Marshall Simonds Middle School Athletic Field Renovation

Geotechnical Engineering Report

Burlington, Massachusetts

March 13, 2025 | Terracon Project No. J1245100

Prepared for:

Nesra Engineering, LLC
829 South Washington Street
North Attleborough, MA 02760

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March 13, 2025

Nesra Engineering, LLC
829 South Washington Street
North Attleborough, MA 02760

Attn: Mr. Arsen Hambardzumian, P.E.
P: (508) 723-2403
E: ah@nesraeng.com

Re: Geotechnical Engineering Report
Marshall Simonds Middle School Athletic Field Renovation
114 Winn Street
Burlington, Massachusetts
Terracon Project No. J1245100

Dear Mr. Hambardzumian:

We have completed the scope of Geotechnical Engineering services for the above referenced project in general accordance with Terracon Proposal No. PJ1245100 dated December 12, 2024. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,

Terracon

COMMONWEALTH OF MASSACHUSETTS
SCOTT M. CARTER
CIVIL
No. 49966
REGISTERED
PROFESSIONAL ENGINEER

Ian D. Gates, EIT(NH)
Project Engineer

Scott M. Carter, P.E.
Geotechnical Department Manager

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Figures

Attachments

Note: This report was originally delivered in a web-based format. **Blue Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section. For more interactive features, please view your project online at **client.terracon.com**.

Refer to each individual Attachment for a listing of contents.

Introduction

This report presents the results of our subsurface exploration and Geotechnical Engineering services performed for the proposed sports field renovation on the Marshall Simonds Middle School Campus located at 114 Winn Street in Burlington, Massachusetts. The purpose of these services was to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil conditions
- Groundwater conditions
- Seismic site classification per IBC
- Site preparation and earthwork
- Foundation design and construction

The geotechnical engineering Scope of Services for this project included the advancement of test borings, laboratory testing, engineering analysis, and preparation of this report.

Plans showing the site and boring locations are shown on the Site Location and Exploration Plan attachments, respectively. The boring logs and laboratory results are shown in the Exploration Results attachment. We also collected photographs at the time of our field exploration program. Representative photos are provided in our Photography Log attachment.

Project Description

Our initial understanding of the project was provided in our proposal and was discussed during project planning. A period of collaboration has transpired since the project was initiated, and our final understanding of the project conditions is provided in the following table. Terracon should be notified if any of the following information is inconsistent with the planned construction, especially the grading limits, as modifications to our recommendations may be necessary.

Item	Description
Information Provided	Nesra provided the following information: ■ Email correspondence with client on November 25, 2024. ■ "Marshall Simonds Middle School Brush Field Renovation Project Plan Set", developed by Nesra Engineering, LLC (Nesra), and last dated December 12, 2024.
Project Description	The project consists of renovating the existing natural turf athletic field with a synthetic turf field and four new athletic field lighting assemblies. Our geotechnical engineering scope of services is limited to the new field lighting structures.
Maximum Loads	Anticipated structural loads were not provided.
Grading/Slopes	Grading plans were provided by Nesra, and minor grade changes (less than 2 feet) will be required for the athletic field. The seating section for the athletic field is shown to have grade changes ranging from 2 to 8 feet of fill placement.
Building Code	Massachusetts State Building Code, 10th Edition

Site Conditions

The following description of site conditions was derived from our site visit in association with the field exploration and our review of publicly available topographic maps.

Item	Description
Parcel Information	The project is located on the campus of Marshall Simonds Middle School at 114 Winn Street in Burlington, Massachusetts. The property is approximately 26.2 acres and is located at approximate coordinates 42.5031°N, 71.1808°W. See Site Location.
Existing Improvements	Existing natural turf soccer field. The site is bound by mature trees to the north, east and south, and parking lot to the west.
Current Ground Cover	Natural turf athletic field.
Existing Topography (Site Specific Topographic Map)	In general, the existing field slopes slightly downward from south to north from approximately elevation (El.) 138 feet to El. 135 feet. The southern portion of project area slopes up at an approximate 2.5 horizontal to 1 vertical (2.5H:1V) to El 150 feet towards the existing school building.

Geotechnical Characterization

In general, test borings encountered varying fill, with observed to depths ranging from 2 to 10 feet below existing ground surface, overlying glacial outwash sand and weathered rock/bedrock. Borings located in the northern portion of the site (B-3 and B-4) encountered an organic deposit immediately beneath the fill material to depths ranging from 5 to 7 feet below existing ground surface. Auger refusal, presumably on bedrock, was encountered in three test borings at depths ranging from 14 to 16 feet below existing grades.

The recommendations presented herein are separated into Northern and Southern areas to account for the variability in encountered subsurface conditions across the project area. The Southern area is separated into subareas to account for the variability in encountered subsurface conditions and the difference in elevation between test borings B-1 and B-2.

We have developed a general characterization of the subsurface conditions based upon our review of the subsurface exploration, laboratory data, geologic setting, and our understanding of the project. This characterization, termed GeoModel, forms the basis of our geotechnical calculations and evaluation of the site. Conditions observed at each exploration point are indicated on the individual logs. The individual logs can be found in the Exploration Results attachment and the GeoModel can be found in the Figures attachment of this report.

As part of our analyses, we identified the following model layers within the subsurface profile. For a more detailed view of the model layer depths at each boring location, refer to the GeoModel.

Model Layer	Layer Name	General Description
1	Topsoil	10 inches of topsoil
2	Fill	Silty Sand to Silty Sand with Gravel, fine to medium grained, brown to brown gray
3	Organic Deposit	Organic Silt with Sand, trace root fragments, fine grained, black, very soft to soft, faint organic odor
4	Outwash Sand Deposit	Poorly Graded Sand and Gravel with various amounts of silt to Silty Sand with various amounts of gravel, fine to coarse grained, light brown to dark gray
5	Weathered Rock [1]	Weathered Rock, trace silt, orangish brown

1. Auger refusal, presumably on bedrock, was encountered in three test borings at depths ranging from 14 to 16 feet below existing grades.

Groundwater Conditions

Groundwater was encountered in each test boring during the field exploration at depths ranging from approximately 5.5 to 15 feet below the existing ground surface. The following table summarizes the observed groundwater depths during the exploration program.

Boring No.	Approximate Groundwater Depth (feet) [1]	Approximate Groundwater Elevation (feet) [2]
B-1	15	134
B-2	7	129
B-3	5.5	129.5
B-4	7	128

1. Groundwater depths are referenced from existing ground surface. Further details can be found in the Exploration Results.
2. Groundwater elevations were referenced from the interpolated existing ground surface elevations from the “Existing Conditions Plan” found in the “Marshall Simonds Middle School Brush Field Renovation Project Plan Set”, developed by Nesra, and last dated December 12, 2024.

Groundwater conditions may be different at the time of construction. Groundwater conditions may change because of seasonal variations in rainfall, runoff, and other conditions not apparent at the time of drilling. Civil designs and construction methods should take into account the potential for shallow groundwater conditions during seasonally wet periods. Long-term groundwater monitoring was outside the scope of services for this project.

Seismic Site Class

The seismic design requirements for buildings and other structures are based on Seismic Design Category. Site Classification is required to determine the Seismic Design Category for a structure. The Site Classification is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard penetration resistance, or undrained shear strength in accordance with Section 20.4 of ASCE 7 and the International Building Code (IBC).

Based on the soil properties observed at the site and as described on the exploration logs and results, it is our professional opinion that the Seismic Site Classification is D. Subsurface explorations at this site were extended to a maximum depth of 24 feet. The site properties below the boring depth to 100 feet were estimated based on our experience and knowledge of geologic conditions of the general area. Additional deeper borings or geophysical testing may be performed to confirm the conditions below the current boring depth.

Geotechnical Overview

The site appears suitable for the proposed field renovation based upon geotechnical conditions encountered in the test borings, given that the recommendations provided in this report are implemented in the design and construction phases of this project. The following geotechnical conditions will require particular attention in the project planning, design, and construction phases and are discussed in greater detail in the following sections.

Undocumented Fill: Existing undocumented fill was encountered to depths ranging from 2 to 10 feet below existing site grades. We do not possess any information regarding whether the fill was placed under the observation of a geotechnical engineer and/or testing agency. Undocumented fill can present a greater than normal risk of post-construction movement of foundations supported on or above these materials due to the potential for unsuitable materials to be present within or buried by the fill. As such, where shallow foundations are used to support the proposed field lighting assemblies, we recommend that existing fill should be overexcavated from beneath foundations and foundation bearing zones, defined as the area beneath 1H:1V lines extending downward and outward from footing edges, to reduce the potential for excessive and/or differential settlement.

