J2950-11-01
February 28, 2022

Ms. Julianne Busa, PhD, SE
Fuss & O'Neill, Inc.
1550 Main Street, Suite 400
Springfield, Massachusetts 01103

Re: Preliminary Geotechnical Engineering Evaluation Report
Queensville Dam Removal Feasibility Study
South Hadley, Massachusetts

Dear Ms. Busa:

O'Reilly, Talbot & Okun Associates, Inc. (OTO) is pleased to provide the results of our preliminary soil investigations, a discussion of geotechnical considerations, and preliminary recommendations for the proposed Queensville Dam Removal Project.

We understand that the feasibility study considers the removal of the existing dam and the construction of a bridge (which would be subject to the Massachusetts General Laws (MGL) Chapter 85, Section 35 Review Process for Municipal Bridge Projects). We note that the results of our preliminary investigations, and recommendations associated with culvert replacements along Joffre and Mountain Avenues, are presented under separate cover.

The existing dam is located on Buttery Brook to the west of Titus Pond on Newton Street (Route 116) in South Hadley, Massachusetts. A Site Locus is provided as Figure 1. A Site Plan is provided as Figure 2. Our preliminary geotechnical investigations consisted of one soil boring, which was performed to the west of the existing dam embankment. The location of the boring was chosen due to access restrictions at the time of our investigations. Our services consisted of the full-time observation of the boring, review of the log and soil samples, engineering analyses, and preparation of this report. This report is subject to the attached limitations.

This discussion of subsurface conditions, geotechnical considerations, and preliminary recommendations for bridge foundations and other construction related issues. Foundation alternatives considered included shallow foundations (spread footings) and deep foundations (driven piles). The recommended type of foundation will be dependent of final structure size and type, subsurface conditions, dimensions and loading conditions. Based upon our current understanding of these factors, we anticipate that the most suitable foundation system will be driven piles deriving their capacity from side friction and/or end bearing in dense soils or on bedrock.

Additional investigations will be required during final design, and the number and depth of these investigations will be dependent on the proposed structure. In addition, a final design report will be required.

## INTRODUCTION

We understand that a feasibility study is on-going for the removal of the Queensville Dam, which is located on Buttery Brook at the west end of Titus Pond in South Hadley, Massachusetts. The location of the Site area is shown on the Project Locus Map, attached as Figure 1. This report provides a discussion of preliminary geotechnical considerations and engineering recommendations for foundation design of a bridge that would be constructed to replace the dam embankment.

The area consists of a dam embankment between Newton Street (Route 116) and Titus Pond. An existing intake structure is located at the western end of the pond. The outfall structure consists of a 24-inch diameter reinforced concrete pipe, which runs beneath Newton Street and towards wetlands located to the west of Newton Street. Topography along the roadway is relatively flat, between 164 and 167 feet, and the existing pipe inverts are between elevations 143.99 (west side or outlet) and 160.20 feet (east side or intake). Topography slopes downward to the east towards Titus Pond and to the west, behind the 7-eleven building and towards the wetland. The approximate location of the existing dam and associated structures are shown on the Boring Location Plan, attached as Figure 2.

Preliminary plans include the replacement of the existing dam embankment and associated structures with a bridge. The exact location, alignment, and size of the bridge is unknown at the time of this report.

## PRELIMINARY SUBSURFACE EXPLORATIONS

Preliminary subsurface investigations consisted of one soil boring (QD-3). The boring was performed on October 22, 2021 by Seaboard Drilling of Chicopee, Massachusetts, using a Mobile B-53 truck mounted drill rig and roller bit with wash drilling techniques. The boring was performed to the west of Newton Street, within a landscaped area. Borings could not be performed on the eastern edge of the road, due to overhead utilities and the presence of other structures (guardrails). The boring was terminated at a depth of 44 feet (corresponding to an elevation of 121 feet) below ground surface. The boring location is shown on Figure 2. The boring log is attached.

Soil samples were collected continuously from the ground surface to a depth of 14 feet, at a depth of 15 feet, and every five feet thereafter. Soil samples were collected using a two-inch diameter split spoon sampler, driven 24 inches with a 140-pound automatic hammer falling 30 inches (American Society for Testing and Materials Test Method D1586 “Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils”). The number of blows required to drive the sampler each six inches was recorded. The standard penetration resistance, or N-value, is the number of blows required to drive the sampler the middle 12 inches. Soil properties, such as strength and density, are related to the N-value. The field N-values are corrected to a standard 60% hammer efficiency, known as $N_{60}$, to account for differing hammer efficiencies for each hammer type and drill rig.

An O'Reilly, Talbot & Okun Associates, Inc. (OTO) engineer observed and logged the boring. Samples were described according to a modified version of the Burmister Soil Classification System. Upon completion, the bore hole was backfilled with soil cuttings.

## SUBSURFACE CONDITIONS

Subsurface conditions were interpreted based upon conditions encountered in the soil boring and as reviewed in published documents. In general, subsurface conditions consisted of fill/reworked Site soils; native varved clay; and glacial till. Details are provided below.

