DESIGN DEVELOPMENT PROJECT MANUAL

GEOTECHNICAL REPORT

6A.3.6 - 02

LGCI
Lahlaf Geotechnical Consulting, Inc.

GEOTECHNICAL REPORT
PROPOSED NORTHEAST METROPOLITAN REGIONAL VOCATIONAL TECHNICAL HIGH SCHOOL
WAKEFIELD, MASSACHUSETTS
LGCI Project No. 2025
August 12, 2022

Prepared for:

DRUMMEY ROSANE ANDERSON, INC.
Howard Clock Building
260 Charles Street, Studio 300
Waltham, MA 02453
Phone: (617) 964-1700

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Phone: (617) 964-1700

Prepared by:

LAHLAF GEOTECHNICAL CONSULTING, INC.
100 Chelmsford Road, Suite 2
Billerica, Massachusetts 01862
Phone: (978) 330-5912
Fax: (978) 330-5056

ABDELMADJID M. LAHLAF
CIVIL
No. 39814

Abdelmadjid M. Lahlaf, Ph.D., P.E.
Principal Engineer

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1. PROJECT INFORMATION

1.1 Project Authorization

This geotechnical report presents the results of the subsurface explorations and a geotechnical evaluation performed by Lahlaf Geotechnical Consulting, Inc. (LGCI) for the proposed Northeast Metropolitan Regional Vocational Technical High School in Wakefield, Massachusetts. To date, we have performed services in four phases as follows:

- We performed a desk review in general accordance with the scope described in our proposal No. 20061 dated July 30, 2020. Mr. Vladimir Lyubetsky of Drummey Rosane Anderson, Inc. (DRA) authorized our desk review services by signing our proposal on July 30, 2020.

- We performed our Preferred Schematic Report (PSR) phase services in general accordance with the scope described in our proposal No. 20079 dated October 23, 2020. Mr. Vladimir Lyubetsky of DRA authorized our PSR phase services by signing our proposal on December 14, 2020.

- We performed our Schematic Design (SD) phase services in general accordance with the scope described in our proposal No. 21003-Rev. 2 dated January 29, 2021 and revised on February 19, 2021. Mr. Vladimir Lyubetsky of DRA authorized our SD phase services by signing our proposal on June 9, 2021.

- We performed our Design Development (DD) phase services in general accordance with the scope described in our proposals No. 21061-Rev. 3 dated February 28, 2022 and revised on April 7, 2022, and our proposal No. 22095 dated July 20, 2022. Mr. Vladimir Lyubetsky of DRA authorized the services in our proposal No. 21061-Rev. 3 by signing the proposal on May 10, 2022, and authorized the services in our proposal No. 22095 in an e-mail dated June 28, 2022.

- We engaged Scarptec, Inc., a rock specialist, to perform a rock study and to provide recommendations about rock cuts in accordance with our proposal No. 22062-Rev. 1 dated May 2, 2022. Mr. Vladimir Lyubetsky of DRA approved our services in an e-mail dated May 23, 3022.

1.2 Purpose and Scope of Services

The purpose of our geotechnical services was to perform subsurface explorations at the site and to provide foundation design and construction recommendations. LGCI performed the following services:

- Performed a desk review that included reviewing available information about the site, including the geologic data available from the U.S. Geological Survey and our field observations from the site visit.

- Coordinated our test pit and boring locations for the PSR, SD, and DD phases with DRA, Nitsch Engineering Inc., the project civil engineer, and with the school staff.

- Marked the test pit and boring locations for the PSR and SD phases at the site by measuring distances from the proposed building corners staked in the field by Nitsch. The DD phase explorations were staked in the field by Nitsch. LGCI notified Dig Safe Systems Inc. (Dig Safe) and the Town of Wakefield for utility clearance.

- Engaged a drilling subcontractor to advance twenty-nine (29) soil borings at the site, including four (4) borings as part of the PSR phase in 2020, six (6) borings as part of the SD phase in 2021, and nineteen (19) borings as part of the DD phase in 2022. Our drilling subcontractor installed seven (7) groundwater observation wells at the site, including two (2) groundwater observation wells as part of the PSR phase in 2020, two (2) groundwater observation wells as part of the SD phase in 2021, and three (3) groundwater observation wells as part of the DD phase in 2022. LGCI's scope includes three (3) borings located within the footprint of the existing building. These borings will be completed after the existing building is demolished.

- Engaged an excavation subcontractor to excavate forty (40) test pits at the site, including eighteen (18) test pits as part of the PSR phase in 2020, thirteen (13) test pits as part of the SD phase in 2021, and nine (9) test pits as part of the DD phase in 2022.

- Provided an LGCI geotechnical engineer at the site to coordinate and observe the test pits and borings, describe the soil samples, and prepare field logs.

- Submitted twenty-four (24) soil samples for laboratory testing, including four (4) soil samples as part of the PSR phase in 2020, four (4) soil samples as part of the SD phase in 2021, and sixteen (16) soil samples as part of the DD phase in 2022. Submitted six (6) rock core samples for compressive strength of rock tests, including four (4) rock core samples as part of the SD phase in 2021, and two (2) rock core samples as part of the DD phase in 2022.

- Engaged a geophysical subcontractor to perform borehole logging with a televiewer in two (2) borings.

- Engaged a rock specialist to visit the site and observe rock outcrop features, perform a kinematic analysis of discontinuities in the rock, and provide a rock engineering design and recommendation report.

- Obtained, at the request of the project landscape architect, four (4) soil samples from locations designated by the landscape architect and submitted them for loam analyses, including gradation tests, pH, and organic content.

- Prepared this geotechnical report containing the results of our subsurface explorations and our recommendations for foundation design and construction.

Following our 2020 desk review, LGCI submitted a preliminary geotechnical review services report dated August 7, 2020. Following our 2020 PSR phase test pits and borings, LGCI submitted a preliminary geotechnical report dated December 14, 2020, and following our 2021 and 2022 SD phase and DD phase test pits and borings, LGCI submitted an SD phase geotechnical report dated June 10, 2021 and a draft DD geotechnical report. The present report includes the results of our desk review, our 2020 explorations, our 2021 and 2022 explorations, and supersedes the four (4) aforementioned reports.

LGCI's scope of services does not include an environmental assessment for the presence or absence of wetlands or analytical testing for hazardous or toxic materials in the soil, surface water, groundwater, or air, on or below or around this site, or mold in the soil or in any structure at the site. Any statements regarding odors, colors, or unusual or suspicious items or conditions are strictly for the information of the client.

Our scope includes attending a meeting to discuss the results of our explorations. These services will be performed separately and are not included in this report. Our scope does not include performing field services. We will be pleased to perform these services for an additional fee. Recommendations for unsupported slopes, stormwater management, erosion control, pavement design, site specific liquefaction analysis, pile analysis and design, and detailed cost or quantity estimates are not included in our scope of work.

1.3 References

LGCI's understanding of the site is based on our observations at the site and on the following drawings and reports:

- Drawing S1 titled: "Typical Details and General Notes, Northeast Metropolitan Regional Vocational Technical School," (1969 Structural Details) prepared by Korslund, LeNormand & Quann, Inc., dated June 2, 1969, and provided to us by DRA on July 30, 2020.

- Drawing S3 titled: "Foundation and First Floor Plan – Unit A, Northeast Metropolitan Regional Vocational Technical School," (First Floor Plan – Unit A) prepared by Korslund, LeNormand & Quann, Inc., dated June 2, 1969, and provided to us by DRA on July 30, 2020.

- Drawing S5 titled: "Foundation and First Floor Plan – Unit B, Northeast Metropolitan Regional Vocational Technical School," (First Floor Plan – Unit B) prepared by Korslund, LeNormand & Quann, Inc., dated June 2, 1969, and provided to us by DRA on July 30, 2020.

- Drawing S7 titled: “Foundation and First Floor Plan – Unit C, Northeast Metropolitan Regional Vocational Technical School,” (First Floor Plan – Unit C) prepared by Korslund, LeNormand & Quann, Inc., dated June 2, 1969, and provided to us by Drummey Rosane Anderson, Inc. (DRA) on July 30, 2020.

- Drawing S9 titled: “Foundation and First Floor Plan – Unit D, Northeast Metropolitan Regional Vocational Technical School,” (First Floor Plan – Unit D) prepared by Korslund, LeNormand & Quann, Inc., dated June 2, 1969, and provided to us by DRA on July 30, 2020.

- Drawing S12 titled: “Foundation and First Floor Plan – Unit E, Northeast Metropolitan Regional Vocational Technical School,” (First Floor Plan – Unit E) prepared by Korslund, LeNormand & Quann, Inc., dated June 2, 1969, and provided to us by DRA on July 30, 2020.

- Drawing S14 titled: “Foundation and First Floor Plan – Unit F, Northeast Metropolitan Regional Vocational Technical School,” (First Floor Plan – Unit F) prepared by Korslund, LeNormand & Quann, Inc., dated June 2, 1969, and provided to us by DRA on July 30, 2020.

- “Custom Soil Resource Report for Essex County, Massachusetts, Southern Part; and Middlesex County, Massachusetts,” (Soil Survey Report) National Cooperative Soil Survey/National Resources Conservation Services, USDA (Map and soil description) printed November 15, 2019 https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx).

- “Surficial Materials Map of the Boston North, Massachusetts,” prepared by Stone, B.D. and DiGiacomo-Cohen, M.L. for U.S. Geological Survey, 2018, Scientific Investigation Map 3402, Quadrangle 125 – Boston North.

- Drawings L-401 to L-405 titled: “Grading Plan, Northeast Metro Technical High School, Wakefield, Massachusetts,” (Grading Plan) prepared by Warner Larson Landscape Architects, dated May 19, 2021, and provided to LGCI by Warner Larson Landscape Architects via e-mail on June 4, 2021.

- Drawings EX-1 to EX-13 titled: “Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA,” (Topographic Survey) prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

- Drawings L401.1 and L402.1 titled: “Grading Plan, Northeast Metropolitan Regional Vocational High School,” (Landscape Drawings) prepared by Warner Larson Landscape Architects, dated February 15, 2022 and provided to us by Warner Larson Landscape Architects via e-mail on February 26, 2022.

- Drawing EX-1 titled: “Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational School, 100 Hemlock Road, Wakefield, MA,” (Exhibit Plan) prepared by Nitsch, dated May 13, 2022, and provided to us by DRA via e-mail on June 3, 2022.

- Untitled site plan showing wetland buffer zones (Wetland Plan), prepared by Warner Larson Landscape Architects, undated, and provided to us by Warner Larson Landscape Architects via e-mail on April 21, 2022.

- Drawings C-300 to C-307 titled: "Utility Site Plan, MSBA Schematic Design Submittal," (Civil Drawings) prepared by DRA, dated June 17, 2021, and provided to us by DRA via e-mail on February 14, 2022.

- Drawings S1-1-1A to S1-1-0D titled: "Lower Level and First Floor Foundation Plan, Northeast Metro Tech," (Structural Drawings) prepared by EDG, dated June 17, 2021, and provided to us by DRA via e-mail on February 14, 2022.

1.4 Site Description

The site consists of the existing Northeast Metropolitan Regional Vocational Technical High School and the vacant land located south of it. The existing Northeast Metropolitan Regional Vocational Technical High School is located at 100 Hemlock Road, Wakefield, Massachusetts, as shown in Figure 1.

The site is bordered by the existing Wakefield High School on the western side, by the Saugus River on the northern side, by a utility easement on the eastern side, and by Farm Street on the southern side.

We have broken down our description of the site into two parts: 1) the existing Northeast Metropolitan Regional Vocational Technical High School where the proposed athletic fields will be constructed as described in Section 1.5, and 2) the vacant land located south of the Northeast Metropolitan Regional Vocational Technical High School where the proposed school will be constructed as described in Section 1.5.

Northeast Metropolitan Regional Vocational Technical High School – The existing Northeast Metropolitan Regional Vocational Technical High School consists of several interconnected buildings and includes an athletic practice field and a small, paved parking lot on the northern side; a football field and a baseball field on the western side; and a parking lot and a drop off loop on the southern side.

Based on the First Floor Plan (Unit A to F), the existing building is founded on conventional, shallow, spread, and continuous footings. Based on the 1969 Structural Details, the existing building footings were designed for allowable bearing capacities of 2 tons per square foot (tsf) for footings bearing on the natural soil or Structural Fill, and 15 tsf for footings bearing on bedrock.

Based on the historical topo maps included in Appendix A, the grades appear to have been cut on the western side of the site in what is currently the football field.

Based on the Topographic Survey, the Landscape Drawings, and the Exhibit Plan, the existing grades vary at the site as described below.

- The grade drops from about El. 91 feet near the western end of the main access driveway (near the guard booth) to about El. 78 feet near the main entrance to the existing building. The grade continues dropping toward the southeastern corner of the existing building to about El. 75 feet then rises to about El. 90 feet near the northeastern corner of the building.

- The grade rises slightly to about El. 93 feet near the northwestern corner of the northern parking lot before it drops steeply to between about El. 58 feet and El. 62 feet at the northern practice field. The grade across the practice field continues dropping to about El. 58 feet near the northeastern corner of the field and gently rises to about El. 65 feet near the northwestern corner of the field.

- The driveway that loops around the building drops in elevation from about El. 93 feet near the northwestern corner of the site to about El. 80 feet on the southern side before it rises again to El. 85 feet where it joins the main driveway.

- On the western side, the site is terraced with tennis courts at about El. 102 feet, the football field at about El. 114 feet, and the baseball field at between El. 84 feet and El. 86 feet.

Vacant Land located south of the existing Northeast Metropolitan Regional Vocational Technical High School – The vacant land located south of the existing Northeast Metropolitan Regional Vocational Technical High School is wooded and is accessible through dirt paths. It extends from the southern side of the existing parking lot to Farm Street. The grades in the wooded area at the southern side of Hemlock Road are characterized by rolling terrain. The grade rises steeply from about El. 82 feet near the eastern side of Hemlock Road to over El. 110 feet over a former rock cut. The grade rises to about El. 207 feet near the western side of the wooded area, with frequent local highs and lows within the area. Rock outcrops and surficial boulders are present throughout the entire extent of the wooded area. Based on the Wetland Plan, wetlands are prominent near the southern side of the vacant land located near Farm Street. A dirt path that extends in a north-south direction across this portion of the site connects to Farm Road. The grade along the dirt path near Farm Road drops to about El. 128 feet.

1.5 Project Description

Our understanding of the proposed construction is based on our discussions with DRA, the Grading Plan, Civil Drawings, and Structural Drawings referenced in Section 1.3, and on the following drawing:

- Drawing L-301 titled: "Northeast Metro Technical High School, Site Plan," (Building Layout Plan) prepared by Warner Larson Landscape Architects, Inc., undated, and provided to LGCI by DRA, via e-mail on May 3, 2021.

The Town of Wakefield is proposing the wooded area located south of the existing Northeast Metropolitan Regional Vocational Technical High School as the site for the proposed high school.

The proposed construction will include a new high school building, paved driveways and parking lots, concrete walkways, and athletic fields. The proposed building will be constructed in the wooded area south of Hemlock Road. Based on the Building Layout Plan, Civil Drawings, and Structural Drawings, the proposed building will be somewhat rectangular in shape with a footprint of about 135,000 square feet. The proposed building will be accessible from Hemlock Road. We understand that the proposed building will consist of several underground levels. Based on the Grading Plan, the proposed building will be stepped with a lower ground floor on the northern side that will have a finished floor elevation (FFE) at El. 143.50 feet and higher ground floor elevation on the southern side with an FFE at El. 163.50 feet. Based on our conversations with the Structural Engineer, we understand that the perimeter walls for the proposed building will be designed as retaining walls with concrete buttresses. Based on the Grading Plan, cuts of up to 34 feet will be required to achieve the proposed FFE grade of the proposed building and the proposed paved areas around the proposed building.

The proposed main parking lot will be in the general area of the current southern parking lot. We understand that infiltration basins will be installed beneath the main parking lot to manage stormwater runoff and that the water will be discharged into the adjacent stream. Additional parking and a driveway loop will be provided around the proposed building. Based on the Grading Plan, the proposed grades along the proposed driveway loop will range between about El. 88 feet near Hemlock Road and El. 165 feet along the northern side of the proposed parking lot on the southern side (southern parking lot) of the proposed building. Cuts of up to 30 feet will be required to achieve the proposed grades on the western portion of the proposed driveway loop and fills of up to 20 feet will be required to achieve the proposed grades for the eastern portion of the proposed driveway loop. The grades within the proposed southern parking lot drop gently in a southerly direction to elevations ranging between El. 160 feet and El. 155 feet; thus, requiring up to 12-foot cuts on the northern side and fills of up to 13 feet on the southern side. The grade will drop from the southern side of the southern parking lot to meet the existing grades via a rip-rap slope currently designed as a 1H:1V slope. Other rip rap slopes are proposed in the fill areas along the eastern portion of the proposed driveway loop.

Based on the Grading Plan, the driveway connecting to Farm Street drops in elevation from El. 166 feet to about El. 135 feet where it connects to Farm Street. Based on the Grading Plan, the concrete walkways leading from the main parking lot to the northern edge of the proposed building will range in grade between El. 84 feet and El. 135 feet.

A nearly vertical rock cut is proposed on the western side of the western portion of the proposed driveway loop. The cut will range up to 33 feet in height. A storm management swale is proposed along the bottom of the near-vertical rock cut, i.e., on the western side of the driveway loop. The proposed swale will be about 10 feet wide.

Based on the Grading Plan, athletic fields will also be provided, including one (1) combined soccer/baseball field, five (5) tennis courts, and one (1) combined football/soccer field with a track and stands. The proposed athletic fields will be constructed within the area of the existing building after the latter has been demolished. The proposed grades within the proposed combined soccer/baseball field range between El. 85.55 feet and El. 87.31 feet, requiring minor cuts and fills to achieve the proposed grades. The proposed grades within the proposed tennis courts will range between El. 85.15 feet and El. 86.15 feet; thus, requiring cuts of up to 9 feet to achieve the proposed grades. The proposed grades within the proposed combined football/soccer field with a track and stands range between El. 83.50 feet and El. 84 feet; thus, requiring cuts of up to 6 feet along the northern portion of the field, and fills of up to 7 feet along the southern portion of the field to achieve the proposed grades.

1.6 Elevation Datum

We understand that the elevations shown in the plans listed in Sections 1.3 and 1.5 are referenced to the North American Vertical Datum of 1988 (NAVD 88).

2. SITE AND SUBSURFACE CONDITIONS

2.1 Surficial Geology

Based on the Surficial Geological Map listed in Section 1.3, the natural soils in the general vicinity of the site mostly consist of the following:

- Thin Till – The thin till is described as non-sorted, non-stratified matrix of sand, some silt, and little clay that contains scattered pebbles, cobbles, and boulders. The thin till is generally less than 10 to 15 feet thick.

- Coarse Deposits – The coarse deposits consist of sand, sand and gravel, and gravel deposits as described below.

  Sand Deposits – The sand deposits are comprised mostly of fine to coarse sand. Coarser layers may contain up to 25 percent gravel. Finer layers may contain very fine sand, silt, and clay.

  Sand and Gravel Deposits –The sand and gravel deposits occur as a mixture of gravel and sand within individual layers and as alternating layers of sand and gravel. The sand and gravel layers range between 25 to 50 percent gravel and 50 to 75 percent sand.

  Gravel Deposits – The gravel deposits are comprised of at least 50 percent gravel, cobbles, and boulders. Sand occurs within gravel beds and as separate layers within the gravel.

- Bedrock Outcrops – The Surficial Geological Map indicates the presence of abundant rock outcrops on the western and southern sides of the site.

The Surficial Geological Map of the site is shown in Figure 2.

2.2 Soil Survey Report

Based on the Soil Survey Report listed in Section 1.3, the soils at the site are classified primarily as follows:

- Charlton-Urban Land-Hollis Complex – Charlton soils are defined as well drained drumlin and ground moraines, and Hollis soils are defined as well drained ridges and hillslopes. Based on the Soil Survey Report, the Charlton soils are generally comprised of up to 5 inches of fine sandy loam, overlying up to 17 inches of sandy loam, overlying up to 43 inches of gravelly sandy loam. The groundwater table is typically deeper than 80 inches. The Hollis soils are generally comprised of up to 14 inches of fine sandy loam, overlying unweathered bedrock. The groundwater table is typically deeper than 80 inches.

- Urban Land – Urban Land is defined as excavated and filled land.

- Rock Outcrop-Hollis Complex – Rock outcrops are defined as granite and gneiss. Hollis soils are defined as well drained, friable, shallow loamy basal till over granite and gneiss. Based on the Soil Survey Report, the Hollis soils are generally comprised of up to 14 inches of fine sandy loam, overlying unweathered bedrock. The groundwater table is typically deeper than 80 inches.

- Charlton-Hollis-Rock Outcrop Complex – Charlton soils are defined as well drained, friable loamy eolian deposits over friable loamy basal till derived from granite and gneiss. Based on the Soil Survey Report, the Charlton soils are generally comprised of up to 5 inches of fine sandy loam, overlying up to 17 inches of sandy loam, overlying up to 43 inches of gravelly sandy loam. The groundwater table is typically deeper than 80 inches. Hollis soils are defined as well drained, friable, shallow loamy basal till over granite and gneiss. Based on the Soil Survey Report, the Hollis soils are generally comprised of up to 14 inches of fine sandy loam, overlying unweathered bedrock. The groundwater table is typically deeper than 80 inches. Rock outcrops are defined as granite and gneiss.

- Swansea Muck – Swansea Muck is defined in the Soil Survey Report as “highly decomposed organic material over loose sandy and gravelly glaciofluvial deposits.” Based on the Soil Survey Report, the Swansea Muck is generally comprised of up to 34 inches of muck, overlying up to 45 inches of coarse sand. The groundwater table typically ranges between 0 and 6 inches.

- Ridgebury Fine Sandy Loam – Ridgebury soils are defined as poorly drained depressions, drumlins, drainageways, hills, and ground moraines. Based on the Soil Survey Report, the Ridgebury soils are generally comprised of up to 1 inch of moderately decomposed plant material, overlying up to 5 inches of fine sandy loam, overlying up to 4 inches of sandy loam, overlying up to 56 inches of gravelly sandy loam. The groundwater table typically ranges between 0 and 6 inches.

A copy of the Soil Survey Report and Map are included in Appendix B.

2.3 LGCI’s Test Pits, Probes, and Borings

2.3.1 General

LGCI coordinated our PSR and SD exploration locations with DRA and marked the exploration locations in the field by taping distances from the proposed building corners staked by Nitsch. Our SD exploration locations were surveyed by Nitsch after completing our explorations to obtain ground surface elevations. Nitsch marked our DD exploration locations prior to performing our services. LGCI notified Dig Safe for utility clearance prior to starting our explorations at the site.

Unless notified otherwise, we will dispose of the soil and rock samples obtained during our explorations after three months.

2.3.2 LGCI's Explorations

2.3.2.1 Test Pits and Hand Probes

During the PSR phase, LGCI engaged Northern Drill Service, Inc. (NDS) of Northborough, Massachusetts to excavate eighteen (18) test pits (TP-1 to TP-18) at the site on December 3 and 4, 2020. The test pits were excavated with a Komatsu PC-120 excavator. The test pits extended to depths ranging between 0.7 and 10.5 feet beneath the ground surface. Upon completion, the test pit excavations were backfilled with the excavated material and tamped with the excavator bucket.

During the SD phase, LGCI engaged NDS to excavate thirteen (13) test pits (TP-101 to TP-111, TP-113, and TP-114) at the site between April 19 and 20, 2021. The test pits were excavated with a Kubota KX-080-4 excavator. The test pits extended to depths ranging between 1.8 and 5.5 feet beneath the ground surface. Upon completion, the test pit excavations were backfilled with the excavated material and tamped with the excavator bucket. Test pit TP-112 was skipped due to proximity to wetlands.

During the DD phase, LGCI engaged NDS to excavate an additional nine (9) test pits (TP-201 to TP-207, TP-B-205, and TP-B-206) at the site between April 26 and 27, 2022. The test pits were excavated with a Kubota KX-080-4 excavator. The test pits extended to depths ranging between 2.5 and 9 feet beneath the ground surface. Upon completion, the test pit excavations were backfilled with the excavated material and tamped with the excavator bucket.

During the DD phase, LGCI also performed four (4) hand probes (HP-TS-1 to HP-TS-4) at the site, at the request of the project landscape architect, on June 15, 2022 for the purpose of measuring the thickness of the topsoil. The hand probes were advanced using a hand auger. The hand probes extended to depths ranging between 1 and 1.3 feet beneath the ground surface. Upon completion, the hand probes were backfilled with the excavated material.

As part of the DD phase services, LGCI also engaged Saunders Construction to excavate an additional six (6) test pits (TP-208 to TP-213) at the site on July 22, 2022. The test pits were excavated with a Takeuchi TB-175 excavator. The test pits extended to depths ranging between 2.6 and 5.6 feet beneath the ground surface. Upon completion, the test pit excavations were backfilled with the excavated material and tamped with the excavator bucket.

An LGCI geotechnical engineer observed and logged the test pits and hand probes in the field.

To explore the subsurface conditions at greater depths, soil borings were also advanced at the site as described in Section 2.3.2.2 below.

2.3.2.2 Soil Borings

During the PSR phase, LGCI engaged NDS to advance four (4) borings (B-1-OW to B-4) at the site on December 10 and 11, 2020. The borings were advanced with a Mobile B-48 track-mounted drill rig using drive and wash techniques with a 4-inch casing. The borings extended to depths ranging between 0.5 feet and 18 feet beneath the ground surface. Upon completion, the boreholes were backfilled with the soil cuttings. Two (2) groundwater observation wells were installed in borings B-1-OW and B-3-OW.

During the SD phase, LGCI engaged NDS to advance six (6) borings (B-101-OW to B-106) at the site between April 26 and May 14, 2021. The borings were advanced with a Mobile B-48 track-mounted drill rig and a Diedrich D-25 track-mounted drill rig using drive and wash techniques with 3-inch and 4-inch casings. The borings extended to depths ranging between 11.5 and 36 feet beneath the ground surface. Upon completion, the boreholes were backfilled with the soil cuttings. Two (2) groundwater observation wells were installed in borings B-101-OW and B-104-OW.

During the DD phase, LGCI engaged NDS to advance an additional nineteen (19) borings (B-201 to B-204-OW, B-206 to B-214, B-216 to B-217, and B-220-OW to B-223) at the site between April 26 and May 11, 2022. The borings were advanced with a Mobile B-48 track-mounted drill rig using drive and wash techniques with 3-inch and 4-inch casings. The borings extended to depths ranging between 4 and 37 feet beneath the ground surface. Upon completion, the boreholes were backfilled with the soil cuttings and gravel. In paved areas, the ground surface was restored using asphalt cold patch. Three (3) groundwater observation wells were installed in borings B-204-OW, B-208-OW, and B-220-OW.

NDS performed Standard Penetration Tests (SPT) during drilling and obtained split spoon samples in the borings with an automatic hammer at typical depth intervals of 2 feet or 5 feet as noted on the boring logs in general accordance with ASTM D-1586. Rock was cored in borings B-1-OW, B-3-OW, B-101-OW to B-106, B-201 to B-204-OW, B-206 to B-209, B-216, and B-220-OW.

An LGCI geotechnical engineer observed and logged the borings in the field.

2.3.2.3 Test Pit, Hand Probe, and Soil Boring Logs and Locations

The test pit, hand probe, and boring locations are shown in Figures 3A to 3D. Appendix C contains LGCI's test pit and hand probe logs. Appendix D contains LGCI's boring logs, the groundwater observation well installation reports, and photographs of the rock cores. Tables 1 and 2 include summaries of LGCI's test pits and hand probes, and borings, respectively.

2.4 Subsurface Conditions

The subsurface description in this report is based on a limited number of test pits, hand probes, and borings and is intended to highlight the major soil strata encountered during our test pits, hand probes, and borings. The subsurface conditions are known only at the actual test pit, hand probe, and boring locations. Variations may occur and should be expected between test pit, hand probe, and boring locations. The test pit, hand probe, and boring logs represent conditions that we observed at the time of our test pits, hand probes, and borings, and were edited, as appropriate, based on the results of the laboratory test data and inspection of the soil samples in the laboratory. The strata boundaries shown in our test pit, hand probe, and boring logs are based on our interpretations and the actual transitions may be gradual. Graphic soil symbols are for illustration only.

The soil strata encountered in the test pits, hand probes, and borings were as follows, starting at the ground surface.

Topsoil/Forest Mat – A layer of surficial topsoil/forest mat was encountered at the ground surface in all hand probes, test pits except in test pit TP-210, and borings except in borings B-210, B-212 to B-214, B-216 to B-217, and B-220-OW to B-223. The topsoil/forest mat extended to depths ranging between 0.1 and 2.3 feet beneath the ground surface. Refusal was encountered in this layer on apparent rock in test pits TP-7, TP-14, and TP-108 and in boring B-2 at depths of 2.0, 0.7, 2.3 and 0.5 feet beneath the ground surface, respectively. Rock outcrops were observed at the ground surface near the locations of the test pits and borings.

Asphalt – A layer of asphalt was encountered at the ground surface in borings B-210, B-212 to B-214, B-216 to B-217, and B-220-OW to B-223. The thickness of the asphalt ranged between 0.2 and 0.5 feet.

Fill – Existing fill was encountered beneath the asphalt or surficial topsoil/forest mat in borings B-210 to B-214, B-216 to B-217, and B-220-OW to B-223, in test pit TP-201, and in hand probes HP-TS-1 to HP-TS-3. These explorations were performed in the grass areas and in the paved areas around the existing building. The fill extended to depths ranging between 0.8 and 4.8 feet beneath the ground surface. Hand probes HP-TS-1 to HP-TS-3 were terminated in the fill layer at depths of 1.3, 1.1, and 1.0 feet beneath the ground surface, respectively.

The samples in this layer were mostly described as silty sand, well graded sand, and poorly graded sand. Four (4) samples were described as well graded gravel. The fines content in the fill layer ranged between 0 and 25 percent, and the gravel content ranged up to 45 percent. When described as gravel, the sand content in the fill ranged between 20 and 45 percent. The fill contained traces of organic soil, roots, wood, brick, and asphalt.

The standard penetration test (SPT) N-values in the fill ranged between 5 blows per foot (bpf) and refusal, with most values higher than 20 bpf, indicating medium dense to very dense material. The higher SPT N-values in the fill may be due to obstructions in the fill and may not represent the true density of the fill. The excavation effort within the fill layer was described as easy.

<u>Subsoil</u> – A layer of subsoil was encountered beneath the surficial topsoil/forest mat or fill in the test pits and borings except in test pits TP-7, TP-14, TP-108, TP-113, TP-114, and TP-201, and in borings B-2, B-101-OW, B-103, B-104-OW, B-106, B-206, B-209 to B-214, B-216 to B-217, and B-221 to B-223. The subsoil extended to depths ranging between 1.5 and 5.0 feet beneath the ground surface. Refusal was encountered in this layer on apparent rock in test pits TP-3, TP-4, TP-101, TP-105, TP-106, TP-110, TP-203, TP-205, TP-208, and TP-B-206, and in borings B-1-OW, B-3-OW, and B-102 at depths of 2.0, 1.5, 3.5, 1.8, 3.2, 2.7, 2.5, 2.5, 2.6, 2.6 2.5, 2.2, and 2.7 feet, respectively.

The samples in this layer were mostly described as silty sand. Eight (8) samples were described as silt with sand or sandy silt, one (1) sample was described as silty gravel, and one (1) sample was described as well graded gravel. The fines content in the subsoil ranged between 20 and 45 percent, and the gravel content ranged up to 35 percent. The fines in the subsoil were occasionally described as slightly plastic. When described as silt, the sand content ranged between 25 and 30 percent. This layer contained traces of organic soil, roots, and wood. The subsoil also contained between 5 and 30 percent cobbles and boulders.

The SPT N-values in the subsoil ranged between 1 bpf and refusal, with most values lower than 10 bpf, indicating very loose to loose soil. The excavation effort within the subsoil was described as easy to very difficult.

<u>Buried Organic Soil</u> – A layer of buried organic soil was encountered beneath the fill in test pit TP-210 and extended to a depth of 2.0 feet below the ground surface. The buried organic soil was described as silty sand. The fines content ranged between 25 and 30 percent, and the soil contained trace of roots.

<u>Sand and Gravel</u> – A layer of sand and gravel was encountered beneath the surficial topsoil/forest mat, the subsoil, or fill in test pits TP-1, TP-5, TP-6, TP-8 to TP-10, TP-12, TP-13, TP-15 to TP-18, TP-102 to TP-104, TP-107, TP-109, TP-111, TP-113, TP-114, TP-202, TP-204, TP-206, TP-207, TP-209 to TP-213 and TP-B-205; and in borings B-4, B-105, B-201, B-204-OW, B-207, B-210 to B-214, B-217, and B-220-OW to B-223. Where encountered, this layer extended to the bottom of the explorations or to refusal. Refusal was encountered in this layer on apparent rock at depths ranging between 1.9 and 10.5 feet beneath the ground surface.