Organic Deposit (Northern Area): Test boring B-3 and B-4, advanced in the northern portion of the project area, encountered organic deposits underlying the existing fill. The organic deposit was observed at depths ranging from 5 to 7 feet. Based on the subsurface soil encountered at other borings and the laboratory results (presented in the Exploration Results), this layer appears to be limited to the northern area of the proposed development, but it should be understood that additional organic deposits may be encountered between the explored locations. Organic deposits are not suitable for supporting foundations and should be removed from the foundation bearing zone. Further details about the extent of removal of organic deposit soils from the proposed foundation footprints are provided within the Earthwork section.

Shallow Groundwater: During our field exploration program, groundwater was observed at depths ranging from approximately 5.5 to 15 feet below existing site grades. Groundwater conditions may be different at the time of construction. Excavations are anticipated to approach the level of existing groundwater and temporary dewatering should be anticipated to achieve the recommended overexcavation depths.

Bedrock: Auger refusal, presumably on bedrock, was encountered within three of the test borings (B-2 through B-4) at depths ranging from approximately 14 to 16 feet below ground surface. Although not anticipated for construction of shallow foundations, the potential for encountering bedrock should be considered during the design and construction phases of the project.

Foundations: Based on subsurface conditions encountered on the site, the proposed field lighting assemblies can be supported on either Deep Foundations, such as drilled pier foundations, or spread-footing foundations bearing on proofrolled Structural Fill or Crushed Stone as discussed in the Shallow Foundations section.

The recommendations contained in this report are based upon the results of field and laboratory testing (presented in the Exploration Results attachment), engineering analyses, and our current understanding of the proposed project. The General Comments section provides an understanding of the report limitations.

Earthwork

Earthwork is anticipated to include clearing and grubbing, excavations, and fill placement. The following sections provide recommendations for use in the preparation of specifications for the work. Recommendations include critical quality criteria, as necessary, to render the site in the state considered in our geotechnical engineering evaluation for foundations.

Site and Subgrade Preparation

Existing vegetation, topsoil, existing fill and organic deposits should be removed before placing new fill or constructing foundations. Existing utilities affected by the development should be removed and/or temporarily relocated prior to construction. Existing fill and organic deposit (where present) should be removed in their entirety from within foundation bearing zones.

Prior to placement of fill or construction of foundations, the soil subgrades should be proofrolled with at least six passes in perpendicular directions using a minimum 10-ton vibratory roller in open areas; or a minimum 1-ton self-propelled vibratory roller or large vibratory plate compacted in trenches or excavations. Proofrolling near groundwater elevation may need to be performed statically to reduce the potential for disturbing subgrades. The proofrolling should be performed under the observation of the Geotechnical Engineer.

Based on the material encountered in the test borings, the onsite materials can be susceptible to disturbance and loss of strength under repeated construction traffic loads and unstable conditions could develop. Stabilization of loose soils may be required at some locations to provide adequate support for construction equipment and proposed structures. If these conditions are encountered, Terracon should be contacted to observe the conditions exposed and to provide guidance regarding stabilization (if needed).

Disturbed native soil and/or areas excessively deflecting under the proofroll should be delineated and subsequently addressed by the Geotechnical Engineer. Unstable areas should be overexcavated to more competent material and replaced with compacted Structural Fill or General Fill depending on the location of the fill placement. Excessively wet or dry materials shall either be removed, or moisture conditioned and recompacted. Once subgrades have been properly prepared, Structural Fill may be placed in controlled lifts to achieve design foundation and slab subgrade elevations.

Excavation

We anticipate that excavations for the proposed construction can generally be accomplished with conventional earthmoving equipment. The bottom of excavations should be thoroughly cleaned of loose soil and disturbed material prior to backfill placement and/or construction. Excavations into the on-site soils could encounter weak and/or saturated soil conditions with possible caving conditions, especially as the depth of excavations approach groundwater.

Depending upon the depth of excavation and seasonal conditions, surface water infiltration and/or groundwater may be encountered in excavations on the site. If dewatering becomes necessary, the contractor should select a dewatering method to lower groundwater at least 2 feet below the excavation subgrade to minimize bearing surface disturbance during fill placement and compaction. Dewatering is a means and methods consideration for the contractor.

Existing Fill

As noted in Geotechnical Characterization, all borings encountered previously placed fill to depths ranging from approximately 2 to 10 feet below existing site grades. We have no records to indicate the degree of control, and consequently, the fill is considered unreliable for support of foundation loads. This risk of unforeseen conditions cannot be eliminated without completely removing the existing fill.

Fill Material Types

Fill required to achieve design grade should be classified as Structural Fill and General Fill. Structural Fill is material used below, or within 5 feet of structures, pavements or constructed slopes. General fill is material used to achieve grade outside of these areas.

Regardless of its source, compacted fill should consist of approved materials that are free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade.

Reuse of On-Site Soil: In general, excavated native on-site soil may be selectively reused as General Fill and as backfill above footings, provided they meet the requirements in the following table. Portions of the existing fill have an elevated fines content and will be sensitive to moisture conditions (particularly during seasonally wet periods) and may not be suitable for reuse when above optimum moisture content. Excavated organic materials are not considered suitable for reuse and should be properly disposed of off-site. Material property requirements for on-site soil used as General Fill are noted in the following table:

Property	General Fill [1]
Composition	Free of deleterious material
Maximum particle size	The lesser of 6 inches or 2/3 of the lift thickness
Fines content [2]	Less than 30%

1. Based on the subsurface exploration. Actual material suitability should be determined in the field at the time of construction.
2. Material passing the #200 sieve.

Imported Fill Materials: Imported fill materials should meet the following material property requirements.

Fill Type	Massachusetts Department of Transportation (MassDOT) Item	Acceptable Location for Placement
General Fill	M1.02.0 – Special Borrow	General raise-in-grade fill within pavement and landscaping areas. General Fill should not be placed beneath settlement sensitive structures and within foundation bearing zones.

Fill Type	Massachusetts Department of Transportation (MassDOT) Item	Acceptable Location for Placement
Structural Fill	M1.03.0 – Gravel Borrow Type B	Beneath foundations, within foundation bearing zones, and as backfill within 5 feet of exterior foundation walls. Structural Fill should also be used as raise-in-grade fill to achieve subgrade elevations beneath floor slabs and settlement sensitive structures.
Crushed Stone [1]	M2.01.4 – ¾-inch Crushed Stone	Backfill of underdrains and over wet subgrades as needed. Crushed Stone may be substituted for Structural Fill when approved by the Geotechnical Engineer.

1. Crushed Stone should be separated from soil subgrades, excavation sidewalls, and backfill using a non-woven geotextile (such as Mirafi 140N or similar).

Fill Placement and Compaction Requirements

Structural and General Fill should meet the following compaction requirements.

Item	Structural Fill	General Fill	Crushed Stone
Maximum Lift Thickness	Vibratory Rollers: 12 inches or less in loose thickness. Plate Compactors: 6 inches or less in loose thickness when hand-guided equipment (i.e., jumping jack or plate compactor) is used.		
Minimum Compaction Requirements [1,2]	At least 95% of the material's maximum dry density	At least 92% of the material's maximum dry density	Densified and compacted using at least six (6) passes of vibratory roller or large vibratory plate compactor
Water Content Range [1]	±3% of optimum water content	±3% of optimum water content	Not applicable

Item	Structural Fill	General Fill	Crushed Stone

1. Maximum density and optimum water content as determined by the Modified Proctor test (ASTM D1557, Method).
2. We recommend testing fill for moisture content and compaction during placement. If the results of in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested, as required, until the specified moisture and compaction requirements are achieved.

Earthwork Construction Considerations

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, “Excavations” and its appendices, and in accordance with any applicable local and/or state regulations.

Construction site safety is the sole responsibility of the contractor who controls the means, methods, and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean Terracon is assuming responsibility for construction site safety or the contractor's activities; such responsibility shall neither be implied nor inferred.

Excavations or other activities resulting in ground disturbance have the potential to affect adjoining properties and structures. Our scope of services does not include review of available final grading information or consider potential temporary grading performed by the contractor for potential effects such as ground movement beyond the project limits. A preconstruction/ precondition survey should be conducted to document nearby property/infrastructure prior to any site development activity. Excavation or ground disturbance activities adjacent or near property lines should be monitored or instrumented for potential ground movements that could negatively affect adjoining property and/or structures.

Construction Observation and Testing

The earthwork efforts should be observed by the Geotechnical Engineer (or others under their direction). Observation should include documentation of adequate removal of surficial materials (vegetation and topsoil), as well as proofrolling and mitigation of unsuitable areas delineated by the proofroll.

Each lift of compacted fill should be tested, evaluated, and reworked, as necessary, as recommended by the Geotechnical Engineer prior to placement of additional lifts. Each lift of fill should be tested for density and water content at a frequency of at least one test for every 1,000 square feet of compacted fill in the softball field and pavement areas. Where not specified by local ordinance, one density and water content test should be performed for every 50 linear feet of compacted utility trench backfill and a minimum of one test performed for every 12 vertical inches of compacted backfill.