### Local Geology

The surficial geology map[1] indicates the presence of fine-grained soils with granular material located nearby. Geologically, the Site is located within the former Lake Hitchcock, which was a large post-glacial lake that formerly covered much of the Connecticut River Valley. The lake was present following the final retreat of the continental glaciers (which once covered all of New England) until about 14,000 years ago, when a natural dam that formed the southern edge of the lake in Connecticut was eroded and the lake drained. Lake sediments consist of thin, interbedded lenses of silt and clay (collectively known as varved clay), which were deposited at the bottom of the lake. The lake bottom deposits along the edges of the lake often contained significant amounts of sand. Published geologic maps[2] indicate that the lake bottom deposits at the Site are on the order of 100 feet thick. However, the subsurface investigation performed for this study indicate that the varved clay only extend to a depth of approximately 40 feet below ground surface in the vicinity of the boring.

According to published documents[3], bedrock at the Site likely consists of Arkose from the Portland Formation, which is a "reddish-brown to pale red arkose and siltstone, and gray sandstone, gray siltstone, and black shale".

### Soil Conditions

We note that the boring was performed outside the limits of the existing roadway, on the opposite side of the roadway from the pond due to the presence of utilities and guardrails. Therefore, we were unable to measure the thickness of the existing pavement or gravel base layer. The location of the preliminary boring was chosen based upon the access agreements with the town and adjacent property owners. The boring was located near the existing culvert location.

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[1] Stone, J.R. and DiGiacomo-Cohen, M.L. (2018). "Surficial Materials Map of the Belchertown Quadrangle, Massachusetts", USGS Open-File Report 2006-1260-G (Sheet 16 of 24).
[2] Langer, W.H. (1979). "Map Showing Distribution and Thickness of the Principal Fine-Grained Deposits, Connecticut Valley Urban Area, Central New England", *Miscellaneous Investigations* Series, USGS Map No. 1-1074-C, Sheet 1 of 2.
[3] Zen, E., Editor (1983). "Bedrock Geologic Map of Massachusetts" USGS and Massachusetts Department of Public Works.

_Fill/Reworked Site Soils_: Approximately 20 to 25 feet of fill was encountered starting at the ground surface. The upper five feet of the fill layer generally consisted of very loose to loose, fine to medium sand, with little to trace amounts of coarse sand, trace amounts of gravel, and little amounts of silt. Trace organics (roots) were encountered within the fill layer in the upper four feet and trace amounts of debris (brick, coal) was encountered within the fill in the upper two feet. Granular soils were encountered beneath the upper loose none engineered fill layer. These lower soils consist of a very loose, fine to medium sand with varying amounts of coarse sand, silt, and gravel. Layers of very soft, clayey silt and very loose, silt with about 10 to 20% fine to medium sand or fine sand and silt were encountered below a depth of approximately 14 feet. These lowery layers appear to be reworked native soils likely placed during the initial construction of the dam, culvert and roadway. Trace amounts of organics (roots, branches) were encountered throughout the upper 25 feet. Lesser thicknesses of fill and/or reworked soils may be located further from the existing culvert; however additional investigations would be needed to confirm subsurface profiles.

_Varved Silt & Clay_: The Site is located within the limits of the ancestral Lake Hitchcock, which filled much of the Connecticut River Valley from the retreat of the last continental glacier until approximately 14,000 years ago. The soil deposit associated with the glacial lake consists of alternating layers of silt, sand, and clay (collectively known as varved clay).

The varved silt and clay at this Site consisted of soft to medium, clay and silt or silt and clay with trace amounts of fine sand, which is consistent with former bottom of lake deposits in the area. The top of the varved clay layer was estimated to be approximately 22 to 25 feet below ground surface (corresponding to an elevation near 143 feet). We note that because the thickness of fill may be variable the depth to the top of the varved silt and clay may vary significantly across the Site.

_Glacial Till_: Sandy glacial till was encountered at a depth of 40 feet below ground surface (corresponding to elevation 125 feet). Glacial till is a very dense, heterogeneous mixture of silt, clay, sand and gravel, and is generally present immediately above bedrock throughout New England. Boring QD-3 encountered roller bit refusal within the glacial till at a depth of 44 feet upon likely dense glacial till. The thickness of the glacial till layer and the depth to bedrock is unknown at this time.

### Groundwater Conditions

Water was first encountered at a depth of 10.5 feet below ground surface (corresponding to elevation 154.5 feet) at boring location QD-3. The elevation appears consistent with the water levels observed in Titus Pond at the time of drilling.

We expect that groundwater will be encountered during the replacement of the dam and construction of the bridge. The level of the water in Titus Pond will likely be dependent on the time of year and upon weather conditions. In addition, the water level at the time the dam is removed, and the new structure is constructed the groundwater level may be lower (draining of the pond). We recommend that this issue be evaluated in detail during the final design and that the installation of groundwater observation wellpoint be considered during final design to determine water levels and aid in the design of dewatering systems. Additional information is provided below.

