Bankfull Depth	0.395	ft
Bankfull Area	1.75	ft^2
Bankfull Streamflow	3.73	ft^3/s

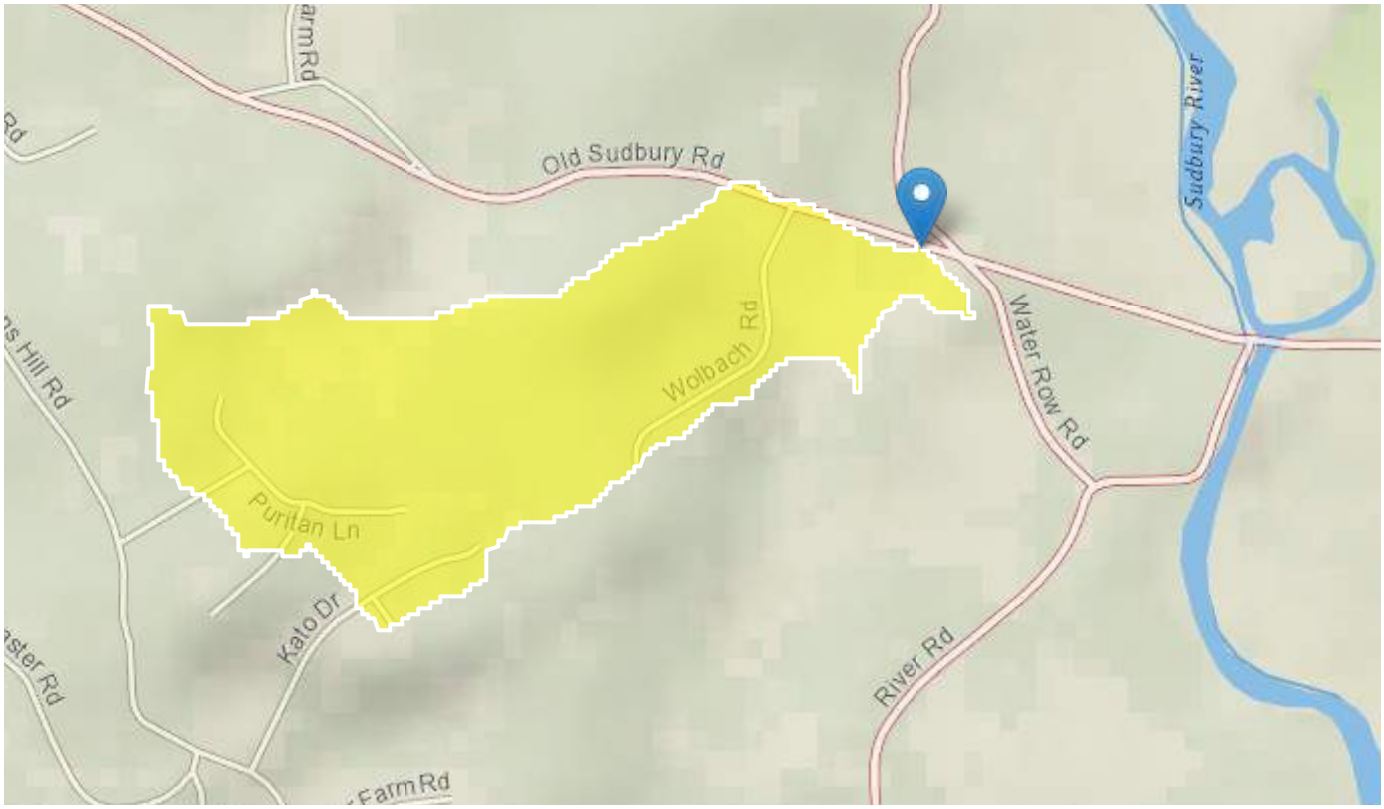
Bankfull Statistics Citations

Bent, G.C., and Waite, A.M.,2013, Equations for estimating bankfull channel geometry and discharge for streams in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2013–5155, 62 p., (http://pubs.usgs.gov/sir/2013/5155/)

Application Version: 4.4.0

Culvert 149 - StreamStats Report

Region ID: MA
Workspace ID: MA20201206220028441000
Clicked Point (Latitude, Longitude): 42.37568, -71.38910
Time: 2020-12-06 17:00:45 -0500