In areas of foundation excavations, the bearing subgrade should be evaluated by the Geotechnical Engineer. If unanticipated conditions are observed, the Geotechnical Engineer should prescribe mitigation options.

In addition to the documentation of the essential parameters necessary for construction, the continuation of the Geotechnical Engineer into the construction phase of the project provides the continuity to maintain the Geotechnical Engineer's evaluation of subsurface conditions, including assessing variations and associated design changes.

Deep Foundations

Northern Project Area

Drilled Pier Design Parameters

Soil design parameters are provided in the following table for the design of drilled pier foundations within the northern area of the project site based on the subsurface conditions encountered in soil borings B-3 and B-4. The values presented for allowable side friction and end bearing include a factor of safety of 2 and 3, respectively.

Depth Below Ground Surface (feet)	Stratigraphy [1]	Allowable Skin Friction (psf) [2,3]	Allowable End Bearing Pressure (psf) [2,4,5]
0 to 2	Fill / Organic Deposit	Neglect	Neglect
2 to 7	Organic Deposit	Neglect	Neglect
7 to 10	Outwash Sand Deposit	350	4,000
10 to 15	Outwash Sand Deposit	450	4,000
Varies	Bedrock	8,000 [6]	10,000

Depth Below Ground Surface (feet)	Stratigraphy [1]	Allowable Skin Friction (psf) [2,3]	Allowable End Bearing Pressure (psf) [2,4,5]

1. See the Geotechnical Characterization section for more details on the stratigraphy.
2. Design capacities are dependent upon the method of installation and quality control parameters. The values provided are estimates and should be verified when installation protocol has been finalized.
3. Applicable for compressive loading only. Reduce to 2/3 of values shown for uplift loading. The effective weight of the pier can be added to uplift load resistance to the extent permitted by IBC.
4. Listed skin friction values are for mass placement of concrete. For pre-cast concrete use 80% of the listed value.
5. Defined as the allowable bond stress between grout and intact bedrock including a factor of safety of 2.
6. Piers should extend at least one diameter into the bearing stratum for end bearing to be considered.

Piers should be adequately reinforced as designed by the Structural Engineer for both tension and shear to sufficient depths. Buoyant unit weights of the soil and concrete should be used in the calculations below the highest anticipated groundwater elevation.

Drilled piers should have a minimum (center-to-center) spacing of three diameters. Closer spacing may require a reduction in axial load capacity. Axial capacity reduction can be determined by comparing the allowable axial capacity determined from the sum of individual piers in a group versus the capacity calculated using the perimeter and base of the pier group acting as a unit. The lesser of the two capacities should be used in design.

A minimum pier diameter of 24 inches should be used. Drilled piers should have a minimum length of 10 feet and should extend into the bearing strata at least one pier diameter for the allowable end-bearing pressures listed in the above table.

Post-construction settlements of drilled piers designed and constructed as described in this report are estimated to range from about ½ to 1 inch. Differential settlement between individual piers is expected to be ½ to ⅔ of the total settlement.

Drilled Pier Lateral Loading

The following table lists input values for use in LPile for lateral analyses. Such analysis should be considered if lateral loads exceed 10 kips. Current versions of LPile provide estimated default values of the horizontal subgrade reaction modulus (k) and the strain factor (E50) and are recommended for the project. Since deflection or a service limit criterion will most likely control lateral capacity design, no safety/resistance factor is included with the parameters.

Depth Below Ground Surface (feet)	Material [1]	LPile Soil Model	Effective Unit Weight, γ' (pcf) [2,3]	Friction Angle, ϕ (deg) [2]	Uniaxial Compressive Strength, q_u (psi) [2]	P-Multiplier
0 to 2	Fill / Organic Deposit	Sand (Reese)	115	30	N/A	0.7
2 to 7	Organic Deposit	Sand (Reese)	18	20	N/A	0.7
7 to 10	Outwash Sand Deposit	Sand (Reese)	55	30	N/A	1.0
10 to 15	Outwash Sand Deposit	Sand (Reese)	55	30	N/A	1.0
Varies	Bedrock	Strong Rock (Vuggy Limestone)	90	N/A	1,000	1.0

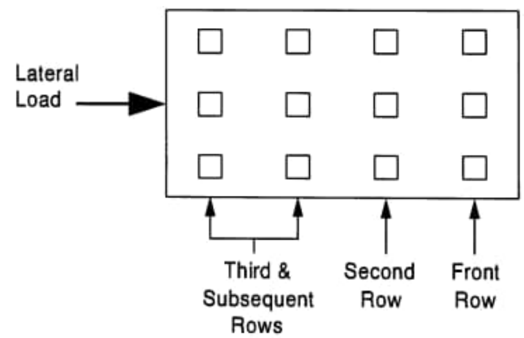
1. See the Geotechnical Characterization section for more details on the stratigraphy.
2. Definition of Terms:
   ϕ: Friction angle
   γ': Effective unit weight
   q_u: Uniaxial Compressive Strength
3. The recommended design depth to groundwater is 5 feet to account for seasonal variation.

When piers are used in groups, the lateral capacities of the piers in the second, third, and subsequent rows of the group should be reduced as compared to the capacity of a single, independent pier. Guidance for applying p-multiplier factors to the p-values in the p-y curves for each row of pier foundations within a pier group are as follows:

Center-to-Center Pier Spacing [1,2]	P-Multiplier, P_m [3]		
	Front Row	Second Row	Third and Subsequent Rows
3B	0.8	0.4	0.3
4B	0.9	0.65	0.5
5B	1.0	0.85	0.7
6B	1.0	1.0	1.0

Center-to-Center Pier Spacing [1,2]	P-Multiplier, P_m [3]		
	Front Row	Second Row	Third and Subsequent Rows

1. Spacing in the direction of loading, where B equals the pier diameter.
2. For the case of a single row of piers supporting a laterally loaded grade beam, group action for lateral resistance of piers would need be considered when spacing is less than three pier diameters (measured center-to-center).
3. See adjacent figure for definition of front, second and third rows.



Spacing closer than 3B (where B is the diameter of the pier) is not recommended without additional geotechnical consultation due to potential for the installation of a new pier disturbing an adjacent installed pier likely resulting in axial capacity reduction.

Southern Project Area

Lower Area (Field Elevation)

Drilled Pier Design Parameters

Soil design parameters are provided in the following table for the design of drilled pier foundations within the southern area of the project site at the existing athletic field elevation based on the subsurface conditions encountered in soil boring B-2. The values presented for allowable side friction and end bearing include a factor of safety of 2 and 3, respectively.

Depth Below Ground Surface (feet)	Stratigraphy [1]	Allowable Skin Friction (psf) [2,3]	Allowable End Bearing Pressure (psf) [2,4,5]
0 to 5	Fill	Neglect	Neglect
5 to 9	Outwash Sand Deposit	250	4,000
9 to 14	Outwash Sand Deposit	450	4,000
Below 14	Bedrock	8,000 [6]	10,000

Depth Below Ground Surface (feet)	Stratigraphy [1]	Allowable Skin Friction (psf) [2,3]	Allowable End Bearing Pressure (psf) [2,4,5]

1. See the Geotechnical Characterization section for more details on the stratigraphy.
2. Design capacities are dependent upon the method of installation and quality control parameters. The values provided are estimates and should be verified when installation protocol has been finalized.
3. Applicable for compressive loading only. Reduce to 2/3 of values shown for uplift loading. The effective weight of the pier can be added to uplift load resistance to the extent permitted by IBC.
4. Listed skin friction values are for mass placement of concrete. For pre-cast concrete use 80% of the listed value.
5. Piers should extend at least one diameter into the bearing stratum for end bearing to be considered.
6. Defined as the allowable bond stress between grout and intact bedrock including a factor of safety of 2.

Piers should be adequately reinforced as designed by the Structural Engineer for both tension and shear to sufficient depths. Buoyant unit weights of the soil and concrete should be used in the calculations below the highest anticipated groundwater elevation.

Drilled piers should have a minimum (center-to-center) spacing of three diameters. Closer spacing may require a reduction in axial load capacity. Axial capacity reduction can be determined by comparing the allowable axial capacity determined from the sum of individual piers in a group versus the capacity calculated using the perimeter and base of the pier group acting as a unit. The lesser of the two capacities should be used in design.

A minimum pier diameter of 24 inches should be used. Drilled piers should have a minimum length of 10 feet and should extend into the bearing strata at least one pier diameter for the allowable end-bearing pressures listed in the above table.

Post-construction settlements of drilled piers designed and constructed as described in this report are estimated to range from about ½ to 1 inch. Differential settlement between individual piers is expected to be ½ to ⅔ of the total settlement.

Drilled Pier Lateral Loading

The following table lists input values for use in LPile for lateral analyses. Such analysis should be considered if lateral loads exceed 10 kips. Current versions of LPile provide estimated default values of the horizontal subgrade reaction modulus (k) and the strain factor (E50) and are recommended for the project. Since deflection or a service limit criterion will most likely control lateral capacity design, no safety/resistance factor is included with the parameters.