The samples in this layer were mostly described as silty sand and well or poorly graded gravel. Eight (8) samples were described as well graded sand, and six (6) samples were described as poorly graded sand. The fines content in the sand and gravel ranged between 0 and 50 percent, and the gravel content ranged up to 40 percent. When described as gravel, the sand content ranged between 0 and 45 percent. A few samples in this layer contained traces of organic soil and roots. The sand and gravel also contained between 5 and 50 percent cobbles and boulders up to 2 feet in diameter.

The SPT N-values in the sand and gravel ranged between 7 bpf and refusal, with most values ranging between 11 and 66 bpf indicating mostly medium dense to very dense sand.

Weathered Rock – Weathered rock was encountered beneath the subsoil or fill in test pits TP-2, TP-11, and TP-201 at depths of 3.5, 2, and 2 feet beneath the ground surface, respectively. The weathered rock broke into a well graded gravel and silty gravel soil matrix.

Rock – Excavation refusal and split spoon refusal were encountered in the test pits and borings, except in borings B-211, B-212, and B-223, at depths ranging between 0.1 and 19.1 feet beneath the ground surface.

To confirm and characterize the rock, rock was cored in borings B-1-OW, B-3-OW, B-101-OW to B-106, B-201 to B-204-OW, B-206 to B-209, B-216, and B-220-OW. The rock generally consisted of hard to very hard, moderately weathered to fresh, extremely fractured to sound, fine-grained to medium-grained, gray to blue, Rhyolite. The rock core recoveries ranged between 81 and 100 percent and the Rock Quality Designation (RQD) ranged between 11.67 and 100 percent. The coring rate was generally less than 20 minutes per foot (min./ft.). However, in borings B-103, B-106, and B-203, coring rates up to 211 min./ft. were recorded, indicating very hard rock.

2.5 Groundwater

Groundwater was encountered in test pits TP-1, TP-2, TP-8, TP-9, TP-15 to TP-17, TP-101, TP-103, TP-107, TP-108, TP-110, TP-111, TP-114, TP-202, TP-204, TP-B-205, and TP-B-206, and in borings B-1-OW, B-4, B-101-OW to B-106, B-201 to B-204-OW, B-206 to B-208, B-210 to B-212, B-216 to B-217, and B-220-OW to B-221 at depths ranging between 0 feet (at the ground surface) and 10.0 feet beneath the ground surface as shown in Tables 1 and 2 and in the test pit and hand probe logs, and boring logs.

Ten (10) groundwater level readings were obtained in groundwater observation wells B-1-OW and B-3-OW, six (6) groundwater level readings were obtained in groundwater observation wells B-101-OW and B-104-OW, four (4) groundwater level readings were obtained in groundwater observation wells B-204-OW and B-208-OW, three (3) groundwater level readings were obtained in boring B-206, and one (1) groundwater level reading was obtained in groundwater observation well B-220-OW between the dates of December 11, 2020, and May 11, 2022. The groundwater level readings ranged between 2.5 and 30.1 feet beneath the ground surface as shown in the tables below.

	B-1-OW G.S. El. = 184.5 ft.	B-3-OW G.S. El. = 170.5 ft.	B-101-OW G.S. El. = 172.6 ft.	B-104-OW G.S. El. = 180.9 ft.
Date	**Depth / Elevation (ft.)**	**Depth / Elevation (ft.)**	**Depth / Elevation (ft.)**	**Depth / Elevation (ft.)**
12/11/2020	10.0 / 174.5	4.9 / 165.6	- / -	- / -
2/1/2021	10.0 / 174.5	8.7 / 161.8	- / -	- / -
3/3/2021	9.4 / 175.1	5.3 / 165.2	- / -	- / -
3/24/2021	9.5 / 175.0	7.8 / 162.7	- / -	- / -
5/13/2021	7.6 / 176.9	8.0 / 162.5	12.5 / 160.1	6.1 / 174.8
6/3/2021	7.9 / 176.6	8.1 / 162.4	23.9 / 148.7	17.1 / 163.8
6/29/2021	11.0 / 173.5	14.1 / 156.4	30.1 / 142.5	24.4 / 156.5
4/26/2022	8.7 / 175.8	7.4 / 163.1	18.4 / 154.2	17.3 / 163.6
5/5/2022	- / -	- / -	- / -	- / -
5/6/2022	10.0 / 174.5	9.4 / 161.1	23.7 / 148.9	19.5 / 161.4
5/9/2022	10.2 / 174.3	10.1 / 160.4	23.5 / 149.1	19.9 / 161.0
5/11/2022	- / -	- / -	- / -	- / -

	B-204-OW G.S. El. = 162.0 ft.	B-206 G.S. El. = 181.0 ft.	B-208-OW G.S. El. = 193.0 ft.	B-220-OW G.S. El. = 88.0 ft.
Date	**Depth / Elevation (ft.)**	**Depth / Elevation (ft.)**	**Depth / Elevation (ft.)**	**Depth / Elevation (ft.)**
12/11/2020	- / -	- / -	- / -	- / -
2/1/2021	- / -	- / -	- / -	- / -
3/3/2021	- / -	- / -	- / -	- / -
3/24/2021	- / -	- / -	- / -	- / -
5/13/2021	- / -	- / -	- / -	- / -
6/3/2021	- / -	- / -	- / -	- / -
6/29/2021	- / -	- / -	- / -	- / -
4/26/2022	2.5 / 159.5	15.5 / 165.5	20.0 / 173.0	- / -
5/5/2022	2.5 / 159.5	15.5 / 165.5	20.0 / 173.0	- / -
5/6/2022	2.8 / 159.2	16.0 / 165.0	22.0 / 171.0	- / -
5/9/2022	3.0 / 159.0	- / -	23.7 / 169.3	- / -
5/11/2022	- / -	- / -	- / -	10.7 / 77.3

Groundwater flowed out of the borehole at boring B-102 upon completion of drilling for 24 hours before the borehole was sealed, possibly indicating an artesian condition. Boring B-102 extended to El. 135.2 feet. This condition was not observed in other borings.

The groundwater information reported herein is based on observations made during or shortly after the completion of drilling and excavation and may not represent the actual groundwater conditions. Furthermore, the drilling procedure introduced water into the boreholes; therefore, additional time may be required for the groundwater levels to stabilize. The groundwater information presented in this report only represents the conditions encountered at the time and location of the explorations. Seasonal fluctuation should be anticipated.

2.6 Borehole Geophysical Logging

LGCI engaged Hager Richter Geoscience, Inc. (HRGI) of Salem New Hampshire on May 5, 2022 to perform borehole geophysical logging in two (2) borings (B-206 and B-208). HRGI lowered a televiewer into the core holes and recorded discontinuities in the rock. The purpose of the borehole logging was to provide data about the rock discontinuities to Scarptec, Inc. who performed a kinematic analysis of discontinuities in the rock, and provided a rock engineering design and recommendation report described in Section 3.7. The results of the borehole logging are included in Appendix E.

2.7 Ground Penetrating Radar Geophysical Survey

LGCI engaged Hager Geoscience of Woburn, Massachusetts to perform a bedrock depth investigation using ground penetrating radar on July 14 and 15, 2022. Hager Geoscience submitted its report on July 22, 2022. The report includes the profile of inferred rock along two (2) lines: one line that extends on the western side of the proposed building, and the second line extending along the eastern side of the proposed building. Hager Geoscience's report is included in Appendix F.

2.8 Laboratory Test Data

LGCI submitted twenty-four (24) soil samples collected from the test pits and borings for grain-size analysis. The results of the grain-size analyses are provided in the test data sheets included in Appendix G and are summarized in the table below.

Grain-Size Analysis Test Results

Exploration No.	Sample No.	Stratum	Sample depth (ft.)	Percent Gravel	Percent Sand	Percent Fines
TP-1	Grab	Subsoil	0.7 – 3.5	10.3	38.1	51.6
TP-5	Grab	Subsoil	0.5 – 3.5	18.9	45.2	35.9
TP-6	Grab	Subsoil	0.5 – 3.0	2.6	39.4	58.0
TP-9	Grab	Natural	1.9 – 6.2	23.2	54.3	22.5
TP-104	Grab	Subsoil	0.5 – 2.5	56.2	22.0	21.8
TP-106	Grab	Subsoil	0.5 – 3.2	8.3	54.4	37.3
TP-107	Grab	Natural	2.1 – 3.1	7.4	51.1	41.5

TP-113	Grab	Natural	0.5 – 3.0	31.6	55.9	12.5
B-201	S3	Natural	4.0 – 6.0	10.0	49.2	40.8
B-202	S1 Bot. 2”	Subsoil	0.3 – 1.8	30.5	36.2	33.3
B-203	S1 Bot. 3”	Subsoil	0.2 – 2.0	17.2	48.4	34.4
B-204-OW	S1 Bot. 6”	Subsoil	0.3 – 2.0	0.5	29.1	70.4
B-204-OW	S2 Bot. 8”	Natural	2.7 – 4.0	49.4	41.2	9.4
B-204-OW	S3	Natural	4.0 – 4.3	37.6	46.0	16.4
B-210	S2	Fill	2.0 – 4.0	18.5	59.1	22.4
TP-201	Grab	Fill	1.0 – 2.0	37.4	43.8	18.8
TP-202	Grab	Subsoil	2.0 – 2.5	9.8	59.4	30.8
TP-204	Grab	Subsoil	0.5 – 3.0	34.5	40.6	24.9
TP-207	Grab	Subsoil	0.5 – 3.0	15.1	45.0	39.9
TP-B-205	Grab	Subsoil	0.5 – 1.5	0.6	28.2	71.2
B-220-OW	S2	Subsoil	2.0 – 4.0	21.4	42.5	36.1
B-220-OW	S3	Natural	4.0 – 5.3	69.1	20.3	10.6
TP-103	Grab	Natural	2.4 – 5.5	15.1	37.4	47.5
TP-207	Grab	Natural	3.0 – 3.5	18.5	58.7	22.8

LGCI submitted six (6) rock specimens to a laboratory for compressive strength tests, including four (4) specimens during the SD phase and two (2) specimens during the DD phase. One (1) sample broke during testing. The results, included in Appendix H, indicate compressive strengths ranging between 17,340 psi and 42,395 psi.

LGCI also submitted four (4) topsoil samples collected from locations selected by the landscape architect for loam analyses. The results are included in Appendix I.

3. EVALUATION AND RECOMMENDATIONS

3.1 General

Based on our understanding of the proposed construction, our observation of the test pits and borings, and the results of our laboratory testing, there are a few issues that we would like to highlight for consideration and discussion.

We anticipate that the major considerations during design and construction will be the removal of the subsoil, the blasting of rock, the stability of the proposed near-vertical rock cuts, the onsite processing of blasted rock to produce rip rap and other fill materials, and under-slab drainage as described below.

3.1.1 Surficial Topsoil, Forest Mat, Subsoil, and Existing Fill

The surficial topsoil and forest mat extended to depths of up to 2.3 feet and subsoil extended to depths of up to 5 feet. Existing fill was encountered in a few explorations performed around the existing building and extended to depths of up to 4.8 feet beneath the ground surface. The existing fill could be deeper at locations not explored by LGCI. The topsoil, forest mat, subsoil, and existing fill should be handled as follows:

- The topsoil, forest mat, subsoil, and existing fill, if any, are not suitable to support the proposed building and should be entirely removed from within the footprint of the proposed building, and under retaining wall and bleacher footings. The removal should extend outside the limits of the proposed building a distance equal to the distance between the bottom of the footings and the bottom of the topsoil, forest mat, subsoil, and existing fill, if any, or 5 feet, whichever is greater.

- The topsoil and the forest mat should be entirely removed within the proposed paved areas.

- In paved areas, we recommend removing the subsoil to the top of the natural sand, or to a minimum depth of 18 inches beneath the bottom of the proposed pavement, whichever occurs first. Where subsoil is encountered and extends to depths greater than 18 inches beneath the bottom of the proposed pavement, the subsoil deeper than 18 inches beneath the bottom of the proposed pavement may remain in place provided that it is improved in accordance with the recommendations in Section 4.1.

- The removal of the topsoil and subsoil should extend laterally 5 feet outside the limits of the proposed paved area.

- The existing fill should be improved within the proposed paved areas in accordance with the requirements of Section 4.1.

- The topsoil, forest mat, subsoil, and existing fill, if any, should be removed within the proposed athletic fields in accordance with the requirements of the project landscape architect.

3.1.2 Rock Blasting

- Significant cuts are anticipated in order to achieve the proposed grades. Based on the test pits and borings, the majority of cuts will be in rock and will require rock blasting.

- To facilitate rock removal and the preparation of the subgrade of footings and slabs, we recommend that blasting extend at least 12 inches below the bottom of the footings over the entire building footprint.

- Care should be exercised by the blasting contractor not to overblast. Overblasted and heaved rock should be removed and replaced with Structural Fill.

- Where a near-vertical rock face is desired for esthetics, pre-splitting may be considered.

- For safety reasons, we recommend providing a catchment area at least 15 feet wide separating the bottom of the near-vertical rock cut and the nearest walkway or driveway. The drainage swale proposed on the western side of the western portion of the proposed driveway loop may be considered part of the catchment area.

- Based on our discussions with the project Civil Engineer, we understand that utilities will come into the building on all sides. Accordingly, rock blasting should be performed beyond the limits of the proposed building to allow for a safe space to install the utilities.

- Due to construction sequencing, rock blasting may not be feasible everywhere, especially for shallow utilities. Therefore, we recommend that the project include a contingency amount for hoe-ramming.

Additional recommendations for rock blasting are provided in Section 4.5.

3.1.3 Stability of the Near-Vertical Rock Cuts

- On the western side of the western portion of the proposed driveway loop, an almost 33-foot-high rock cut is proposed. We recommend that the cut be performed in accordance with the recommendations in Section 3.7.

- We would like to highlight that rock faces sloped at 1H:8V may not be feasible if rock discontinuities dip into the excavations. Depending on the number, type, and the orientation of discontinuities in the rock, flatter slopes and/or rock bolts may be required to maintain stable rock faces.

- Typically, the rock faces are inspected after rock blasting is completed during the excavation of the blasted rock. At that time, it may become evident that the rock requires local treatment/reinforcement by means of nets or rock bolts. We recommend that the cost estimate include a contingency for rock bolting and/or netting to support and protect the rock faces.

3.1.4 Shallow Foundations and Slabs-on-Grade

- After the surficial topsoil, forest mat, subsoil, and existing fill are entirely removed from within the proposed building footprint and from under the proposed retaining walls, if any, and other structure footings, the proposed building, retaining walls, and footings may be supported on shallow footings bearing in Structural Fill placed directly on the natural sand and gravel or on top of rock. Due to the susceptibility of the natural sand to disturbance, we recommend placing footings on a minimum of 6 inches of Structural Fill.

- The proposed slab may be designed as a slab-on-grade supported on Structural Fill placed directly on top of the natural sand.

3.1.5 Under-Slab Drainage System

Based on the groundwater levels observed in the groundwater observation wells, we believe that an under-sab drainage system is required beneath the proposed slab-on-grade. We anticipate that the under-slab drainage system will generate a considerable volume of water. We recommend that the system be designed to flow by gravity. Based on our discussions with the project Civil Engineer, we understand that the water from the under-slab drainage system may be channeled to one of the infiltration systems under the proposed main parking lot and from there the overflow will be discharged into the Saugus River on the northern side of the site. Our recommendations for the under-slab drainage system are presented in Section 3.4.

3.1.6 Silt Content

The natural soil is silty. Silty soils are very susceptible to disturbance when exposed to moisture. Care should be exercised during construction to maintain a dry working subgrade and to provide working mats, e.g., crushed stone or concrete mud mats, to reduce the potential for disturbance of the foundation subgrade and to improve working conditions.

3.1.7 Reuse of Onsite Materials

The onsite materials are not suitable for reuse as Structural Fill.

The contractor may consider mobilizing a rock crusher to the site. Existing cobble and boulders, and blasted rock can be processed by blending them with the natural soil and crushing them to produce a well graded material. Processed material obtained by crushing blasted rock, boulders, and soil should meet the gradation requirements of Ordinary Fill and Structural Fill. Material produced by the crushing operation should be well graded so as to reduce the potential for formation of honeycombs during its placement and compaction.

Additional recommendations for fill materials and reuse of onsite materials are presented in Sections 4.3 and 4.4, respectively.

Our recommendations for footing design are presented in Section 3.2.1. Our estimates for settlement are presented in Section 3.2.2. Our concrete slab considerations are presented in Section 3.3 and the lateral earth pressure recommendations are presented in Section 3.6. Section 4.1 provides recommendations for preparation of subgrades.

3.2 Foundation Recommendations

3.2.1 Footing Design

- For footings supported on a minimum of 6 inches of Structural Fill placed directly over the natural sand and gravel or on rock after removing the surficial topsoil and the subsoil, we recommend a net allowable bearing pressure of 4 kips per square foot (ksf) for footings bearing in the natural sand or in deep Structural Fill thicker than 4 feet, and 10 ksf for footings bearing on a leveling layer of crushed stone or Structural Fill placed on rock.

- Footing subgrades should be prepared in accordance with the recommendations in Section 4.1.

- All foundations should be designed in accordance with *The Commonwealth of Massachusetts State Building Code 780 CMR, ninth Edition* (MSBC 9th Edition).

- Exterior footings and footings in unheated areas should be placed at a minimum depth of 4 feet below the final exterior grade to provide adequate frost protection. Interior footings in heated areas may be designed and constructed at a minimum depth of 2 feet below finished floor grades.

- Wall footings should be designed and constructed with continuous, longitudinal steel reinforcement for greater bending strength to span across small areas of loose or soft soils that may go undetected during construction.

- A representative of LGCI should be engaged to observe that the subgrade has been prepared in accordance with our recommendations.

3.2.2 Settlement Estimate

For footings designed using the net allowable bearing pressure recommended above, we anticipate that the settlement will be about 1 inch and that the differential settlement of the footings will be 3/4 inch or less, over 25 feet. Total and differential settlements of these magnitudes are usually considered tolerable for the anticipated construction. As the design progresses and the settlement estimates are refined, the tolerance of the proposed structure to the predicted total and differential settlements should be assessed by the structural engineer.

3.3 Concrete Slab Considerations

- Floor slabs can be constructed as slabs-on-grade bearing on a minimum of 12 inches of Structural Fill placed directly on top of the natural sand. The subgrade of the slabs should be prepared as described in Section 4.1.

- To reduce the potential for dampness in the proposed floor slabs, the project architect may consider placing a vapor barrier beneath the floor slabs. The vapor barrier should be protected from puncture during construction of the slabs.

- For the design of the floor slabs bearing on the materials described above, we recommend using a modulus of subgrade reaction, k_{s1}, of 100 tons per cubic foot (tcf). Please note that the values of k_{s1} are for a 1 x 1 square foot area. These values should be adjusted for larger areas using the following expression:

$$\textit{Modulus of Subgrade Reaction}\,(k_s) = k_{s1} * \left(\frac{B+1}{2B}\right)^2$$

where:

k_s = Coefficient of vertical subgrade reaction for loaded area,
k_{s1} = Coefficient of vertical subgrade reaction for 1 x 1 square foot area, and
B = Width of area loaded, in feet.

Please note that cracking of slabs-on-grade can occur as a result of heaving or compression of the underlying soil, but also as a result of concrete curing stresses. To reduce the potential for cracking, the precautions listed below should be closely followed for construction of all slabs-on-grade:

- Construction joints should be provided between the floor slab and the walls and columns in accordance with the American Concrete Institute (ACI) requirements, or other applicable code.

- Backfill in interior utility trenches should be properly compacted.

- In order for the movement of exterior slabs not to be transmitted to the building foundation or superstructure, exterior slabs should be isolated from the building superstructure.

3.4 Under-Slab Drains

Based on the current groundwater levels observed in the explorations, we anticipate that an under-slab drainage system will be required under the proposed building.

We anticipate that the under-slab drainage system will generate considerable quantities of water. Accordingly, we recommend that the under-slab drainage system consist of 1) a minimum of 12 inches of ¾-inch crushed stone placed below the slab, and 2) 6-inch-diameter slotted PVC pipes installed with their inverts at least 15 inches below the bottom of the slab. The pipes should be installed in trenches placed at 10 to 15 inches apart. The trenches should be at least 18 inches wide and 9 inches deep (below the bottom of the 12 inches of crushed stone) to allow placing crushed stone around the PVC pipe. The slotted PVC pipes should connect to a 6-inch solid PVC header pipe that collects and channels the collected water out of the building. We recommend at least three (3) exit points from the building for the groundwater collected by the under-slab drainage system.

A non-woven geotextile fabric should be installed between the crushed stone and the underlying soil or rock for separation. The slots on the PVC pipes should be placed facing downward to allow for entry of water at the bottom of the pipe. Clean-outs should be included at the end of the perforated pipes, at changes in directions, and at about 100-foot intervals.

We recommend channeling the water from the under-slab drainage system to flow by gravity to a discharge area or to an infiltration system. The owner should apply for a discharge permit and should perform analytical tests as required by the permits.

3.5 Seismic Design

In accordance with Section 1613 of MSBC 9th Edition and International Building Code (2015 IBC) and based on the boring data, the seismic criteria for the site are as follows:

• Site Class:	C
• Spectral Response Acceleration at short period (Ss):	0.232g
• Spectral Response Acceleration at 1 sec. (S_1):	0.072g
• Site Coefficient Fa (Table 1613.5.3(1)):	1.2
• Site Coefficient Fv (Table 1613.5.3(2):	1.7
• Adjusted spectral response S_{MS}:	0.278 g
• Adjusted spectral responses S_{M1}:	0.122 g

Based on the boring information, we believe the site soils are not susceptible to liquefaction.

3.6 Lateral Pressures for Wall Design

3.6.1 Lateral Earth Pressures

Lateral earth pressures recommended for design of below-ground building walls, including the wall separating the ground floor (FFE of El. 143.5 feet) and the main floor (FFE of El. 163.5 feet), perimeter walls that are below ground, and site retaining walls, if any, are provided below.

Coefficient of Active Earth Pressure, K_A:	0.33 (see note below)
Coefficient of At-Rest Earth Pressure, K_o:	0.50
Coefficient of Passive Earth Pressure, K_p:	3.0
Total Unit Weight γ:	125 pcf

Note: The values in the table are based on a friction angle for the backfill of 30 degrees and neglecting friction between the backfill and the wall. The design active and passive coefficients are based on horizontal surfaces (non-sloping backfill) on both the active and passive sides, and a vertical wall face.

- Exterior walls of below-ground spaces and retaining walls braced at the top to restrain movement/rotation, such as the perimeter walls of the proposed building and the wall separating the two levels, should be designed using the “at-rest” pressure coefficient.

- We recommend placing free-draining material within the 3 feet immediately behind the retaining wall.

- We recommend providing weep holes in site walls to promote drainage where possible, or a pipe should be placed at the base of the walls to collect the groundwater. Groundwater collected by the wall drains should be discharged in a lower area if gravity flow is possible.

- Passive earth pressures should only be used at the toe of the wall where special measures or provisions are taken to prevent disturbance or future removal of the soil on the passive side of the wall, or in areas where the wall design includes a key. In any case, the passive pressures should be neglected in the top 2 feet.

- Where a permanent vertical uniform load will be applied on the active side immediately adjacent to the wall, a horizontal surcharge load equal to half of the uniform vertical load should be applied over the height of the wall. At a minimum, a temporary construction surcharge of 100 psf should be applied uniformly over the height of the wall.

- We recommend using an ultimate friction factor of 0.50 between the natural sand and the bottom of the wall. Below-ground walls should be designed for minimum factors of safety of 1.5 for sliding and 2.0 for overturning.

3.6.2 Seismic Pressures

In accordance with MSBC 9th Edition, Section 1610, a lateral earthquake force equal to $0.100*(S_s)*(F_a)*\gamma*H^2$ should be included in the design of walls (for horizontal backfill), where S_s is the maximum considered earthquake spectral response acceleration (defined in Section 3.5), F_a is the site coefficient (defined in Section 3.5), γ is the total unit weight of the soil backfill, and H is the height of the wall.

The earthquake force should be distributed as an inverted triangle over the height of the wall. In accordance with MSBC 9th Edition, Section 1610.2, a load factor of 1.43 shall be applied to the earthquake force for wall strength design.

Temporary surcharges should not be included when designing for earthquake loads. Surcharge loads applied for extended periods of time shall be included in the total static lateral soil pressure and their earthquake lateral force shall be computed and added to the force determined above.

3.6.3 Wall Drains

- We recommend that free-draining material be placed within 3 feet of the below-ground spaces such the perimeter walls of the proposed building, and the wall separating the ground floor and the main floor. To reduce the potential for dampness in below-ground spaces, perimeter walls of the proposed below-ground spaces, if any, should be damp-proofed.

- We recommend that drains be provided behind walls of below-ground spaces and behind site retaining walls. The drains should consist of 6-inch perforated PVC pipes installed with the slots facing down. Perimeter drains should be installed at the bottom of the wall in 18 inches of crushed stone wrapped in a geotextile fabric for separation and filtration. Site retaining walls may be designed with weep holes discharging near the bottom of the face of the walls.

- Groundwater collected by the wall drains could be discharged in a lower area if gravity flow is possible. Alternatively, it should be discharged into the street drains. A permit would be required for discharge into street drains.

- Perimeter walls and the wall separating the two ground floors should be waterproofed.

3.7 Rock Cuts

Rock cuts up to 33 feet will be required on the western side of the proposed building. In its report dated July 25, 2022, Scarptec, Inc. made the following recommendations:

- The slope angle of the rock cut should not be steeper than 3V:1H.

- To the extent possible, the alignment of the rock cut should be performed to reduce the potential for outwardly concave curves. Scarptec, Inc. suggested an alignment for the rock cut.

- The rock cut should be observed after the rock is blasted and removed to assess the need for reinforcement of loose zones and zones where a fault is exposed.

- Rock dowels may be needed locally. The project should include a contingency for rock dowels.

- The project should also include a contingency for 10- to 20-foot-long drains drilled into the rock at a slope of 4H:1V (with upward batter).

- Presplitting and perimeter control will be required. Scarptec, Inc. recommended using less explosives during presplitting.

- Scaling of the slope should be performed after the rock cut is completed. Scarptec, Inc. recommended removing vegetation within 15 feet of the crest of the slope and cutting the overburden at 2H:1V or flatter.

- The minimum dimension of the ditch (catchment area) at the bottom of the rock cut should be 12 feet. The ditch should be cut at a slope of 4H:1V.

- Signage should be provided at the top of the slope to warn against falling hazard.

- There should be a program of periodic (long term) maintenance of the slope performed, including scaling and possibly additional rock reinforcement.

The recommendations above represent a short summary of the Scarptec, Inc. recommendations. Scarptec, Inc.'s report, included in Appendix J, should be read in its entirety for a full understanding of the recommendations.

3.8 Slope Stability

3.8.1 General

LGCI performed limit equilibrium analyses to evaluate the global stability of the proposed 20-foot-high, fill, rip rapped slope on the eastern side of the proposed building along the eastern side of the proposed access road. LGCI performed stability analyses using the slope stability program PCSTABL5M to calculate the factor of safety, FS, for a sliding failure using the Simplified Bishop Method of slices for circular failure surfaces. For this project, we defined critical failure surfaces as those surfaces that start on the upper side of the proposed rip rap slope on the access road and extend to the lower side of the proposed slope, i.e., surfaces that entirely encompass the existing slope (global failure surfaces).

3.8.2 Slope Geometry and Loads

Our understanding of the proposed slope is based on the Landscape Drawings listed in Section 1.3.

For our analyses, we assumed a 1H:1V slope starting at El. 150 feet and dropping to about El. 130 feet. We assumed a 2-foot-thick rip rap layer at the top of the slope. We assumed that the slope will be filled with Ordinary Fill. We assumed a surcharge load equivalent to 2 feet of soil, i.e., 240 pounds per square foot (psf), to account for vehicular traffic.

3.8.3 Soil Parameters

LGCI estimated the friction angles of the onsite soils, including the existing fill, and the natural sand and gravel layer, based on SPT data from the borings.

The table below shows the soil parameters we used in our slope stability analyses.

Soil Layer	Total Unit Weight (pcf)	Saturated Unit Weight (pcf)	Friction Angle (degrees)
Ordinary Fill	120	125	34
Natural Sand and Gravel	125	130	42
Rip Rap	140	140	42

For rock, we assigned high strength values to force the failure surfaces into the overlying sand and gravel.

3.8.4 Results of Slope Stability Analyses

The results of our analyses, included in Appendix K, indicated a factor of safety, FS, less than the target FS of 1.5.

To improve the stability of the slope, LGCI performed slope stability analyses assuming that the slope is reinforced with geogrids. To achieve a factor of safety, FS, of 1.5, we estimate that the geogrid reinforcements should extend at least 10 feet into the slope from the back of the rip rap.

The design of reinforced slopes is a delegated design and is typically performed by a registered professional engineer engaged by the contractor. LGCI should be engaged to review the design and update our slope stability analyses using the actual reinforced slope geometry.

3.9 Radon Mitigation System

We understand that a radon mitigation system will be installed at the site. The radon mitigation system should consist of 6-inch solid PVC pipes connected to the crushed stone installed under the proposed slab as part of the under-slab drainage system. The pipes should be installed vertically with one open end in the crushed stone and the other end daylighting on the roof of the proposed building. The system could be installed to operate passively. However, the pipes should be outfitted to be ready to install extraction fans.

We recommend at least one (1) stack per 10,000 square feet of building.

3.10 Pavement Considerations

3.10.1 General

The subsurface conditions encountered at the site are generally suitable to support the proposed driveway after preparation of the subgrade as described in Section 4.1.

- We recommend entirely removing the topsoil and forest mat from within the footprint of the proposed paved areas.

- The subsoil should be removed in accordance with the recommendations in Sections 3.1.1 and 4.1.

- The existing fill should be improved in accordance with the recommendations in Sections 4.1.

- Cobbles and boulders should be removed to at least 18 inches below the bottom of the pavement.

3.10.2 Exterior Slabs

- Exterior slabs such as sidewalks/walkways and surface pads should be placed on a minimum of 12 inches of Structural Fill with less than 5 percent fines.

- To reduce the potential for heave caused by surface water penetrating under the concrete panels of the proposed sidewalks/walkways, the joints between the concrete sections should be sealed with a waterproof compound. The exterior slabs should be sloped away from the building or other vertical surfaces to promote flow of water. To the extent possible, roof leaders should not discharge onto exterior slab surfaces.

- Based on the groundwater levels measured during our explorations, we do not believe that sidewalk drains are needed. LGCI will update this recommendation after additional explorations are performed and more groundwater observation wells are installed at the site.

3.10.3 Pavement Sections

The proposed driveways and parking areas should be constructed with minimum asphalt and subbase thicknesses in accordance with the recommendations and details prepared by the project Civil Engineer. At a minimum, the following typical pavement sections should be used.

A typical, minimum, standard-duty pavement section that could be used for parking areas is as follows:

1.5"	Asphalt "Top Course"
2.0"	Asphalt "Base Course"
8"	Processed Gravel for Sub-Base (MassDOT M1.03.1)

A typical, minimum, heavy-duty pavement section that could be used for driveways and areas of heavy truck traffic is as follows:

2.0"	Asphalt "Top Course"
2.5"	Asphalt "Base Course"
12"	Processed Gravel for Sub-Base (MassDOT M1.03.1)

Other than in parking spaces, the heavy-duty section should be used in all paved areas.

The pavement sections shown above represent minimum thicknesses representative of typical local construction practices for similar use. Periodic maintenance should be anticipated.

Pavement material types and construction procedures should conform to specifications of the “Standard Specifications for Highways and Bridges,” prepared by the Commonwealth of Massachusetts Department of Public Works and dated 1988 (with the latest Supplemental Specifications).

4. CONSTRUCTION CONSIDERATIONS

4.1 Subgrade Preparation

- The topsoil, subsoil, organic materials, abandoned utilities, if any, and other below-ground structures, if any, should be entirely removed from within the footprint of the proposed building and site structures, including site retaining walls and exterior stairs, if any, before the start of foundation work.

- Tree stumps, root balls, and roots larger than ½ inch in diameter should be removed and the cavities filled with suitable material and compacted per Section 4.3 of this report.

- Topsoil, root balls, organic material, and other deleterious material should be entirely removed from within the proposed paved areas.

- The site contractor should note that the surficial materials at the site may contain large boulders.

- Cobbles and boulders should be removed at least 6 inches from beneath footings, 24 inches beneath the bottom of proposed slabs, 24 inches beneath the bottom of the asphalt in paved areas, and 24 inches beneath the base material of the turf in the proposed athletic fields. The resulting excavations should be backfilled with compacted Structural Fill within the proposed building and with Ordinary Fill under the subbase of paved areas and under the base material in athletic fields.

- The base material of athletic fields should conform to the gradation and placement requirements of the Landscape Architect or the manufacturer/installer of synthetic turf.

- Due to the high susceptibility of the natural sand and gravel for disturbance under foot and vehicular traffic, we recommend placing a minimum of 6 inches of Structural Fill at the bottom of the excavation or 4 inches of lean concrete to serve as a working mat.