**GEOTECHNICAL CONSIDERATIONS AND PRELIMINARY RECOMMENDATIONS**

The following recommendations are provided for preliminary foundation design. Foundations will be designed to resist lateral and vertical loads. Vertical loads consist of downward pressures due to the dead weight of the bridge and live traffic loads, as well as uplift pressures due to overturning loads (such as seismic forces). Other factors such as wind loads should be minor. All foundations should be designed according to requirements provided in the 2013 MassDOT *Bridge Manual* (MassDOT) and the 2017 AASHTO *LRFD Bridge Design Specifications* (AASHTO).

Design details for the new bridge or the dam embankment were not available at the time of this preliminary report. We understand that a traditional short to medium span steel or concrete bridge structure is being considered. The new bridge would likely be supported on driven piles deriving their capacity in dense soils or bedrock present at a depth of 50 feet or more below ground surface.

<u>Embankment Considerations</u>

We recommend that stability of embankment slopes be reviewed during final design. We have assumed that any side slopes of the channel below the bridge will be armored to protect against erosion. Provided the earthwork recommendations provided below are followed, side slopes at 2H:1V or flatter should be stable. However, we recommend that global stability of slopes be reviewed during final design.

<u>Deep Foundations</u>

Based upon the anticipated structure and soil profile, it appears that a deep foundation system will be most economical and technically acceptable alternative for this project. We assume that the deep foundation system for the new bridge would consist of driven piles. The driven piles would fully penetrate the near surface soils and should derive their capacity from side friction and/or end bearing in glacial till or bedrock. We anticipate that the piles would be on the order of 50 to 75 feet in depth; however, additional investigations will be needed for final design. It is typical to perform a minimum of two borings at each bridge abutment. Since subsurface can vary, we recommend that the owner include an allowance for the length (depth) of pile installation.

Supporting the bridge on shallow foundations bearing in the soft varved silt and clay is not technically feasible due to scour and settlement concerns. Assuming the piles terminate in the dense glacial till or in bedrock, the settlement of the bridge should be tolerable. Lateral forces will be dissipated through the piles and through earth pressures along the side of abutments and the pile cap. If a pile foundation is utilized, it is recommended that the capacity of the pile be confirmed in the field using a Pile Driving Analyzer (PDA).

Additional investigations, along with anticipated loading conditions, would be needed to estimate a preliminary pile size.

Seismic Design Category Evaluation

Earthquake loadings must be considered under requirements of the 2013 MassDOT *Bridge Manual*, with 2020 Revisions (MassDOT) and the most recent edition of the AASHTO *LRFD Bridge Design Specifications* (AASHTO).

Section 3.4 of MassDOT covers seismic analysis and design. Lateral forces generated during a seismic event are dependent on the type and properties of soils present beneath the Site as well as geographic location. The *USGS Seismic Design Maps*[4] web service was used to determine seismic parameters for the Site. The peak ground acceleration (PGA), as well as the maximum considered earthquake spectral response accelerations for short periods ($S_s$) and for one-second ($S_1$) were determined to be 0.059, 0.13, and 0.038, respectively, for South Hadley, Massachusetts.

Soil properties are represented through Site Classification. Procedures for the Site-specific determination of Site Classification are provided in Article 3.10.3.1 of AASHTO. At this Site, we evaluated Site Classification using Standard Penetration Resistance (SPT N-value) and field estimation of shear strength of fine-grained soils via a pocket torvane field testing device. The Site Class was determined to be Class E for based upon soil data collected. This classification should be reviewed during final design.

Liquefaction Potential

The potential for liquefaction was evaluated for the Site soils beneath the groundwater table. Based upon conditions encountered in the soil borings, liquefaction of the native, varved clay soils is unlikely to occur under the design earthquake. However, the saturated loose fill layer encountered in the upper 20 feet may be susceptible to liquefaction under the design earthquake.

## PRELIMINARY CONSTRUCTION CONSIDERATIONS

These recommendations are provided for preliminary review of the project and should be reviewed with consideration to final design of the project.

Groundwater and Surface Water Control

Groundwater was encountered in the upper 10.5 feet, corresponding to the approximate water level in Titus Pond. We note that the pond will likely be drained prior to construction. Therefore, groundwater levels should be lower at that time. Regardless dewatering/water control system will be required during construction. Any surface water runoff and groundwater infiltration encountered during the excavations will need to be controlled via a positive cutoff wall (such as a sheet pile wall, dewatering wells, or trenching and sumps).

[4] https://earthquake.usgs.gov/ws/designmaps/ accessed in December 2021.

We also anticipate that temporary water controls (such as cut off walls, temporary cofferdams, or bypass pumping) will be needed to divert water during construction. We recommend that careful consideration be given to groundwater control and water diversion during final design. We note that is important to keep excavations stable and dry. Supplemental investigations should consider the installation of a groundwater monitoring wellpoint to determine fluctuations and groundwater levels.

Excavations and Demolition of Existing Dam

Soil may become unstable when excavations extend deeper than four feet. Shoring or sloping will be necessary to protect personnel and to provide stability. The soils encountered in the upper 25 feet are estimated to be Type C soils for slope stability purposes. The maximum allowable slope for excavations of Class C soils is 1.5H: 1V (34°), provided the water levels are below the bottom of the excavation. All excavations should conform to current OSHA requirements.