Depth Below Ground Surface (feet)	Material [1]	LPile Soil Model	Effective Unit Weight, γ' (pcf) [2,3]	Friction Angle, ϕ (deg) [2]	Uniaxial Compressive Strength, q_u (psi) [2]	P-Multiplier
0 to 5	Fill	Sand (Reese)	115	30	N/A	0.7
5 to 9	Outwash Sand Deposit	Sand (Reese)	55	30	N/A	1.0
9 to 14	Outwash Sand Deposit	Sand (Reese)	55	30	N/A	1.0
Below 14	Bedrock	Strong Rock (Vuggy Limestone)	90	N/A	1,000	1.0

1. See the Geotechnical Characterization section for more details on the stratigraphy.
2. Definition of Terms:
   ϕ: Friction angle
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3. The recommended design depth to groundwater is 5 feet to account for seasonal variation.

When piers are used in groups, the lateral capacities of the piers in the second, third, and subsequent rows of the group should be reduced as compared to the capacity of a single, independent pier. Guidance for applying p-multiplier factors to the p-values in the p-y curves for each row of pier foundations within a pier group are as follows:

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	Front Row	Second Row	Third and Subsequent Rows
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4B	0.9	0.65	0.5
5B	1.0	0.85	0.7
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Center-to-Center Pier Spacing [1,2]	P-Multiplier, P_m [3]		
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1. Spacing in the direction of loading, where B equals the pier diameter.
2. For the case of a single row of piers supporting a laterally loaded grade beam, group action for lateral resistance of piers would need be considered when spacing is less than three pier diameters (measured center-to-center).
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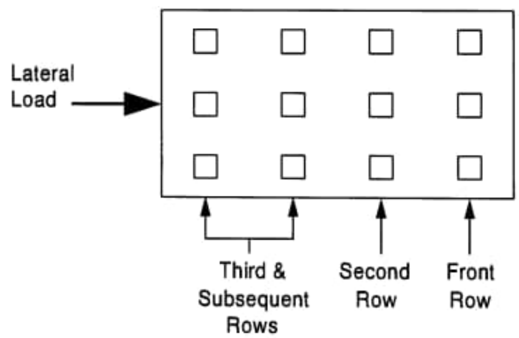


Spacing closer than 3B (where B is the diameter of the pier) is not recommended without additional geotechnical consultation due to potential for the installation of a new pier disturbing an adjacent installed pier likely resulting in axial capacity reduction.

Upper Area (School Building Elevation)

Drilled Pier Design Parameters

Soil design parameters are provided in the following table for the design of drilled pier foundations within the southern area of the project site near the existing middle school building elevation based on the subsurface conditions encountered in soil boring B-1. The values presented for allowable side friction and end bearing include a factor of safety of 2 and 3, respectively.

Depth Below Ground Surface (feet)	Stratigraphy [1]	Allowable Skin Friction (psf) [2,3]	Allowable End Bearing Pressure (psf) [2,4,5]
0 to 5	Fill	Neglect	Neglect
5 to 10	Fill	Neglect	Neglect
10 to 15	Outwash Sand Deposit	200	2,000
15 to 20	Outwash Sand Deposit	400	3,000
20 to 24	Outwash Sand Deposit	400	3,000

Depth Below Ground Surface (feet)	Stratigraphy [1]	Allowable Skin Friction (psf) [2,3]	Allowable End Bearing Pressure (psf) [2,4,5]

1. See the Geotechnical Characterization section for more details on the stratigraphy.
2. Design capacities are dependent upon the method of installation and quality control parameters. The values provided are estimates and should be verified when installation protocol has been finalized.
3. Applicable for compressive loading only. Reduce to 2/3 of values shown for uplift loading. The effective weight of the pier can be added to uplift load resistance to the extent permitted by IBC.
4. Listed skin friction values are for mass placement of concrete. For pre-cast concrete use 80% of the listed value.
5. Piers should extend at least one diameter into the bearing stratum for end bearing to be considered.

Piers should be adequately reinforced as designed by the Structural Engineer for both tension and shear to sufficient depths. Buoyant unit weights of the soil and concrete should be used in the calculations below the highest anticipated groundwater elevation.

Drilled piers should have a minimum (center-to-center) spacing of three diameters. Closer spacing may require a reduction in axial load capacity. Axial capacity reduction can be determined by comparing the allowable axial capacity determined from the sum of individual piers in a group versus the capacity calculated using the perimeter and base of the pier group acting as a unit. The lesser of the two capacities should be used in design.

A minimum pier diameter of 24 inches should be used. Drilled piers should have a minimum length of 10 feet and should extend into the bearing strata at least one pier diameter for the allowable end-bearing pressures listed in the above table.

Post-construction settlements of drilled piers designed and constructed as described in this report are estimated to range from about ½ to 1 inch. Differential settlement between individual piers is expected to be ½ to ⅔ of the total settlement.

Drilled Pier Lateral Loading

The following table lists input values for use in LPile for lateral analyses. Such analysis should be considered if lateral loads exceed 10 kips. Current versions of LPile provide estimated default values of the horizontal subgrade reaction modulus (k) and the strain factor (E50) and are recommended for the project. Since deflection or a service limit criterion will most likely control lateral capacity design, no safety/resistance factor is included with the parameters.

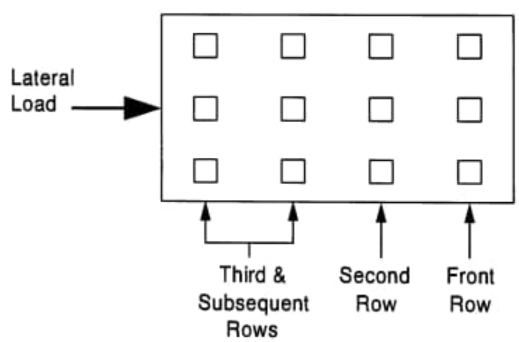
Depth Below Ground Surface (feet)	Material [1]	LPile Soil Model	Effective Unit Weight, γ' (pcf) [2,3]	Friction Angle, ϕ (deg) [2]	P-Multiplier
0 to 5	Fill	Sand (Reese)	115	30	0.7
5 to 10	Fill	Sand (Reese)	115	30	0.7
10 to 15	Outwash Sand Deposit	Sand (Reese)	55	30	1.0
15 to 20	Outwash Sand Deposit	Sand (Reese)	55	30	1.0
20 to 24	Outwash Sand Deposit	Sand (Reese)	55	30	1.0

1. See the Geotechnical Characterization section for more details on the stratigraphy.
2. Definition of Terms:
   ϕ: Friction angle
   γ': Effective unit weight
3. The recommended design depth to groundwater is 10 feet to account for seasonal variation.

When piers are used in groups, the lateral capacities of the piers in the second, third, and subsequent rows of the group should be reduced as compared to the capacity of a single, independent pier. Guidance for applying p-multiplier factors to the p-values in the p-y curves for each row of pier foundations within a pier group are as follows:

Center-to-Center Pier Spacing [1,2]	P-Multiplier, P_m [3]		
	Front Row	Second Row	Third and Subsequent Rows
3B	0.8	0.4	0.3
4B	0.9	0.65	0.5
5B	1.0	0.85	0.7
6B	1.0	1.0	1.0

1. Spacing in the direction of loading, where B equals the pier diameter.
2. For the case of a single row of piers supporting a laterally loaded grade beam, group action for lateral resistance of piers would need be considered when spacing is less than three pier diameters (measured center-to-center).
3. See adjacent figure for definition of front, second and third rows.



Spacing closer than 3B (where B is the diameter of the pier) is not recommended without additional geotechnical consultation due to potential for the installation of a new pier disturbing an adjacent installed pier likely resulting in axial capacity reduction.

Drilled Pier Construction Considerations

The drilling contractor should be experienced in the subsurface conditions observed at the site, and the excavations should be performed with equipment capable of providing a clean bearing surface. The drilled straight-pier foundation system should be installed in general accordance with the procedures presented in "Standard Specification for the Construction of Drilled Piers", ACI Publication No. 336.1-01.

Weak soils as well as relatively shallow groundwater and bedrock were observed in the borings. To prevent collapse of the sidewalls and/or to control groundwater seepage, the use of temporary steel casing and/or slurry drilling procedures may be required for construction of the drilled pier foundations. Significant seepage could occur in the case of excavations penetrating water-bearing sandy soil and/or highly broken bedrock layers. The drilled shaft contractor and foundation design engineer should be informed of these risks.

The drilling contractor should remove all soft and disturbed soils from the base of the drilled pier prior to placing concrete. The drilled pier installation process should be performed under the observation of the Geotechnical Engineer. The Geotechnical Engineer should document the pier installation process including soil and groundwater conditions observed, consistency with expected conditions, and details of the installed pier.