- The bottom of the excavation resulting from the removal of the topsoil and subsoil in areas where the excavation terminates in the natural sand and gravel should be compacted with a dynamic vibratory compactor imparting a minimum of 40 kips of force to the subgrade.

- The base of the footing excavations terminating in granular soil should be compacted with a dynamic vibratory compactor weighing at least 200 pounds and imparting a minimum of 4 kips of force to the subgrade before placing the required 6 inches of Structural Fill.

- The subgrade of the slabs should be compacted using a vibratory roller compactor imparting a minimum of 10 kips of force to the subgrade before placing Structural Fill.

- Where soft zones are revealed during the preparation of the subgrade, the soft materials or buried organic soil should be removed and replaced with Structural Fill within the building footprint and with Ordinary Fill beneath the subbase of paved areas.

- The subgrade in rock should be prepared in accordance with the recommendations is Section 4.5.

- To reduce the potential of increasing lateral pressures on the retaining walls, fill placed within 3 feet of the walls, if any, should be compacted using a small plate compactor imparting a maximum dynamic effort of 4 kips. The fill within 3 feet of the walls should be placed in maximum 8-inch loose lifts.

- After the surficial topsoil and forest mat are entirely removed and after the subsoil is removed from within the proposed paved areas in accordance with the recommendations in Section 3.1.1, the existing subsoil deeper than 18 inches beneath the bottom of the proposed pavement should be improved by compacting the exposed surface with at least eight (8) passes (4 passes in each direction) of a vibratory roller compactor imparting a dynamic effort of at least 40 kips. Where soft zones of soil are observed, the soft soil should be removed, and the grade should be restored using Ordinary Fill to the bottom of the proposed subbase layer. If pumping of the subsoil deeper than 18 inches beneath the bottom of the proposed grade is observed, the compactor should be switched to static mode and the soft material should be removed and replaced with Ordinary Fill.

- In paved areas, the existing fill should be improved by compacting the exposed surface of the existing fill with a minimum of eight (8) overlapping passes of a vibratory roller compactor imparting a dynamic effort of at least 40 kips. Where soft zones of soil or pumping are observed, the soft/pumping soil should be removed, and the grade should be restored using Ordinary Fill to the bottom of the proposed subbase layer.

- After the topsoil and forest mat are removed from within the proposed athletic fields, the exposed subsoil or natural soil should be proofrolled with a loaded rubber tire truck or with a large vibratory roller compactor imparting a minimum dynamic effort of 40 kips. Where soft zones are indicated by the proofrolling, the soft zones should be removed and the grades should be restored using Ordinary Fill to the bottom of the base material of the proposed turf designed by the Landscape Architect or the manufacturer/installer of synthetic turf, if any. The preparation of the subgrade before the placement of the turf subbase should follow the recommendations of the Landscape Architect.

- Fill placed within the footprint of the proposed building should meet the gradation and compaction requirements of Structural Fill shown in Section 4.3.1.

- Fill placed under the subbase of paved areas, should meet the gradation and compaction requirements of Ordinary Fill shown in Section 4.3.2.

- Fill placed in the top 12 inches beneath exterior slabs should consist of Structural Fill with less than 5 percent fines.

- When crushed stone is required in the drawings or it is used for the convenience of the contractor, it should be wrapped in a geotextile fabric for separation. The geotextile fabric should not be used under retaining walls as it promotes a plane of sliding such as under retaining wall footings.

- An LGCI geotechnical representative should observe the subgrades of footings and slabs prior to fill and concrete placement to verify that the exposed bearing materials are suitable for the design soil bearing pressure. If soft or loose pockets are encountered in the footing excavations, the soft or loose materials should be removed, and the bottom of the footing should be placed at a lower elevation on firm soil, or the resulting excavation should be backfilled with Structural Fill or crushed stone wrapped in geotextile for separation. The LGCI representative should also observe the improvement of the existing subsoil if any, and/or fill within the proposed paved areas.

4.2 Subgrade Protection

The site soils are frost susceptible. If construction takes place during freezing weather, special measures should be taken to prevent the subgrade from freezing. Such measures should include the use of heat blankets or excavating the final six inches of soil just before pouring concrete. Footings should be backfilled as soon as possible after footing construction. Soil used as backfill should be free of frozen material, as should the ground on which it is placed. Filling operations should be halted during freezing weather.

Materials with high fines contents are typically difficult to handle when wet as they are sensitive to moisture content variations. Subgrade support capacities may deteriorate when such soils become wet and/or disturbed. The contractor should keep exposed subgrades properly drained and free of ponded water. Subgrades should be protected from machine and foot traffic to reduce disturbance.

4.3 Fill Materials

Structural Fill and Ordinary Fill should consist of inert, hard, durable sand and gravel, free from organic matter, clay, surface coatings and deleterious materials, and should conform to the gradation requirements shown below.

4.3.1 Structural Fill

The Structural Fill should have a plasticity index of less than 6 and should meet the gradation requirements shown below. Structural Fill should be compacted in maximum 9-inch loose lifts to at least 95 percent of the Modified Proctor maximum dry density (ASTM D1557), with moisture contents within ±2 percentage points of optimum moisture content.

Sieve Size Percent	Passing by Weight
3 inches	100
1 ½ inch	80-100
½ inch	50-100
No. 4	30-85
No. 20	15-60
No. 60	5-35
No. 200*	0-10

* 0 – 5 Under sidewalks, unheated slabs, exterior stairs, ramps, and pads, and walkways

4.3.2 Ordinary Fill

Ordinary Fill should have a plasticity index of less than 6 and should meet the gradation requirements shown below. Ordinary Fill should be compacted in maximum 9-inch loose lifts to at least 95 percent of the Modified Proctor maximum dry density (ASTM D1557), with moisture contents within ±2 percentage points of optimum moisture content.

Sieve Size Percent	Passing by Weight
6 inches	100
1 inch	50-100
No. 4	20-100
No. 20	10-70
No. 60	5-45
No. 200	0-20

4.4 Reuse and Processing of Onsite Materials

Based on our field observations and the results of the grain-size analyses, the natural soils at the site are not suitable for reuse as Structural Fill or Ordinary Fill.

The contractor should avoid mixing the existing soils with suitable imported material. Should reusable materials be encountered during excavation, they should be excavated and stockpiled separately for compliance testing.

Soils with 20 percent or greater fines content are generally very sensitive to moisture content variations and are susceptible to frost. Such soils are very difficult to compact at moisture contents that are much higher or much lower than the optimum moisture content determined from the laboratory compaction test. Therefore, strict moisture control should be implemented during compaction of onsite soils with fines contents of 20 percent or greater. The contractor should be prepared to remove and replace such soils if pumping occurs.

The contractor may consider mobilizing a rock crusher to the site. Boulders and blasted rock can be processed with the natural soil and crushed to produce granular fill that is lower in fines if blended with a sufficient proportion of rock. Processed material obtained by crushing blasted rock, boulders, and soil should meet the gradation requirements of Ordinary Fill and Structural Fill. Material produced by the crushing operation should be well graded so as to reduce the potential for formation of honeycombs during its placement and compaction. The site contractor should be prepared to produce batches of material processed using different blending ratios at the start of the earthwork operations. LGCI will review the results of grain-size analyses performed on the processed material and provide an opinion about the blending ratio to maintain throughout construction.

All materials to be used as fill, including blended materials, should first be tested for compliance with the applicable gradation specifications.

4.5 Rock Blasting Considerations

4.5.1 Rock Removal

Deep rock cuts will be required to achieve the proposed FFE of the proposed building and the proposed grades of the paved areas.

Minor rock cuts (less than one foot) over short distances may be achieved using hoe-rams or using other non-blasting techniques. For the majority of the cuts, we anticipate that rock blasting will be required.

- Rock should be cut to at least 12 inches beneath footings and to a minimum of 24 inches beneath the bottom of the proposed slabs. To facilitate rock excavation and backfilling, we recommend that the blasting extend to an elevation corresponding to 12 inches beneath the bottom of the deepest footings under the entire building footprint.

- The rock should be cut laterally at least one foot beyond each side of the footing. For retaining wall footings, the rock should be cut laterally at least 3 feet from the outside face of the wall to allow for placement of the formwork. Where utilities are installed around the perimeter of the proposed building, the rock should be cut at least 3 feet from the nearest utility.

- The rock surface should be cut as level as possible. The surface of rock should not be steeper than 12H:1V.

- Structural Fill should not be placed directly on rock surfaces that are fractured. The fractures should be covered with a geotextile fabric for separation before placing Structural Fill on the fractured rock.

- Rock should be cut at least 18 inches beneath the bottom of paved areas and the ground surface of athletic fields.

- Under utility pipes, manholes, and catch basins, rock should be cut a minimum of 12 inches beneath the pipe or structure.

- Laterally, rock should be cut a minimum of 12 inches outside utility structures and a minimum of 18 inches on each side of utility pipes.

- To reduce overblasting and the potential for heaved rock, drill holes for blasting should not extend more than 2 feet beneath the minimum depths shown above.

- Rock blasting should be controlled to reduce vibrations and airblast overpressure to below thresholds established in the Earth Moving Specifications.

- Pre-splitting or controlled blasting may be desirable to reduce the amount of over-blast.

- To reduce the potential for blasted rock intended for crushing mixing with organic soil, we recommend that the topsoil, roots, tree stumps, and vegetation be removed before blasting. The remainder of the overburden soils and excavatable weathered rock should not be removed before blasting.

- To help obtain information about the top of the rock for rock quantity estimating purposes, we recommend that the Earth Moving Specifications include a requirement for the contractor to perform rock probes at the site in a grid pattern before the start of blasting. The results of the probes should include at a minimum the ground surface elevation and the elevation of the top of the rock. The probes should extend at least 10 feet beyond the perceived top of rock to make sure that the perceived top of rock is not a boulder.

4.5.2 Ground Vibration Monitoring

Rock blasting operations will generate ground vibrations that may result in minor cracks and cosmetic damage to nearby structures. To protect the adjacent structures from potential damage, construction blasting should be carefully controlled and monitored. We recommend monitoring vibrations at the ground surface and at nearby structures before and during the rock blasting operations. We recommend a peak particle velocity (PPV) of 2 inches per second (ips) for concrete foundations and 1 ips for masonry foundations.

4.5.3 Public Notification

The human perception threshold to vibration is very low, i.e., people are far more sensitive to vibrations than are the structures they occupy. Various studies have indicated that the sound effects are noticeable at PPV values of 0.02 ips and complaints and claims of damage are likely at PPV values of 0.2 to 0.3 ips. These vibration intensities are well below the intensities that would cause structural damage to buildings. For these reasons, we recommend that the owner implement a proactive program of public notification and education of neighbors on the physical characteristics of blasting effects before the start of blasting.

4.5.4 Pre-Construction Condition Survey

We recommend that the Owner perform a pre-construction condition survey of structures located within 250 feet of the nearest blasting operation to document the existing conditions of the structures. The Owner may also consider using crack monitoring gauges to monitor large cracks identified during the pre-construction surveys.

4.6 Groundwater Control Procedures

Based on the groundwater levels encountered in our explorations, we anticipate that groundwater control procedures will be needed during removal of the subsoil and after rock blasting. We anticipate that significant quantities of water will be generated at the bottom of the rock excavation. Accordingly, we recommend that a groundwater control plan be designed and implemented that disposes of the groundwater by gravity. We anticipate that filtered sump pumps installed in pits located at least three feet below the bottom of the excavation may be sufficient to handle surface runoff that may enter shallow excavation. The contractor should be prepared to install multiple deep sump pumps to maintain a dry subgrade. Also, where deep trenches are required for utilities, multiple sump pumps would be required to maintain a dry excavation subgrade.

The contractor should be permitted to employ whatever commonly accepted means and practices as necessary to maintain the groundwater level below the bottom of the excavation and to maintain a dry excavation during wet weather. Groundwater levels should be maintained at a minimum of 1-foot below the bottom of excavations during construction. Placement of reinforcing steel or concrete in standing water should not be permitted.

Proper permits should be obtained from authorities having jurisdiction over the work. At a minimum, the water collected from excavations should be filtered for fines in sedimentation basins before being discharged. The sedimentation basins could be constructed of hay bales wrapped in a geotextile fabric.

To reduce the potential for sinkholes developing over sump pump pits after the sump pumps are removed, the crushed stone placed in the sump pump pits should be wrapped in a geotextile for separation. Alternatively, the crushed stone should be entirely removed after the sump pump is no longer in use and the sump pump pit should be restored with suitable backfill.

4.7 Temporary Excavations

All excavations to receive human traffic should be constructed in accordance with the OSHA guidelines.

The site soils should generally be considered Type "C" and should have a maximum allowable slope of 1.5 Horizontal to 1 Vertical (1.5H:1V) for excavations less than 20 feet deep. Deeper excavations, if needed, should have shoring designed by a professional engineer.

The contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of the excavation sides and bottom and to protect existing structures.

The contractor should engage a design professional to inspect the rock cuts where workers will be working near the bottom of the cuts. Where the rock is deemed unstable, it should be cut to render the slope stable.

5. RECOMMENDATIONS FOR FUTURE WORK

As part of our current scope, LGCI will prepare Earth Moving Specifications and will review the geotechnical aspect of the SD Foundation and Civil Drawing.

We recommend engaging LGCI to perform the following services:

- Review the geotechnical aspects of contractor submittals and requests for information (RFIs).
- Observe the rock probes performed by the contractor before the start of blasting.
- Observe the excavation of rock and observe the exposed rock surfaces.
- Observe rock bolting, if needed.
- Observe the processing of onsite soils and blasted rock; and
- Provide a field representative during construction to observe the subgrade of foundations and slabs.

6. REPORT LIMITATIONS

Our analysis and recommendations are based on project information provided to us at the time of this report. If changes to the type, size, and location of the proposed structures or to the site grading are made, the recommendations contained in this report shall not be considered valid unless the changes are reviewed, and the conclusions and recommendations modified in writing by LGCI. LGCI cannot accept responsibility for designs based on our recommendations unless we are engaged to review the final plans and specifications to determine whether any changes in the project affect the validity of our recommendations and whether our recommendations have been properly implemented in the design.

It is not part of our scope to perform a more detailed site history; therefore, we have not explored for or researched the locations of buried utilities or other structures in the area of the proposed construction. Our scope did not include environmental services or services related to moisture, mold, or other biological contaminants in or around the site.

The recommendations in this report are based in part on the data obtained from the subsurface explorations. The nature and extent of variations between explorations may not become evident until construction. If variations from anticipated conditions are encountered, it may be necessary to revise the recommendations in this report. We cannot accept responsibility for designs based on recommendations in this report unless we are engaged to 1) make site visits during construction to check that the subsurface conditions exposed during construction are in general conformance with our design assumptions and 2) ascertain that, in general, the work is being performed in compliance with the contract documents.

Our report has been prepared in accordance with generally accepted engineering practices and in accordance with the terms and conditions set forth in our agreement. No other warranty, expressed or implied, is made. This report has been prepared for the exclusive use of Drummey Rosane Anderson, Inc. for the specific application to the Proposed Northeast Metropolitan Regional Vocational Technical High School in Wakefield, Massachusetts as conceived at this time.

7. REFERENCES

In addition to the references included in the text of the report, we used the following references:

The Commonwealth of Massachusetts (2015), “The Massachusetts State Building Code, Ninth Edition,” comprised of the International Building Code (IBC-2015) and 780 CMR: Massachusetts Amendments to IBC-2015.

The Department of Labor, Occupational Safety and Health Administration (1989), “Occupational Safety and Health Standards - Excavations; Final Rule,” 20 CFR Part 1926, Subpart P.

USGS Wakefield, MA topographic map from http://mapserver.mytopo.com.

Table 1 - Summary of LGCI's Test Pits and Probes
Proposed Northeast Metro Regional Vocational Technical High School
Wakefield, Massachusetts
LGCI Project No. 2025

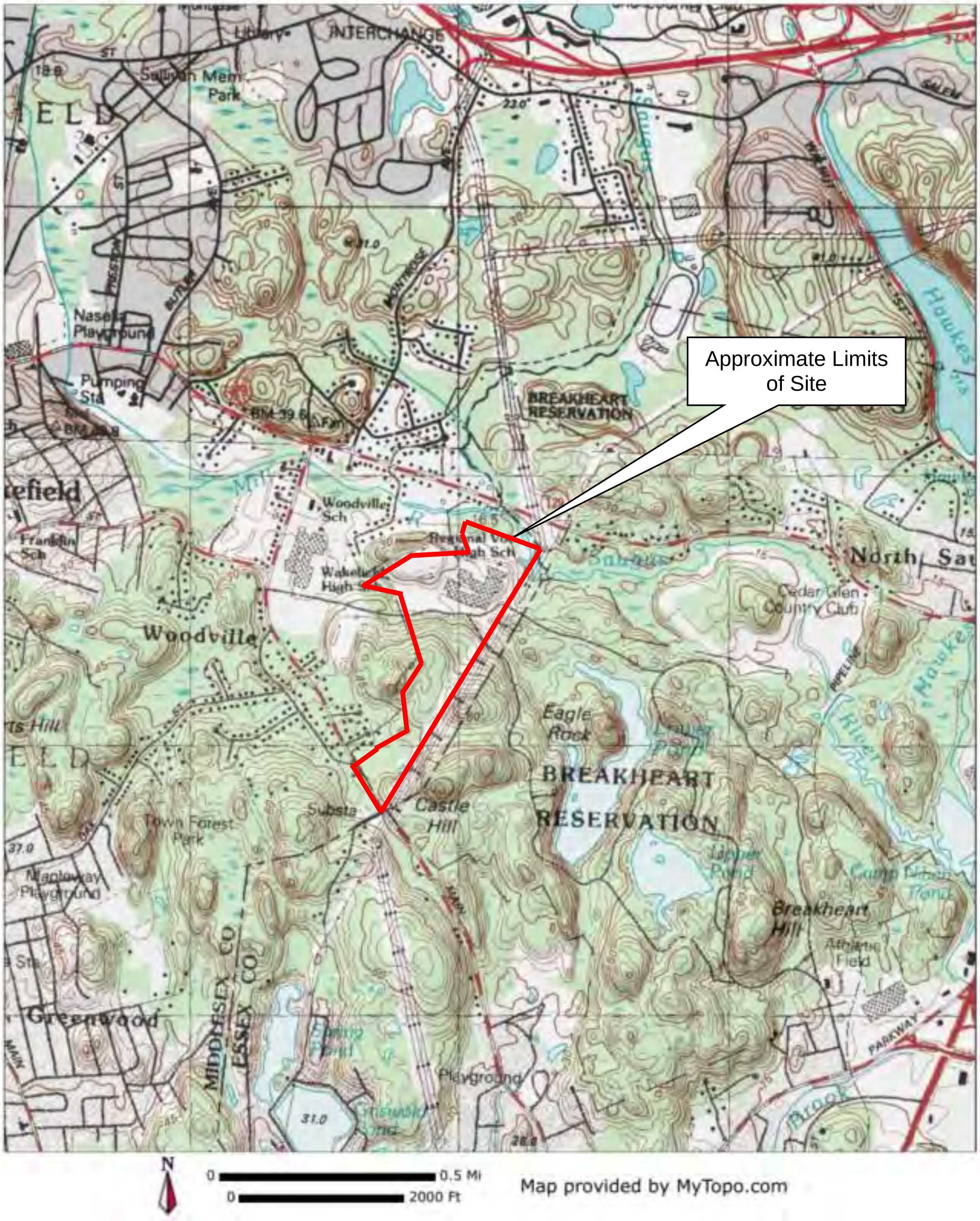
Test Pit No.	Ground Surface Elevation (ft.)[1,2]	Groundwater[3] Depth / El. (ft.)	Bottom of Forest Mat / **Topsoil** Depth / El. (ft.)	Bottom of Subsoil / **Fill** Depth / El. (ft.)	Bottom of Sand and Gravel Depth / El. (ft.)	Top of Possible Weathered Rock / Rock Depth / El. (ft.)	Bottom of Test Pit Depth / El. (ft.)
2020 Test Pits							
TP-1	156.2	2.0 / **154.2**	**0.7** / **155.5**	3.5 / **152.7**	9.0 / **147.2**	- / -	9.0 / **147.2**
TP-2	165.0	4.0 / **161.0**	**0.8** / **164.2**	3.5 / **161.5**	- / -	3.5 / **161.5**	4.3 / **160.7**
TP-3	180.6	- / -	**1.0** / **179.6**	2.0 / **178.6**	- / -	2.0 / **178.6**	2.0 / **178.6**
TP-4	171.3	- / -	**0.5** / **170.8**	1.5 / **169.8**	- / -	1.5 / **169.8**	1.5 / **169.8**
TP-5	173.2	- / -	**0.5** / **172.7**	3.5 / **169.7**	5.0 / **168.2**	5.0 / **168.2**	5.0 / **168.2**
TP-6	138.7	- / -	**0.5** / **138.2**	3.0 / **135.7**	4.5 / **134.2**	4.5 / **134.2**	4.5 / **134.2**
TP-7	158.1	- / -	**2.0** / **156.1**	- / -	- / -	2.0 / **156.1**	2.0 / **156.1**
TP-8	130.0	2.0 / **128.0**	**1.0** / **129.0**	3.0 / **127.0**	9.0 / **121.0**	9.0 [5]/ **121.0**	9.0 / **121.0**
TP-9	162.9	3.6 / **159.3**	**0.4** / **162.5**	1.9 / **161.0**	6.2 / **156.7**	6.2 [5]/ **156.7**	6.2 / **156.7**
TP-10	187.9	- / -	**0.3** / **187.6**	2.1 / **185.8**	2.7 / **185.2**	2.7 / **185.2**	2.7 / **185.2**
TP-11	181.1	- / -	**0.5** / **180.6**	2.0 / **179.1**	- / -	2.0 / **179.1**	3.2 / **177.9**
TP-12	136.0	- / -	**1.0** / **135.0**	4.0 / **132.0**	7.0 / **129.0**	7.0 / **129.0**	7.0 / **129.0**
TP-13	162.2	- / -	**0.4** / **161.8**	2.3 / **159.9**	4.8 / **157.4**	4.8 / **157.4**	4.8 / **157.4**
TP-14	164.9	- / -	**0.7** / **164.2**	- / -	- / -	0.7 / **164.2**	0.7 / **164.2**
TP-15	162.0	2.5 / **159.5**	**0.5** / **161.5**	4.0 / **158.0**	5.0 / **157.0**	5.0 / **157.0**	5.0 / **157.0**
TP-16	143.7	3.5 / **140.2**	**1.0** / **142.7**	5.0 / **138.7**	10.5 / **133.2**	10.5 / **133.2**	10.5 / **133.2**
TP-17	139.5	1.5 / **138.0**	**0.2** / **139.3**	1.9 / **137.6**	3.1 / **136.4**	3.1 [5]/ **136.4**	3.1 / **136.4**
TP-18	132.0	- / -	**0.3** / **131.7**	2.8 / **129.2**	3.9 / **128.1**	3.9 / **128.1**	3.9 / **128.1**
2021 Test Pits							
TP-101	126.5	3.5 / **123.0**	1.0 / **125.5**	3.5 / **123.0**	- / -	3.5 / **123.0**	3.5 / **123.0**
TP-102	126.4	- / -	0.7 / **125.7**	2.9 / **123.5**	3.7 / **122.7**	3.7 / **122.7**	3.7 / **122.7**
TP-103	135.0	1.3 / **133.7**	0.8 / **134.2**	2.4 / **132.6**	5.5 / **129.5**	5.5 / **129.5**	5.5 / **129.5**
TP-104	180.0	- / -	0.5 / **179.5**	2.5 / **177.5**	3.0 / **177.0**	3.0 / **177.0**	3.0 / **177.0**
TP-105	180.1	- / -	0.5 / **179.6**	1.8 / **178.3**	- / -	1.8 / **178.3**	1.8 / **178.3**
TP-106	161.0	- / -	0.5 / **160.5**	3.2 / **157.8**	- / -	3.2 / **157.8**	3.2 / **157.8**
TP-107	168.1	3.0 / **165.1**	0.3 / **167.8**	2.1 / **166.0**	3.1 / **165.0**	3.1 / **165.0**	3.1 / **165.0**
TP-108	180.4	2.3 / **178.1**	2.3 / **178.1**	- / -	- / -	2.3 / **178.1**	2.3 / **178.1**
TP-109	171.2	- / -	0.5 / **170.7**	3.0 / **168.2**	4.6 / **166.6**	4.6 / **166.6**	4.6 / **166.6**
TP-110	168.1	2.5 / **165.6**	0.5 / **167.6**	2.7 / **165.4**	- / -	2.7 / **165.4**	2.7 / **165.4**
TP-111	156.3	5.0 / **151.3**	0.5 / **155.8**	3.5 / **152.8**	5.0 / **151.3**	5.0 / **151.3**	5.0 / **151.3**
TP-113	143.6	- / -	0.5 / **143.1**	- / -	3.0 / **140.6**	3.0 / **140.6**	3.0 / **140.6**
TP-114	147.4	1.9 / **145.5**	0.3 / **147.1**	- / -	1.9 / **145.5**	1.9 / **145.5**	1.9 / **145.5**
2022 Test Pits							
TP-201	84.0	- / -	1.0 / **83.0**	**2.0** / **82.0**	- / -	2.0 / **82.0**	4.5 / **79.5**
TP-202	120.0	2.0 / **118.0**	0.3 / **119.7**	2.0 / **118.0**	4.5 / **115.5**	4.5 / **115.5**	4.5 / **115.5**
TP-203	129.0	- / -	0.3 / **128.7**	2.5 / **126.5**	- / -	2.5 / **126.5**	2.5 / **126.5**
TP-204	155.0	6.0 / **149.0**	0.5 / **154.5**	3.0 / **152.0**	8.7 / **146.3**	8.7 / **146.3**	8.7 / **146.3**
TP-205	181.0	- / -	0.5 / **180.5**	2.5 / **178.5**	- / -	2.5 / **178.5**	2.5 / **178.5**
TP-206	159.0	- / -	1.0 / **158.0**	3.0 / **156.0**	6.5 / **152.5**	6.5 / **152.5**	6.5 / **152.5**
TP-207	153.0	- / -	0.5 / **152.5**	3.0 / **150.0**	3.5 / **149.5**	3.5 / **149.5**	3.5 / **149.5**
TP-208	165.0	- / -	0.9 / **164.1**	2.6 / **162.4**	- / -	2.6 / **162.4**	2.6 / **162.4**
TP-209	137.0	- / -	1.4 / **135.6**	2.5 / **134.5**	4.2 / **132.8**	4.2 / **132.8**	4.2 / **132.8**
TP-210	133.0	- / -	- / -	**1.2** / **131.8**	4.6 [10,11]/ **128.4**	4.6 / **128.4**	4.6 / **128.4**
TP-211	129.0	- / -	1.7 / **127.3**	2.5 / **126.5**	5.6 / **123.4**	5.6 / **123.4**	5.6 / **123.4**
TP-212	133.0	- / -	0.9 / **132.1**	3.0 / **130.0**	4.9 / **128.1**	4.9 / **128.1**	4.9 / **128.1**
TP-213	136.0	- / -	0.3 / **135.7**	2.3 / **133.7**	3.3 / **132.7**	3.3 / **132.7**	3.3 / **132.7**
TP-B-205	134.0	3.0 / **131.0**	0.5 / **133.5**	1.5 / **132.5**	9.0 / **125.0**	9.0 / **125.0**	9.0 / **125.0**
TP-B-206	151.0	2.6 / **148.4**	0.4 / **150.6**	2.6 / **148.4**	- / -	2.6 / **148.4**	2.6 / **148.4**
2022 Probes							
HP-TS-1	86.0	- / -	**0.8** / **85.2**	**1.3** [9]/ **84.7**	- / -	- / -	1.3 / **84.7**
HP-TS-2	85.0	- / -	**0.8** / **84.2**	**1.1** [9]/ **83.9**	- / -	- / -	1.1 / **83.9**
HP-TS-3	65.0	- / -	**0.8** / **64.2**	**1.0** [9]/ **64.0**	- / -	- / -	1.0 / **64.0**
HP-TS-4	58.0	- / -	**1.2** [8]/ **56.8**	- / -	- / -	- / -	1.2 / **56.8**

1. The ground surface elevations for the 2020 and 2021 test pits were surveyed by Nitsch Engineering, Inc. (Nitsch) and were obtained by LGCI from drawings EX-1 to EX-13 titled: “Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA,” prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.
2. The ground surface elevations for the 2022 test pits and probes were interpolated to the nearest foot from drawing titled: "Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to LGCI by DRA via e-mail on June 3, 2022.
3. Groundwater depths based on level observed during excavation.
4. "-" means groundwater or layer was not encountered.
5. Refusal encountered on cobbles and boulders.
6. TP-112 was not performed.
7. The probes were performed while obtaining samples for loam analysis.
8. Probe terminated in the forest mat.
9. Probe terminated in the fill.
10. A layer of buried organic soil was encountered between depths of 1.2 feet and 2.0 feet beneath the ground surface.
11. A layer of buried subsoil was encountered between depths of 2.0 feet and 3.0 feet beneath the ground surface.

Table 2 - Summary of LGCI's Borings
Proposed Northeast Metro Regional Vocational Technical High School
Wakefield, Massachusetts
LGCI Project No. 2025

Boring No.	Ground Surface Elevation (ft.)^{1,2}	Groundwater^3 Depth / El. (ft.)	Bottom of Asphalt Depth / El. (ft.)	Bottom of Forest Mat/ **Topsoil** Depth / El. (ft.)	Bottom of Fill Depth / El. (ft.)	Bottom of Subsoil Depth / El. (ft.)	Bottom of Sand and Gravel Depth / El. (ft.)	Top of Rock Depth / El. (ft.)	Bottom of Boring Depth / El. (ft.)
2020 Boring Logs									
B-1-OW	184.5	10.0 / **174.5**	- / **-**	**0.3 / 184.2**	- / **-**	2.5 / **182.0**	- / **-**	2.5 / **182.0**	14.0 / **170.5**
B-2	166.5	- / **-**	- / **-**	**0.5 / 166.0**	- / **-**	- / **-**	- / **-**	0.5 / **166.0**	0.5 / **166.0**
B-3-OW	170.5	- / **-**	- / **-**	**0.3 / 170.2**	- / **-**	2.2 / **168.3**	- / **-**	2.2 / **168.3**	18.0 / **152.5**
B-4	180.7	0.8 / **179.9**	- / **-**	**0.3 / 180.4**	- / **-**	2.6 / **178.1**	6.0 / **174.7**	6.0 / **174.7**	8.0 / **172.7**
2021 Boring Logs									
B-101-OW	172.6	5.2 / **167.4**	- / **-**	0.1 / **172.5**	- / **-**	- / **-**	- / **-**	0.1 / **172.5**	36.0 / **136.6**
B-102	158.7	2.5 / **156.2**	- / **-**	0.5 / **158.2**	- / **-**	2.7 / **156.0**	- / **-**	2.7 / **156.0**	23.5 / **135.2**
B-103	174.6	0.1 / **174.5**	- / **-**	1.8 / **172.8**	- / **-**	- / **-**	- / **-**	1.8 / **172.8**	23.5 / **151.1**
B-104-OW	180.9	0.0 / **180.9**	- / **-**	0.7 / **180.2**	- / **-**	- / **-**	- / **-**	0.7 / **180.2**	27.0 / **153.9**
B-105	161.5	2.0 / **159.5**	- / **-**	0.3 / **161.2**	- / **-**	2.0 / **159.5**	3.5 / **158.0**	3.5 / **158.0**	17.0 / **144.5**
B-106	161.9	1.0 / **160.9**	- / **-**	1.4 / **160.5**	- / **-**	- / **-**	- / **-**	1.4 / **160.5**	11.5 / **150.4**
2022 Boring Logs									
B-201	167.0	2.0 / **165.0**	- / **-**	2.0 / **165.0**	- / **-**	3.0 / **164.0**	19.1 ^{4}/ **147.9**	19.1 / **147.9**	24.5 / **142.5**
B-202	176.0	5.2 / **170.8**	- / **-**	0.3 / **175.7**	- / **-**	1.8 / **174.2**	- / **-**	1.8 / **174.2**	22.5 / **153.5**
B-203	167.0	1.0 / **166.0**	- / **-**	0.2 / **166.8**	- / **-**	2.0 / **165.0**	- / **-**	2.0 / **165.0**	11.5 / **155.5**
B-204-OW	162.0	1.0 / **161.0**	- / **-**	0.3 / **161.7**	- / **-**	2.7 / **159.3**	4.4 / **157.6**	4.4 / **157.6**	25.2 / **136.8**
B-206	181.0	4.5 / **176.5**	- / **-**	1.3 / **179.7**	- / **-**	- / **-**	- / **-**	1.3 / **179.7**	21.5 / **159.5**
B-207	139.0	2.0 / **137.0**	- / **-**	0.3 / **138.7**	- / **-**	2.5 / **136.5**	2.9 / **136.1**	2.9 / **136.1**	13.0 / **126.0**
B-208-OW	193.0	7.0 / **186.0**	- / **-**	0.3 / **192.7**	- / **-**	1.5 / **191.5**	- / **-**	1.5 / **191.5**	37.0 / **156.0**
B-209	152.0	- / **-**	- / **-**	0.5 / **151.5**	- / **-**	- / **-**	- / **-**	0.5 / **151.5**	5.5 / **146.5**
B-210	80.0	1.0 / **79.0**	*0.3* / **79.7**	- / **-**	4.8 / **75.2**	- / **-**	8.0 / **72.0**	8.0 / **72.0**	10.0 / **70.0**
B-211	79.0	6.1 / **72.9**	- / **-**	**0.5** / **78.5**	2.4 / **76.6**	- / **-**	20.1 / **58.9**	- / **-**	20.1 / **58.9**
B-212	83.0	3.5 / **79.5**	0.5 / **82.5**	- / **-**	4.0 / **79.0**	- / **-**	11.0 / **72.0**	- / **-**	11.0 / **72.0**
B-213	85.0	- / **-**	*0.2* / **84.8**	- / **-**	2.3 / **82.7**	- / **-**	2.6 / **82.4**	2.6 / **82.4**	4.0 / **81.0**
B-214	201.0	- / **-**	*0.3* / **200.7**	- / **-**	0.8 / **200.2**	- / **-**	7.0 / **194.0**	7.0 / **194.0**	8.0 / **193.0**
B-216	89.0	4.9 / **84.1**	0.3 / **88.7**	- / **-**	3.3 / **85.7**	- / **-**	- / **-**	3.3 / **85.7**	8.5 / **80.5**
B-217	89.0	2.0 / **87.0**	0.3 / **88.7**	- / **-**	1.0 / **88.0**	- / **-**	3.5 / **85.5**	3.5 / **85.5**	4.0 / **85.0**
B-220-OW	88.0	4.0 / **84.0**	0.3 / **87.7**	- / **-**	2.0 / **86.0**	4.0 / **84.0**	5.3 / **82.7**	5.3 / **82.7**	11.0 / **77.0**
B-221	79.0	4.0 / **75.0**	0.3 / **78.7**	- / **-**	4.0 / **75.0**	- / **-**	19.0 / **60.0**	19.0 / **60.0**	21.0 / **58.0**
B-222	76.0	- / **-**	0.3 / **75.7**	- / **-**	0.8 / **75.2**	- / **-**	5.1 / **70.9**	5.1 / **70.9**	7.0 / **69.0**
B-223	78.0	3.5 / **74.5**	0.4 / **77.6**	- / **-**	2.3 / **75.7**	- / **-**	13.5 / **64.5**	- / **-**	13.5 / **64.5**

1. The ground surface elevations for the 2020 and 2021 borings were surveyed by Nitsch Engineering, Inc. (Nitsch) and were obtained by LGCI from drawings EX-1 to EX-13 titled: “Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA,” prepared by Nitsch and provided to LGCI by Nitsch via e-mail on June 4, 2021.
2. The ground surface elevations for the 2022 borings were interpolated to the nearest foot from drawing titled: "Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to LGCI by DRA via e-mail on June 3, 2022.
3. Groundwater depths based on sample moisture or level at the end of drilling, whichever is shallower.
4. Possible weathered rock encountered at depth of 10.5 feet beneath the ground surface.
5. "-" means groundwater or layer was not encountered.