In areas where sloping is not feasible, excavations will require temporary earth support systems during construction. The design of the temporary earth support systems should be the responsibility of the contractor. Additional consideration to earth support should be given during final design.

We understand that the existing dam embankment removed, and associated structures will be demolished. Existing structures (e.g., headwalls, abutments, piers, utilities) outside of the new foundation area should be removed to at least 24 inches below the final ground surface or the bottom of the new pavement section. Any excavations resulting from the removal of existing foundations, piles, abutments, utilities, or other structures should be backfilled with compacted engineered fill, consistent with the recommendations provided below.

Abandoned buried utilities containing asbestos (such as electrical conduit insulation or transite pipe) are commonly found during construction excavations. Furthermore, former structures (pipes, conduits, foundations) may contain or be covered with materials containing asbestos. Such materials should be handled in accordance with MassDEP asbestos regulations (310 CMR 7.15). We recommend that suspect materials be managed appropriately and tested by a Department of Labor Standards (DLS) certified asbestos inspector prior to disturbances.

Engineered Fill Recommendations

We anticipate that engineered fill will need to be imported for this project. It is unlikely that the near surface, existing fill or native soils will be suitable for reuse as engineered fill due to the high silt content, presence of organics, and variability in composition. Imported fill materials should be free of debris, organics, and other unsuitable materials and consistent with requirements with MassDOT engineered fill specifications. Additional earthwork considerations and recommendations should be provided during final design.

## FINAL DESIGN INVESTIGATIONS AND RECOMMENDATIONS

Final design investigations will be required. The scope of the design investigations will be dependent on the roadway functional class and the category of the proposed structure (span) as described in the MGL Chapter 85 Section 35 Review Process for Municipal Bridge Projects. We anticipate that final geotechnical design will require a geotechnical report and a design boring program in accordance with Part 1, Section 1.2 of the MassDOT Bridge Manual.

For a structure supported on piles, we recommend a minimum of three to four additional borings, so there are at least two borings at each abutment. If wingwalls extend to greater than 30 feet long, additional borings will be required (at the end of each wing wall). We anticipate that one boring at each abutment will be extended to bedrock to obtain a 10-foot-long core.

Soil samples should be collected of the varved clay soil layer in each boring, to establish a detailed profile. We recommend that selected samples be analyzed in the laboratory for soil properties such as: undrained shear strength, moisture content and Atterberg limits to aid in design of the pile system. Additional laboratory testing may be required to evaluate erodibility, hydraulic conductivity, and compressibility of the Site soils. In addition, we recommend that the installation of a groundwater observation wellpoint be considered during final design to determine water levels and aid in the design of dewatering systems.

If you have any questions, please do not hesitate to contact the undersigned.

Sincerely yours,
O'Reilly, Talbot & Okun Associates, Inc.

Ashley L. Sullivan P.E.
Principal

Michael J. Talbot, P.E.
Reviewer

Attachments: Limitations, Figures, Boring Log

# LIMITATIONS

1. The observations presented in this report were made under the conditions described herein. The conclusions presented in this report were based solely upon the services described in the report and not on scientific tasks or procedures beyond the scope of the project or the time and budgetary constraints imposed by the client. The work described in this report was carried out in accordance with the Statement of Terms and Conditions attached to our proposal.

2. The analysis and recommendations submitted in this report are based in part upon the data obtained from widely spaced subsurface explorations. The nature and extent of variations between these explorations may not become evident until construction. If variations then appear evident, it may be necessary to reevaluate the recommendations of this report.

3. The generalized soil profile described in the text is intended to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized and have been developed by interpretations of widely spaced explorations and samples; actual soil transitions are probably more erratic. For specific information, refer to the boring logs.