Shallow Foundations

If the site has been prepared in accordance with the requirements noted in the Earthwork section, the following design parameters are applicable for shallow foundations.

Design Parameters – Compressive Loads

Item	Description
Maximum Net Allowable Bearing Pressure [1, 2]	4,000 pounds per square foot (psf)
Required Bearing Stratum [3]	Minimum 12 inches Compacted Structural Fill or Crushed Stone[8] over proofrolled native soil subgrades.

Item	Description
Minimum Foundation Dimensions	Columns: 30 inches
Ultimate Passive Resistance [4] (Equivalent Fluid Pressures)	390 pcf (granular backfill)
Ultimate Coefficient of Friction [5]	0.45 (Cast-in-Place Concrete on Structural Fill or Crushed Stone)
Minimum Embedment below Finished Grade [6]	Exterior footings: 48 inches
Estimated Total Settlement from Structural Loads [2]	Less than about 1 inch
Estimated Differential Settlement [2, 7]	About 1/2 of total settlement

1. The maximum net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. Values assume that exterior grades are no steeper than 20% within 10 feet of structure.
2. Values provided are for maximum loads noted in the Project Description section. Additional geotechnical consultation will be necessary if higher loads are anticipated.
3. Unsuitable or soft soils should be over-excavated and replaced per the recommendations presented in the Earthwork section.
4. Use of passive earth pressures require the sides of the excavation for the spread footing foundation to be nearly vertical and the concrete placed neat against these vertical faces or that the footing forms be removed and compacted structural fill be placed against the vertical footing face. Assumes no hydrostatic pressure.
5. Can be used to compute sliding resistance where foundations are placed on suitable soil/materials. Frictional resistance for granular materials is dependent on the bearing pressure which may vary due to load combinations. For precast concrete elements the coefficient of friction should be taken as 80% of the provided value.
6. Embedment necessary to minimize the effects of frost and/or seasonal water content variations. For sloping ground, maintain depth below the lowest adjacent exterior grade within 5 horizontal feet of the structure.
7. Differential settlements are noted for equivalent-loaded foundations and bearing elevation as measured over a span of 50 feet.
8. Crushed Stone, if used, should be separated from the subgrade and excavation sidewalls and backfill using a non-woven geotextile such as Mirafi 140N or equivalent.

Design Parameters – Overturning and Uplift Loads

Shallow foundations subjected to overturning loads should be proportioned such that the resultant eccentricity is maintained in the center-third of the foundation (e.g., eccentricity (e) < b/6, where b is the foundation width). This requirement is intended to keep the entire foundation area in compression during the extreme lateral/overturning load event. Foundation oversizing may be required to satisfy this condition.

Uplift resistance of spread footings can be developed from the effective weight of the footing and the overlying soils with consideration to the IBC basic load combinations.

Item	Description
Soil Moist Unit Weight	115 pcf
Soil Effective Unit Weight [1]	53pcf
Soil Weight Included in Uplift Resistance	Soil included within the prism extending up from the top perimeter of the footing at an angle of 20 degrees from vertical to ground surface

1. Effective (or buoyant) unit weight should be used for soil above the foundation level and below a water level. The high groundwater level should be used in uplift design as applicable.

Foundation Construction Considerations

As noted in the Earthwork section, the foundation excavations should be evaluated under the observation of the Geotechnical Engineer. The base of all foundation excavations should be free of water and loose soil, prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. Excessively wet or dry material or any loose/disturbed material in the bottom of the foundation excavations should be removed/reconditioned before foundation concrete is placed.

If unsuitable bearing soils are observed at the base of the planned footing excavation, the excavation should be extended deeper to suitable soils. The over-excavation should be backfilled up to the footing base elevation, with compacted Structural Fill, as recommended in the Earthwork section.

General Comments

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration.

Variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

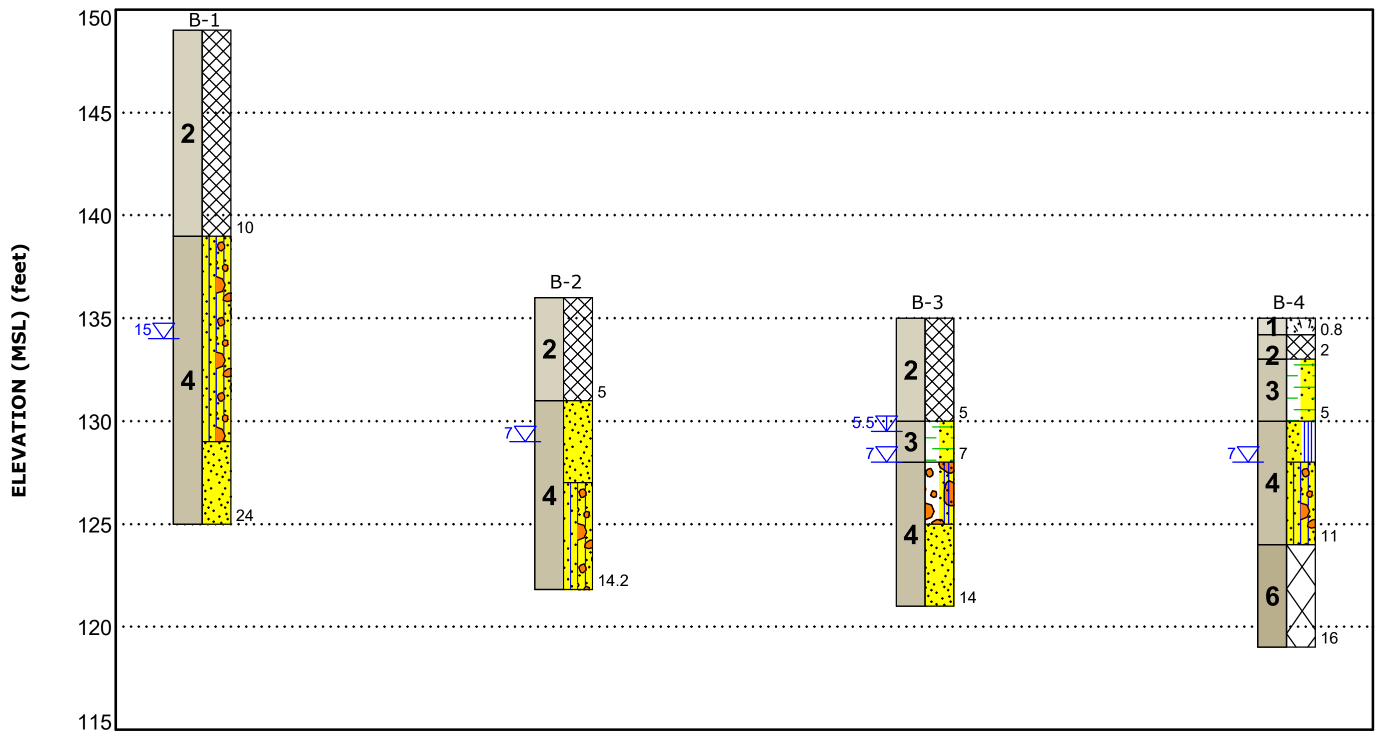
Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly affect excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety and cost estimating including excavation support and dewatering requirements/design are the responsibility of others. Construction and site development have the potential to affect adjacent properties. Such impacts can include damages due to vibration, modification of groundwater/surface water flow during construction, foundation movement due to undermining or subsidence from excavation, as well as noise or air quality concerns. Evaluation of these items on nearby properties are commonly associated with contractor means and methods and are not addressed in this report. The owner and contractor should consider a preconstruction/precondition survey of surrounding development. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

Figures

Contents:

Terracon
77 Sundial Ave, Ste 401W
Manchester, NH

GeoModel



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

Model Layer	Layer Name	General Description
1	**Topsoil**	10 inches of topsoil
2	**Fill**	Silty Sand to Silty Sand with Gravel, fine to medium grained, brown to brown gray
3	**Organic Deposit**	Organic Silt with Sand, trace root fragments, fine grained, black, very soft to soft, faint organic odor
4	**Outwash Sand Deposit**	Poorly Graded Sand and Gravel with various amounts of silt to Silty Sand with various amounts of gravel, fine to coarse grained, light brown to dark gray
5	**Weathered Rock**	Weathered Rock, trace silt, orangish brown

Legend

- Fill
- Silty Sand with Gravel
- Poorly-graded Sand
- Organic Silt with Sand
- Poorly-graded Gravel with Silt and Sand
- Topsoil
- Poorly-graded Sand with Silt
- Weathered Rock

First Water Observation
Second Water Observation

Groundwater levels are temporal. The levels shown are representative of the date and time of our exploration. Significant changes are possible over time.
Water levels shown are as measured during and/or after drilling. In some cases, boring advancement methods mask the presence/absence of groundwater. See individual logs for details.

NOTES:
Layering shown on this figure has been developed by the geotechnical engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project.
Numbers adjacent to soil column indicate depth below ground surface.