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	0.2	square miles
ELEV	Mean Basin Elevation	244	feet
LC06STOR	Percentage of water bodies and wetlands determined from the NLCD 2006	1.28	percent
BSLDEM10M	Mean basin slope computed from 10 m DEM	9.223	percent
PCTSNDGRV	Percentage of land surface underlain by sand and gravel deposits	9.3	percent
FOREST	Percentage of area covered by forest	56.19	percent

Parameter Code	Parameter Description	Value	Unit
MAREGION	Region of Massachusetts 0 for Eastern 1 for Western	0	dimensionless

Peak-Flow Statistics Parameters[Peak Statewide 2016 5156]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.2	square miles	0.16	512
ELEV	Mean Basin Elevation	244	feet	80.6	1948
LC06STOR	Percent Storage from NLCD2006	1.28	percent	0	32.3

Peak-Flow Statistics Flow Report[Peak Statewide 2016 5156]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
2 Year Peak Flood	12.6	ft^3/s	6.32	25.1	42.3
5 Year Peak Flood	21.5	ft^3/s	10.6	43.6	43.4
10 Year Peak Flood	28.8	ft^3/s	13.8	59.9	44.7
25 Year Peak Flood	39.5	ft^3/s	18.3	85.3	47.1
50 Year Peak Flood	48.4	ft^3/s	21.7	108	49.4
100 Year Peak Flood	58.1	ft^3/s	25.2	134	51.8
200 Year Peak Flood	68.7	ft^3/s	28.8	164	54.1
500 Year Peak Flood	84.2	ft^3/s	33.6	211	57.6

Peak-Flow Statistics Citations

Zarriello, P.J.,2017, Magnitude of flood flows at selected annual exceedance probabilities for streams in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2016–5156, 99 p. (https://dx.doi.org/10.3133/sir20165156)

Bankfull Statistics Parameters[Bankfull Statewide SIR2013 5155]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.2	square miles	0.6	329
BSLDEM10M	Mean Basin Slope from 10m DEM	9.223	percent	2.2	23.9

Bankfull Statistics Disclaimers[Bankfull Statewide SIR2013 5155]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Bankfull Statistics Flow Report[Bankfull Statewide SIR2013 5155]

Statistic	Value	Unit
Bankfull Width	8.35	ft
Bankfull Depth	0.619	ft
Bankfull Area	5.08	ft^2
Bankfull Streamflow	13.4	ft^3/s

Bankfull Statistics Citations

Bent, G.C., and Waite, A.M.,2013, Equations for estimating bankfull channel geometry and discharge for streams in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2013–5155, 62 p., (http://pubs.usgs.gov/sir/2013/5155/)

Probability Statistics Parameters[Perennial Flow Probability]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.2	square miles	0.01	1.99
PCTSNDGRV	Percent Underlain By Sand And Gravel	9.3	percent	0	100
FOREST	Percent Forest	56.19	percent	0	100
MAREGION	Massachusetts Region	0	dimensionless	0	1

Probability Statistics Flow Report[Perennial Flow Probability]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PC
Probability Stream Flowing Perennially	0.503	dim	71

Probability Statistics Citations

Bent, G.C., and Steeves, P.A.,2006, A revised logistic regression equation and an automated procedure for mapping the probability of a stream flowing perennially in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2006–5031, 107 p. (http://pubs.usgs.gov/sir/2006/5031/pdfs/SIR_2006-5031rev.pdf)

Application Version: 4.4.0

ATTACHMENTS F1 AND F2 – CULVERT ANALYSIS REPORTS, CULVERT #110 & CULVERT #149

PCSWMM Report

Sudbury110

Model Sudbury_110.inp

January 27, 2021

Table of Contents

Summary 1: Options

Name	Sudbury_110
Flow Units	CFS
Infiltration method	Horton
Flow routing method	Dynamic Wave
Link offsets defined by	Depth
Allow ponding	No
Skip steady flow periods	No
Inertial dampening	Partial
Define supercritical flow by	Both
Force Main Equation	H-W
Variable time step	On
Adjustment factor (%)	75
Conduit lengthening (s)	0
Minimum surface area (ft²)	0
Starting date	Dec-16-2020 12:00:00 AM
Ending date	Dec-17-2020 12:00:00 AM
Duration of simulation (hours)	24
Antecedent dry days (days)	0
Rain interval (h:mm)	0:06
Report time step (h:mm:ss)	00:01:00
Wet time step (h:mm:ss)	00:05:00
Dry time step (h:mm:ss)	00:05:00
Routing time step (s)	5
Minimum time step used (s)	0.93
Average time step used (s)	5
Minimum conduit slope	0
Ignore rainfall/runoff	No
Ignore snow melt	No
Ignore groundwater	No
Ignore flow routing	No
Ignore water quality	No
Report average results	No