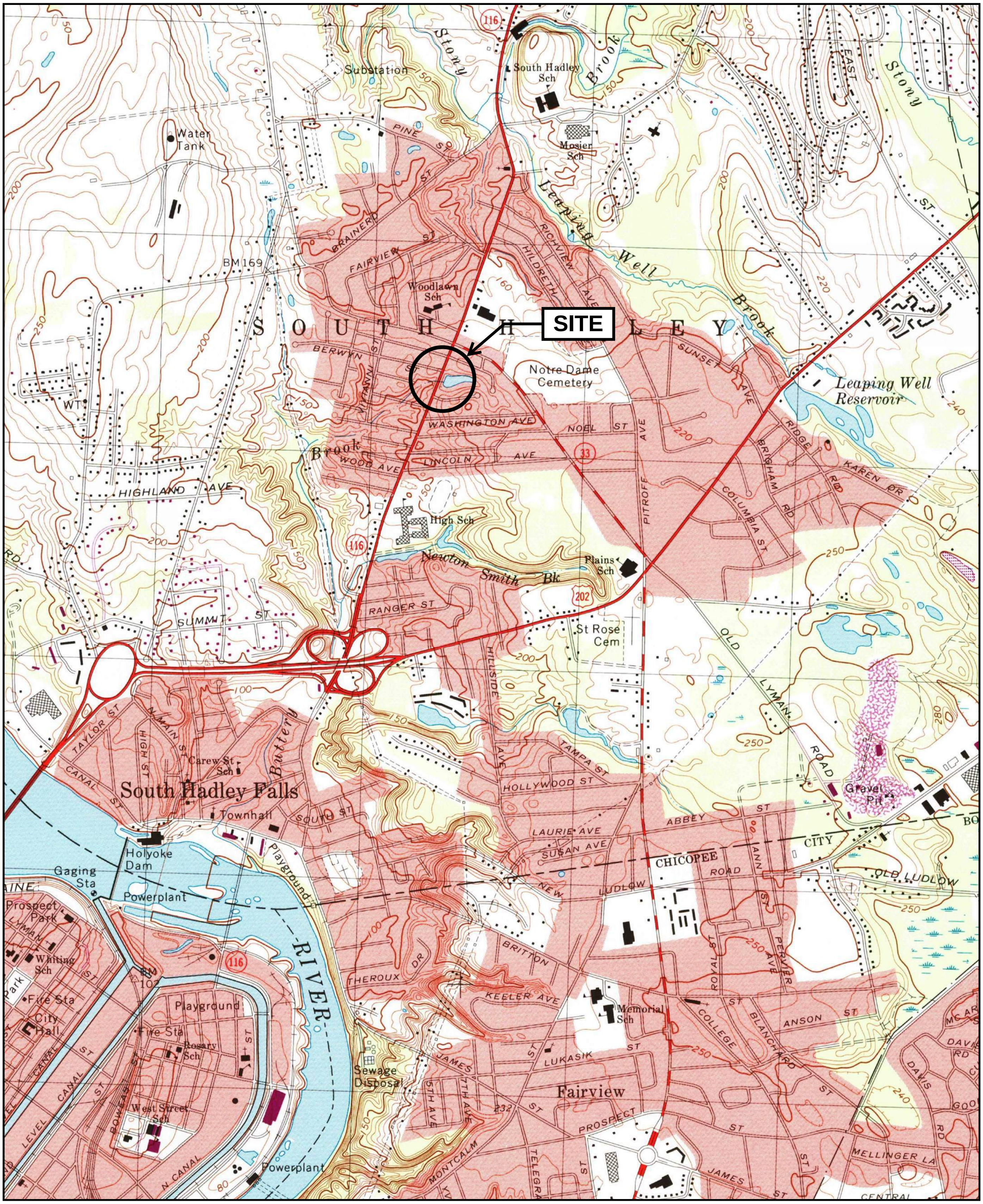
4. Observations were made of the site and site structures; however no opinion is rendered as to the condition of portions of the site or site structures where access was limited or unavailable.

5. The response of the watershed was analyzed for storm conditions stated herein. For other conditions other than those analyzed, the response of the watershed has not been evaluated.

6. In reviewing this report, the condition of the dam as reported is based upon observations of field conditions at the time of site visits, along with review of data available to O'Reilly Talbot & Okun Associates, Inc. It is critical to note that the condition of the dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

7. In the event that any changes in the nature, design or location of the proposed structures are planned, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and conclusions of this report modified or verified in writing by O'Reilly, Talbot & Okun Associates Inc. It is recommended that we be retained to provide a general review of final plans and specifications.

8. Our report was prepared for the exclusive benefit of our client. Reliance upon the report and its conclusions is not made to third parties or future property owners.