Attachments

Exploration and Testing Procedures

Field Exploration

Number of Borings	Approximate Boring Depth (feet)	Location
4	14 to 24	Proposed field lighting structures

Boring Layout and Elevations: Terracon personnel provided the boring layout using handheld GPS equipment (estimated horizontal accuracy of about ±15 feet) and referencing existing site features. Approximate ground surface elevations were obtained by interpolation from the site-specific topographic map in the “Marshall Simonds Middle School Brush Field Renovation Project” drawings developed by Nesra Engineering, and last dated December 15, 2024. If elevations and a more precise boring layout are desired, we recommend borings be surveyed.

Subsurface Exploration Procedures: We advanced the borings with a track-mounted rotary drill rig using continuous flight augers. Four samples were obtained in the upper 10 feet of each boring and at intervals of 5 feet thereafter. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon was driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 18 inches of a normal 24-inch penetration was recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths. We observed and recorded groundwater levels while drilling and sampling. For safety purposes, all borings were backfilled with auger cuttings upon completion.

We also observed the boreholes while drilling and at the completion of drilling for the presence of groundwater. The groundwater levels are shown on the attached boring logs.

The sampling depths, penetration distances, and other sampling information was recorded on the field boring logs. The samples were placed in appropriate containers and taken to our soil laboratory for testing and classification by a Geotechnical Engineer. Our exploration team prepared field boring logs as part of the drilling operations. These field logs included visual classifications of the materials observed while drilling and our interpretation of the subsurface conditions between samples. Final boring logs were prepared from the field logs. The final boring logs represent the Geotechnical Engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

Laboratory Testing

The project engineer reviewed the field data and assigned laboratory tests. The laboratory testing program included the following types of tests:

- Moisture Content
- Grain Size Distribution

The laboratory testing program included examination of soil samples by an engineer. Based on the results of our field and laboratory programs, we described and classified the soil samples in accordance with the Unified Soil Classification System, as shown in the Supporting Information attachment.

Photography Log

Photograph 1: General Site Photo
(Viewing Southeast in between B-3 and B-4)

Photograph 2: General Site Photo (Viewing Northeast Near B-1)

Site Location and Exploration Plans

Contents:

Note: All attachments are one page unless noted above.

Site Location

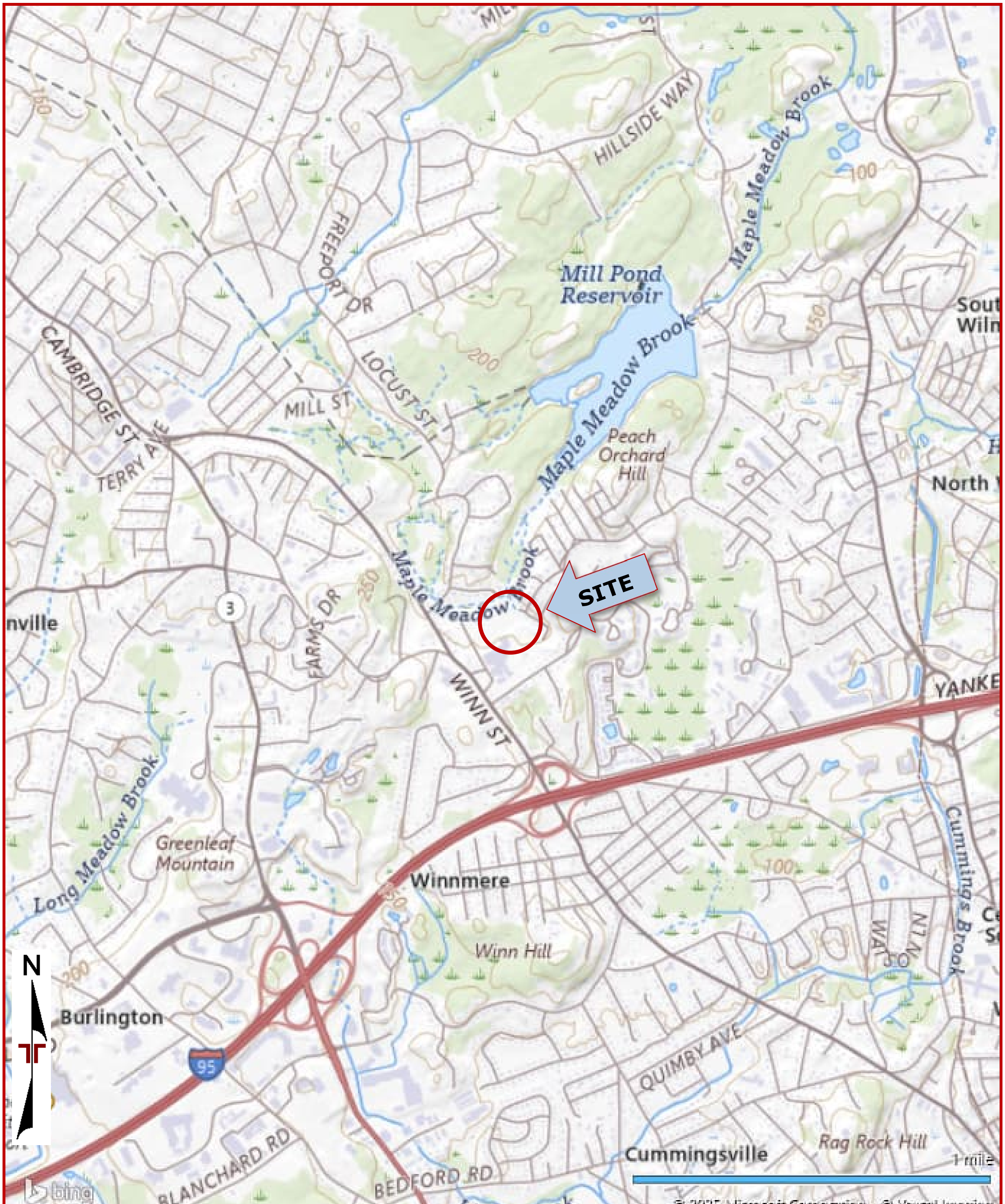


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES   MAP COURTESY OF U.S. GEOLOGIC SURVEY

Exploration Plan (Aerial View)

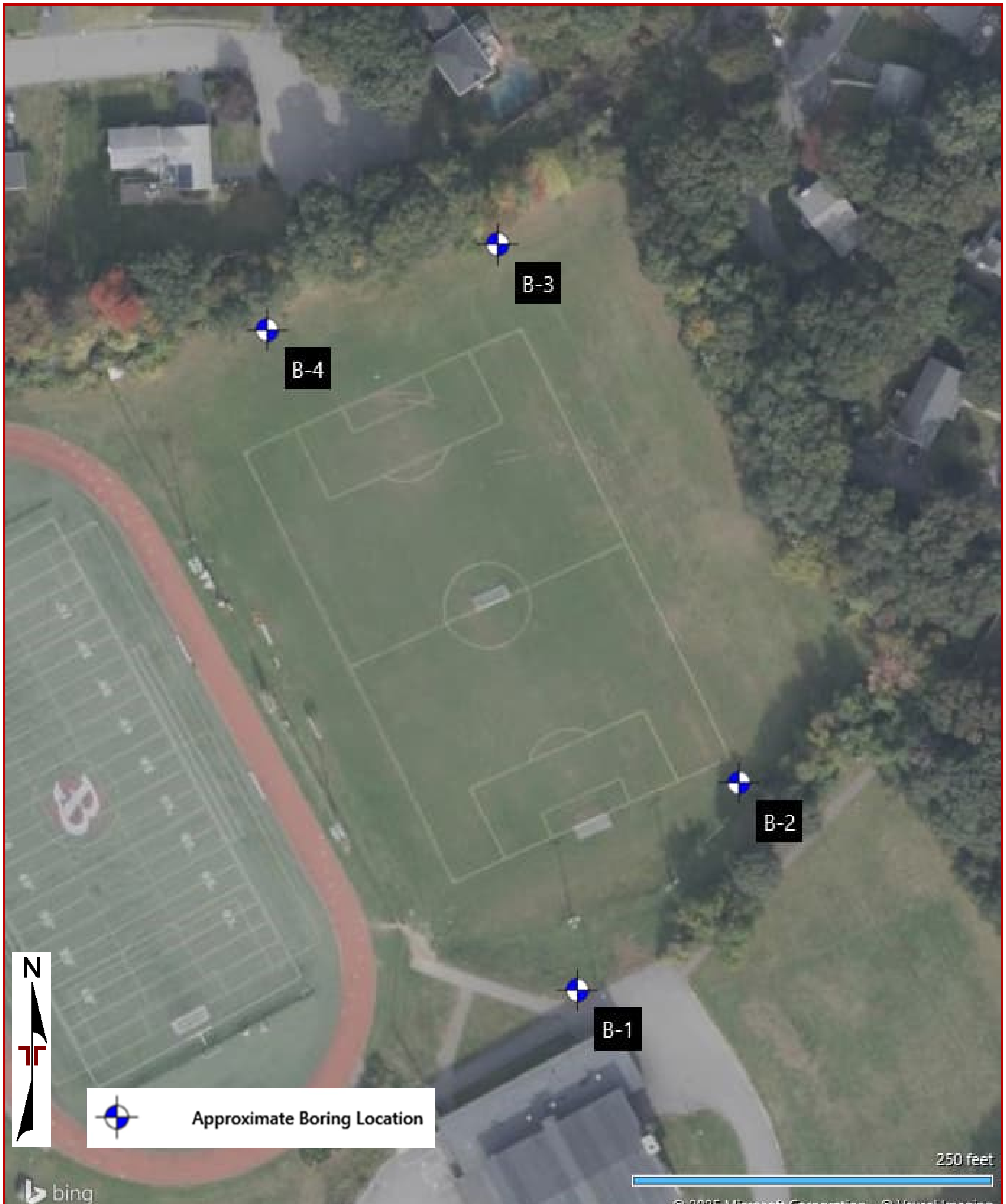


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

Exploration Plan (Grading Plan Overlay)

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY NESRA ENGINEERING

Exploration and Laboratory Results

Contents:

Note: All attachments are one page unless noted above.