Summary 2: Model inventory

Name	Sudbury_110
Raingages	1
Subcatchments	1
Aquifers	0
Snowpacks	0
RDII hydrographs	0
Junction nodes	0
Outfall nodes	2
Flow divider nodes	0
Storage unit nodes	1
Conduit links	1
Pump links	0
Orifice links	0
Weir links	1
Outlet links	0
Treatment units	0
Transects	0
Control rules	0
Pollutants	0
Land Uses	0
Control Curves	0
Diversion Curves	0
Pump Curves	0
Rating Curves	0
Shape Curves	0
Storage Curves	0
Tidal Curves	0
Weir Curves	0
Time Series	1
Time Patterns	0

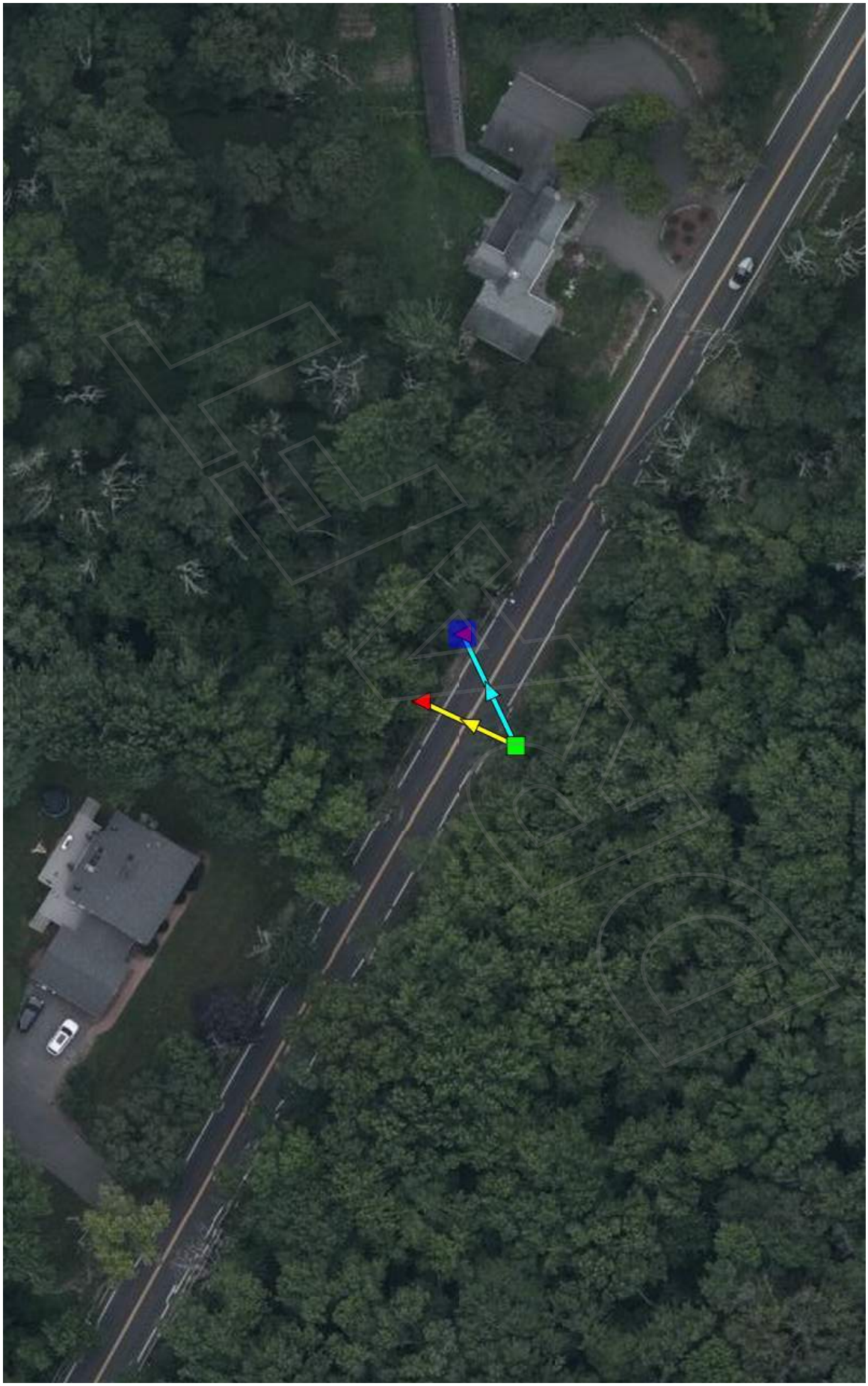


Figure 1: Extent 1

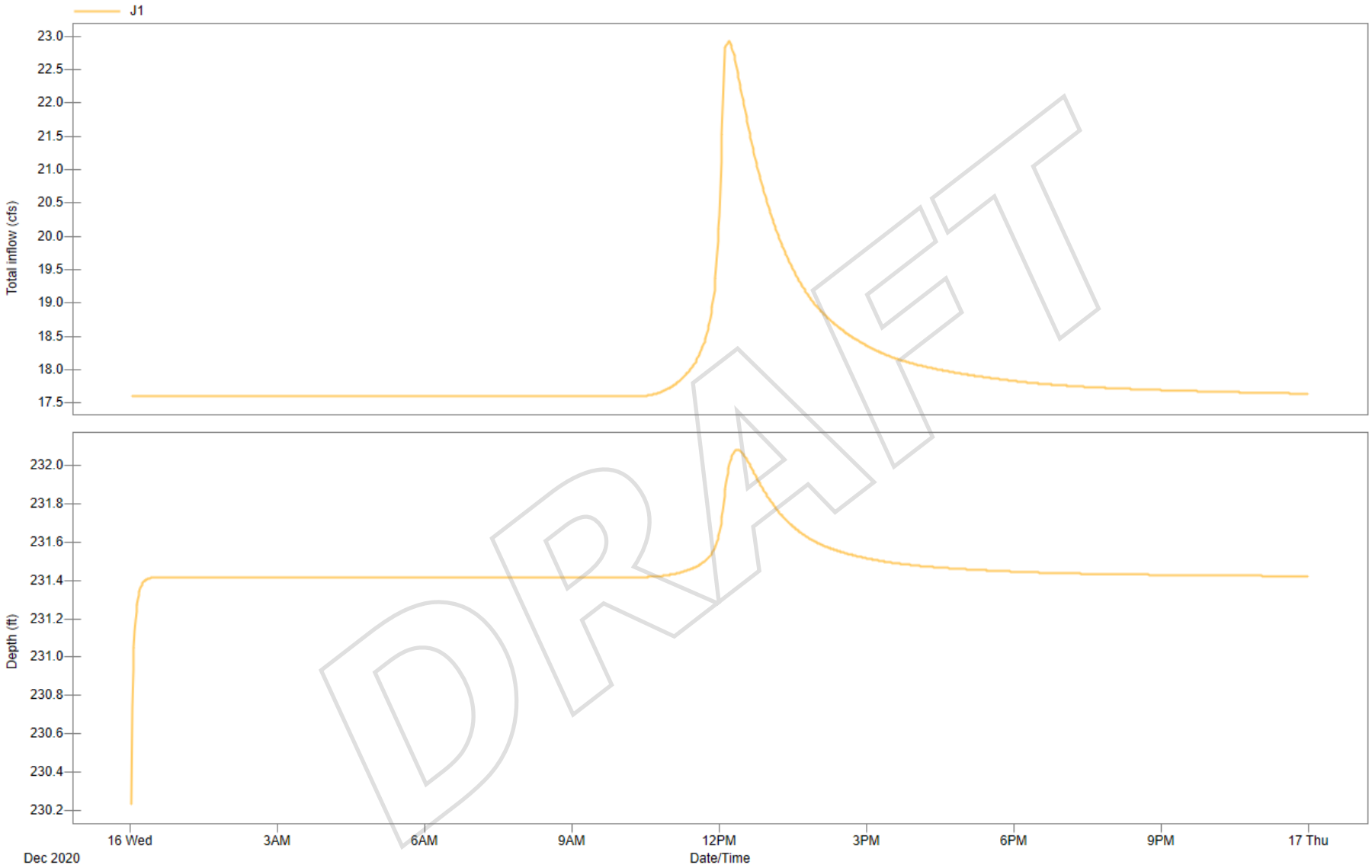


Figure 2: UpstreamWSE

HEC-RAS Plan: Alt3 River: River 1 Reach: Reach 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1	420	1_PCTAC	58.30	112.33	121.01		121.01	0.000000	0.04	2057.60	280.90	0.00
Reach 1	420	2_PCTAC	48.60	112.33	120.57		120.57	0.000000	0.04	1933.64	280.90	0.00
Reach 1	420	4_PCTAC	39.60	112.33	120.05		120.05	0.000000	0.04	1786.38	280.90	0.00
Reach 1	420	10_PCTAC	28.90	112.33	118.53		118.53	0.000000	0.03	1358.77	280.90	0.00
Reach 1	326	1_PCTAC	58.30	112.43	121.01		121.01	0.000000	0.04	2406.27	352.20	0.00
Reach 1	326	2_PCTAC	48.60	112.43	120.57		120.57	0.000000	0.04	2250.85	352.20	0.00
Reach 1	326	4_PCTAC	39.60	112.43	120.05		120.05	0.000000	0.03	2066.21	352.20	0.00