0 1000 FEET

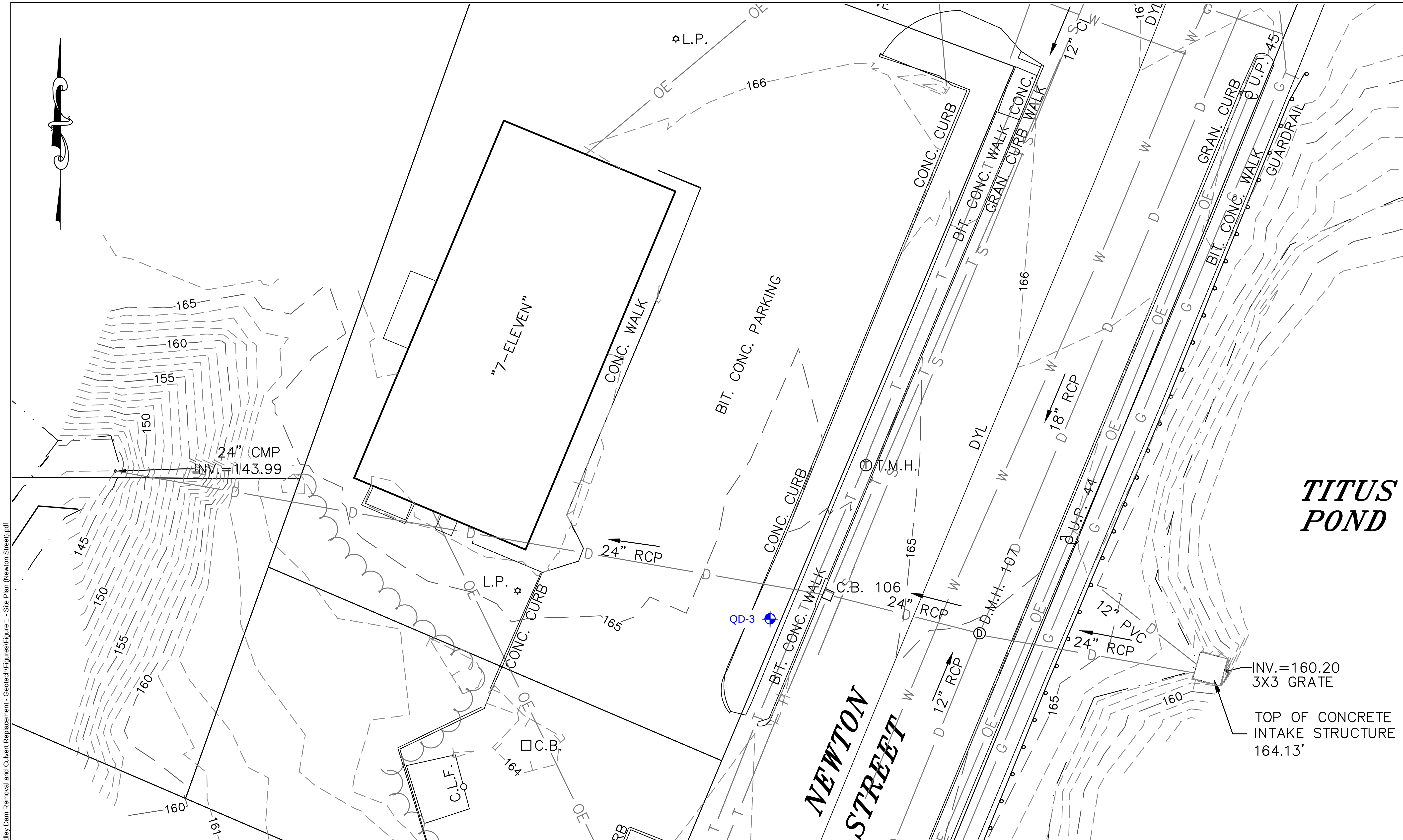
0 0.5 1.0 MILES

0 0.5 1 KILOMETERS

1:25,000 SCALE   NATIONAL GEODETIC VERTICAL DATUM 1929   10 FOOT CONTOUR INTERVAL

O:\J2900\2950 Fuss & O'Neill\11-01 South Hadley Dam Removal and Culvert Replacement - Geotech\Figures\Figure 1 - Site Locus.pdf

| | | | |
|---|---|---|---|
| O'Reilly, Talbot & Okun ENGINEERING ASSOCIATES<br>293 Bridge Street, Suite 500 Springfield, MA 01103 413.788.6222<br>www.OTO-ENV.com | QUEENSVILLE DAM REMOVAL FEASIBILITY STUDY<br>NEWTON STREET<br>SOUTH HADLEY, MASSACHUSETTS | Topographic Map Quadrant: SPRINGFIELD NORTH, MA<br>Map Version: 1972<br>Current As Of: 1979 | PROJECT No.<br>J2950-11-01 |
| | SITE LOCUS | Date: FEBRUARY 2022 | FIGURE No.<br>1 |




LEGEND:

APPROXIMATE SOIL BORING LOCATION PERFORMED BY SEABOARD DRILLING ON 10/22/2021, OBSERVED BY OTO

NOTES:

1. PLAN CREATED IN PART FROM PLAN TITLED "PARTIAL EXISTING CONDITIONS" SHEET 2 OF 4 BY SHERMAN & FRYDRYK DATED 1/24/2022.
2. SAMPLE LOCATIONS ARE SHOWN ACCORDING TO TAPED MEASUREMENTS TAKEN FROM EXISTING SITE FEATURES.
3. ALL DATA IS TO BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHODS USED IN THE DEVELOPMENT OF THIS PLAN.

SCALE IN FEET
1" = 20'
0' 10' 20' 40'


O'Reilly, Talbot & Okun
ENGINEERING ASSOCIATES
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www.OTO-ENV.com


DESIGNED BY: JE
DRAWN BY: JE
CHECKED BY:
DATE: 2/7/2022
REV. DATE:

QUEENSVILLE DAM REMOVAL FEASIBILITY STUDY
NEWTON STREET
SOUTH HADLEY, MASSACHUSETTS

SITE PLAN

PROJECT NO.
J2950-11-01

FIGURE NO.
2

O'Reilly, Talbot & Okun
ENGINEERING ASSOCIATES

# BORING LOGS

## SUMMARY OF THE BURMISTER SOIL CLASSIFICATION SYSTEM (MODIFIED)

***RELATIVE DENSITY (of nonplastic soils) OR CONSISTENCY (of plastic soils)***

**STANDARD PENETRATION TEST (SPT)**

**Method**: Samples were collected in accordance with ASTM D1586-99, using a 2" diameter split spoon sampler driven 24 inches. If samples were collected using direct push methodology (geoprobe), SPTs were not performed and relative density/consistency were not reported.
**N-Value**: The number of blows with a 140 lb. hammer required to drive the sampler the middle 12 inches.
**WOR**: Weight Of Rod (depth dependent)
**WOH**: Weight Of Hammer (140 lbs.)