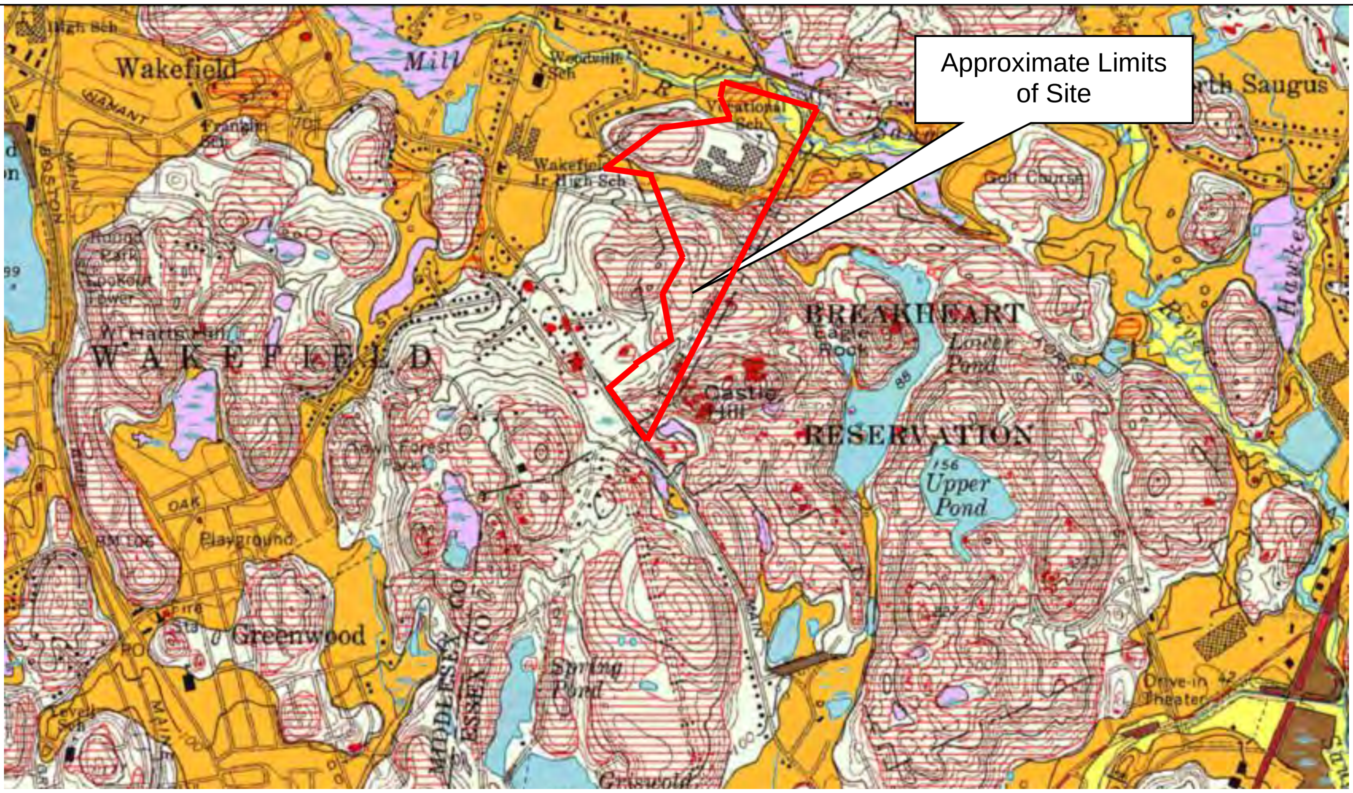


Map provided by MyTopo.com

Contour Intervals: 10 feet

Figure based on USGS topographic map of Wakefield, MA obtained from www.mytopo.com

Client: Drummey Rosane Anderson, Inc.	Project: Prop. Northeast Metro Regional Vocational Technical H.S.	Figure 1 – Site Location Map	
LGCI Lahlaf Geotechnical Consulting, Inc.	Project Location: Wakefield, MA	LGCI Project No.: 2025	Date: June 2022



🟩 **Thin till**—Nonsorted, nonstratified matrix of sand, some silt, and little clay containing scattered pebble, cobble, and boulder clasts; large surface boulders are common; unit was mapped where till is generally less than 10 to 15 ft thick including areas of shallow bedrock. Predominantly consists of upper till of the last glaciation; loose to moderately compact, generally sandy, commonly stony. Two facies are present in some places: a looser, coarser grained ablation facies, melted out from supraglacial position; and an underlying more compact, finer grained lodgement facies deposited subglacially. In general, both ablation and lodgement facies of upper till derived from fine-grained bedrock are finer grained, more compact, less stony and have fewer surface boulders than upper till derived from coarse-grained crystalline rocks. Across Massachusetts, fine-grained bedrock sources include the red Mesozoic sedimentary rocks of the Connecticut Valley lowland, marble in the western river valleys, and fine-grained schists in upland areas

🟧 **Coarse deposits** consist of *gravel deposits*, *sand and gravel deposits*, and *sand deposits*, not differentiated in this report. *Gravel deposits* are composed of at least 50 percent gravel-size clasts; cobbles and boulders predominate; minor amounts of sand occur within gravel beds, and sand comprises a few separate layers. Gravel layers generally are poorly sorted, and bedding commonly is distorted and faulted due to postdepositional collapse related to melting of ice. *Sand and gravel deposits* occur as mixtures of gravel and sand within individual layers and as layers of sand alternating with layers of gravel. Sand and gravel layers generally range between 25 and 50 percent gravel particles and between 50 and 75 percent sand particles. Layers are well sorted to poorly sorted; bedding may be distorted and faulted due to postdepositional collapse. *Sand deposits* are composed mainly of very coarse to fine sand, commonly in well-sorted layers. Coarser layers may contain up to 25 percent gravel particles, generally granules and pebbles; finer layers may contain some very fine sand, silt, and clay

N

🟥 **Bedrock outcrops and areas of abundant outcrop or shallow bedrock**—Solid color shows extent of individual bedrock outcrops; horizontal-line pattern indicates areas of shallow bedrock or areas where small outcrops are too numerous to map individually; in areas of shallow bedrock, surficial materials are less than 5 to 10 ft thick. These units were not mapped consistently among all quadrangles; see note at beginning of appendix 1 for information on bedrock outcrop mapping by quadrangle

Figure based on map titled: "Surficial Materials Map of the Boston North, Massachusetts," prepared by Stone, B.D. and DiGiacomo-Cohen, M.L. for U.S. Geological Survey, 2018, Scientific Investigation Map 3402, Quadrangle 125 – Boston North.

Client:
Drummey Rosane Anderson, Inc.

Project:
Prop. Northeast Metro Regional Vocational Technical H.S.

Figure 2 – Surficial Geologic Map

LGCI
Lahlaf Geotechnical Consulting, Inc.

Project Location:
Wakefield, MA

LGCI Project No.:
2025

Date:
June 2022

Legend

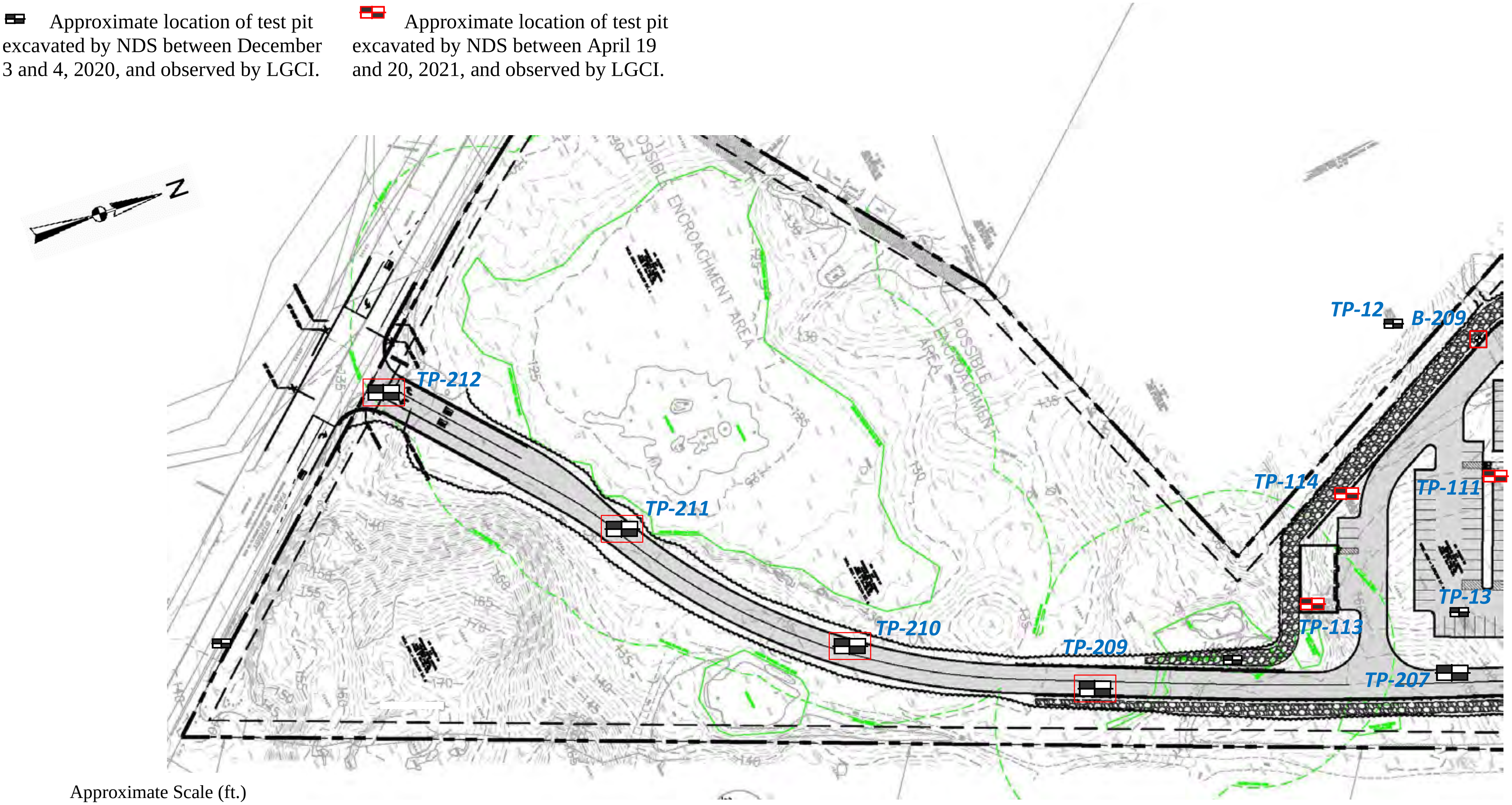
▣ Approximate location of test pit excavated by Saunders Construction on July 26th, 2022, and observed by LGCI.

▬ Approximate location of test pit excavated by NDS between April 26 and 27, 2022, and observed by LGCI.

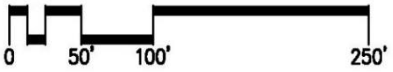
⊡ Approximate location of boring advanced by NDS between April 26, 2022, and May 11, 2022, and observed by LGCI.

▬ Approximate location of test pit excavated by NDS between December 3 and 4, 2020, and observed by LGCI.

🟥 Approximate location of test pit excavated by NDS between April 19 and 20, 2021, and observed by LGCI.



Approximate Scale (ft.)



Note
Figure based on untitled drawing provided to LGCI by Warner Larson via e-mail on April 21, 2022.

Client: Drummey Rosane Anderson, Inc.	Project: Proposed Northeast Metro Regional Vocational Technical High School	Figure 3A –Test Pit Location Plan for Proposed Access Road from Farm Street
LGCI Lahlaf Geotechnical Consulting, Inc.	Project Location: Wakefield, MA	LGCI Project No.: 2025
		Date: August 2022

Legend

⊕ Approximate location of boring advanced by Northern Drill Service, Inc. (NDS) of Northborough, MA between December 10 and 11, 2020, and observed by Lahlaf Geotechnical Consulting, Inc. (LGCI).

⊕ Approximate location of boring advanced by NDS between April 26, 2021, and May 14, 2021, and observed by LGCI.

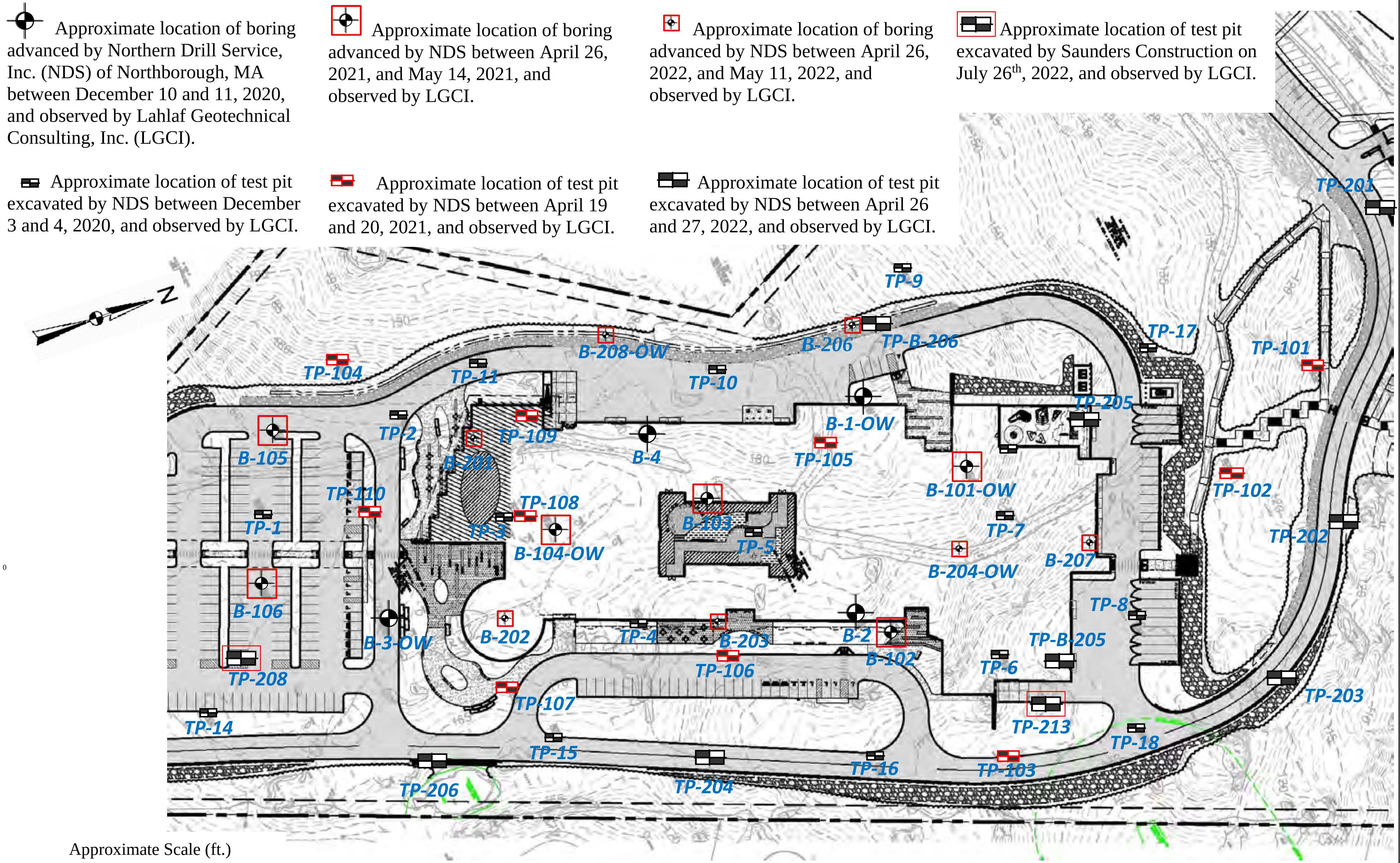
⊕ Approximate location of boring advanced by NDS between April 26, 2022, and May 11, 2022, and observed by LGCI.

▬ Approximate location of test pit excavated by Saunders Construction on July 26th, 2022, and observed by LGCI.

▬ Approximate location of test pit excavated by NDS between December 3 and 4, 2020, and observed by LGCI.

▬ Approximate location of test pit excavated by NDS between April 19 and 20, 2021, and observed by LGCI.

▬ Approximate location of test pit excavated by NDS between April 26 and 27, 2022, and observed by LGCI.



Approximate Scale (ft.)

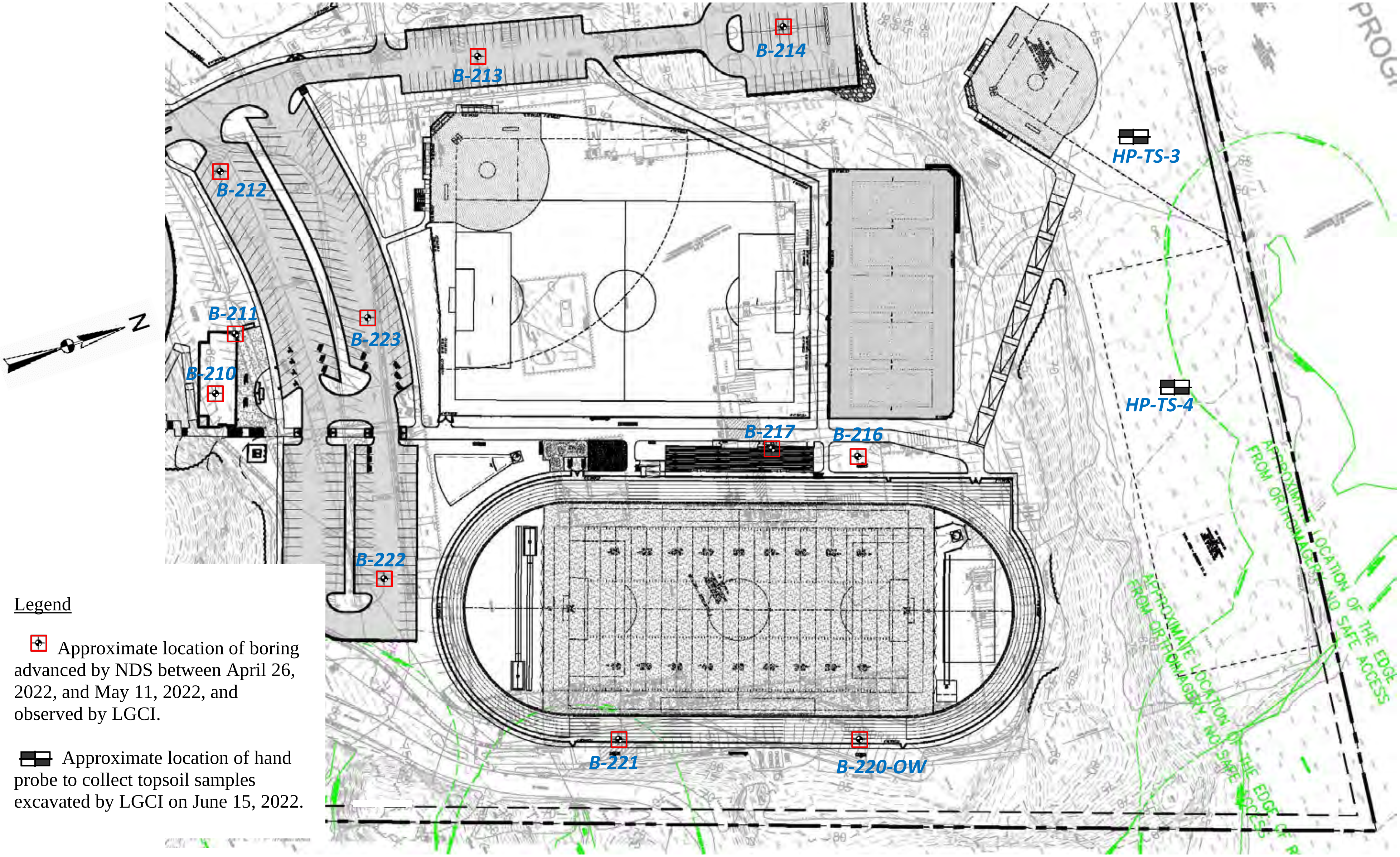
0 50' 100' 250'

Note
Figure based on untitled drawing provided to LGCI by Warner Larson via e-mail on April 21, 2022.

Client:	Project:	
Drummey Rosane Anderson, Inc.	Proposed Northeast Metro Regional Vocational Technical High School	Figure 3B –Test Pit and Boring Location Plan for Proposed Building

LGCI
Lahlaf Geotechnical Consulting, Inc.

Project Location:	LGCI Project No.:	Date:
Wakefield, MA	2025	August 2022

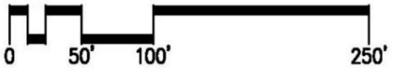


Legend

⊡ Approximate location of boring advanced by NDS between April 26, 2022, and May 11, 2022, and observed by LGCI.

▬ Approximate location of hand probe to collect topsoil samples excavated by LGCI on June 15, 2022.

Approximate Scale (ft.)



Note
Figure based on untitled drawing provided to LGCI by Warner Larson via e-mail on April 21, 2022.

Client:
Drummey Rosane Anderson, Inc.

Project:
Proposed Northeast Metro Regional Vocational Technical High School

Figure 3C – Test Pit, Hand Probe, and Boring Location Plan for Prop. Athletic Fields

LGCI
Lahlaf Geotechnical Consulting, Inc.

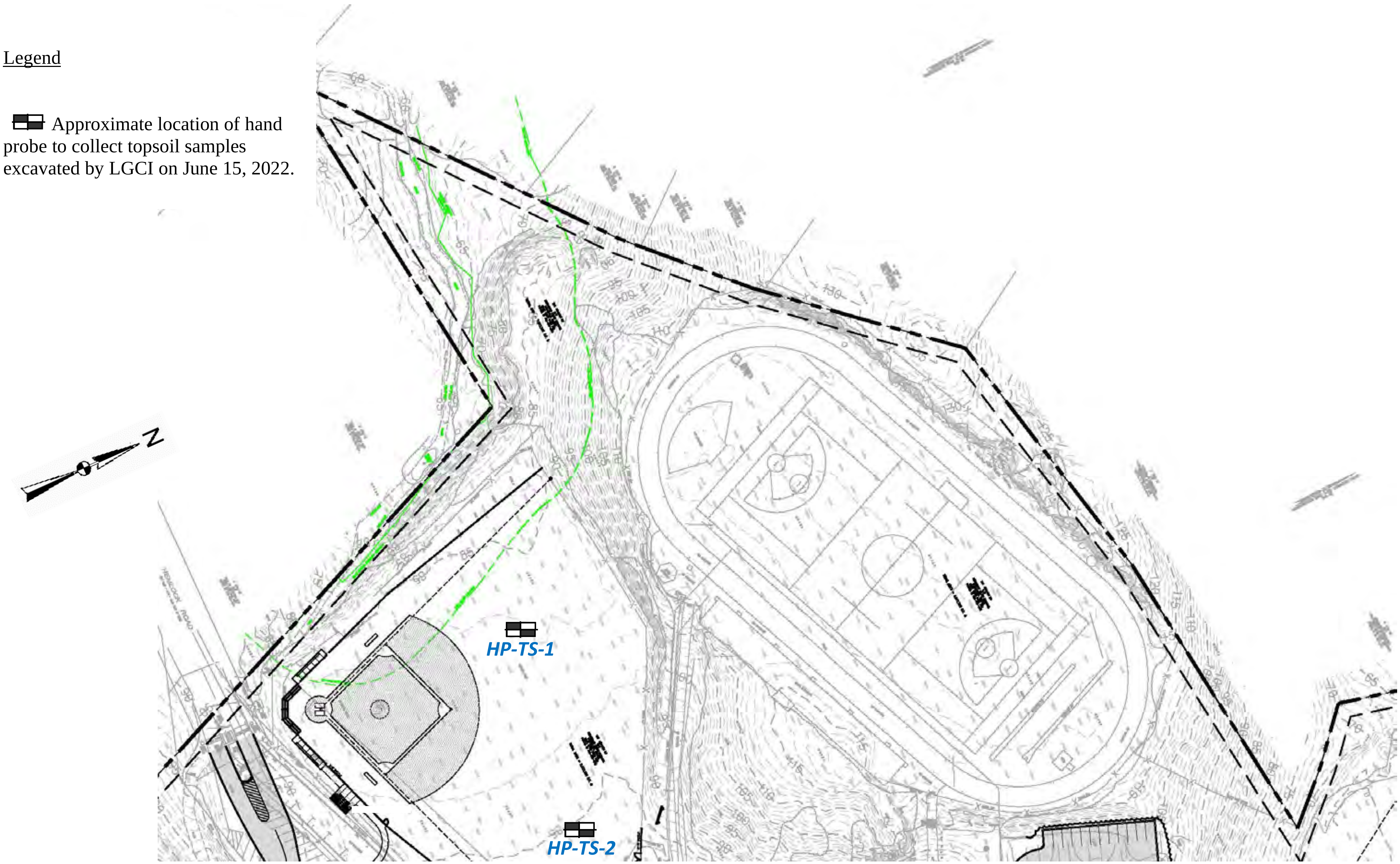
Project Location:
Wakefield, MA

LGCI Project No.:
2025

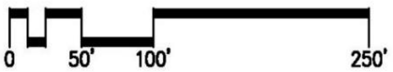
Date:
August 2022

Legend

◧ Approximate location of hand probe to collect topsoil samples excavated by LGCI on June 15, 2022.



Approximate Scale (ft.)



Note

Figure based on untitled drawing provided to LGCI by Warner Larson via e-mail on April 21, 2022.

Client:
Drummey Rosane Anderson, Inc.

Project:
Proposed Northeast Metro Regional Vocational Technical High School

Figure 3D – Hand Probe Location Plan for Western Baseball Field

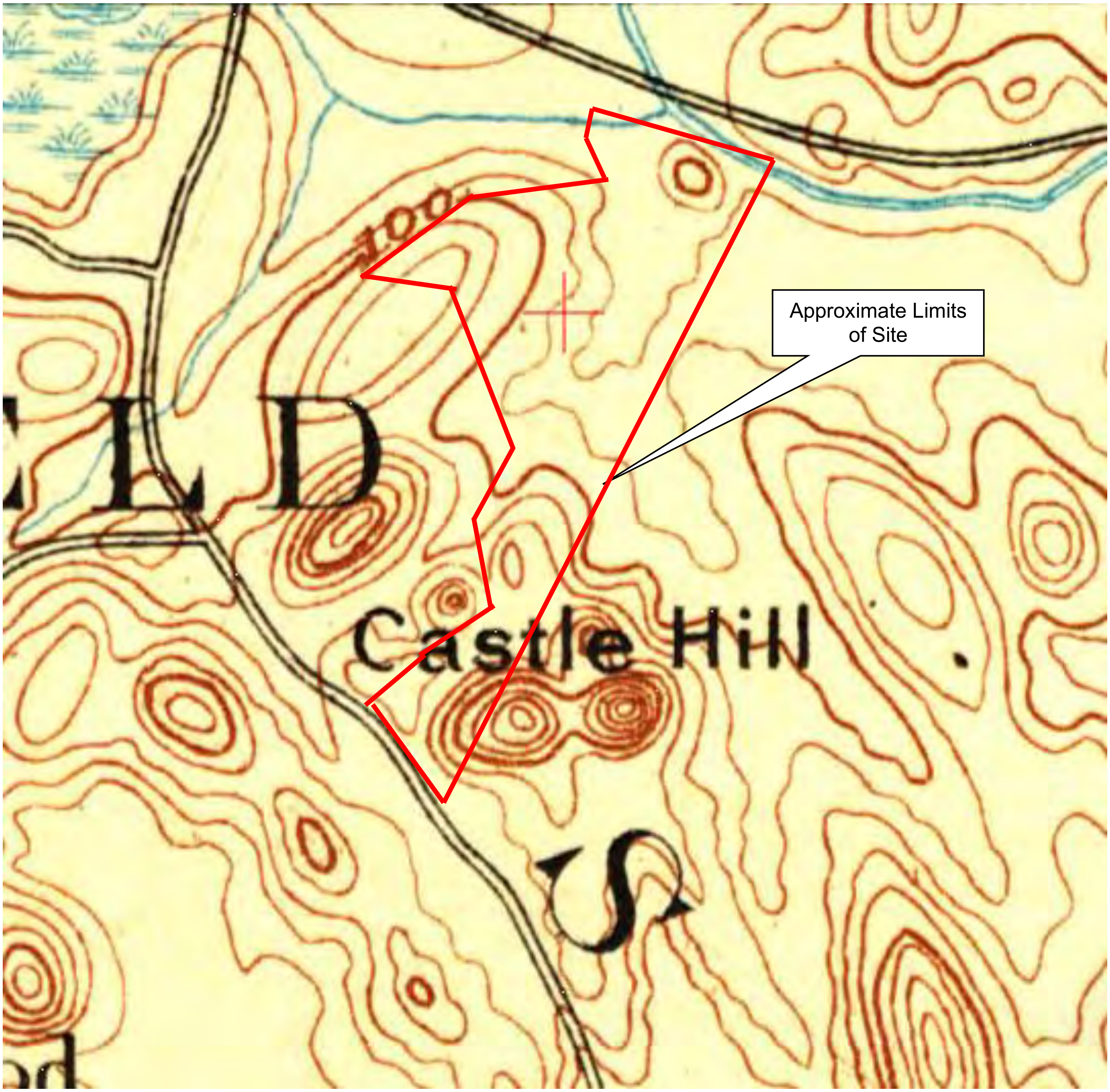
LGCI
Lahlaf Geotechnical Consulting, Inc.