Reach 1	326	10_PCTAC	28.90	112.43	118.53		118.53	0.000000	0.03	1530.05	352.20	0.00
Reach 1	247	1_PCTAC	58.30	112.31	121.01	114.53	121.01	0.000002	0.23	696.13	308.90	0.01
Reach 1	247	2_PCTAC	48.60	112.31	120.57	114.46	120.57	0.000002	0.25	559.80	308.90	0.02
Reach 1	247	4_PCTAC	39.60	112.31	120.05	114.39	120.05	0.000004	0.29	397.77	308.90	0.02
Reach 1	247	10_PCTAC	28.90	112.31	118.53	114.12	118.53	0.000002	0.16	282.80	308.90	0.01
Reach 1	214		Bridge									
Reach 1	181	1_PCTAC	58.30	112.04	121.00		121.00	0.000001	0.16	1008.22	477.80	0.01
Reach 1	181	2_PCTAC	48.60	112.04	120.50		120.50	0.000001	0.16	775.75	433.57	0.01
Reach 1	181	4_PCTAC	39.60	112.04	120.00		120.00	0.000000	0.10	568.04	407.45	0.01
Reach 1	181	10_PCTAC	28.90	112.04	118.50		118.50	0.000000	0.10	433.06	402.06	0.01
Reach 1	152	1_PCTAC	58.30	110.79	121.00		121.00	0.000000	0.06	2182.61	393.40	0.00
Reach 1	152	2_PCTAC	48.60	110.79	120.50		120.50	0.000000	0.05	1988.44	375.53	0.00
Reach 1	152	4_PCTAC	39.60	110.79	120.00		120.00	0.000000	0.04	1807.27	347.91	0.00
Reach 1	152	10_PCTAC	28.90	110.79	118.50		118.50	0.000000	0.05	1302.18	332.25	0.00
Reach 1	107	1_PCTAC	58.30	112.38	121.00	113.18	121.00	0.000000	0.08	1612.97	359.10	0.00