| COHESIONLESS SOILS | | COHESIVE SOILS | |
|---|---|---|---|
| BLOWS/FOOT (SPT N-Value) | RELATIVE DENSITY | BLOWS/FOOT (SPT N-Value) | CONSISTENCY |
| 0-4 | Very loose | <2 | Very soft |
| 4-10 | Loose | 2-4 | Soft |
| 10-30 | Medium dense | 4-8 | Medium |
| 30-50 | Dense | 8-15 | Stiff |
| >50 | Very dense | 15-30 | Very stiff |
| *Based upon uncorrected field N-values | | >30 | Hard |

***MATERIAL: (major constituent identified in CAPITAL letters)***

| COHESIONLESS SOILS | | |
|---|---|---|
| MATERIAL | FRACTION | GRAIN SIZE RANGE |
| **GRAVEL** | Coarse | 3/4" to 3" |
| | Fine | 1/4" to 3/4" |
| **SAND** | Coarse | 1/16" to 1/4" |
| | Medium | 1/64" to 1/16" |
| | Fine | Finest visible & distinguishable particles |
| **SILT/CLAY** | see adjacent table | Cannot distinguish individual particles |
| **COBBLES** | 3" to 6" in diameter | |
| **BOULDERS** | > 6" in diameter | |

Note: Boulders and cobbles are observed in test pits and/or auger cuttings.

| COHESIVE SOILS | | |
|---|---|---|
| SMALLEST DIAMETER | PLASTICITY | IDENTITY |
| None | Nonplastic | **SILT** |
| 1/4" (pencil) | Slight | **Clayey SILT** |
| 1/8" | Low | **SILT & CLAY** |
| 1/16" | Medium | **CLAY & SILT** |
| 1/32" | High | **Silty CLAY** |
| 1/64" | Very High | **CLAY** |

Wetted sample is rolled in hands to smallest possible diameter before breaking.

**ORGANIC SILT**: Typically gray to dark gray, often has strong H2S odor. May contain shells or shell fragments. Light weight.
**Fibrous PEAT**: Light weight, spongy, mostly visible organic matter, water squeezed readily from sample. Typically near top of layer.
**Fine grained PEAT**: Light weight, spongy, little visible organic matter, water squeezed from sample. Typically below fibrous peat.
**DEBRIS**: Detailed contents described in parentheses (wood, glass, ash, crushed brick, metal, etc.)
**BEDROCK**: Underlying rock beneath loose soil, can be weathered (easily crushed) or competent (difficult to crush).

***ADDITIONAL CONSTITUENTS***

| TERM | % OF TOTAL |
|---|---|
| and | 35-50% |
| some | 20-35% |
| little | 10-20% |
| trace | 1-10% |

***COMMON TERMS***

**Glacial till**: Very dense/hard, heterogeneous mixture of sand, silt, clay, sub-angular gravel. Deposited at base of glaciers, which covered all of New England.

**Varved clay**: Fine-grained, post-glacial lake sediments characterized by alternating layers (or varves) of silt, sand and clay.

**Fill**: Material used to raise ground, can be engineered or non-engineered.

***COMMON FIELD MEASUREMENTS***

**Torvane**: Undrained shear strength is estimated using an E285 Pocket Torvane (TV). Values in tons/$ft^2$.
**Penetrometer**: Unconfined compressive strength is estimated using a Pocket Penetrometer (PP). Values in tons/$ft^2$.

**RQD**: Rock Quality Designation is determined by measuring total length of pieces of core 4" or greater and dividing by the total length of the run, expressed as %. 100-90% excellent; 90-75% good; 75-50% fair; 50-25% poor; 25-0% very poor.

**PID**: Soil screened for volatile organic compounds (VOCs) using a photoionization detector (PID) referenced to benzene in air. Readings in parts per million by volume.

O'Reilly, Talbot & Okun
ENGINEERING ASSOCIATES

# LOG OF BORING QD-3



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| PROJECT | Queensville Dam Removal and Culvert Replacements | | | CONTRACTOR | Seaboard Environmental Drilling | | |
| JOB NUMBER | 2950-11-01 | FINAL DEPTH (ft) | 44.0 | DRILLING EQUIPMENT | B-53 Truck Mounted Rig | | |
| LOCATION | South Hadley, MA | SURFACE ELEV (ft) | 165.0 | FOREMAN | Doug F. | CASING | |
| START DATE | 10/22/2021 | DISTURBED SAMPLES | 12 | HELPER | Jarrett S. | CASE DIAMETER | 4" |
| FINISH DATE | 10/22/2021 | UNDISTURBED SAMPLES | 1 | BIT TYPE | Roller Bit with Wash | HAMMER WGT | 300 lb |
| ENGINEER/SCIENTIST | Jhonatan Escobar | WATER LEVEL | | ROD TYPE | N (2 3/8" O.D.) | HAMMER DROP | 30" |
| BORING LOCATION | South of Existing Culvert Located on Route 116 | FIRST (ft) | 10.5 | SAMPLER | 2" O.D. Split Spoon | ROCK CORING INFORMATION | |
| | | LAST (ft) | -- | HAMMER TYPE | Automatic | TYPE | N/A |
| | | TIME (hr) | -- | HAMMER WGT/DROP | 140 lb / 30" | SIZE | N/A |