Project Location:
Wakefield, MA

LGCI Project No.:
2025

Date:
August 2022

APPENDIX A – Historical Topo Maps

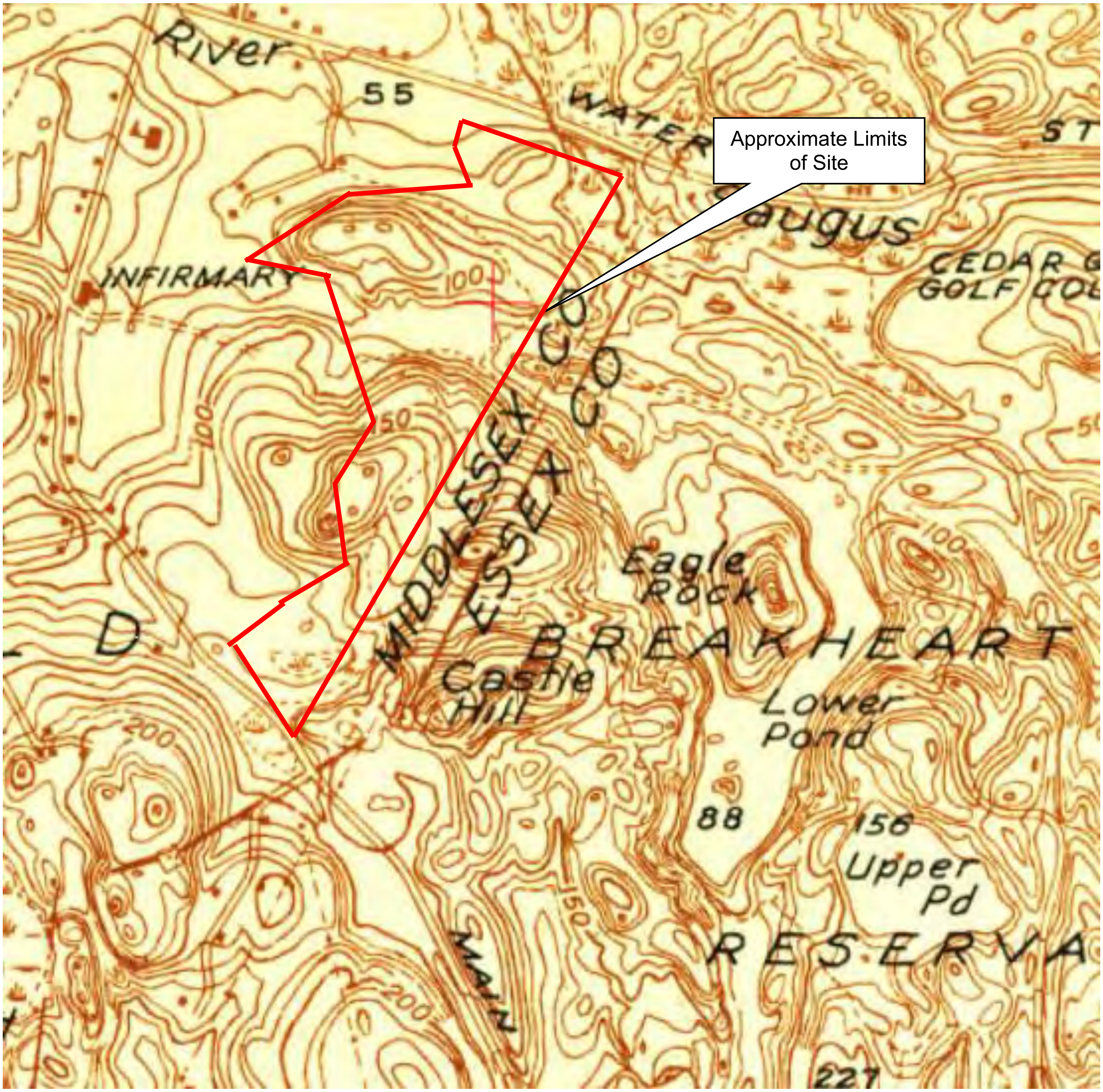


Contour Intervals: 20 feet

Figure based on USGS topographic map of Wakefield, MA obtained from https://livingatlas.arcgis.com/topoexplorer/index.html

Client:	Project:	
Drummey Rosane Anderson, Inc.	Proposed Northeast Metropolitan Regional Vocational High School	Figure A1 – 1893 Historical Topo Map

	Project Location:	LGCI Project No.:	Date:
LGCI Lahlaf Geotechnical Consulting, Inc.	Wakefield, MA	2025	June 2021



Approximate Limits of Site

Contour Intervals: 10 feet

Figure based on USGS topographic map of Wakefield, MA obtained from https://livingatlas.arcgis.com/topoexplorer/index.html

Client:
Drummey Rosane Anderson, Inc.

Project:
Proposed Northeast Metropolitan Regional Vocational High School

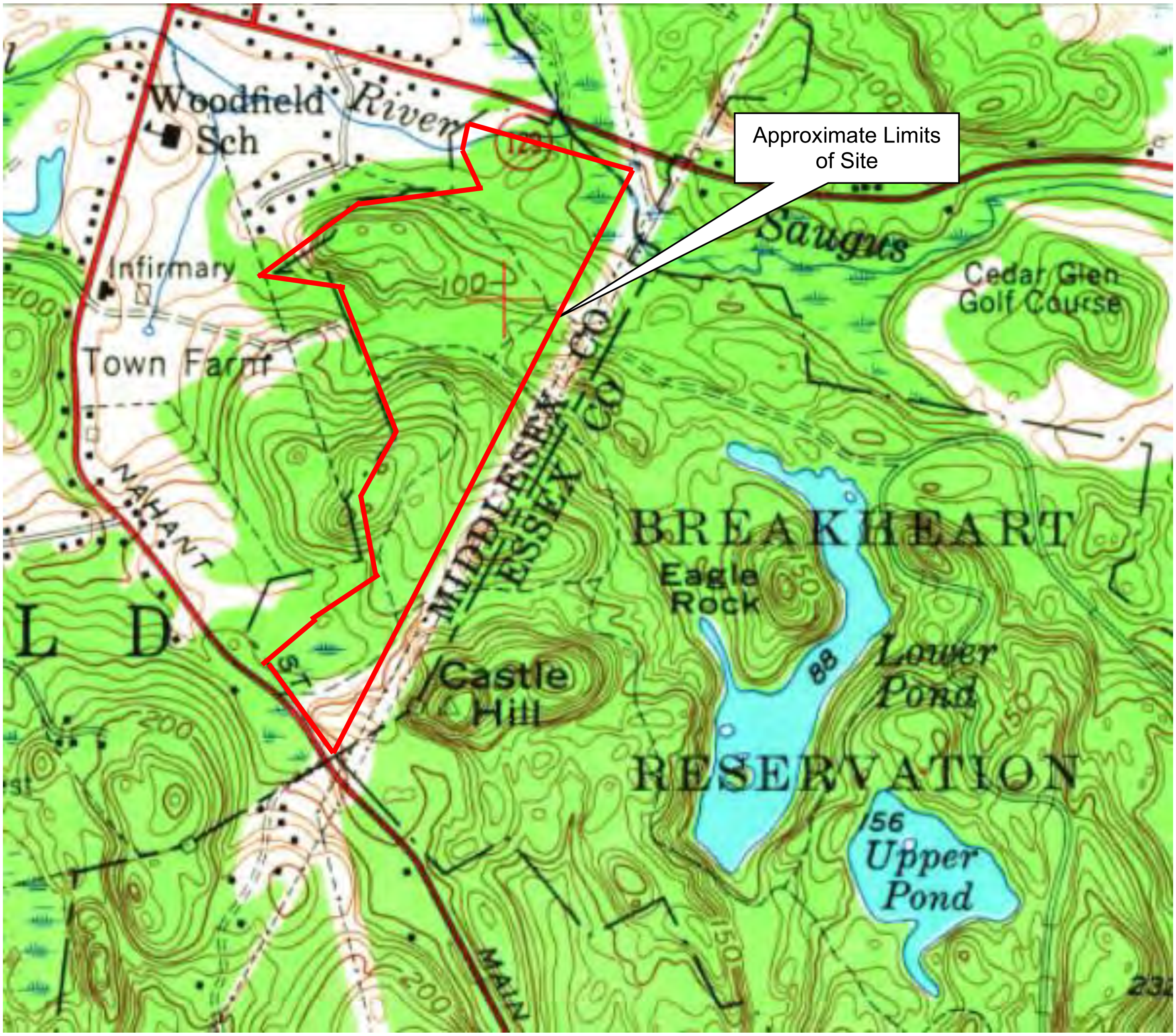
Figure A2 – 1943 Historical Topo Map

LGCI
Lahlaf Geotechnical Consulting, Inc.

Project Location:
Wakefield, MA

LGCI Project No.:
2025

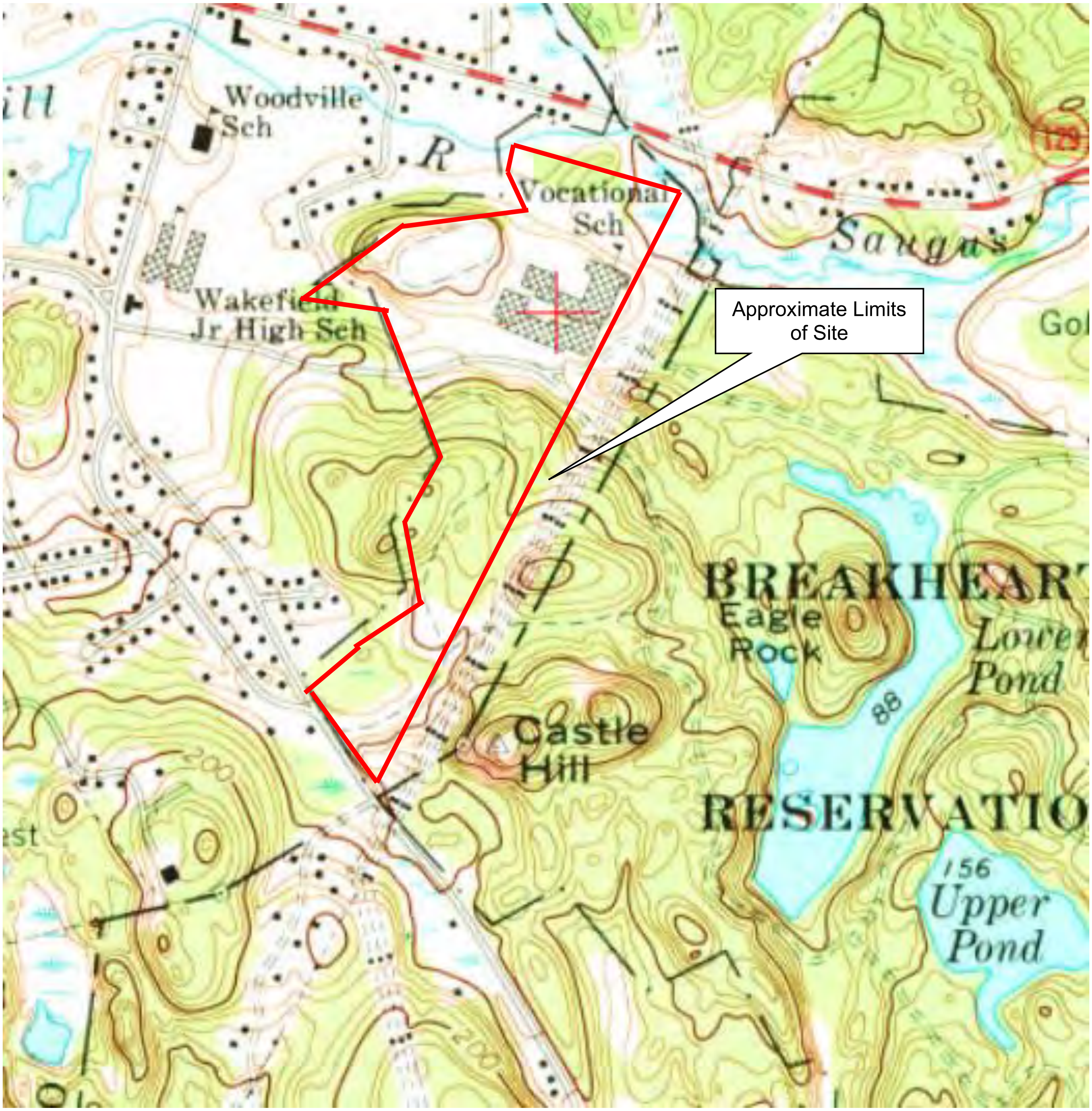
Date:
June 2021



Contour Intervals: 10 feet

Figure based on USGS topographic map of Wakefield, MA obtained from https://livingatlas.arcgis.com/topoexplorer/index.html

Client: Drummey Rosane Anderson, Inc.	Project: Proposed Northeast Metropolitan Regional Vocational High School	Figure A3 – 1956 Historical Topo Map	
LGCI Lahlaf Geotechnical Consulting, Inc.	Project Location: Wakefield, MA	LGCI Project No.: 2025	Date: June 2021



Contour Intervals: 10 feet

Figure based on USGS topographic map of Wakefield, MA obtained from https://livingatlas.arcgis.com/topoexplorer/index.html

Client: Drummey Rosane Anderson, Inc.	Project: Proposed Northeast Metropolitan Regional Vocational High School	Figure A4 – 1971 Historical Topo Map	
LGCI Lahlaf Geotechnical Consulting, Inc.	Project Location: Wakefield, MA	LGCI Project No.: 2025	Date: June 2021

Contour Intervals: 3 meters

Figure based on USGS topographic map of Wakefield, MA obtained from https://livingatlas.arcgis.com/topoexplorer/index.html

Client:	Project:	
Drummey Rosane Anderson, Inc.	Proposed Northeast Metropolitan Regional Vocational High School	Figure A5 – 1985 Historical Topo Map

	Project Location:	LGCI Project No.:	Date:
LGCI Lahlaf Geotechnical Consulting, Inc.	Wakefield, MA	2025	June 2021

APPENDIX B – Soil Survey Report and Map

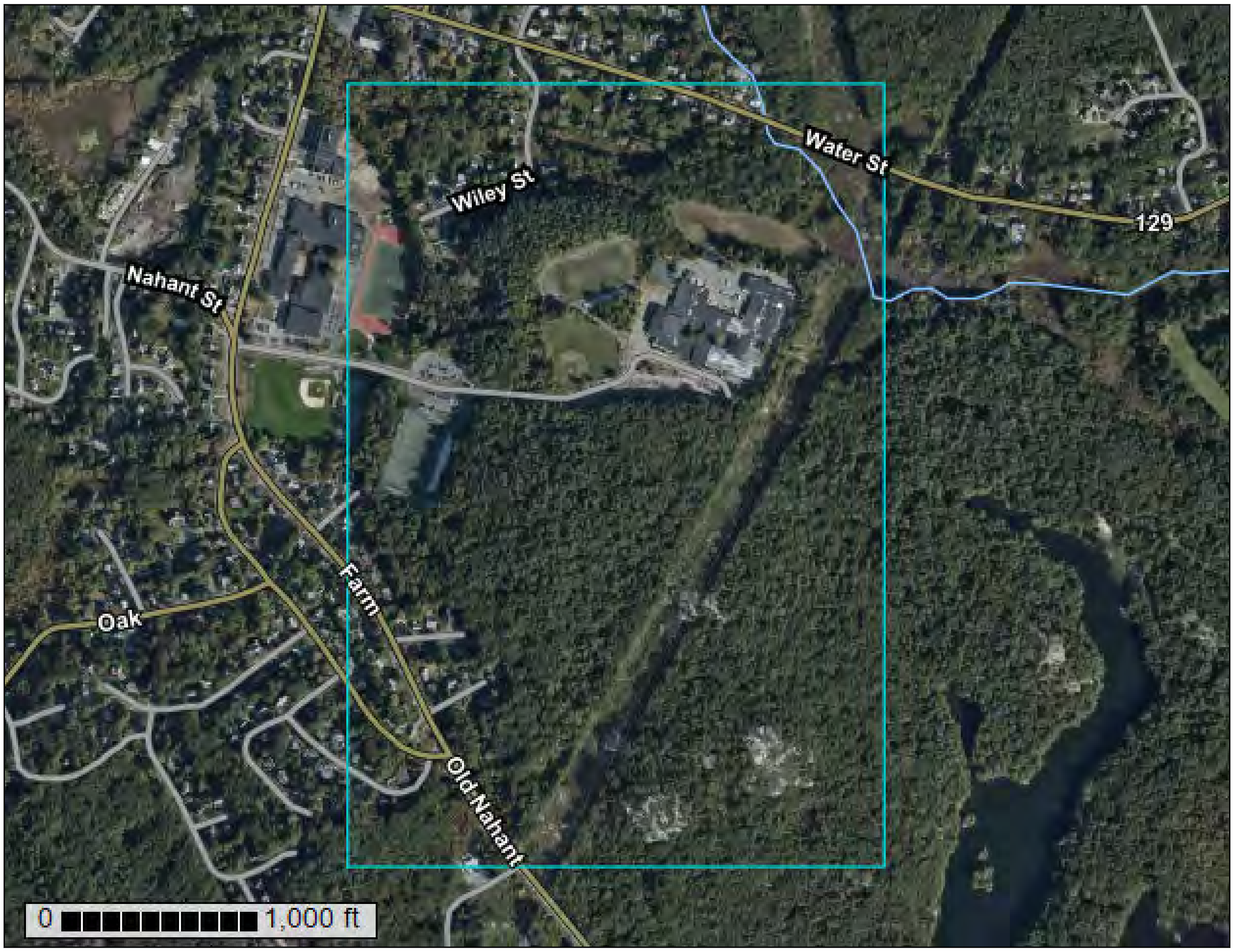
United States
Department of
Agriculture

NRCS

Natural
Resources
Conservation
Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Essex County, Massachusetts, Southern Part; and Middlesex County, Massachusetts



August 3, 2020

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map

Map Scale: 1:7,120 if printed on A portrait (8.5" x 11") sheet.

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)	
▭	Area of Interest (AOI)
Soils	
▭	Soil Map Unit Polygons
〰	Soil Map Unit Lines
■	Soil Map Unit Points
Special Point Features	
◎	Blowout
⊠	Borrow Pit
✱	Clay Spot
◇	Closed Depression
✕	Gravel Pit
∴	Gravelly Spot
●	Landfill
Λ	Lava Flow
⫫	Marsh or swamp
⚒	Mine or Quarry
◎	Miscellaneous Water
○	Perennial Water
∨	Rock Outcrop
+	Saline Spot
⁘	Sandy Spot
⊖	Severely Eroded Spot
◇	Sinkhole
⊳	Slide or Slip
⌀	Sodic Spot
≣	Spoil Area
◊	Stony Spot
∞	Very Stony Spot
ψ	Wet Spot
△	Other
╌	Special Line Features
Water Features	
∼	Streams and Canals
Transportation	
┼┼┼	Rails
〰	Interstate Highways
〰	US Routes
〰	Major Roads
〰	Local Roads
Background	
🟩	Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at scales ranging from 1:15,800 to 1:25,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Essex County, Massachusetts, Southern Part
Survey Area Data: Version 17, Jun 9, 2020

Soil Survey Area: Middlesex County, Massachusetts
Survey Area Data: Version 20, Jun 9, 2020

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

MAP LEGEND

MAP INFORMATION

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 13, 2019—Oct 5, 2019

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
102C	Chatfield-Hollis-Rock outcrop complex, 0 to 15 percent slopes	13.4	5.3%
102E	Chatfield-Hollis-Rock outcrop complex, 15 to 35 percent slopes	1.2	0.5%
105D	Rock outcrop-Hollis complex, 3 to 25 percent slopes	39.7	15.7%
242B	Hinckley gravelly fine sandy loam, 3 to 8 percent slopes	1.7	0.7%
616A	Fluvaquents, frequently flooded, 0 to 3 percent slopes	4.7	1.8%
Subtotals for Soil Survey Area		**60.6**	**24.0%**
Totals for Area of Interest		**252.2**	**100.0%**

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
51A	Swansea muck, 0 to 1 percent slopes	4.6	1.8%
52A	Freetown muck, 0 to 1 percent slopes	10.0	4.0%
53A	Freetown muck, ponded, 0 to 1 percent slopes	3.8	1.5%
71B	Ridgebury fine sandy loam, 3 to 8 percent slopes, extremely stony	6.8	2.7%
103B	Charlton-Hollis-Rock outcrop complex, 3 to 8 percent slopes	8.3	3.3%
103C	Charlton-Hollis-Rock outcrop complex, 8 to 15 percent slopes	3.0	1.2%
104C	Hollis-Rock outcrop-Charlton complex, 0 to 15 percent slopes	4.6	1.8%
104D	Hollis-Rock outcrop-Charlton complex, 15 to 25 percent slopes	6.4	2.6%
105E	Rock outcrop-Hollis complex, 3 to 35 percent slopes	58.2	23.1%
253B	Hinckley loamy sand, 3 to 8 percent slopes	2.9	1.2%
602	Urban land	11.7	4.6%
631C	Charlton-Urban land-Hollis complex, 3 to 15 percent slopes, rocky	39.8	15.8%

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
655	Udorthents, wet substratum	15.7	6.2%
656	Udorthents-Urban land complex	15.7	6.2%
Subtotals for Soil Survey Area		**191.6**	**76.0%**
Totals for Area of Interest		**252.2**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Essex County, Massachusetts, Southern Part

102C—Chatfield-Hollis-Rock outcrop complex, 0 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2w69g
Elevation: 0 to 1,540 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Chatfield, extremely stony, and similar soils: 39 percent
Hollis, extremely stony, and similar soils: 26 percent
Rock outcrop: 17 percent
Minor components: 18 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Chatfield, Extremely Stony

Setting

Landform: Hills, ridges
Landform position (two-dimensional): Backslope, shoulder, summit
Landform position (three-dimensional): Crest, side slope, nose slope
Down-slope shape: Convex
Across-slope shape: Linear, convex
Parent material: Coarse-loamy melt-out till derived from granite, gneiss, and/or schist

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 2 inches: fine sandy loam
Bw - 2 to 30 inches: gravelly fine sandy loam
2R - 30 to 40 inches: bedrock

Properties and qualities

Slope: 0 to 15 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: 20 to 41 inches to lithic bedrock
Drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water capacity: Low (about 4.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: B
Ecological site: F144AY034CT - Well Drained Till Uplands

Hydric soil rating: No

Description of Hollis, Extremely Stony

Setting

Landform: Ridges, hills
Landform position (two-dimensional): Backslope, shoulder, summit
Landform position (three-dimensional): Nose slope, crest, side slope
Down-slope shape: Convex
Across-slope shape: Linear, convex
Parent material: Coarse-loamy melt-out till derived from granite, gneiss, and/or schist

Typical profile

Oi - 0 to 2 inches: slightly decomposed plant material
A - 2 to 7 inches: gravelly fine sandy loam
Bw - 7 to 16 inches: gravelly fine sandy loam
2R - 16 to 26 inches: bedrock

Properties and qualities

Slope: 0 to 15 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: 8 to 23 inches to lithic bedrock
Drainage class: Somewhat excessively drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water capacity: Very low (about 2.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: D
Ecological site: F144AY033MA - Shallow Dry Till Uplands
Hydric soil rating: No

Description of Rock Outcrop

Setting

Parent material: Igneous and metamorphic rock

Properties and qualities

Slope: 0 to 15 percent
Depth to restrictive feature: 0 inches to lithic bedrock
Runoff class: Very high

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydrologic Soil Group: D
Hydric soil rating: No

Minor Components

Charlton, extremely stony

Percent of map unit: 12 percent
Landform: Hills, ridges
Landform position (two-dimensional): Backslope, shoulder, summit
Landform position (three-dimensional): Crest, side slope
Down-slope shape: Linear, convex
Across-slope shape: Convex
Hydric soil rating: No

Sutton, extremely stony

Percent of map unit: 3 percent
Landform: Ground moraines, hills
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: No

Paxton, extremely stony

Percent of map unit: 2 percent
Landform: Drumlins, hills, ground moraines
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex, linear
Across-slope shape: Linear, convex
Hydric soil rating: No

Leicester, extremely stony

Percent of map unit: 1 percent
Landform: Depressions, drainageways, hills, ground moraines
Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear, concave
Across-slope shape: Concave
Hydric soil rating: Yes

102E—Chatfield-Hollis-Rock outcrop complex, 15 to 35 percent slopes

Map Unit Setting

National map unit symbol: 2w69h
Elevation: 0 to 1,540 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Chatfield, extremely stony, and similar soils: 35 percent
Hollis, extremely stony, and similar soils: 30 percent
Rock outcrop: 20 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Chatfield, Extremely Stony

Setting

Landform: Ridges, hills
Landform position (two-dimensional): Backslope, shoulder, summit
Landform position (three-dimensional): Crest, side slope, nose slope
Down-slope shape: Convex
Across-slope shape: Convex, linear
Parent material: Coarse-loamy melt-out till derived from granite, gneiss, and/or schist

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 2 inches: fine sandy loam
Bw - 2 to 30 inches: gravelly fine sandy loam
2R - 30 to 40 inches: bedrock

Properties and qualities

Slope: 15 to 35 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: 20 to 41 inches to lithic bedrock
Drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water capacity: Low (about 4.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: B
Ecological site: F144AY034CT - Well Drained Till Uplands
Hydric soil rating: No

Description of Hollis, Extremely Stony

Setting

Landform: Hills, ridges
Landform position (two-dimensional): Backslope, shoulder, summit
Landform position (three-dimensional): Side slope, nose slope, crest
Down-slope shape: Convex
Across-slope shape: Linear, convex
Parent material: Coarse-loamy melt-out till derived from granite, gneiss, and/or schist

Typical profile

Oi - 0 to 2 inches: slightly decomposed plant material
A - 2 to 7 inches: gravelly fine sandy loam
Bw - 7 to 16 inches: gravelly fine sandy loam
2R - 16 to 26 inches: bedrock

Properties and qualities

Slope: 15 to 35 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: 8 to 23 inches to lithic bedrock
Drainage class: Somewhat excessively drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water capacity: Very low (about 2.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: D
Ecological site: F144AY033MA - Shallow Dry Till Uplands
Hydric soil rating: No

Description of Rock Outcrop

Setting

Landform: Hills, ridges
Parent material: Igneous and metamorphic rock

Typical profile

R - 0 to 79 inches: bedrock

Properties and qualities

Slope: 15 to 35 percent
Depth to restrictive feature: 0 inches to lithic bedrock
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr)
Available water capacity: Very low (about 0.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydrologic Soil Group: D
Hydric soil rating: No

Minor Components

Charlton, extremely stony

Percent of map unit: 7 percent
Landform: Hills, ridges
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope

Down-slope shape: Linear, convex
Across-slope shape: Convex
Hydric soil rating: No

Leicester, extremely stony

Percent of map unit: 4 percent
Landform: Depressions, drainageways, hills, ground moraines
Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear, concave
Across-slope shape: Concave
Hydric soil rating: Yes

Sutton, extremely stony

Percent of map unit: 2 percent
Landform: Hills, ground moraines
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: No

Paxton, extremely stony

Percent of map unit: 2 percent
Landform: Hills, ground moraines, drumlins
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear, convex
Across-slope shape: Convex, linear
Hydric soil rating: No

105D—Rock outcrop-Hollis complex, 3 to 25 percent slopes

Map Unit Setting

National map unit symbol: vkcq
Elevation: 0 to 280 feet
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Rock outcrop: 65 percent
Hollis and similar soils: 20 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Rock Outcrop

Setting

Parent material: Granite

Properties and qualities

Slope: 25 to 35 percent
Depth to restrictive feature: 0 inches to lithic bedrock

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8s
Hydric soil rating: Unranked

Description of Hollis

Setting

Landform: Ridges, hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Friable, shallow loamy basal till derived from granite and gneiss over granite

Typical profile

O - 0 to 2 inches: muck
H2 - 2 to 4 inches: fine sandy loam
H3 - 4 to 17 inches: gravelly fine sandy loam
H4 - 17 to 19 inches: unweathered bedrock

Properties and qualities

Slope: 25 to 35 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: 10 to 20 inches to lithic bedrock
Drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very low (about 1.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: D
Ecological site: F144AY033MA - Shallow Dry Till Uplands
Hydric soil rating: No

Minor Components

Chatfield

Percent of map unit: 15 percent
Hydric soil rating: No

242B—Hinckley gravelly fine sandy loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: vk5l
Elevation: 0 to 1,000 feet
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Hinckley and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hinckley

Setting

Landform: Flood plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Friable sandy and gravelly glaciofluvial deposits derived from granite and gneiss

Typical profile

H1 - 0 to 8 inches: gravelly fine sandy loam
H2 - 8 to 17 inches: gravelly loamy sand
H3 - 17 to 60 inches: stratified cobbly coarse sand to very gravelly loamy fine sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (6.00 to 20.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 3.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: A
Ecological site: F144AY022MA - Dry Outwash
Hydric soil rating: No

Minor Components

Windsor

Percent of map unit: 10 percent
Hydric soil rating: No

Sudbury

Percent of map unit: 3 percent
Hydric soil rating: No

Wareham

Percent of map unit: 1 percent
Landform: Terraces
Hydric soil rating: Yes

Swansea

Percent of map unit: 1 percent
Landform: Bogs
Hydric soil rating: Yes

616A—Fluvaquents, frequently flooded, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: vk56
Elevation: 0 to 100 feet
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Fluvaquents and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Fluvaquents

Setting

Landform: Alluvial flats
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Friable loamy alluvium over friable sandy eolian deposits

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Depth to water table: About 0 to 12 inches
Frequency of flooding: NoneFrequent

Frequency of ponding: None

Minor Components

Swansea

Percent of map unit: 10 percent
Landform: Bogs
Hydric soil rating: Yes

Unnamed soils

Percent of map unit: 5 percent
Hydric soil rating: No

Middlesex County, Massachusetts

51A—Swansea muck, 0 to 1 percent slopes

Map Unit Setting

National map unit symbol: 2trl2
Elevation: 0 to 1,140 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Swansea and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Swansea

Setting

Landform: Swamps, bogs
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Highly decomposed organic material over loose sandy and gravelly glaciofluvial deposits

Typical profile

Oa1 - 0 to 24 inches: muck
Oa2 - 24 to 34 inches: muck
Cg - 34 to 79 inches: coarse sand

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 14.17 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: Rare
Frequency of ponding: Frequent
Available water capacity: Very high (about 16.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8w
Hydrologic Soil Group: B/D
Ecological site: F144AY043MA - Acidic Organic Wetlands
Hydric soil rating: Yes

Minor Components

Freetown

Percent of map unit: 10 percent
Landform: Bogs, swamps

Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Whitman

Percent of map unit: 5 percent
Landform: Depressions, drainageways
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Scarboro

Percent of map unit: 5 percent
Landform: Drainageways, depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope, tread, dip
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

52A—Freetown muck, 0 to 1 percent slopes

Map Unit Setting

National map unit symbol: 2t2q9
Elevation: 0 to 1,110 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Freetown and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Freetown

Setting

Landform: Depressions, depressions, bogs, marshes, kettles, swamps
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread, dip
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Highly decomposed organic material

Typical profile

Oe - 0 to 2 inches: mucky peat
Oa - 2 to 79 inches: muck

Properties and qualities

Slope: 0 to 1 percent
Surface area covered with cobbles, stones or boulders: 0.0 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 14.17 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: Rare
Frequency of ponding: Frequent
Available water capacity: Very high (about 19.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: B/D
Ecological site: F144AY043MA - Acidic Organic Wetlands
Hydric soil rating: Yes

Minor Components

Swansea

Percent of map unit: 5 percent
Landform: Kettles, depressions, depressions, marshes, swamps, bogs
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread, dip
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Scarboro

Percent of map unit: 5 percent
Landform: Depressions, drainageways
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope, tread, dip
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Whitman

Percent of map unit: 5 percent
Landform: Depressions, drainageways
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

53A—Freetown muck, ponded, 0 to 1 percent slopes

Map Unit Setting

National map unit symbol: 2t2qc
Elevation: 0 to 1,140 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Freetown, ponded, and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Freetown, Ponded

Setting

Landform: Marshes, kettles, swamps, bogs, depressions, depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread, dip
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Highly decomposed organic material

Typical profile

Oe - 0 to 2 inches: mucky peat
Oa - 2 to 79 inches: muck

Properties and qualities

Slope: 0 to 1 percent
Surface area covered with cobbles, stones or boulders: 0.0 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 14.17 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: Rare
Frequency of ponding: Frequent
Available water capacity: Very high (about 19.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: B/D
Hydric soil rating: Yes

Minor Components

Whitman, ponded

Percent of map unit: 5 percent
Landform: Depressions on ground moraines
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Swansea, ponded

Percent of map unit: 5 percent
Landform: Kettles, depressions, depressions, marshes, swamps, bogs
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread, dip
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Scarboro

Percent of map unit: 5 percent
Landform: Depressions, drainageways
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope, tread, dip
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

71B—Ridgebury fine sandy loam, 3 to 8 percent slopes, extremely stony

Map Unit Setting

National map unit symbol: 2w69c
Elevation: 0 to 1,290 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Ridgebury, extremely stony, and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ridgebury, Extremely Stony

Setting

Landform: Depressions, drumlins, drainageways, hills, ground moraines
Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Base slope, head slope

Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Coarse-loamy lodgment till derived from gneiss, granite, and/or schist