Terracon
77 Sundial Ave, Ste 401W
Manchester, NH

Boring Log No. B-1

Location: See Exploration Plan

Latitude: 42.5024° Longitude: -71.1806°

Depth (Ft.) Approximate Elevation: 149 (Ft.)

Model Layer	Depth (Ft.)	Material Description	Elevation (Ft.)
2	0.0–10.0	**FILL - SILTY SAND**, trace gravel, fine to medium grained, brown and brown gray Auger refusal at 9 feet Offset boring ~9 feet east of B-1	139
4	10.0–20.0	**SILTY SAND WITH GRAVEL (SM)**, fine to medium grained, light brown, loose to dense	129
4	20.0–24.0	**POORLY GRADED SAND (SP)**, trace silt, fine grained, light brown, very loose to medium dense	125

Boring Terminated at 24 Feet

Recovery (In.)	Field Test Results	Water Content (%)
14	12-4-12-47 N=16	
10	25-12-9-8 N=21	
8	10-43-17-23 N=60	
10	15-9-6-8 N=15	
6	3-4-1-2 N=5	10.4
15	8-16-24-34 N=40	
12	WOH/18"-3	
24	5-6-10-18 N=16	

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Elevations were interpolated from a site specific topographic site plan.

Samples obtained using a 2" O.D. split spoon sampler

Notes
WOH=Weight of Hammer

Water Level Observations
15 feet while sampling

Advancement Method
4-1/4-inch I.D. hollow stem augers

Abandonment Method
Boring backfilled with soil cuttings upon completion.

Drill Rig
CME-55

Hammer Type
Automatic

Driller
Geosearch/S. Preston

Logged by
D. Drouin

Boring Started
01-13-2025

Boring Completed
01-13-2025

Terracon
77 Sundial Ave, Ste 401W
Manchester, NH

Boring Log No. B-2

Location: See Exploration Plan

Latitude: 42.5028° Longitude: -71.1802°

Approximate Elevation: 136 (Ft.)

Model Layer	Depth (Ft.)	Material Description	Elevation (Ft.)	Water Level Observations	Recovery (In.)	Field Test Results	Water Content (%)
2		**FILL - SILTY SAND WITH GRAVEL**, fine grained, dark brown			15	5-4-4-4 N=8	
					8	2-2-2-19 N=4	
	5.0		131				
4		**POORLY GRADED SAND WITH SILT (SP)**, trace gravel, fine grained, brown gray, medium dense			6	WOH-3-8-3 N=11	
				▽ (7 ft)	11	5-9-7-7 N=16	
	9.0		127				
		SILTY SAND WITH GRAVEL (SM), fine grained, light brown, medium dense Increased drilling resistance from 9 to 10 feet			9	11-13-14-24 N=27	
	14.2	Increased drilling resistance from 12 to 14 feet	121.8			50/2"	

Auger Refusal on Possible Bedrock at 14.2 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Elevations were interpolated from a site specific topographic site plan.

Samples obtained using a 2" O.D. split spoon sampler

Notes
WOH=Weight of Hammer

Water Level Observations
▽ 7 feet while sampling

Advancement Method
4-1/4-inch I.D. hollow stem augers

Abandonment Method
Boring backfilled with soil cuttings upon completion.

Drill Rig
CME-55

Hammer Type
Automatic

Driller
Geosearch/S. Preston

Logged by
D. Drouin

Boring Started
01-13-2025

Boring Completed
01-13-2025

Terracon
77 Sundial Ave, Ste 401W
Manchester, NH

Boring Log No. B-3

Location: See Exploration Plan

Latitude: 42.5038° Longitude: -71.1808°

Approximate Elevation: 135 (Ft.)

Model Layer	Depth (Ft.)	Description	Elevation (Ft.)
2	0.0 – 5.0	**FILL - SILTY SAND WITH GRAVEL**, fine grained, brown gray	130
3	5.0 – 7.0	**ORGANIC SILT WITH SAND (OL)**, trace root fragments, fine grained, black, very soft, faint organic odor	128
4	7.0 – 10.0	**POORLY GRADED GRAVEL WITH SILT AND SAND (GP-GM)**, fine to coarse grained, dark gray, dense	125
4	10.0 – 14.0	**POORLY GRADED SAND (SP)**, trace silt, fine grained, light brown, medium dense Increased drilling resistance from 12 to 14 feet	121
		Auger Refusal on Possible Bedrock at 14 Feet	

Sample Depth (Ft.)	Recovery (In.)	Field Test Results	Water Content (%)
0 – 2	18	8-12-13-12 N=25	
2 – 4	6	6-3-3-8 N=6	
5 – 7	11	WOH/18"-1	
7 – 9	17	8-13-24-13 N=37	13.4
10 – 12	19	6-8-13-21 N=21	

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Elevations were interpolated from a site specific topographic site plan.

Samples obtained using a 2" O.D. split spoon sampler

Notes
WOH=Weight of Hammer

Water Level Observations
7 feet while sampling
5.5 feet at completion of drilling

Advancement Method
4-1/4-inch I.D. hollow stem augers

Abandonment Method
Boring backfilled with soil cuttings upon completion.

Drill Rig
CME-55

Hammer Type
Automatic

Driller
Geosearch/S. Preston

Logged by
D. Drouin

Boring Started
01-13-2025

Boring Completed
01-13-2025

Terracon
77 Sundial Ave, Ste 401W
Manchester, NH

Boring Log No. B-4

Location: See Exploration Plan

Latitude: 42.5036° Longitude: -71.1814°

Approximate Elevation: 135 (Ft.)

Model Layer	Depth (Ft.)	Material Description	Elevation (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)
1	0.8	**10 INCHES OF TOPSOIL**	134.2					
2	2.0	**FILL - SILTY SAND WITH GRAVEL**, fine grained, brown Cobble at 2 feet	133		Split spoon	15	5-4-4-4 N=8	
3	5.0	**ORGANIC SILT WITH SAND (OL)**, trace root fragments, fine grained, black, soft, faint organic odor	130		Split spoon	8	2-2-2-19 N=4	
4	7.0	**POORLY GRADED SAND WITH SILT (SP-SM)**, fine to coarse grained, light gray, dense Increased drilling resistance from 6 to 10 feet	128	▽ (7 ft)	Split spoon	6	WOH-3-8-3 N=11	
4	11.0	**SILTY SAND WITH GRAVEL (SP-SM)**, fine grained, light brown, medium dense to very dense	124		Split spoon	11	5-9-7-7 N=16	
					Split spoon	9	11-13-14-24 N=27	
6	16.0	**WEATHERED ROCK**, trace silt, orangish brown, very dense Increased drilling resistance from 15 to 16 feet	119		Split spoon		50/4"	

Auger Refusal on Possible Bedrock at 16 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Elevations were interpolated from a site specific topographic site plan.

Samples obtained using a 2" O.D. split spoon sampler

Notes

Water Level Observations
▽ 7 feet while sampling

Advancement Method
4-1/4-inch I.D. hollow stem augers

Abandonment Method
Boring backfilled with soil cuttings upon completion.