Reach 1	107	2_PCTAC	48.60	112.38	120.50	113.11	120.50	0.000000	0.08	1433.42	359.10	0.00
Reach 1	107	4_PCTAC	39.60	112.38	120.00	113.03	120.00	0.000000	0.07	1253.88	359.10	0.00
Reach 1	107	10_PCTAC	28.90	112.38	118.50	112.93	118.50	0.000000	0.09	740.82	320.49	0.01
Reach 1	87		Bridge									
Reach 1	65	1_PCTAC	58.30	112.10	121.00		121.00	0.000000	0.07	1687.97	367.60	0.00
Reach 1	65	2_PCTAC	48.60	112.10	120.50		120.50	0.000000	0.07	1504.16	367.60	0.00
Reach 1	65	4_PCTAC	39.60	112.10	120.00		120.00	0.000000	0.06	1320.37	367.60	0.00
Reach 1	65	10_PCTAC	28.90	112.10	118.50		118.50	0.000000	0.09	768.96	367.60	0.01
Reach 1	31	1_PCTAC	58.30	112.16	121.00		121.00	0.000000	0.04	2983.47	436.70	0.00
Reach 1	31	2_PCTAC	48.60	112.16	120.50		120.50	0.000000	0.03	2765.12	436.70	0.00
Reach 1	31	4_PCTAC	39.60	112.16	120.00		120.00	0.000000	0.03	2546.77	436.70	0.00
Reach 1	31	10_PCTAC	28.90	112.16	118.50		118.50	0.000000	0.03	1891.72	436.70	0.00
Reach 1	1	1_PCTAC	58.30	111.89	121.00	112.88	121.00	0.000000	0.03	3703.86	564.40	0.00
Reach 1	1	2_PCTAC	48.60	111.89	120.50	112.73	120.50	0.000000	0.03	3422.92	554.33	0.00
Reach 1	1	4_PCTAC	39.60	111.89	120.00	112.62	120.00	0.000000	0.02	3149.32	537.18	0.00
Reach 1	1	10_PCTAC	28.90	111.89	118.50	112.50	118.50	0.000000	0.02	2352.48	527.15	0.00