Typical profile
Oe - 0 to 1 inches: moderately decomposed plant material
A - 1 to 6 inches: fine sandy loam
Bw - 6 to 10 inches: sandy loam
Bg - 10 to 19 inches: gravelly sandy loam
Cd - 19 to 66 inches: gravelly sandy loam

Properties and qualities
Slope: 3 to 8 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: 15 to 35 inches to densic material
Drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.14 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water capacity: Low (about 3.0 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: D
Ecological site: F144AY009CT - Wet Till Depressions
Hydric soil rating: Yes

Minor Components

Woodbridge, extremely stony
Percent of map unit: 10 percent
Landform: Drumlins, hills, ground moraines
Landform position (two-dimensional): Footslope, summit, backslope
Landform position (three-dimensional): Crest, side slope
Down-slope shape: Convex
Across-slope shape: Linear
Hydric soil rating: No

Whitman, extremely stony
Percent of map unit: 8 percent
Landform: Depressions
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Paxton, extremely stony
Percent of map unit: 2 percent
Landform: Drumlins, hills, ground moraines
Landform position (two-dimensional): Shoulder, summit, backslope
Landform position (three-dimensional): Crest, side slope
Down-slope shape: Linear, convex

Across-slope shape: Convex, linear
Hydric soil rating: No

103B—Charlton-Hollis-Rock outcrop complex, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 98yc
Elevation: 0 to 1,490 feet
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 110 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Charlton and similar soils: 50 percent
Hollis and similar soils: 25 percent
Rock outcrop: 15 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Charlton

Setting

Landform: Ground moraines, drumlins
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Friable loamy eolian deposits over friable loamy basal till derived from granite and gneiss

Typical profile

H1 - 0 to 5 inches: fine sandy loam
H2 - 5 to 22 inches: sandy loam
H3 - 22 to 65 inches: gravelly sandy loam

Properties and qualities

Slope: 3 to 8 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s

Hydrologic Soil Group: A
Ecological site: F144AY034CT - Well Drained Till Uplands
Hydric soil rating: No

Description of Hollis

Setting

Landform: Ridges, hills
Landform position (two-dimensional): Shoulder, summit
Landform position (three-dimensional): Crest
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Friable, shallow loamy basal till over granite and gneiss

Typical profile

H1 - 0 to 2 inches: fine sandy loam
H2 - 2 to 14 inches: fine sandy loam
H3 - 14 to 18 inches: unweathered bedrock

Properties and qualities

Slope: 3 to 8 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: 8 to 20 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.14 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very low (about 2.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: D
Ecological site: F144AY033MA - Shallow Dry Till Uplands
Hydric soil rating: No

Description of Rock Outcrop

Setting

Landform: Ledges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Head slope
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Granite and gneiss

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: 0 inches to lithic bedrock

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8s

Minor Components

Canton

Percent of map unit: 2 percent
Landform: Hills
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Head slope
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Woodbridge

Percent of map unit: 2 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder, toeslope, summit
Landform position (three-dimensional): Head slope, base slope, nose slope
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: No

Scituate

Percent of map unit: 2 percent
Landform: Hillslopes, depressions
Landform position (two-dimensional): Toeslope, summit
Landform position (three-dimensional): Head slope, base slope
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: No

Narragansett

Percent of map unit: 2 percent
Landform: Ridges, hills
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Convex
Hydric soil rating: No

Unnamed

Percent of map unit: 1 percent

Montauk

Percent of map unit: 1 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder, summit
Landform position (three-dimensional): Head slope, nose slope
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

103C—Charlton-Hollis-Rock outcrop complex, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2wzp1
Elevation: 0 to 1,390 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Charlton, extremely stony, and similar soils: 50 percent
Hollis, extremely stony, and similar soils: 20 percent
Rock outcrop: 10 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Charlton, Extremely Stony

Setting

Landform: Hills, ridges
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear, convex
Across-slope shape: Convex
Parent material: Coarse-loamy melt-out till derived from granite, gneiss, and/or schist

Typical profile

Oe - 0 to 2 inches: moderately decomposed plant material
A - 2 to 4 inches: fine sandy loam
Bw - 4 to 27 inches: gravelly fine sandy loam
C - 27 to 65 inches: gravelly fine sandy loam

Properties and qualities

Slope: 8 to 15 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 14.17 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water capacity: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: B
Ecological site: F144AY034CT - Well Drained Till Uplands
Hydric soil rating: No

Description of Hollis, Extremely Stony

Setting

Landform: Hills, ridges
Landform position (two-dimensional): Backslope, shoulder, summit
Landform position (three-dimensional): Crest, side slope, nose slope
Down-slope shape: Convex
Across-slope shape: Linear, convex
Parent material: Coarse-loamy melt-out till derived from granite, gneiss, and/or schist

Typical profile

Oi - 0 to 2 inches: slightly decomposed plant material
A - 2 to 7 inches: gravelly fine sandy loam
Bw - 7 to 16 inches: gravelly fine sandy loam
2R - 16 to 26 inches: bedrock

Properties and qualities

Slope: 8 to 15 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: 8 to 23 inches to lithic bedrock
Drainage class: Somewhat excessively drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water capacity: Very low (about 2.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: D
Ecological site: F144AY033MA - Shallow Dry Till Uplands
Hydric soil rating: No

Description of Rock Outcrop

Setting

Landform: Hills, ridges
Parent material: Igneous and metamorphic rock

Typical profile

R - 0 to 79 inches: bedrock

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: 0 inches to lithic bedrock

Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr)
Available water capacity: Very low (about 0.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydrologic Soil Group: D
Hydric soil rating: No

Minor Components

Woodbridge, extremely stony

Percent of map unit: 8 percent
Landform: Drumlins, hills, ground moraines
Landform position (two-dimensional): Backslope, footslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Hydric soil rating: No

Canton, extremely stony

Percent of map unit: 5 percent
Landform: Moraines, ridges, hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex, linear
Across-slope shape: Convex
Hydric soil rating: No

Chatfield, extremely stony

Percent of map unit: 5 percent
Landform: Hills, ridges
Landform position (two-dimensional): Summit, backslope, shoulder
Landform position (three-dimensional): Crest, side slope, nose slope
Down-slope shape: Convex
Across-slope shape: Linear, convex
Hydric soil rating: No

Ridgebury, extremely stony

Percent of map unit: 2 percent
Landform: Hills, ground moraines, depressions, drumlins, drainageways
Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Base slope, head slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

104C—Hollis-Rock outcrop-Charlton complex, 0 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2w69p
Elevation: 0 to 1,270 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Hollis, extremely stony, and similar soils: 35 percent
Charlton, extremely stony, and similar soils: 25 percent
Rock outcrop: 25 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hollis, Extremely Stony

Setting

Landform: Hills, ridges
Landform position (two-dimensional): Backslope, shoulder, summit
Landform position (three-dimensional): Crest, side slope, nose slope
Down-slope shape: Convex
Across-slope shape: Linear, convex
Parent material: Coarse-loamy melt-out till derived from granite, gneiss, and/or schist

Typical profile

Oi - 0 to 2 inches: slightly decomposed plant material
A - 2 to 7 inches: gravelly fine sandy loam
Bw - 7 to 16 inches: gravelly fine sandy loam
2R - 16 to 26 inches: bedrock

Properties and qualities

Slope: 0 to 15 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: 8 to 23 inches to lithic bedrock
Drainage class: Somewhat excessively drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water capacity: Very low (about 2.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: D
Ecological site: F144AY033MA - Shallow Dry Till Uplands
Hydric soil rating: No

Description of Charlton, Extremely Stony

Setting

Landform: Ridges, hills
Landform position (two-dimensional): Summit, backslope, shoulder
Landform position (three-dimensional): Crest, side slope
Down-slope shape: Linear, convex
Across-slope shape: Convex
Parent material: Coarse-loamy melt-out till derived from granite, gneiss, and/or schist

Typical profile

Oe - 0 to 2 inches: moderately decomposed plant material
A - 2 to 4 inches: fine sandy loam
Bw - 4 to 27 inches: gravelly fine sandy loam
C - 27 to 65 inches: gravelly fine sandy loam

Properties and qualities

Slope: 0 to 15 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 14.17 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water capacity: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: B
Ecological site: F144AY034CT - Well Drained Till Uplands
Hydric soil rating: No

Description of Rock Outcrop

Setting

Landform: Hills, ridges
Parent material: Igneous and metamorphic rock

Typical profile

R - 0 to 79 inches: bedrock

Properties and qualities

Slope: 0 to 15 percent
Depth to restrictive feature: 0 inches to lithic bedrock

Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr)
Available water capacity: Very low (about 0.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydrologic Soil Group: D
Hydric soil rating: No

Minor Components

Canton, extremely stony

Percent of map unit: 7 percent
Landform: Hills, moraines, ridges
Landform position (two-dimensional): Backslope, shoulder, summit
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Convex
Hydric soil rating: No

Chatfield, extremely stony

Percent of map unit: 6 percent
Landform: Hills, ridges
Landform position (two-dimensional): Backslope, shoulder, summit
Landform position (three-dimensional): Crest, side slope, nose slope
Down-slope shape: Convex
Across-slope shape: Linear, convex
Hydric soil rating: No

Montauk, extremely stony

Percent of map unit: 1 percent
Landform: Recessionial moraines, hills, drumlins, ground moraines
Landform position (two-dimensional): Summit, backslope, shoulder
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Linear, convex
Across-slope shape: Convex
Hydric soil rating: No

Scituate, extremely stony

Percent of map unit: 1 percent
Landform: Drumlins, hills, ground moraines
Landform position (two-dimensional): Footslope, backslope, summit
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Linear, convex
Across-slope shape: Convex
Hydric soil rating: No

104D—Hollis-Rock outcrop-Charlton complex, 15 to 25 percent slopes

Map Unit Setting

National map unit symbol: 98yh
Elevation: 0 to 1,530 feet
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 110 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Hollis and similar soils: 35 percent
Rock outcrop: 30 percent
Charlton and similar soils: 20 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hollis

Setting

Landform: Ridges, hills
Landform position (two-dimensional): Footslope, backslope
Landform position (three-dimensional): Crest, head slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Friable, shallow loamy basal till over granite and gneiss

Typical profile

H1 - 0 to 2 inches: fine sandy loam
H2 - 2 to 14 inches: fine sandy loam
H3 - 14 to 18 inches: unweathered bedrock

Properties and qualities

Slope: 15 to 25 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: 8 to 20 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.14 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very low (about 2.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s

Hydrologic Soil Group: D
Ecological site: F144AY033MA - Shallow Dry Till Uplands
Hydric soil rating: No

Description of Rock Outcrop

Setting

Parent material: Granite and gneiss

Properties and qualities

Slope: 15 to 25 percent
Depth to restrictive feature: 0 inches to lithic bedrock

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8s

Description of Charlton

Setting

Landform: Hills
Landform position (two-dimensional): Shoulder, summit
Landform position (three-dimensional): Side slope, base slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Friable loamy eolian deposits over friable loamy basal till derived from granite and gneiss

Typical profile

H1 - 0 to 5 inches: fine sandy loam
H2 - 5 to 22 inches: sandy loam
H3 - 22 to 65 inches: gravelly sandy loam

Properties and qualities

Slope: 15 to 25 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Ecological site: F144AY034CT - Well Drained Till Uplands
Hydric soil rating: No

Minor Components

Canton

Percent of map unit: 10 percent
Landform: Hills
Landform position (two-dimensional): Shoulder, summit

Landform position (three-dimensional): Head slope
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Montauk

Percent of map unit: 3 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder, summit
Landform position (three-dimensional): Nose slope, head slope
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Unnamed

Percent of map unit: 2 percent

105E—Rock outcrop-Hollis complex, 3 to 35 percent slopes

Map Unit Setting

National map unit symbol: 98yj
Elevation: 0 to 2,100 feet
Mean annual precipitation: 32 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 110 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Rock outcrop: 50 percent
Hollis and similar soils: 45 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Rock Outcrop

Setting

Landform: Ledges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Head slope
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Granite and gneiss

Properties and qualities

Slope: 5 to 20 percent
Depth to restrictive feature: 0 inches to lithic bedrock

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 8s

Description of Hollis

Setting

Landform: Ridges, hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Friable, shallow loamy basal till over granite and gneiss

Typical profile

H1 - 0 to 2 inches: fine sandy loam
H2 - 2 to 14 inches: fine sandy loam
H3 - 14 to 18 inches: unweathered bedrock

Properties and qualities

Slope: 3 to 35 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: 8 to 20 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.14 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very low (about 2.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: D
Ecological site: F144AY033MA - Shallow Dry Till Uplands
Hydric soil rating: No

Minor Components

Whitman

Percent of map unit: 3 percent
Landform: Depressions, drainageways
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Swansea

Percent of map unit: 1 percent
Landform: Bogs, depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Unnamed

Percent of map unit: 1 percent

253B—Hinckley loamy sand, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2svm8
Elevation: 0 to 1,430 feet
Mean annual precipitation: 36 to 53 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 250 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Hinckley and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hinckley

Setting

Landform: Outwash terraces, outwash deltas, outwash plains, eskers, moraines, kame terraces, kames
Landform position (two-dimensional): Summit, shoulder, backslope, footslope
Landform position (three-dimensional): Nose slope, side slope, base slope, crest, riser, tread
Down-slope shape: Linear, convex, concave
Across-slope shape: Convex, linear, concave
Parent material: Sandy and gravelly glaciofluvial deposits derived from gneiss and/or granite and/or schist

Typical profile

Oe - 0 to 1 inches: moderately decomposed plant material
A - 1 to 8 inches: loamy sand
Bw1 - 8 to 11 inches: gravelly loamy sand
Bw2 - 11 to 16 inches: gravelly loamy sand
BC - 16 to 19 inches: very gravelly loamy sand
C - 19 to 65 inches: very gravelly sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (1.42 to 99.90 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water capacity: Very low (about 3.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: A
Ecological site: F144AY022MA - Dry Outwash
Hydric soil rating: No

Minor Components

Windsor

Percent of map unit: 8 percent
Landform: Moraines, outwash terraces, outwash deltas, kame terraces, outwash plains, kames, eskers
Landform position (two-dimensional): Summit, shoulder, backslope, footslope
Landform position (three-dimensional): Nose slope, side slope, base slope, crest, riser, tread
Down-slope shape: Linear, convex, concave
Across-slope shape: Convex, linear, concave
Hydric soil rating: No

Sudbury

Percent of map unit: 5 percent
Landform: Kame terraces, outwash plains, moraines, outwash terraces, outwash deltas
Landform position (two-dimensional): Backslope, footslope
Landform position (three-dimensional): Side slope, base slope, head slope, tread
Down-slope shape: Concave, linear
Across-slope shape: Linear, concave
Hydric soil rating: No

Agawam

Percent of map unit: 2 percent
Landform: Outwash deltas, kame terraces, outwash plains, kames, eskers, moraines, outwash terraces
Landform position (two-dimensional): Summit, shoulder, backslope, footslope
Landform position (three-dimensional): Nose slope, side slope, base slope, crest, riser, tread
Down-slope shape: Linear, convex, concave
Across-slope shape: Convex, linear, concave
Hydric soil rating: No

602—Urban land

Map Unit Setting

National map unit symbol: 9950
Elevation: 0 to 3,000 feet
Mean annual precipitation: 32 to 50 inches
Mean annual air temperature: 45 to 50 degrees F
Frost-free period: 110 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition

Urban land: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Urban Land

Setting

Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Excavated and filled land

Minor Components

Rock outcrop

Percent of map unit: 5 percent
Landform: Ledges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Head slope
Down-slope shape: Concave
Across-slope shape: Concave

Udorthents, wet substratum

Percent of map unit: 5 percent
Hydric soil rating: No

Udorthents, loamy

Percent of map unit: 5 percent
Hydric soil rating: No

631C—Charlton-Urban land-Hollis complex, 3 to 15 percent slopes, rocky

Map Unit Setting

National map unit symbol: vr1g
Elevation: 0 to 1,000 feet
Mean annual precipitation: 32 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 110 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Charlton and similar soils: 45 percent
Urban land: 35 percent
Hollis and similar soils: 10 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Charlton

Setting

Landform: Drumlins, ground moraines
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Friable loamy eolian deposits over friable loamy basal till derived from granite and gneiss

Typical profile

H1 - 0 to 5 inches: fine sandy loam
H2 - 5 to 22 inches: sandy loam
H3 - 22 to 65 inches: gravelly sandy loam

Properties and qualities

Slope: 3 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: A
Ecological site: F144AY034CT - Well Drained Till Uplands
Hydric soil rating: No

Description of Urban Land

Setting

Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Excavated and filled land

Description of Hollis

Setting

Landform: Ridges, hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Friable, shallow loamy basal till over granite and gneiss

Typical profile

H1 - 0 to 2 inches: fine sandy loam
H2 - 2 to 14 inches: fine sandy loam
H3 - 14 to 18 inches: unweathered bedrock

Properties and qualities

Slope: 3 to 15 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: 8 to 20 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.14 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very low (about 2.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: D
Ecological site: F144AY033MA - Shallow Dry Till Uplands
Hydric soil rating: No

Minor Components

Canton

Percent of map unit: 4 percent
Landform: Hills
Landform position (two-dimensional): Backslope, toeslope
Landform position (three-dimensional): Side slope, base slope
Down-slope shape: Linear
Across-slope shape: Convex
Hydric soil rating: No

Udorthents, loamy

Percent of map unit: 2 percent
Hydric soil rating: No

Rock outcrop

Percent of map unit: 2 percent
Landform: Ledges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Head slope
Down-slope shape: Concave
Across-slope shape: Concave

Scituate

Percent of map unit: 1 percent
Landform: Depressions, hillslopes
Landform position (two-dimensional): Toeslope, summit
Landform position (three-dimensional): Base slope, head slope
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: No

Montauk

Percent of map unit: 1 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder, summit
Landform position (three-dimensional): Nose slope, head slope
Down-slope shape: Convex

Across-slope shape: Convex
Hydric soil rating: No

655—Udorthents, wet substratum

Map Unit Setting

National map unit symbol: vr1n
Elevation: 0 to 3,000 feet
Mean annual precipitation: 32 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 110 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Udorthents, wet substratum, and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Udorthents, Wet Substratum

Setting

Parent material: Loamy alluvium and/or sandy glaciofluvial deposits and/or loamy glaciolacustrine deposits and/or loamy marine deposits and/or loamy basal till and/or loamy lodgment till

Properties and qualities

Slope: 0 to 8 percent
Depth to restrictive feature: More than 80 inches
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None

Minor Components

Urban land

Percent of map unit: 8 percent
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear

Freetown

Percent of map unit: 4 percent
Landform: Depressions, bogs
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave

Hydric soil rating: Yes

Swansea

Percent of map unit: 3 percent
Landform: Bogs, depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

656—Udorthents-Urban land complex

Map Unit Setting

National map unit symbol: 995k
Elevation: 0 to 3,000 feet
Mean annual precipitation: 32 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 110 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Udorthents and similar soils: 45 percent
Urban land: 35 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Udorthents

Setting

Parent material: Loamy alluvium and/or sandy glaciofluvial deposits and/or loamy glaciolacustrine deposits and/or loamy marine deposits and/or loamy basal till and/or loamy lodgment till

Properties and qualities

Slope: 0 to 15 percent
Depth to restrictive feature: More than 80 inches
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None

Description of Urban Land

Setting

Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Excavated and filled land

Minor Components

Canton

Percent of map unit: 10 percent
Landform: Hills
Landform position (two-dimensional): Backslope, toeslope
Landform position (three-dimensional): Side slope, base slope
Down-slope shape: Linear
Across-slope shape: Convex
Hydric soil rating: No

Merrimac

Percent of map unit: 5 percent
Landform: Plains, terraces
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Tread, rise
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Paxton

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope, summit
Landform position (three-dimensional): Head slope, side slope
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

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APPENDIX C – LGCI's Test Pit and Hand Probe Logs

LGCI
Lahlaf Geotechnical Consulting, Inc.
100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

TP-1

PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 12/3/20
DATE COMPLETED: 12/3/20
TEST PIT LOCATION: Near SW side of prop. building
COORDINATES: NA
SURFACE EL.: 156.2 ft. (see note 1)
TOTAL DEPTH: 9 ft.
GROUNDWATER LEVELS:
▽ **DURING EXCAVATION:** -
▼ **AT END OF EXCAVATION:** 2.0 ft. / El. 154.2 ft.

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.
EXCAVATION FOREMAN: Dave Edilberti
EXCAVATOR TYPE/MODEL: Komatsu PC 120
WEATHER: 40's / Sunny
TEST PIT DIMENSIONS: 13.0' x 4.5'
LOGGED BY: SD
CHECKED BY: TG

Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
		E		Topsoil	0.7 155.5	0 ft. - 0.7 ft.: Topsoil
2.5	155.0	E		Subsoil	3.5 152.7	0.7 ft. - 3.5 ft.: Sandy SILT (ML), slightly plastic, 35-40% fine sand, 10-15% fine subrounded gravel, trace of organic soil, trace of roots, trace of wood, 5-10% boulders, brown, wet ▼
5.0 7.5	152.5 150.0 147.5	E D	1	Sand and Gravel	9.0	3.5 ft. - 9 ft.: Silty SAND with Gravel (SM), fine to coarse, 15-20% fines, 30-35% fine to coarse subrounded gravel, 15-20% cobbles, light brown, wet (natural)

REMARK 1: Excavator refusal encountered on possible rock at depth of 9.0'.

Bottom of test pit at 9.0 feet. Backfilled excavation with excavated material.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

LGCI
Lahlaf Geotechnical Consulting, Inc.
100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

TP-2

PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 12/4/20
DATE COMPLETED: 12/4/20
TEST PIT LOCATION: Along western side of prop. building
COORDINATES: NA
SURFACE EL.: 165.0 ft. (see note 1)
TOTAL DEPTH: 4.3 ft.
GROUNDWATER LEVELS:
▽ **DURING EXCAVATION:** -
▼ **AT END OF EXCAVATION:** 4.0 ft. / El. 161.0 ft.

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.
EXCAVATION FOREMAN: Dave Edilberti
EXCAVATOR TYPE/MODEL: Komatsu PC 120
WEATHER: 50's / Sunny
TEST PIT DIMENSIONS: 10.0' x 5.0'
LOGGED BY: TG
CHECKED BY: SD

Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
		E		Topsoil	0.8	0 ft. - 0.8 ft.: Topsoil
2.5	162.5	E		Subsoil	164.2 3.5	0.8 ft. - 3.5 ft.: SILT (ML), slightly plastic, 5-10% fine sand, trace of organic soil, trace of roots, 15-20% cobbles and boulders, brown, moist
		M D	1	Weathered Rock	4.3	3.5 ft. - 4.3 ft.: Well Graded GRAVEL with Silt (GW-GM), fine to coarse, subangular, 5-10% fines, 10-15% ▼ fine to coarse sand, wet (weathered rock)

REMARK 1: Excavator refusal encountered on possible rock at depth of 4.3'.

Bottom of test pit at 4.3 feet. Backfilled excavation with excavated material.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

LGCI
Lahlaf Geotechnical Consulting, Inc.
100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

TP-3

PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 12/3/20
DATE COMPLETED: 12/3/20
TEST PIT LOCATION: Within footprint of prop. building
COORDINATES: NA
SURFACE EL.: 180.6 ft. (see note 1)
TOTAL DEPTH: 2 ft.
GROUNDWATER LEVELS:
▽ **DURING EXCAVATION:** -
▼ **AT END OF EXCAVATION:** Not encountered

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.
EXCAVATION FOREMAN: Dave Edilberti
EXCAVATOR TYPE/MODEL: Komatsu PC 120
WEATHER: 40's / Sunny
TEST PIT DIMENSIONS: 13.0' x 3.5'
LOGGED BY: SD
CHECKED BY: TG

Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
	180.0	E		Topsoil	1.0	0 ft. - 1 ft.: Topsoil
		D	1	Subsoil	2.0	1 ft. - 2 ft.: Silty SAND (SM), fine to medium, trace coarse, 30-35% fines, 10-15% coarse subrounded gravel, trace of organic soil, trace of roots, trace of wood, brown, wet

REMARK 1: Excavator refusal encountered on possible rock at depth of 2.0'.
Bottom of test pit at 2.0 feet. Backfilled excavation with excavated material.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

Lahlaf Geotechnical Consulting, Inc.
100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

TP-4

PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.

PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.

LGCI PROJECT NUMBER: 2025

PROJECT LOCATION: Wakefield, MA

DATE STARTED: 12/3/20

DATE COMPLETED: 12/3/20

TEST PIT LOCATION: Along SE side of prop. building

COORDINATES: NA

SURFACE EL.: 171.3 ft. (see note 1)

TOTAL DEPTH: 1.5 ft.

GROUNDWATER LEVELS:

▽ **DURING EXCAVATION:** -

▼ **AT END OF EXCAVATION:** Not encountered

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.

EXCAVATION FOREMAN: Dave Edilberti

EXCAVATOR TYPE/MODEL: Komatsu PC 120

WEATHER: 40's / Sunny

TEST PIT DIMENSIONS: 12.0' x 4.0'

LOGGED BY: SD

CHECKED BY: TG

Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
		E		Topsoil	0.5	0 ft. - 0.5 ft.: Topsoil
	170.0	D	1	Subsoil	1.5	0.5 ft. - 1.5 ft.: Silty SAND (SM), fine to medium, trace coarse, 30-35% fines, ~10% fine to coarse subrounded gravel, trace of organic soil, trace of roots, 15-20% cobbles, brown, moist

REMARK 1: Excavator refusal encountered on possible rock at depth of 1.5'.

Bottom of test pit at 1.5 feet. Backfilled excavation with excavated material.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

LGCI
Lahlaf Geotechnical Consulting, Inc.
100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

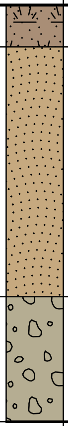
TP-5

PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 12/3/20 **DATE COMPLETED:** 12/3/20
TEST PIT LOCATION: Within footprint of prop. building
COORDINATES: NA
SURFACE EL.: 173.2 ft. (see note 1) **TOTAL DEPTH:** 5 ft.
GROUNDWATER LEVELS:
▽ **DURING EXCAVATION:** -
▼ **AT END OF EXCAVATION:** Not encountered

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.
EXCAVATION FOREMAN: Dave Edilberti
EXCAVATOR TYPE/MODEL: Komatsu PC 120
WEATHER: 40's / Sunny
TEST PIT DIMENSIONS: 11.0' x 6.0'
LOGGED BY: SD **CHECKED BY:** TG



Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
		E		Topsoil	0.5	0 ft. - 0.5 ft.: Topsoil
2.5	172.5 170.0	E		Subsoil	172.7 3.5	0.5 ft. - 3.5 ft.: Silty SAND with Gravel (SM), fine to coarse, 35-40% fines, 15-20% fine to coarse subrounded gravel, trace of organic soil, trace of roots, 25-30% cobbles and boulders, light brown, wet
5.0		D	1	Sand and Gravel	169.7 5.0	3.5 ft. - 5 ft.: Well Graded SAND with Silt and Gravel (SW-SM), fine to coarse, 10-15% fines, 30-35% fine to coarse subrounded gravel, 45-50% cobbles and boulders, gray, wet REMARK 1: Excavator refusal encoutered on possible rock at depth of 5.0'. Bottom of test pit at 5.0 feet. Backfilled excavation with excavated material.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

LGCI
Lahlaf Geotechnical Consulting, Inc.
100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

TP-6

PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 12/3/20 **DATE COMPLETED:** 12/3/20
TEST PIT LOCATION: Along NE side of prop. building
COORDINATES: NA
SURFACE EL.: 138.7 ft. (see note 1) **TOTAL DEPTH:** 4.5 ft.
GROUNDWATER LEVELS:
▽ **DURING EXCAVATION:** -
▼ **AT END OF EXCAVATION:** Not encountered

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.
EXCAVATION FOREMAN: Dave Edilberti
EXCAVATOR TYPE/MODEL: Komatsu PC 120
WEATHER: 40's / Sunny
TEST PIT DIMENSIONS: 7.5' x 5.0'
LOGGED BY: SD **CHECKED BY:** TG

Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
		E		Topsoil	0.5	0 ft. - 0.5 ft.: Topsoil
2.5	137.5	E		Subsoil	138.2 3.0	0.5 ft. - 3 ft.: Sandy SILT (ML), 35-40% fine sand, 0-5% fine subrounded gravel, trace of organic soil, trace of roots, 0-5% cobbles, brown, wet
	135.0	D	1	Sand and Gravel	135.7 4.5	3 ft. - 4.5 ft.: Well Graded SAND with Silt and Gravel (SW-SM), fine to coarse, 10-15% fines, 20-25% fine to coarse subrounded gravel, gray, wet

REMARK 1: Excavator refusal encountered on possible rock at depth of 4.5'.

Bottom of test pit at 4.5 feet. Backfilled excavation with excavated material.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

LGCI
Lahlaf Geotechnical Consulting, Inc.
100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

TP-7

PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 12/3/20
DATE COMPLETED: 12/3/20
TEST PIT LOCATION: Along northern side of prop. building
COORDINATES: NA
SURFACE EL.: 158.1 ft. (see note 1)
TOTAL DEPTH: 2 ft.
GROUNDWATER LEVELS:
▽ **DURING EXCAVATION:** -
▼ **AT END OF EXCAVATION:** Not encountered

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.
EXCAVATION FOREMAN: Dave Edilberti
EXCAVATOR TYPE/MODEL: Komatsu PC 120
WEATHER: 40's / Sunny
TEST PIT DIMENSIONS: 11.0' x 5.0'
LOGGED BY: SD
CHECKED BY: TG

Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
	157.5	E		Topsoil		0 ft. - 2 ft.: Topsoil
		D				
			1		2.0	REMARK 1: Excavator refusal encountered on possible rock at depth of 2.0'. Bottom of test pit at 2.0 feet. Backfilled excavation with excavated material.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

LGCI
Lahlaf Geotechnical Consulting, Inc.
100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

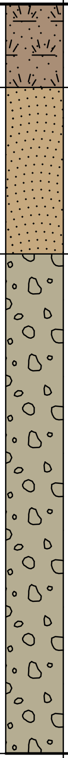
TEST PIT LOG

TP-8
PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 12/3/20 **DATE COMPLETED:** 12/3/20
TEST PIT LOCATION: Within prop. parking lot north of prop. building
COORDINATES: NA
SURFACE EL.: 130.0 ft. (see note 1) **TOTAL DEPTH:** 9 ft.
GROUNDWATER LEVELS:
▽ **DURING EXCAVATION:** -
▼ **AT END OF EXCAVATION:** 2.0 ft. / El. 128.0 ft.

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.
EXCAVATION FOREMAN: Dave Edilberti
EXCAVATOR TYPE/MODEL: Komatsu PC 120
WEATHER: 40's / Sunny
TEST PIT DIMENSIONS: 8.5' x 4.5'
LOGGED BY: SD **CHECKED BY:** TG



Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
		E		Topsoil	1.0 129.0	0 ft. - 1 ft.: Topsoil
2.5	127.5	E		Subsoil	3.0 127.0	1 ft. - 3 ft.: Silty SAND with Gravel (SM), fine to medium, trace coarse, ~30% fines, 15-20% fine to coarse subrounded gravel, trace of organic soil, trace of roots, light brown, wet ▼
5.0 7.5	125.0 122.5	E M D	1	Sand and Gravel	9.0	3 ft. - 9 ft.: Silty SAND with Gravel (SM), fine to coarse, 20-25% fines, 15-20% fine to coarse subrounded gravel, gray, wet

REMARK 1: Excavator refusal encountered on cobbles and boulders at depth of 9.0' (possible weathered rock).

Bottom of test pit at 9.0 feet. Backfilled excavation with excavated material.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

Lahlaf Geotechnical Consulting, Inc.
100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

TP-9

PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 12/4/20 **DATE COMPLETED:** 12/4/20
TEST PIT LOCATION: Near NW corner of prop. building
COORDINATES: NA
SURFACE EL.: 162.9 ft. (see note 1) **TOTAL DEPTH:** 6.2 ft.
GROUNDWATER LEVELS:
▽ **DURING EXCAVATION:** -
▼ **AT END OF EXCAVATION:** 3.6 ft. / El. 159.3 ft.

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.
EXCAVATION FOREMAN: Dave Edilberti
EXCAVATOR TYPE/MODEL: Komatsu PC 120
WEATHER: 50's / Sunny
TEST PIT DIMENSIONS: 13.0' x 4.0'
LOGGED BY: TG **CHECKED BY:** SD

Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
	162.5	E		Topsoil	0.4	0 ft. - 0.4 ft.: Topsoil
		E		Subsoil	162.5 1.9	0.4 ft. - 1.9 ft.: Silty SAND (SM), fine to medium, 35-40% fines, 5-10% fine to coarse subrounded gravel, trace of organic soil, trace of roots, brown, moist
2.5	160.0	E		Sand and Gravel	161.0	1.9 ft. - 6.2 ft.: Silty SAND with Gravel (SM), fine to coarse, 20-25% fines, 20-25% fine to coarse subrounded gravel, 5-10% cobbles and boulders, gray, moist ▼
5.0	157.5	M				
		D	1		6.2	REMARK 1: Excavator refusal encountered on cobbles and boulders at depths ranging between 4.0' and 6.2' (possible weathered rock).