Drill Rig
CME-55

Hammer Type
Automatic

Driller
Geosearch/S. Preston

Logged by
D. Drouin

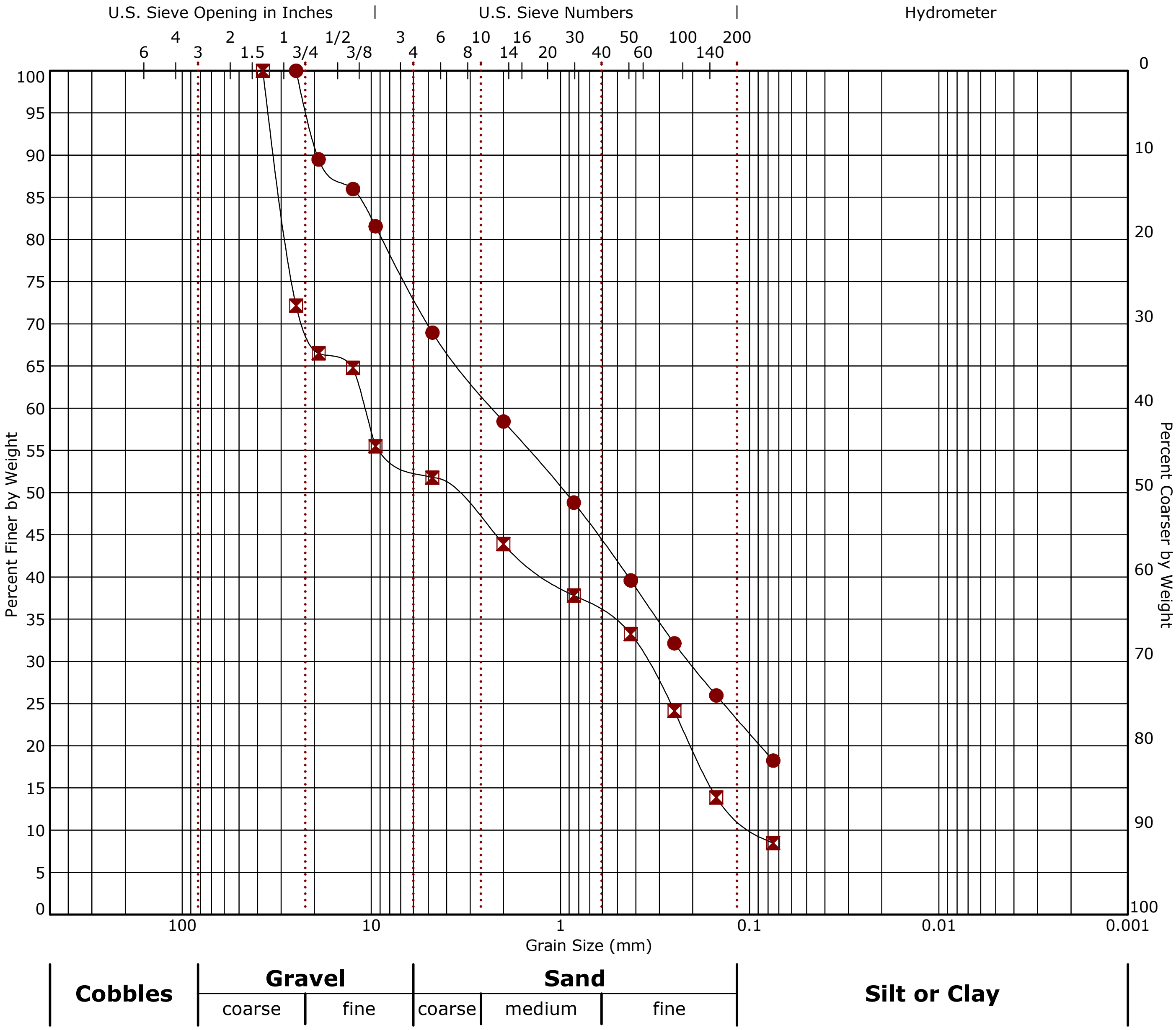
Boring Started
01-13-2025

Boring Completed
01-13-2025

Terracon
77 Sundial Ave, Ste 401W
Manchester, NH

Grain Size Distribution

ASTM D422 / ASTM C136



	Boring ID	Depth (Ft)	Description	USCS	LL	PL	PI	Cc	Cu
●	B-1	10 - 12	SILTY SAND WITH GRAVEL	SM					
⊠	B-3	7 - 9	POORLY GRADED GRAVEL WITH SILT AND SAND	GP-GM				0.12	118.95

	Boring ID	Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
●	B-1	10 - 12	25	2.274	0.209		0.0	31.0	50.7	18.2		
⊠	B-3	7 - 9	37.5	10.855	0.352	0.091	0.0	48.2	43.3	8.5		

Supporting Information

Contents:

Note: All attachments are one page unless noted above.

Terracon
77 Sundial Ave, Ste 401W
Manchester, NH

General Notes

Sampling	Water Level		Field Tests	
Standard Penetration Test		Water Initially Encountered	N	Standard Penetration Test Resistance (Blows/Ft.)
		Water Level After a Specified Period of Time	(HP)	Hand Penetrometer
		Water Level After a Specified Period of Time	(T)	Torvane
		Cave In Encountered	(DCP)	Dynamic Cone Penetrometer
			UC	Unconfined Compressive Strength
			(PID)	Photo-Ionization Detector
			(OVA)	Organic Vapor Analyzer

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

Descriptive Soil Classification

Soil classification as noted on the soil boring logs is based Unified Soil Classification System. Where sufficient laboratory data exist to classify the soils consistent with ASTM D2487 "Classification of Soils for Engineering Purposes" this procedure is used. ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)" is also used to classify the soils, particularly where insufficient laboratory data exist to classify the soils in accordance with ASTM D2487. In addition to USCS classification, coarse grained soils are classified on the basis of their in-place relative density, and fine-grained soils are classified on the basis of their consistency. See "Strength Terms" table below for details. The ASTM standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

Location And Elevation Notes

Exploration point locations as shown on the Exploration Plan and as noted on the soil boring logs in the form of Latitude and Longitude are approximate. See Exploration and Testing Procedures in the report for the methods used to locate the exploration points for this project. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

Strength Terms

Relative Density of Coarse-Grained Soils (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance		**Consistency of Fine-Grained Soils** (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance		
Relative Density	**Standard Penetration or N-Value (Blows/Ft.)**	**Consistency**	**Unconfined Compressive Strength Qu (tsf)**	**Standard Penetration or N-Value (Blows/Ft.)**
Very Loose	0 - 3	Very Soft	less than 0.25	0 - 1
Loose	4 - 9	Soft	0.25 to 0.50	2 - 4
Medium Dense	10 - 29	Medium Stiff	0.50 to 1.00	4 - 8
Dense	30 - 50	Stiff	1.00 to 2.00	8 - 15
Very Dense	> 50	Very Stiff	2.00 to 4.00	15 - 30
		Hard	> 4.00	> 30

Relevance of Exploration and Laboratory Test Results

Exploration/field results and/or laboratory test data contained within this document are intended for application to the project as described in this document. Use of such exploration/field results and/or laboratory test data should not be used independently of this document.

Unified Soil Classification System

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]				Soil Classification	
				Group Symbol	Group Name [B]
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	Gravels: More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels: Less than 5% fines [C]	Cu≥4 and 1≤Cc≤3 [E]	GW	Well-graded gravel [F]
			Cu<4 and/or [Cc<1 or Cc>3.0] [E]	GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH	GM	Silty gravel [F, G, H]
			Fines classify as CL or CH	GC	Clayey gravel [F, G, H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	Clean Sands: Less than 5% fines [D]	Cu≥6 and 1≤Cc≤3 [E]	SW	Well-graded sand [I]
			Cu<6 and/or [Cc<1 or Cc>3.0] [E]	SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH	SM	Silty sand [G, H, I]
			Fines classify as CL or CH	SC	Clayey sand [G, H, I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	Silts and Clays: Liquid limit less than 50	Inorganic:	PI > 7 and plots above “A” line [J]	CL	Lean clay [K, L, M]
			PI < 4 or plots below “A” line [J]	ML	Silt [K, L, M]
		Organic:	$\frac{LL\ oven\ dried}{LL\ not\ dried} < 0.75$	OL	Organic clay [K, L, M, N]
					Organic silt [K, L, M, O]
	Silts and Clays: Liquid limit 50 or more	Inorganic:	PI plots on or above “A” line	CH	Fat clay [K, L, M]
			PI plots below “A” line	MH	Elastic silt [K, L, M]
		Organic:	$\frac{LL\ oven\ dried}{LL\ not\ dried} < 0.75$	OH	Organic clay [K, L, M, P]
					Organic silt [K, L, M, Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve.
[B] If field sample contained cobbles or boulders, or both, add “with cobbles or boulders, or both” to group name.
[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.
[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.
[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
[F] If soil contains ≥ 15% sand, add “with sand” to group name.
[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.
[H] If fines are organic, add “with organic fines” to group name.
[I] If soil contains ≥ 15% gravel, add “with gravel” to group name.
[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.
[K] If soil contains 15 to 29% plus No. 200, add “with sand” or “with gravel,” whichever is predominant.
[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add “sandy” to group name.
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add “gravelly” to group name.
[N] PI ≥ 4 and plots on or above “A” line.
[O] PI < 4 or plots below “A” line.
[P] PI plots on or above “A” line.
[Q] PI plots below “A” line.