Attachment: Seed Specifications

New England Conservation/Wildlife Mix
The New England Conservation/Wildlife Mix provides a permanent cover of grasses, forbs, wildflowers, legumes and grasses to provide both good erosion control and wildlife habitat value. This mix is designed to be a no maintenance seeding, and it is appropriate for cut and fill slopes, detention basins, and disturbed areas adjacent to commercial and residential projects.

Application Rate: 25 LBS/ACRE (1750 SQ. FT./LB)

Price: $30.00/LB**

Species *: Big Bluestem (*Andropogon gerardii*), Switchgrass (*Panicum virgatum*), Little Bluestem (*Schizachyrium scoparium*), Canada Wild Rye (*Elymus canadensis*), Fox Sedge (*Carex vulpinoidea*), Partridge Pea (*Chamaecrista fasciculata*), Fringed Bromegrass (*Bromus ciliatus*), Pennsylvania Smartweed (*Polygonum pensylvanicum*), Common Milkweed (*Asclepias syriaca*), Showy Tick-Trefoil (*Desmodium canadense*), New England Aster (*Aster novae-angliae*), Flat-top Aster (*Aster umbellatus*), Nodding Bur-Marigold (*Bidens cernua*).

New England Erosion Control/Restoration Mix for Detention Basins and Moist Sites
The New England Erosion Control/Restoration Mix contains a selection of native grasses and wildflowers designed to colonize generally moist, recently disturbed sites where quick growth of vegetation is desired to stabilize the soil surface. It is an excellent seed mix for ecologically appropriate restorations on moist sites that require quick stabilization as well as long-term establishment of native vegetation. This mix is particularly appropriate for detention basis that do not normally hold standing water. The plants in this mix can tolerate infrequent inundation, but not constant flooding.

Seeding: The mix may be applied by hydroseeding, by mechanical spreader, or on small sites it can be spread by hand. When applying on bare soil, rake the soil to create grooves, apply seed, then lightly rake over. In New England, the best results are obtained with a Spring or early Fall seeding. Summer and late Fall seeding will benefit with a light mulching of weed-free straw to conserve moisture. Late Fall and Winter dormant seeding require a slight increase in the seeding rate. Fertilization is not required unless the soils are particularly infertile.

Application Rate: 35 LBS/ACRE (1250 SQ. FT./LB.)

Price: $26.00/LB**

Species *: Switchgrass (*Panicum virgatum*), Virginia Wild Rye (*Elymus virginicus*), Creeping Red Fescue (*Festuca rubra*), Fox Sedge (*Carex vulpinoidea*), Creeping Bentgrass (*Agrostis stolonifera*), Soft Rush (*Juncus effusus*), New England Aster (*Aster novae-angliae*), Grass-leaved Goldenrod (*Euthamia graminifolia*), Nodding Bur Marigold (*Bidens cernua*), Green Bulrush (*Scirpus atrovirens*), Joe-Pye Weed (*Eupatorium maculatum*), Boneset (*Eupatorium perfoliatum*), Blue Vervain (*Verbena hastata*).