Bottom of test pit at 6.2 feet. Backfilled excavation with excavated material.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.1.

Lahlaf Geotechnical Consulting, Inc.

100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

TP-10

PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.

PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.

LGCI PROJECT NUMBER: 2025

PROJECT LOCATION: Wakefield, MA

DATE STARTED: 12/4/20 **DATE COMPLETED:** 12/4/20

TEST PIT LOCATION: West of prop. building

COORDINATES: NA

SURFACE EL.: 187.9 ft. (see note 1) **TOTAL DEPTH:** 2.7 ft.

GROUNDWATER LEVELS:

▽ **DURING EXCAVATION:** -

▼ **AT END OF EXCAVATION:** Not encountered

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.

EXCAVATION FOREMAN: Dave Edilberti

EXCAVATOR TYPE/MODEL: Komatsu PC 120

WEATHER: 50's / Sunny

TEST PIT DIMENSIONS: 14.0' x 4.0'

LOGGED BY: TG **CHECKED BY:** SD

Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
	187.5	E		Topsoil	0.3 187.6	0 ft. - 0.3 ft.: Topsoil
		E		Subsoil	2.1	0.3 ft. - 2.1 ft.: Silty SAND (SM), fine to medium, 35-40% fines, trace of organic soil, trace of roots, brown, moist
2.5		D	1	Sand and Gravel	2.7	2.1 ft. - 2.7 ft.: Silty SAND with Gravel (SM), fine to coarse, 25-30% fines, 20-25% fine to coarse subrounded to subangular gravel, trace of roots, gray, moist REMARK 1: Excavator refusal encountered on possible rock at depth of 2.7'.
						Bottom of test pit at 2.7 feet. Backfilled excavation with excavated material.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

LGCI
Lahlaf Geotechnical Consulting, Inc.
100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

TP-11

PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 12/4/20 **DATE COMPLETED:** 12/4/20
TEST PIT LOCATION: West of prop. building
COORDINATES: NA
SURFACE EL.: 181.1 ft. (see note 1) **TOTAL DEPTH:** 3.2 ft.
GROUNDWATER LEVELS:
▽ **DURING EXCAVATION:** -
▼ **AT END OF EXCAVATION:** Not encountered

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.
EXCAVATION FOREMAN: Dave Edilberti
EXCAVATOR TYPE/MODEL: Komatsu PC 120
WEATHER: 50's / Sunny
TEST PIT DIMENSIONS: 9.0' x 5.0'
LOGGED BY: TG **CHECKED BY:** SD

Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
		E		Topsoil	0.5	0 ft. - 0.5 ft.: Topsoil
	180.0	E		Subsoil	180.6 2.0	0.5 ft. - 2 ft.: Silty SAND (SM), fine to medium, 35-40% fines, trace of organic soil, trace of roots, 20-25% cobbles and boulders, brown, moist
2.5		M	1	Weathered Rock	179.1	2 ft. - 3.2 ft.: Silty GRAVEL with Sand (GM), fine to coarse, subangular to angular, 15-20% fines, 15-20% fine to coarse sand, trace of roots, moist (weathered rock) REMARK 1: Encountered two boulders about 2.0' x 1.0'.
		D	2		3.2	REMARK 2: Excavator refusal encountered on possible rock at depth of 3.2'.

Bottom of test pit at 3.2 feet. Backfilled excavation with excavated material.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

LGCI
Lahlaf Geotechnical Consulting, Inc.

100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

TP-12

PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 12/3/20 **DATE COMPLETED:** 12/3/20
TEST PIT LOCATION: South of prop. building
COORDINATES: NA
SURFACE EL.: 136.0 ft. (see note 1) **TOTAL DEPTH:** 7 ft.
GROUNDWATER LEVELS:
▽ **DURING EXCAVATION:** -
▼ **AT END OF EXCAVATION:** Not encountered

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.
EXCAVATION FOREMAN: Dave Edilberti
EXCAVATOR TYPE/MODEL: Komatsu PC 120
WEATHER: 40's / Sunny
TEST PIT DIMENSIONS: 13.5' x 5.0'
LOGGED BY: SD **CHECKED BY:** TG

Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
	135.0	E		Topsoil	1.0 135.0	0 ft. - 1 ft.: Topsoil
2.5	132.5	E		Subsoil	4.0 132.0	1 ft. - 4 ft.: Silty SAND with Gravel (SM), fine to medium, trace coarse, 30-35% fines, 15-20% fine subrounded gravel, trace of organic soil, trace of roots, 10-15% boulders, light brown, moist
5.0	130.0	E D	1	Sand and Gravel	7.0	4 ft. - 7 ft.: Poorly Graded SAND with Silt and Gravel (SP-SM), medium to coarse, trace fine, 10-15% fines, 30-35% fine to coarse subrounded to subangular gravel, 15-20% cobbles, dark brown, moist

REMARK 1: Excavator refusal encountered on possible rock at depth of 7.0'.

Bottom of test pit at 7.0 feet. Backfilled excavation with excavated material.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

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PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 12/4/20 **DATE COMPLETED:** 12/4/20
TEST PIT LOCATION: South of prop. building
COORDINATES: NA
SURFACE EL.: 162.2 ft. (see note 1) **TOTAL DEPTH:** 4.8 ft.
GROUNDWATER LEVELS:
▽ **DURING EXCAVATION:** -
▼ **AT END OF EXCAVATION:** Not encountered

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.
EXCAVATION FOREMAN: Dave Edilberti
EXCAVATOR TYPE/MODEL: Komatsu PC 120
WEATHER: 50's / Sunny
TEST PIT DIMENSIONS: 11.0' x 4.5'
LOGGED BY: TG / SD **CHECKED BY:** TG

Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
		E		Topsoil	0.4	0 ft. - 0.4 ft.: Topsoil
	160.0	E		Subsoil	161.8 2.3	0.4 ft. - 2.3 ft.: Silty SAND with Gravel (SM), fine to medium, trace coarse, 30-35% fines, 15-20% fine to coarse subrounded to subangular gravel, trace of organic soil, trace of roots, 15-20% cobbles and boulders, light brown, moist
2.5	157.5	D	1	Sand and Gravel	159.9 4.8	2.3 ft. - 4.8 ft.: Silty SAND with Gravel (SM), fine to coarse, 15-20% fines, 25-30% fine to coarse subrounded to subangular gravel, 15-20% cobbles, brown, moist

REMARK 1: Excavator refusal encountered on possible rock at depth of 4.8'.

Bottom of test pit at 4.8 feet. Backfilled excavation with excavated material.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

LGCI
Lahlaf Geotechnical Consulting, Inc.
100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

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PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 12/4/20
DATE COMPLETED: 12/4/20
TEST PIT LOCATION: East of prop. building
COORDINATES: NA
SURFACE EL.: 164.9 ft. (see note 1)
TOTAL DEPTH: 0.7 ft.
GROUNDWATER LEVELS:
▽ **DURING EXCAVATION:** -
▼ **AT END OF EXCAVATION:** Not encountered

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.
EXCAVATION FOREMAN: Dave Edilberti
EXCAVATOR TYPE/MODEL: Komatsu PC 120
WEATHER: 50's / Sunny
TEST PIT DIMENSIONS: 11.0' x 4.0'
LOGGED BY: SD / TG
CHECKED BY: TG

Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
		D	1	Topsoil ▨	0.7	0 ft. - 0.7 ft.: Topsoil
						REMARK 1: Excavator refusal encountered on possible rock at depth of 0.7'. Bottom of test pit at 0.7 feet. Backfilled excavation with excavated material.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

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Lahlaf Geotechnical Consulting, Inc.

100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

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PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 12/3/20
DATE COMPLETED: 12/3/20
TEST PIT LOCATION: East of prop. building
COORDINATES: NA
SURFACE EL.: 162.0 ft. (see note 1)
TOTAL DEPTH: 5 ft.
GROUNDWATER LEVELS:
▽ **DURING EXCAVATION:** -
▼ **AT END OF EXCAVATION:** 2.5 ft. / El. 159.5 ft.

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.
EXCAVATION FOREMAN: Dave Edilberti
EXCAVATOR TYPE/MODEL: Komatsu PC 120
WEATHER: 40's / Sunny
TEST PIT DIMENSIONS: 13.5' x 4.5'
LOGGED BY: SD
CHECKED BY: TG

Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
		E		Topsoil	0.5 161.5	0 ft. - 0.5 ft.: Topsoil
	160.0	E		Subsoil		0.5 ft. - 4 ft.: Silty SAND (SM), fine to medium, trace coarse, 25-30% fines, 10-15% fine to coarse subangular gravel, trace of organic soil, trace of roots, 15-20% cobbles, brown, wet
2.5						▼
		M			4.0	
	157.5	D		Sand and Gravel		4 ft. - 5 ft.: Silty SAND with Gravel (SM), fine to coarse, 15-20% fines, 25-30% fine to coarse subrounded to subangular gravel, 25-30% cobbles, gray, wet
5.0			1		5.0	REMARK 1: Excavator refusal encountered on possible rock at depth of 5.0'.

Bottom of test pit at 5.0 feet. Backfilled excavation with excavated material.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

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PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.

PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.

LGCI PROJECT NUMBER: 2025

PROJECT LOCATION: Wakefield, MA

DATE STARTED: 12/3/20 **DATE COMPLETED:** 12/3/20

TEST PIT LOCATION: East of prop. building

COORDINATES: NA

SURFACE EL.: 143.7 ft. (see note 1) **TOTAL DEPTH:** 10.5 ft.

GROUNDWATER LEVELS:

∇ **DURING EXCAVATION:** -

▼ **AT END OF EXCAVATION:** 3.5 ft. / El. 140.2 ft.

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.

EXCAVATION FOREMAN: Dave Edilberti

EXCAVATOR TYPE/MODEL: Komatsu PC 120

WEATHER: 40's / Sunny

TEST PIT DIMENSIONS: 12.5' x 4.5'

LOGGED BY: SD **CHECKED BY:** TG

Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
		E		Topsoil	1.0	0 ft. - 1 ft.: Topsoil
2.5	142.5 140.0	E		Subsoil	142.7 ▼ 5.0	1 ft. - 5 ft.: Silty SAND (SM), fine to medium, trace coarse, 25-30% fines, 10-15% fine subrounded gravel, trace of organic soil, trace of roots, ~15% cobbles and boulders, light brown, wet
5.0 7.5	137.5 135.0	E		Sand and Gravel	138.7	5 ft. - 10.5 ft.: Well Graded SAND with Silt and Gravel (SW-SM), fine to coarse, 5-10% fines, 15-20% fine to coarse subrounded to subangular gravel, 25-30% cobbles and boulders, gray, moist
10.0		D	1		10.5	REMARK 1: Excavator refusal encountered on possible rock at depth of 10.5'. Bottom of test pit at 10.5 feet. Backfilled excavation with excavated material.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

Lahlaf Geotechnical Consulting, Inc.

100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

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PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 12/4/20
DATE COMPLETED: 12/4/20
TEST PIT LOCATION: Prop. parking lot north of prop. building
COORDINATES: NA
SURFACE EL.: 139.5 ft. (see note 1)
TOTAL DEPTH: 3.1 ft.
GROUNDWATER LEVELS:
▽ **DURING EXCAVATION:** -
▼ **AT END OF EXCAVATION:** 1.5 ft. / El. 138.0 ft.

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.
EXCAVATION FOREMAN: Dave Edilberti
EXCAVATOR TYPE/MODEL: Komatsu PC 120
WEATHER: 50's / Sunny
TEST PIT DIMENSIONS: 22.0' x 3.0'
LOGGED BY: TG
CHECKED BY: SD

Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
		E		Topsoil	0.2 139.3	0 ft. - 0.2 ft.: Topsoil
	137.5	E		Subsoil	1.9 137.6	0.2 ft. - 1.9 ft.: Silty SAND (SM), fine to medium, 35-40% fines, 0-5% fine subrounded gravel, trace of organic soil, trace of roots, brown, moist ▼
2.5		M	1	Sand and Gravel	3.1	1.9 ft. - 3.1 ft.: Silty SAND with Gravel (SM), fine to coarse, 25-30% fines, 15-20% fine to coarse subrounded gravel, trace of roots, gray, wet

REMARK 1: Excavator refusal encountered on cobbles and boulders at depths ranging between 0.2' and 3.1'.

Bottom of test pit at 3.1 feet. Backfilled excavation with excavated material.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

LGCI
Lahlaf Geotechnical Consulting, Inc.
100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

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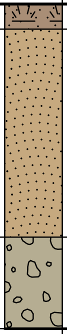
PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 12/4/20
DATE COMPLETED: 12/4/20
TEST PIT LOCATION: Near driveway NE of prop. building
COORDINATES: NA
SURFACE EL.: 132.0 ft. (see note 1)
TOTAL DEPTH: 3.9 ft.
GROUNDWATER LEVELS:
▽ **DURING EXCAVATION:** -
▼ **AT END OF EXCAVATION:** Not encountered

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.
EXCAVATION FOREMAN: Dave Edilberti
EXCAVATOR TYPE/MODEL: Komatsu PC 120
WEATHER: 50's / Sunny
TEST PIT DIMENSIONS: 14.0' x 3.0'
LOGGED BY: TG
CHECKED BY: SD



Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
		E		Topsoil	0.3 131.7	0 ft. - 0.3 ft.: Topsoil
2.5	130.0	E		Subsoil	2.8 129.2	0.3 ft. - 2.8 ft.: Silty SAND (SM), fine to medium, 30-35% fines, trace fine subangular gravel, trace of organic soil, trace of roots, brown, moist
		D	1	Sand and Gravel	3.9	2.8 ft. - 3.9 ft.: Silty SAND with Gravel (SM), fine to coarse, 15-20% fines, 15-20% fine to coarse subrounded gravel, trace of roots, light brown, moist

REMARK 1: Excavator refusal encountered on possible rock at depth of 3.9'.
Bottom of test pit at 3.9 feet. Backfilled excavation with excavated material.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

Lahlaf Geotechnical Consulting, Inc.
100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

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PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.

PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.

LGCI PROJECT NUMBER: 2025

PROJECT LOCATION: Wakefield, MA

DATE STARTED: 4/19/21

DATE COMPLETED: 4/19/21

TEST PIT LOCATION: Wooded area north of prop. building

COORDINATES: NA

SURFACE EL.: 126.5 ft. (see note 1)

TOTAL DEPTH: 3.5 ft.

GROUNDWATER LEVELS:

▽ **DURING EXCAVATION:** -

▼ **AT END OF EXCAVATION:** 3.5 ft. / El. 123.0 ft.

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.

EXCAVATION FOREMAN: Justin Stevens

EXCAVATOR TYPE/MODEL: Kubota KX 080-4

WEATHER: 60's / Sunny

TEST PIT DIMENSIONS: 13.0' x 7.0'

LOGGED BY: NP

CHECKED BY: AML

Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
		M/D	1	Forest Mat	1.0 125.5	0 ft. - 1 ft.: Forest Mat REMARK 1: Several rock outcrops observed at the ground surface.
	125.0	D/V		Subsoil		1 ft. - 3.5 ft.: Silty SAND (SM), fine, 25-30% fines, 0-5% cobbles up to 8" in diameter, trace of organic soil, trace of roots, brown, moist to wet
2.5		V				
		V	2		3.5 ▼	REMARK 2: Excavator refusal encountered on possible rock at depth of 3.5'. Bottom of test pit at 3.5 feet. Backfilled excavation with excavated material and tamped with the excavator bucket.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

Lahlaf Geotechnical Consulting, Inc.

100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

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PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.

PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.

LGCI PROJECT NUMBER: 2025

PROJECT LOCATION: Wakefield, MA

DATE STARTED: 4/20/21 **DATE COMPLETED:** 4/20/21

TEST PIT LOCATION: Near prop. driveway north of prop. building

COORDINATES: NA

SURFACE EL.: 126.4 ft. (see note 1) **TOTAL DEPTH:** 3.7 ft.

GROUNDWATER LEVELS:

▽ **DURING EXCAVATION:** -

▼ **AT END OF EXCAVATION:** Not encountered

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.

EXCAVATION FOREMAN: Justin Stevens

EXCAVATOR TYPE/MODEL: Kubota KX 080-4

WEATHER: 70's / Sunny

TEST PIT DIMENSIONS: 11.0' x 6.5'

LOGGED BY: TG **CHECKED BY:** NP

Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
		E		Forest Mat	0.7	0 ft. - 0.7 ft.: Forest Mat
	125.0	E	1	Subsoil	125.7	0.7 ft. - 2.9 ft.: Silty SAND (SM), fine, 40-45% slightly plastic fines, trace of organic soil, trace of roots, brown, moist to wet REMARK 1: Excavator refusal encountered on possible rock at depths ranging between 1' and 3.7'.
2.5		M			2.9	
		V		Sand and Gravel	3.7	2.9 ft. - 3.7 ft.: Silty SAND (SM), fine to coarse, 30-35% fines, 5-10% fine to coarse subangular gravel, gray, moist
						Bottom of test pit at 3.7 feet. Backfilled excavation with excavated material and tamped with the excavator bucket.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

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PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 4/20/21
DATE COMPLETED: 4/20/21
TEST PIT LOCATION: Near prop. driveway NW of prop. building
COORDINATES: NA
SURFACE EL.: 135.0 ft. (see note 1)
TOTAL DEPTH: 5.5 ft.
GROUNDWATER LEVELS:
▽ **DURING EXCAVATION:** -
▼ **AT END OF EXCAVATION:** 1.3 ft. / El. 133.7 ft.

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.
EXCAVATION FOREMAN: Justin Stevens
EXCAVATOR TYPE/MODEL: Kubota KX 080-4
WEATHER: 70's / Sunny
TEST PIT DIMENSIONS: 9.0' x 4.0'
LOGGED BY: TG
CHECKED BY: NP

Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
		M		Forest Mat		0 ft. - 0.8 ft.: Forest Mat
		M		Subsoil	0.8 134.2	0.8 ft. - 2.4 ft.: Sandy SILT (ML), slightly plastic, ~40% fine sand, trace of organic soil, trace of roots, ▼ brown, wet
2.5	132.5	D				
		D		Sand and Gravel	2.4 132.6	2.4 ft. - 5.5 ft.: Silty SAND with Gravel (SM), fine to coarse, 45-50% fines, 15-20% fine subangular gravel, light brown, wet
5.0	130.0	V	1		5.5	

REMARK 1: Excavator refusal encountered on possible rock at depth of 5.5'.

Bottom of test pit at 5.5 feet. Backfilled excavation with excavated material and tamped with the excavator bucket.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

LGCI
Lahlaf Geotechnical Consulting, Inc.
100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

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PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 4/19/21 **DATE COMPLETED:** 4/19/21
TEST PIT LOCATION: Near prop. parking lot west of prop. building
COORDINATES: NA
SURFACE EL.: 180.0 ft. (see note 1) **TOTAL DEPTH:** 3 ft.
GROUNDWATER LEVELS:
▽ **DURING EXCAVATION:** -
▼ **AT END OF EXCAVATION:** Not encountered

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.
EXCAVATION FOREMAN: Justin Stevens
EXCAVATOR TYPE/MODEL: Kubota KX 080-4
WEATHER: 60's / Sunny
TEST PIT DIMENSIONS: 11.0' x 6.0'
LOGGED BY: NP **CHECKED BY:** AML

Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
		D	1	Forest Mat	0.5 179.5	0 ft. - 0.5 ft.: Forest Mat REMARK 1: Several rock outcrops observed at the ground surface.
2.5	177.5	D/V		Subsoil	2.5	0.5 ft. - 2.5 ft.: Silty GRAVEL with Sand (GM), fine to coarse, 20-25% fines, 20-25% fine to coarse sand, 10-15% cobbles and boulders up to 2' in diamater, trace of organic soil, trace of roots, brown, moist
		V	2	Sand and Gravel	3.0	2.5 ft. - 3 ft.: Silty SAND with Gravel (SM), fine to medium, ~20% fines, 25-30% fine subangular to subrounded gravel, trace of organic soil, trace of weathered rock, light brown, moist REMARK 2: Excavator refusal encountered on possible rock at depth of 3'.

Bottom of test pit at 3.0 feet. Backfilled with excavation with excavated material and tamped with excavator bucket.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

TP-105

PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.

PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.

LGCI PROJECT NUMBER: 2025

PROJECT LOCATION: Wakefield, MA

DATE STARTED: 4/19/21 **DATE COMPLETED:** 4/19/21

TEST PIT LOCATION: Near NW portion of prop. building

COORDINATES: NA

SURFACE EL.: 180.1 ft. (see note 1) **TOTAL DEPTH:** 1.8 ft.

GROUNDWATER LEVELS:

▽ **DURING EXCAVATION:** -

▼ **AT END OF EXCAVATION:** Not encountered

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.

EXCAVATION FOREMAN: Justin Stevens

EXCAVATOR TYPE/MODEL: Kubota KX 080-4

WEATHER: 60's / Sunny

TEST PIT DIMENSIONS: 13.0' x 12.0'

LOGGED BY: NP **CHECKED BY:** AML

Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
		D/V	1	Forest Mat	0.5 179.6	0 ft. - 0.5 ft.: Forest Mat REMARK 1: Several rock outcrops observed at the ground surface.
		V		Subsoil		0.5 ft. - 1.8 ft.: Silty SAND (SM), fine, 35-40% slightly plastic fines, trace of organic soil, trace of roots, brown, moist
			2		1.8	REMARK 2: Excavator refusal encountered on possible rock at depth of 1.8'.
						Bottom of test pit at 1.8 feet. Backfilled with excavation with excavated material and tamped with excavator bucket.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

LGCI
Lahlaf Geotechnical Consulting, Inc.
100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

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CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 4/20/21 **DATE COMPLETED:** 4/20/21
TEST PIT LOCATION: Near prop. parking lot west of prop. building
COORDINATES: NA
SURFACE EL.: 161.0 ft. (see note 1) **TOTAL DEPTH:** 3.2 ft.
GROUNDWATER LEVELS:
▽ **DURING EXCAVATION:** -
▼ **AT END OF EXCAVATION:** Not encountered.

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.
EXCAVATION FOREMAN: Justin Stevens
EXCAVATOR TYPE/MODEL: Kubota KX 080-4
WEATHER: 70's / Sunny
TEST PIT DIMENSIONS: 12.0' x 3.0'
LOGGED BY: TG **CHECKED BY:** NP

Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
		M		Forest Mat	0.5	0 ft. - 0.5 ft.: Forest Mat
	160.0	D			160.5	0.5 ft. - 3.2 ft.: Silty SAND (SM), fine to coarse, 35-40% fines, 5-10% fine gravel, trace of organic soil, trace of roots, brown, moist
			1	Subsoil		REMARK 1: Excavator refusal encountered on possible rock at depths ranging between 2.0' and 3.2'.
2.5		V			3.2	
						Bottom of test pit at 3.2 feet. Backfilled with excavation with excavated material and tamped with excavator bucket.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

LGCI
Lahlaf Geotechnical Consulting, Inc.

100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

TP-107
PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 4/20/21 **DATE COMPLETED:** 4/20/21
TEST PIT LOCATION: Near prop. parking lot west of prop. building
COORDINATES: NA
SURFACE EL.: 168.1 ft. (see note 1) **TOTAL DEPTH:** 3.1 ft.
GROUNDWATER LEVELS:
▽ **DURING EXCAVATION:** -
▼ **AT END OF EXCAVATION:** 3.0 ft. / El. 165.1 ft.

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.
EXCAVATION FOREMAN: Justin Stevens
EXCAVATOR TYPE/MODEL: Kubota KX 080-4
WEATHER: 70's / Sunny
TEST PIT DIMENSIONS: 10.0' x 3.5'
LOGGED BY: TG **CHECKED BY:** NP

Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
		E		Forest Mat	0.3 167.8	0 ft. - 0.3 ft.: Forest Mat
	167.5	M		Subsoil	2.1	0.3 ft. - 2.1 ft.: Silty SAND (SM), fine, 40-45% slightly plastic fines, trace of organic soil, trace of roots, brown, moist
2.5	165.0	V	1	Sand and Gravel	3.1 ▼	2.1 ft. - 3.1 ft.: Silty SAND (SM), fine to coarse, 40-45% fines, 5-10% fine subrounded to subangular gravel, gray, moist to wet REMARK 1: Excavator refusal encountered on possible rock at depth of 3.1'.

Bottom of test pit at 3.1 feet. Backfilled with excavation with excavated material and tamped with excavator bucket.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

LGCI
Lahlaf Geotechnical Consulting, Inc.
100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

TP-108

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 4/20/21 **DATE COMPLETED:** 4/20/21
TEST PIT LOCATION: Near eastern side of prop. building
COORDINATES: NA
SURFACE EL.: 180.4 ft. (see note 1) **TOTAL DEPTH:** 2.3 ft.
GROUNDWATER LEVELS:
▽ **DURING EXCAVATION:** -
▼ **AT END OF EXCAVATION:** 2.3 ft. / El. 178.1 ft.

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.
EXCAVATION FOREMAN: Justin Stevens
EXCAVATOR TYPE/MODEL: Kubota KX 080-4
WEATHER: 70's / Sunny
TEST PIT DIMENSIONS: 13.0' x 3.0'
LOGGED BY: TG **CHECKED BY:** NP

Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
	180.0	E	1	Forest Mat		0 ft. - 2.3 ft.: Forest Mat, 0-5% cobbles and boulders up to 1' in diameter REMARK 1: Excavator refusal encountered on possible rock at depths ranging between 0.5' and 2.3'.
		D				
		V			2.3 ▼	
						Bottom of test pit at 2.3 feet. Backfilled with excavation with excavated material and tamped with excavator bucket.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

LGCI
Lahlaf Geotechnical Consulting, Inc.

100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

TP-109
PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 4/19/21 **DATE COMPLETED:** 4/20/21
TEST PIT LOCATION: Near western side of prop. building
COORDINATES: NA
SURFACE EL.: 171.2 ft. (see note 1) **TOTAL DEPTH:** 4.6 ft.
GROUNDWATER LEVELS:
▽ **DURING EXCAVATION:** -
▼ **AT END OF EXCAVATION:** Not encountered

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.
EXCAVATION FOREMAN: Justin Stevens
EXCAVATOR TYPE/MODEL: Kubota KX 080-4
WEATHER: 60's / Sunny
TEST PIT DIMENSIONS: 10.0' x 3.0'
LOGGED BY: TG **CHECKED BY:** NP

Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
		M	1	Forest Mat	0.5 170.7	0 ft. - 0.5 ft.: Forest Mat REMARK 1: Several rock outcrops observed at the ground surface.
2.5	170.0	M/D D		Subsoil	3.0 168.2	0.5 ft. - 3 ft.: Silty SAND (SM), fine, ~40% slightly plastic fines, trace of organic soil, trace of roots, brown, moist
	167.5	D V	2 3	Sand and Gravel	4.6	3 ft. - 4.6 ft.: Silty SAND with Gravel (SM), fine to coarse, ~20% fines, ~30% fine to coarse subangular to angular gravel, 5-10% cobbles and boulders up to 2' in diameter, light brown, moist REMARK 2: Excavator blew hydraulic line at depth of 4' on 4/19/2021. The excavator bucket was left at the bottom of the excavation and the excavation was taped off with caution tape. Test pit continued on 4/20/2021. REMARK 3: Excavator refusal encountered on possible rock at depth of 4.6'.

Bottom of test pit at 4.6 feet. Backfilled with excavation with excavated material and tamped with excavator bucket.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

Lahlaf Geotechnical Consulting, Inc.
100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

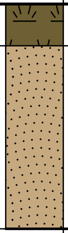
TP-110

PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 4/19/21 **DATE COMPLETED:** 4/19/21
TEST PIT LOCATION: South of prop. building
COORDINATES: NA
SURFACE EL.: 168.1 ft. (see note 1) **TOTAL DEPTH:** 2.7 ft.
GROUNDWATER LEVELS:
▽ **DURING EXCAVATION:** -
▼ **AT END OF EXCAVATION:** 2.5 ft. / El. 165.6 ft.

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.
EXCAVATION FOREMAN: Justin Stevens
EXCAVATOR TYPE/MODEL: Kubota KX 080-4
WEATHER: 60's / Sunny
TEST PIT DIMENSIONS: 14.0' x 6.0'
LOGGED BY: NP **CHECKED BY:** AML



Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
	167.5	M	1	Forest Mat	0.5 167.6	0 ft. - 0.5 ft.: Forest Mat REMARK 1: Several rock outcrops observed at the ground surface.
2.5		D V	2	Subsoil	▼ 2.7	0.5 ft. - 2.7 ft.: Silty SAND (SM), fine, 35-40% slightly plastic fines, trace fine gravel, trace of organic soil, trace of roots, brown, moist to wet REMARK 2: Excavator refusal encountered on possible rock at depth of 2.7'.
						Bottom of test pit at 2.7 feet. Backfilled with excavation with excavated material and tamped with excavator bucket.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

Lahlaf Geotechnical Consulting, Inc.
100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

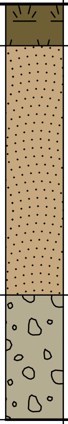
TP-111

PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 4/19/21 **DATE COMPLETED:** 4/19/21
TEST PIT LOCATION: Prop. parking lot south of prop. building
COORDINATES: NA
SURFACE EL.: 156.3 ft. (see note 1) **TOTAL DEPTH:** 5 ft.
GROUNDWATER LEVELS:
▽ **DURING EXCAVATION:** -
▼ **AT END OF EXCAVATION:** 5.0 ft. / El. 151.3 ft.

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.
EXCAVATION FOREMAN: Justin Stevens
EXCAVATOR TYPE/MODEL: Kubota KX 080-4
WEATHER: 60's / Sunny
TEST PIT DIMENSIONS: 13.0' x 7.0'
LOGGED BY: NP **CHECKED BY:** AML



Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
		M	1	Forest Mat	0.5 155.8	0 ft. - 0.5 ft.: Forest Mat REMARK 1: Several rock outcrops observed at the ground surface.
	155.0	D		Subsoil		0.5 ft. - 3.5 ft.: Silty SAND (SM), fine, 35-40% fines, trace fine gravel, trace of organic soil, trace of roots, brown, moist
2.5		D/V				
		V			3.5 152.8	
	152.5	V		Sand and Gravel		3.5 ft. - 5 ft.: Silty SAND with Gravel (SM), fine, trace medium, 15-20% fines, 15-20% fine subrounded gravel, trace of roots, light brown, moist to wet
5.0			2		5.0 ▼	REMARK 2: Excavator refusal encountered on possible rock at depth of 5'. Bottom of test pit at 5.0 feet. Backfilled with excavation with excavated material and tamped with excavator bucket.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

Lahlaf Geotechnical Consulting, Inc.
100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

TP-113

PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 4/19/21
DATE COMPLETED: 4/19/21
TEST PIT LOCATION: Wooded area SW of prop. building
COORDINATES: NA
SURFACE EL.: 143.6 ft. (see note 1)
TOTAL DEPTH: 3 ft.
GROUNDWATER LEVELS:
▽ **DURING EXCAVATION:** -
▼ **AT END OF EXCAVATION:** Not encountered.

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.
EXCAVATION FOREMAN: Justin Stevens
EXCAVATOR TYPE/MODEL: Kubota KX 080-4
WEATHER: 60's / Sunny
TEST PIT DIMENSIONS: 12.0' x 6.0'
LOGGED BY: NP
CHECKED BY: AML

Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
		D	1	Forest Mat	0.5 143.1	0 ft. - 0.5 ft.: Forest mat REMARK 1: Several rock outcrops observed at the ground surface.
	142.5	V		Sand and Gravel		0.5 ft. - 3 ft.: Well Graded SAND with Silt and Gravel (SW-SM), fine to coarse, 10-15% fines, 30-35% fine to coarse subrounded gravel, trace of roots, light brown
2.5		V	2		3.0	REMARK 2: Excavator refusal encountered on possible rock at depth of 3'.

Bottom of test pit at 3.0 feet. Backfilled with excavation with excavated material and tamped with excavator bucket.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

LGCI
Lahlaf Geotechnical Consulting, Inc.
100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

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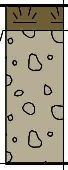
PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 4/19/21 **DATE COMPLETED:** 4/19/21
TEST PIT LOCATION: Prop. parking lot south of the prop. building
COORDINATES: NA
SURFACE EL.: 147.4 ft. (see note 1) **TOTAL DEPTH:** 1.9 ft.
GROUNDWATER LEVELS:
∇ **DURING EXCAVATION:** -
▼ **AT END OF EXCAVATION:** 1.9 ft. / El. 145.5 ft.