| DEPTH (ft)/ SAMPLES | SAMPLES: PENETR. RESIST. (bl / 6 in) | REC. (in) | TYPE/ NO. | FIELD TEST DATA | SAMPLE DESCRIPTION (MODIFIED BURMISTER) | PROFILE DEPTH (ft) ELEV. | REMARKS/ WELL CONSTRUCTION |
|---|---|---|---|---|---|---|---|
| | 2/3/5/2 | 9/24 | S-1 (0-2') | -- | Loose, dark brown, fine to medium SAND, trace coarse sand, trace gravel, trace organics (roots), little silt, trace debris (brick, coal), damp (FILL) | FILL/ REWORKED SOILS | |
| | 2/3/2/2 | 7/24 | S-2 (2-4') | -- | Loose, dark brown to black, fine to medium SAND, little coarse sand, trace gravel, trace organics (roots), little silt, damp (FILL) | | |
| 5' | 1/1/1/2 | 8/24 | S-3 (4-6') | -- | Top 4": Very loose, dark brown to black, fine to medium SAND, little coarse sand, trace gravel, little silt, damp (FILL)<br>Bottom 4": Very loose, brown, fine to medium SAND, trace silt, trace organics (roots, branch), damp | | |
| | 2/1/1/2 | 16/24 | S-4 (6-8') | -- | Very loose, brown, fine to medium SAND, trace silt, trace gravel, damp | | |
| | WOH 6"/1/1/1 | 2/24 | S-5 (8-10') | -- | Very loose, gray, fine SAND, some silt, damp | | |
| 10' | WOH 2' | 0/24 | S-6 (10-12') | -- | NO RECOVERY | ▽ 154.5 | |
| | 1/1 FOR 1'/1 | 12/24 | S-7 (12-14') | -- | Top 9": Very loose, brown, fine to medium SAND, trace coarse sand, trace gravel, trace silt, wet<br>Bottom 3": Very soft, gray, clayey SILT, trace fine to medium sand, wet | | |
| 15' | WOH 18"/1 | 9/24 | S-8 (15-17') | -- | Very loose, gray, SILT, little fine to medium sand, trace organics (wood, roots), wet | | |
| 20' | WOH 12"/2/3 | 14/24 | S-9 (20-22') | -- | Top 3": Very loose, gray, fine SAND and SILT, wet<br>Bottom 11": Very loose, black and gray, fine SAND and SILT, trace organics (wood, roots), wet | 22.0 143.0 | |
| | | | | | | VARVED CLAY | |
| 25' | 4/6/6/10 | 0/24 | S-10 (25-27') | -- | NO RECOVERY | | |

Remarks:
1. Undrained shear strength estimated in field using E285 Pocket Torvane (TV). Values in tons/$ft^2$.
2. Unconfined compressive strength estimated in field using Pocket Penetrometer (PP). Values in tons/$ft^2$.
3. Shelby Tube (undisturbed) sample collected from 32 to 34 feet.
4. Auger grinding continuously from 39 to 43 feet, upon dense soils

**PROJECT NO.**
**2950-11-01**

**LOG OF BORING**
**QD-3**

O'Reilly, Talbot & Okun
ENGINEERING ASSOCIATES

Job No. 2950-11-01

## LOG OF BORING QD-3



| DEPTH (ft)/ SAMPLES | PENETR. RESIST. (bl / 6 in) | REC. (in) | TYPE/ NO. | FIELD TEST DATA | SAMPLE DESCRIPTION (MODIFIED BURMISTER) | PROFILE DEPTH (ft) ELEV. | REMARKS/ WELL CONSTRUCTION |
|---|---|---|---|---|---|---|---|
| | 4/2/3/3 | 24/24 | S-11 (27-29') | PP=0.5 TSF TV=0.20 TSF | Medium, gray, SILT and CLAY, trace fine sand, wet (Varved, 1/2" Varves) | VARVED CLAY | |
| 30' | WOH 12"/3/3 | 20/24 | S-12 (30-32') | PP=0.75 TSF TV=0.20 TSF | Soft, gray, CLAY and SILT, trace fine sand, wet (Varved) | | |
| | N/A | 24/24 | S-13 (32-34') | -- | 3" Shelby Tube Sample | | 3 |
| 35' | 1/2/3/4 | 20/24 | S-14 (35-37') | PP=0.5 TSF TV=0.3 TSF | Medium, gray, clayey SILT, trace fine sand, wet (Varved) | | |
| | | | | | | | 4 |
| 40' | | | | | | 40.0 125.0 | |
| | 11/43/ 50 FOR 4" | 5/16 | S-15 (40-41.3') | -- | Very dense, red brown, fine to medium SAND, some coarse sand, trace fine gravel, little silt, wet (GLACIAL TILL) | GLACIAL TILL | |
| | | | | | | 44.0 121.0 | |
| 45' | | | | | End of exploration at 44', Upon likely glacial till or weather bedrock | | |
| 50' | | | | | | | |
| 55' | | | | | | | |
| 60' | | | | | | | |