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.
EXCAVATION FOREMAN: Justin Stevens
EXCAVATOR TYPE/MODEL: Kubota KX 080-4
WEATHER: 60's / Sunny
TEST PIT DIMENSIONS: 12.0' x 5.0'
LOGGED BY: NP **CHECKED BY:** AML



Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
		D/V	1	Forest Mat	0.3 147.1	0 ft. - 0.3 ft.: Forest Mat REMARK 1: Several rock outcrops observed at the ground surface.
		V		Sand and Gravel		0.3 ft. - 1.9 ft.: Well Graded GRAVEL with Silt and Sand (GW-GM), fine to coarse, subrounded, 10-15% fines, 25-30% fine to coarse sand, trace of roots, light brown, moist to wet
			2		1.9 ▼	REMARK 2: Excavator refusal encountered on possible rock at depth of 1.9'.
						Bottom of test pit at 1.9 feet. Backfilled with excavation with excavated material and tamped with excavator bucket.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

LGCI Lahlaf Geotechnical Consulting, Inc.
100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

TP-201

PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 4/27/22 **DATE COMPLETED:** 4/27/22
TEST PIT LOCATION: Prop. roadway NW of prop. building
COORDINATES: NA
SURFACE EL.: 84 ft. (see note 1) **TOTAL DEPTH:** 4.5 ft.
GROUNDWATER LEVELS:
▽ **DURING EXCAVATION:** -
▼ **AT END OF EXCAVATION:** Not encountered.

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.
EXCAVATION FOREMAN: Justin Reymond
EXCAVATOR TYPE/MODEL: Kubota KX 080-4
WEATHER: 50's / Cloudy
TEST PIT DIMENSIONS: 8.5' x 3.5'
LOGGED BY: HO **CHECKED BY:** NP

Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
		E		Topsoil	1.0	0 ft. - 1 ft.: Topsoil
	82.5	E		Fill	2.0 82.0	1 ft. - 2 ft.: Silty SAND with Gravel (SM), fine to coarse, 15-20% fines, 35-40% fine to coarse subrounded gravel, trace of organic soil, trace of roots, brown, moist
2.5	80.0	M		Weathered Rock		2 ft. - 4.5 ft.: Well Graded GRAVEL with Silt and Sand (GW-GM), fine to coarse, angular, 5-10% fines, 20-25% coarse sand, 15-20% boulder up to 22" in diamater, brown, moist
		D	1		4.5	

REMARK 1: Excavator refusal encountered on possible rock at depth 4.5 feet.

Bottom of test pit at 4.5 feet. Backfilled the excavation with excavated material in 18" to 24" lifts and tamped with excavator bucket.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was interpolated to the nearest foot from drawing titled: "Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by DRA via e-mail on June 3, 2022.

100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

TP-202

PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.

PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.

LGCI PROJECT NUMBER: 2025

PROJECT LOCATION: Wakefield, MA

DATE STARTED: 4/27/22 **DATE COMPLETED:** 4/27/22

TEST PIT LOCATION: Prop. roadway north of prop. building

COORDINATES: NA

SURFACE EL.: 120 ft. (see note 1) **TOTAL DEPTH:** 4.5 ft.

GROUNDWATER LEVELS:

▽ **DURING EXCAVATION:** -

▼ **AT END OF EXCAVATION:** 2.0 ft. / El. 118.0 ft.

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.

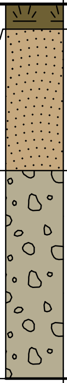
EXCAVATION FOREMAN: Justin Reymond

EXCAVATOR TYPE/MODEL: Kubota KX 080-4

WEATHER: 50's / Cloudy

TEST PIT DIMENSIONS: 15.5' x 4'

LOGGED BY: HO **CHECKED BY:** NP



Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
		E		Forest Mat	0.3 119.7	0 ft. - 0.3 ft.: Forest Mat
		E		Subsoil	2.0 ▼ 118.0	0.3 ft. - 2 ft.: Silty SAND (SM), fine to medium, 35-40% fines, trace of organic soil, trace of roots, brown, moist
2.5	117.5	D		Sand and Gravel		2 ft. - 2.5 ft.: Silty SAND (SM), fine to medium, trace coarse, 30-35% fines, 5-10% fine to coarse subangular gravel, trace of roots, gray, wet 2.5 ft. - 4.5 ft.: Similar to G3
		D				
		V	1		4.5	REMARK 1: Excavator refusal encountered on possible rock at depth of 4.5 feet.

Bottom of test pit at 4.5 feet. Backfilled the excavation with excavated material in 18" to 24" lifts and tamped with excavator bucket.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was interpolated to the nearest foot from drawing titled: "Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by DRA via e-mail on June 3, 2022.

LGCI Lahlaf Geotechnical Consulting, Inc.

100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

TP-203

PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.

PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.

LGCI PROJECT NUMBER: 2025

PROJECT LOCATION: Wakefield, MA

DATE STARTED: 4/27/22 **DATE COMPLETED:** 4/27/22

TEST PIT LOCATION: Prop. roadway north of prop. building

COORDINATES: NA

SURFACE EL.: 129 ft. (see note 1) **TOTAL DEPTH:** 2.5 ft.

GROUNDWATER LEVELS:

▽ **DURING EXCAVATION:** -

▼ **AT END OF EXCAVATION:** Not encountered

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.

EXCAVATION FOREMAN: Justin Reymond

EXCAVATOR TYPE/MODEL: Kubota KX 080-4

WEATHER: 50's / Cloudy

TEST PIT DIMENSIONS: 11' x 5'

LOGGED BY: HO **CHECKED BY:** NP

Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
		E		Forest Mat	0.3 128.7	0 ft. - 0.3 ft.: Forest Mat
		E		Subsoil		0.3 ft. - 2.5 ft.: Silty SAND (SM), fine to medium, 30-35% fines, 5-10% coarse subangular gravel, 5-10% cobbles up to 9" in diameter, trace of organic soil, trace of roots, brown, moist
	127.5	M				
2.5		V	1		2.5	REMARK 1: Excavation refusal encountered on possible rock at depth of 2.5 feet. Bottom of test pit at 2.5 feet. Backfilled the excavation with excavated material in 18" to 24" lifts and tamped with excavator bucket.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was interpolated to the nearest foot from drawing titled: "Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by DRA via e-mail on June 3, 2022.

LGCI
Lahlaf Geotechnical Consulting, Inc.
100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

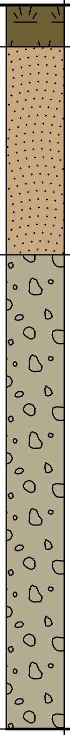
TP-204

PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 4/26/22
DATE COMPLETED: 4/26/22
TEST PIT LOCATION: Prop. roadway east of prop. building
COORDINATES: NA
SURFACE EL.: 155 ft. (see note 1)
TOTAL DEPTH: 8.7 ft.
GROUNDWATER LEVELS:
▽ **DURING EXCAVATION:** -
▼ **AT END OF EXCAVATION:** 6.0 ft. / El. 149.0 ft.

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.
EXCAVATION FOREMAN: Justin Reymond
EXCAVATOR TYPE/MODEL: Kubota KX 080-4
WEATHER: 50's / Cloudy
TEST PIT DIMENSIONS: 13' x 4.5'
LOGGED BY: HO
CHECKED BY: NP



Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
		E		Forest Mat		0 ft. - 0.5 ft.: Forest Mat
2.5	152.5	E		Subsoil	0.5 154.5	0.5 ft. - 3 ft.: Silty SAND with Gravel (SM), fine to coarse, 20-25% fines, 30-35% fine to coarse subrounded gravel, 5-10% cobbles up to 6" in diamter, trace of roots, light brown, moist
5.0	150.0	M		Sand and Gravel	3.0 152.0	3 ft. - 6 ft.: Silty SAND with Gravel (SM), fine to coarse, ~20% fines, 15-20% fine to coarse angular gravel, gray, moist
7.5	147.5	D			▼	6 ft. - 8.7 ft.: Similar to G3, 5-10% cobbles up to 8" in diameter, wet
		V	1		8.7	REMARK 1: Excavator refusal encountered on possible rock at depth of 8.7 feet.

Bottom of test pit at 8.7 feet. Backfilled the excavation with excavated material in 18" to 24" lifts and tamped with excavator bucket.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was interpolated to the nearest foot from drawing titled: "Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by DRA via e-mail on June 3, 2022.

LGCI
Lahlaf Geotechnical Consulting, Inc.
100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

TP-205

PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 4/26/22
DATE COMPLETED: 4/26/22
TEST PIT LOCATION: Near NW corner of prop. building
COORDINATES: NA
SURFACE EL.: 181 ft. (see note 1)
TOTAL DEPTH: 2.5 ft.
GROUNDWATER LEVELS:
▽ **DURING EXCAVATION:** -
▼ **AT END OF EXCAVATION:** Not encountered

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.
EXCAVATION FOREMAN: Justin Reymond
EXCAVATOR TYPE/MODEL: Kubota KX 080-4
WEATHER: 50's / Cloudy
TEST PIT DIMENSIONS: 10' x 3.5'
LOGGED BY: HO
CHECKED BY: NP

Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
		E		Forest Mat	0.5	0 ft. - 0.5 ft.: Forest Mat
	180.0	E		Subsoil	180.5	0.5 ft. - 2.5 ft.: Silty SAND with Gravel (SM), fine to medium, 30-35% fines, 15-20% coarse subangular gravel, trace of organic soil, trace of roots, brown, moist
		M				
2.5		V	1		2.5	REMARK 1: Excavator refusal encountered on possible rock at depth of 2.5 feet.

Bottom of test pit at 2.5 feet. Backfilled the excavation with excavated material in 18" to 24" lifts and tamped with excavator bucket.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was interpolated to the nearest foot from drawing titled: "Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by DRA via e-mail on June 3, 2022.

Lahlaf Geotechnical Consulting, Inc.
100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

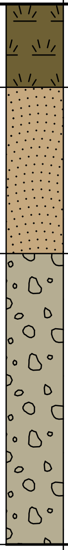
TP-206

PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 4/26/22
DATE COMPLETED: 4/26/22
TEST PIT LOCATION: Prop. roadway SE of prop. building
COORDINATES: NA
SURFACE EL.: 159 ft. (see note 1)
TOTAL DEPTH: 6.5 ft.
GROUNDWATER LEVELS:
▽ **DURING EXCAVATION:** -
▼ **AT END OF EXCAVATION:** Not encountered

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.
EXCAVATION FOREMAN: Justin Reymond
EXCAVATOR TYPE/MODEL: Kubota KX 080-4
WEATHER: 50's / Cloudy
TEST PIT DIMENSIONS: 14' x 4'
LOGGED BY: HO
CHECKED BY: NP



Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
		E		Forest Mat	1.0	0 ft. - 1 ft.: Forest Mat
2.5	157.5	M		Subsoil	158.0 3.0	1 ft. - 3 ft.: Silty SAND (SM), 35-40% fines, 5-10% fine to coarse subangular gravel, 0-5% cobbles up to 8" in diamter, trace of organic soil, trace of roots, brown, moist
5.0	155.0	D		Sand and Gravel	156.0	3 ft. - 6.5 ft.: Silty SAND with Gravel (SM), fine to medium, trace coarse, 15-20% fines, ~30% fine to coarse angular gravel, 5-10% cobbles up to 9" in diameter, gray, moist
	152.5	V	1		6.5	REMARK 1: Excavator refusal encountered on possible rock at depth of 6.5 feet.

Bottom of test pit at 6.5 feet. Backfilled the excavation with excavated material in 18" to 24" lifts and tamped with excavator bucket.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was interpolated to the nearest foot from drawing titled: "Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by DRA via e-mail on June 3, 2022.

LGCI
Lahlaf Geotechnical Consulting, Inc.
100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

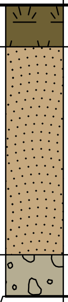
TP-207

PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 4/26/22 **DATE COMPLETED:** 4/26/22
TEST PIT LOCATION: Prop. roadway SE of prop. building
COORDINATES: NA
SURFACE EL.: 153 ft. (see note 1) **TOTAL DEPTH:** 3.5 ft.
GROUNDWATER LEVELS:
∇ **DURING EXCAVATION:** -
▼ **AT END OF EXCAVATION:** Not encountered

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.
EXCAVATION FOREMAN: Justin Reymond
EXCAVATOR TYPE/MODEL: Kubota KX 080-4
WEATHER: 50's / Cloudy
TEST PIT DIMENSIONS: 10' x 4.5'
LOGGED BY: HO **CHECKED BY:** NP



Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
	152.5	E		Forest Mat	0.5	0 ft. - 0.5 ft.: Forest Mat
2.5	150.0	E M		Subsoil	152.5 3.0	0.5 ft. - 3 ft.: Silty SAND with Gravel (SM), fine to coarse, 35-40% fines, 15-20% fine to coarse subrounded gravel, 5-10% cobbles up to 8" in diameter, trace of organic soil, trace of roots, orange brown, moist
		V	1	Sand and Gravel	3.5	3 ft. - 3.5 ft.: Silty SAND with Gravel (SM), fine to medium, 20-25% fines, 15-20% fine to coarse subangular gravel, 10-15% cobbles up to 44" in diameter, light brown, moist REMARK 1: Excavator refusal encountered on possible rock at depth of 3.5 feet.

Bottom of test pit at 3.5 feet. Backfilled the excavation with excavated material in 18" to 24" lifts and tamped with excavator bucket.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was interpolated to the nearest foot from drawing titled: "Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by DRA via e-mail on June 3, 2022.

LGCI
Lahlaf Geotechnical Consulting, Inc.

100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

TP-208

PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 7/22/22
DATE COMPLETED: 7/22/22
TEST PIT LOCATION: Near prop. parking lot south of prop. building
COORDINATES: NA
SURFACE EL.: 165 ft. (see note 1)
TOTAL DEPTH: 2.6 ft.
GROUNDWATER LEVELS:
∇ **DURING EXCAVATION:** -
▼ **AT END OF EXCAVATION:** Not encountered

EXCAVATION SUBCONTRACTOR: Saunders Construction
EXCAVATION FOREMAN: Chris Saunders
EXCAVATOR TYPE/MODEL: Takeuchi TB-175
WEATHER: 90's / Sunny
TEST PIT DIMENSIONS: 13.0' x 6.5'
LOGGED BY: TG
CHECKED BY: NP

Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
		E		Forest Mat	0.9	0 ft. - 0.9 ft.: Forest Mat
		M		Subsoil	164.1	0.9 ft. - 2.6 ft.: Silty SAND (SM), fine to medium, 30-35% fines, 10-15% fine to coarse subrounded gravel, trace of organic soil, trace of roots, light brown, moist
2.5	162.5	V	1		2.6	REMARK 1: Excavator refusal encountered at depth of 2.6' on rock. Bottom of test pit at 2.6 feet. Backfilled the excavation with excavated material in 12" to 18" lifts and tamped with excavator bucket.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was interpolated to the nearest foot from drawing titled: "Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by DRA via e-mail on June 3, 2022.

LGCI
Lahlaf Geotechnical Consulting, Inc.

100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

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PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 7/22/22 **DATE COMPLETED:** 7/22/22
TEST PIT LOCATION: Near northern side of prop. driveway
COORDINATES: NA
SURFACE EL.: 137 ft. (see note 1) **TOTAL DEPTH:** 4.2 ft.
GROUNDWATER LEVELS:
▽ **DURING EXCAVATION:** -
▼ **AT END OF EXCAVATION:** Not encountered

EXCAVATION SUBCONTRACTOR: Saunders Construction
EXCAVATION FOREMAN: Chris Saunders
EXCAVATOR TYPE/MODEL: Takeuchi TB-175
WEATHER: 90's / Sunny
TEST PIT DIMENSIONS: 13.0' x 8.0'
LOGGED BY: TG **CHECKED BY:** NP

Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
		E		Forest Mat	1.4 135.6	0 ft. - 1.4 ft.: Forest Mat
	135.0	E		Subsoil	2.5 134.5	1.4 ft. - 2.5 ft.: Silty SAND (SM), fine to medium, 25-30% fines, ~5% fine to coarse subrounded gravel, 0-5% cobbles and boulders up to 16" in diameter, trace of organic soil, trace of roots, brown, moist
2.5		E M V	1	Sand and Gravel	4.2	2.5 ft. - 4.2 ft.: Silty SAND (SM), fine to medium, trace of coarse, 30-35% fines, 5-10% fine to coarse subrounded gravel, trace of roots, light brown to gray, moist

REMARK 1: Excavator refusal encountered at depth of 4.2' on rock.

Bottom of test pit at 4.2 feet. Backfilled the excavation with excavated material in 12" to 18" lifts and tamped with excavator bucket. Ground surface restored with excavated Forest Mat. Area raked and straw placed for erosion control.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was interpolated to the nearest foot from drawing titled: "Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by DRA via e-mail on June 3, 2022.

Lahlaf Geotechnical Consulting, Inc.

100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

TP-210

PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.

PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.

LGCI PROJECT NUMBER: 2025

PROJECT LOCATION: Wakefield, MA

DATE STARTED: 7/22/22 **DATE COMPLETED:** 7/22/22

TEST PIT LOCATION: Near northern side of prop. driveway

COORDINATES: NA

SURFACE EL.: 133 ft. (see note 1) **TOTAL DEPTH:** 4.6 ft.

GROUNDWATER LEVELS:

∇ **DURING EXCAVATION:** -

▼ **AT END OF EXCAVATION:** Not encountered

EXCAVATION SUBCONTRACTOR: Saunders Construction

EXCAVATION FOREMAN: Chris Saunders

EXCAVATOR TYPE/MODEL: Takeuchi TB-175

WEATHER: 90's / Sunny

TEST PIT DIMENSIONS: 11.0' x 5.0'

LOGGED BY: TG **CHECKED BY:** NP

Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
	132.5	M E		Fill	1.2	0 ft. - 1.2 ft.: Well Graded SAND with Silt and Gravel (SW-SM), fine to coarse, 10-15% fines, 25-30% fine to coarse subrounded gravel, 5-10% cobbles and boulders up to 12" in diameter, light brown, moist
		E		Buried Organic Soil	2.0	1.2 ft. - 2 ft.: Silty SAND (SM), fine, 25-30% fines, trace of organic soil, trace of roots, black, moist
2.5	130.0	M		Buried Subsoil	3.0 130.0	2 ft. - 3 ft.: Silty SAND (SM), fine to medium, 25-30% fines, 5-10% fine to coarse subrounded gravel, trace of organic soil, trace of roots, orange-brown, moist
		D V	1	Sand and Gravel	4.6	3 ft. - 4.6 ft.: Silty SAND with Gravel (SM), fine to medium, trace of coarse, 20-25% fines, 20-25% fine to coarse subangular gravel, 5-10% cobbles up to 8" in diameter, trace of roots, light brown, moist

REMARK 1: Excavator refusal encountered at depth of 4.6' on rock.

Bottom of test pit at 4.6 feet. Backfilled the excavation with excavated material in 12" to 18" lifts and tamped with excavator bucket. Ground surface restored with excavated Forest Mat. Area raked and straw placed for erosion control.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was interpolated to the nearest foot from drawing titled: "Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by DRA via e-mail on June 3, 2022.

LGCI
Lahlaf Geotechnical Consulting, Inc.

100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

TP-211

PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.

PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.

LGCI PROJECT NUMBER: 2025

PROJECT LOCATION: Wakefield, MA

DATE STARTED: 7/22/22 **DATE COMPLETED:** 7/22/22

TEST PIT LOCATION: Near southern side of prop. driveway

COORDINATES: NA

SURFACE EL.: 129 ft. (see note 1) **TOTAL DEPTH:** 5.6 ft.

GROUNDWATER LEVELS:

▽ **DURING EXCAVATION:** -

▼ **AT END OF EXCAVATION:** Not encountered

EXCAVATION SUBCONTRACTOR: Saunders Construction

EXCAVATION FOREMAN: Chris Saunders

EXCAVATOR TYPE/MODEL: Takeuchi TB-175

WEATHER: 90's / Sunny

TEST PIT DIMENSIONS: 12.0' x 7.0'

LOGGED BY: TG **CHECKED BY:** NP

Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
	127.5	M D	1	Forest Mat	1.7	0 ft. - 1.7 ft.: Forest Mat with ~8" layer of Silty SAND (SM), fine to medium, 20-25% fines, 10-15% fine to coarse angular gravel, ~10% cobbles and boulders up to 18" in diameter, brown, moist REMARK 1: Thin layer of fill encountered on northern side of test pit between depths of 0' and 0.7'.
2.5		D		Subsoil	2.5 126.5	1.7 ft. - 2.5 ft.: Silty SAND (SM), fine to medium, 25-30% fines, ~10% fine to coarse subangular gravel, trace of organic soil, trace of roots, brown, moist
5.0	125.0	D M V	2	Sand and Gravel	5.6	2.5 ft. - 5.6 ft.: Silty SAND with Gravel (SM), fine to medium, 20-25% fines, 15-20% fine to coarse subangular gravel, ~10% cobbles and boulders up to 16" in diameter, trace of roots, gray, moist

REMARK 2: Excavator refusal encountered at depth of 5.6' on rock.

Bottom of test pit at 5.6 feet. Backfilled the excavation with excavated material in 12" to 18" lifts and tamped with excavator bucket. Ground surface restored with excavated Forest Mat. Area raked and straw placed for erosion control.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was interpolated to the nearest foot from drawing titled: "Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by DRA via e-mail on June 3, 2022.

TEST PIT LOG

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PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 7/22/22
DATE COMPLETED: 7/22/22
TEST PIT LOCATION: Near prop. entrance at Farm Road
COORDINATES: NA
SURFACE EL.: 133 ft. (see note 1)
TOTAL DEPTH: 4.9 ft.
GROUNDWATER LEVELS:
▽ **DURING EXCAVATION:** -
▼ **AT END OF EXCAVATION:** Not encountered

EXCAVATION SUBCONTRACTOR: Saunders Construction
EXCAVATION FOREMAN: Chris Saunders
EXCAVATOR TYPE/MODEL: Takeuchi TB-175
WEATHER: 90's / Sunny
TEST PIT DIMENSIONS: 13.0' x 6.0'
LOGGED BY: TG
CHECKED BY: NP

Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
	132.5	E	1	Forest Mat	0.9 132.1	0 ft. - 0.9 ft.: Forest Mat REMARK 1: Boulder about 5' in diameter observed at ground surface.
		E		Subsoil		0.9 ft. - 3 ft.: Silty SAND (SM), fine to medium, 20-25% fines, 5-10% fine to coarse subrounded gravel, trace of organic soil, trace of roots, orange-brown, moist
2.5	130.0	M			3.0 130.0	
		M		Sand and Gravel		3 ft. - 4.9 ft.: Poorly Graded SAND with Silt (SP-SM), fine. 10-15% fines, 5-10% fine subangular gravel, trace of roots, gray, moist
		V	2		4.9	REMARK 2: Excavator refusal encountered at depth of 4.9' on rock.

Bottom of test pit at 4.9 feet. Backfilled the excavation with excavated material in 12" to 18" lifts and tamped with excavator bucket. Ground surface restored with excavated Forest Mat. Area raked and straw placed for erosion control.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was interpolated to the nearest foot from drawing titled: "Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by DRA via e-mail on June 3, 2022.

LGCI Lahlaf Geotechnical Consulting, Inc.
100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

TP-213

PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 7/22/22 **DATE COMPLETED:** 7/22/22
TEST PIT LOCATION: Near prop. parking lot north of prop. building
COORDINATES: NA
SURFACE EL.: 136 ft. (see note 1) **TOTAL DEPTH:** 3.3 ft.
GROUNDWATER LEVELS:
∇ **DURING EXCAVATION:** -
▼ **AT END OF EXCAVATION:** Not encountered

EXCAVATION SUBCONTRACTOR: Saunders Construction
EXCAVATION FOREMAN: Chris Saunders
EXCAVATOR TYPE/MODEL: Takeuchi TB-175
WEATHER: 90's / Sunny
TEST PIT DIMENSIONS: 10.0' x 7.0'
LOGGED BY: TG **CHECKED BY:** NP

Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
		E		Forest Mat	0.3 135.7	0 ft. - 0.3 ft.: Forest Mat
	135.0	E		Subsoil		0.3 ft. - 2.3 ft.: Silty SAND (SM), fine to medium, 25-30% fines, 10-15% fine to coarse subrounded gravel, trace of organic soil, trace of roots, brown, moist
		M				
		D			2.3	
2.5		D		Sand and Gravel		2.3 ft. - 3.3 ft.: Poorly Graded SAND with Silt (SP-SM), fine, trace of medium, 10-15% fines, 5-10% cobbles up to 10" in diameter, trace of roots, light brown, moist
		V	1		3.3	REMARK 1: Excavator refusal encountered at depth of 3.3' on rock.
						Bottom of test pit at 3.3 feet. Backfilled the excavation with excavated material in 12" to 18" lifts and tamped with excavator bucket.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was interpolated to the nearest foot from drawing titled: "Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by DRA via e-mail on June 3, 2022.

LGCI
Lahlaf Geotechnical Consulting, Inc.
100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

TP-B-205

PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 4/27/22 **DATE COMPLETED:** 4/27/22
TEST PIT LOCATION: Near NE corner of prop. building
COORDINATES: NA
SURFACE EL.: 134 ft. (see note 1) **TOTAL DEPTH:** 9 ft.
GROUNDWATER LEVELS:
▽ **DURING EXCAVATION:** -
▼ **AT END OF EXCAVATION:** 3.0 ft. / El. 131.0 ft.

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.
EXCAVATION FOREMAN: Justin Reymond
EXCAVATOR TYPE/MODEL: Kubota KX 080-4
WEATHER: 50's / Cloudy
TEST PIT DIMENSIONS: 11.5' x 4.5'
LOGGED BY: HO **CHECKED BY:** NP

Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
		E		Forest Mat	0.5	0 ft. - 0.5 ft.: Forest Mat
	132.5	E		Subsoil	1.5 132.5	0.5 ft. - 1.5 ft.: SILT with Sand (ML), slightly plastic, 25-30% fine to medium sand, trace coarse sand, trace fine subrounded gravel, trace of roots, trace of organic soil, brown, moist
2.5		E		Sand and Gravel		1.5 ft. - 3 ft.: Silty SAND with Gravel (SM), fine to coarse, ~20% fines, 15-20% fine to coarse subangular gravel, 5-10% cobbles up to 8" in diameter, gray, moist
	130.0	E			▼	3 ft. - 9 ft.: Similar to G3, 20-25% fines, wet
5.0	127.5	M				
7.5	125.0	D	1		9.0	REMARK 1: Excavator refusal encountered on possible rock at depth of 9 feet.

Bottom of test pit at 9.0 feet. Backfilled the excavation with excavated material in 18" to 24" lifts and tamped with excavator bucket.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was interpolated to the nearest foot from drawing titled: "Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by DRA via e-mail on June 3, 2022.

100 Chelmsford Road, Suite 2
Billerica, MA 01862
Telephone: (978) 330-5912
Fax: (978) 330-5056

TEST PIT LOG

TP-B-206

PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 4/27/22 **DATE COMPLETED:** 4/27/22
TEST PIT LOCATION: Near west of prop. building
COORDINATES: NA
SURFACE EL.: 151 ft. (see note 1) **TOTAL DEPTH:** 2.6 ft.
GROUNDWATER LEVELS:
▽ **DURING EXCAVATION:** -
▼ **AT END OF EXCAVATION:** 2.6 ft. / El. 148.4 ft.

EXCAVATION SUBCONTRACTOR: Northern Drill Service, Inc.
EXCAVATION FOREMAN: Justin Reymond
EXCAVATOR TYPE/MODEL: Kubota KX 080-4
WEATHER: 50's / Cloudy
TEST PIT DIMENSIONS: 10.5' x 5.0'
LOGGED BY: HO **CHECKED BY:** NP

Depth (ft)	El. (ft)	Excavation Effort	Remark	Strata	Depth El.(ft.)	Material Description
		E		Forest Mat	0.4 150.6	0 ft. - 0.4 ft.: Forest Mat
	150.0	E		Subsoil		0.4 ft. - 2.6 ft.: Silty SAND with Gravel (SM), fine to medium, ~40% fines, 15-20% fine to coarse subangular gravel, 15-20% boulders up to 55" in diameter, trace of organic soil, trace of roots, brown, moist
		V				
2.5			1		2.6 ▼	REMARK 1: Excavator refusal encountered on possible rock at depth of 2.6 feet.
						Bottom of test pit at 2.6 feet. Backfilled the excavation with excavated material in 18" to 24" lifts and tamped with excavator bucket.

GENERAL COMMENTS: **E = Easy, M - Moderate, D = Difficult, V = Very Difficult**

1. The ground surface elevation was interpolated to the nearest foot from drawing titled: "Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by DRA via e-mail on June 3, 2022.

APPENDIX D – LGCI’s Boring Logs, Groundwater Observation Well Installation Reports, and Photographs of the Rock Cores

BORING LOG

B-1-OW

PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 12/10/20 **DATE COMPLETED:** 12/10/20
BORING LOCATION: Near NW corner of prop. building
COORDINATES: NA
SURFACE El.: 184.5 ft. (see note 1) **TOTAL DEPTH:** 14 ft.
WEATHER: 30's / Sunny
GROUNDWATER LEVELS:
∇ **DURING DRILLING:** -
▼ **AT END OF DRILLING:** 10.0 ft. / El. 174.5 ft.
▼ **OTHER:** -

DRILLING SUBCONTRACTOR: Northern Drill Service, Inc.
DRILLING FOREMAN: Jon Beirholm
DRILLING METHOD: Drive and wash with 4-inch casing
DRILL RIG TYPE/MODEL: Mobile Drill B-48
HAMMER TYPE: Automatic
HAMMER WEIGHT: 140 lb. **HAMMER DROP:** 30 in.
SPLIT SPOON DIA.: 1.375 in. I.D., 2 in. O.D.
CORE BARREL SIZE: NX
LOGGED BY: TG **CHECKED BY:** SD

Depth (ft.)	El. (ft.)	Sample Interval (ft.)	Sample Number	Blow Counts (N Value)	Pen./Rec. (in.)	Remark	Strata	Depth El.(ft.)	Material Description
		0	S1	1-1-8 (2)	24/11		Topsoil	0.3 184.3	S1 - Top 3": Topsoil
							Subsoil		Bot. 8": Silty SAND with Gravel (SM), fine to medium, 30-35% fines, 15-20% fine to coarse subrounded to angular gravel, trace of organic soil, trace of roots, brown, moist
		2	S2	43	6/5				S2 - Similar to S1 Bot. 8", 25-30% fine to coarse subangular to angular gravel, gray
		2.5				1		2.5 182.0	REMARK 1: Split spoon refusal encountered on rock at depth of 2.5'. Advanced button bit about 1.5' to depth of 4'.
		4	C1		60/57		Rock		C1 - min/ft: 12.6, 5.7, 3.5, 6.3, 7.5 REC=95%, RQD= 66% Very hard, slightly weathered to fresh, moderately fractured to sound, gray, medium-grained, RHYOLITE
5	180.0					2			REMARK 2: Rock core sampler jammed at depth of 5'.
		9	C2		60/59				C2 - min/ft: 6.6, 3.3, 2.0, 3.1, 4.0 REC=98%, RQD=92% Very hard, fresh, moderately fractured to sound, gray, medium-grained, RHYOLITE
10	175.0							▼	
		14						14.0	Bottom of borehole at 14.0 feet. Installed groundwater observation well in borehole.
15	170.0								
20	165.0								
25	160.0								

GENERAL NOTES:

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

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BORING LOG

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PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 12/11/20 **DATE COMPLETED:** 12/11/20
BORING LOCATION: Near NE corner of prop. building
COORDINATES: NA
SURFACE El.: 166.5 ft. (see note 1) **TOTAL DEPTH:** 0.5 ft.
WEATHER: 50's / Sunny
GROUNDWATER LEVELS:
∇ **DURING DRILLING:** Not encountered
▼ **AT END OF DRILLING:** Not encountered
▼ **OTHER:** -

DRILLING SUBCONTRACTOR: Northern Drill Service, Inc.
DRILLING FOREMAN: Jon Beirholm
DRILLING METHOD: Drive and wash with 4-inch casing
DRILL RIG TYPE/MODEL: Mobile B-48 ATV Rig
HAMMER TYPE: Automatic
HAMMER WEIGHT: 140 lb. **HAMMER DROP:** 30 in.
SPLIT SPOON DIA.: 1.375 in. I.D., 2 in. O.D.
CORE BARREL SIZE: NX
LOGGED BY: TG **CHECKED BY:** SD

Depth (ft.)	El. (ft.)	Sample Interval (ft.)	Sample Number	Blow Counts (N Value)	Pen./Rec. (in.)	Remark	Strata	Depth El.(ft.)	Material Description
		0 0.5	☒ S1	42	6/4	1 2	Topsoil ▨	0.5	S1 - Topsoil REMARK 1: Split spoon sampler refusal encountered on possible rock at depth of 0.5'. REMARK 2: Moved borehole 18' south and encountered refusal at 0.5'. Exposed a 1' x 2' area of rock with a shovel. Bottom of borehole at 0.5 feet. Backfilled borehole with drill cuttings.
	165.0								
5									
	160.0								
10									
	155.0								
15									
	150.0								
20									
	145.0								
25									

GENERAL NOTES:

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

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BORING LOG

B-3-OW

PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 12/10/20
DATE COMPLETED: 12/11/20
BORING LOCATION: Near SE corner of prop. building
COORDINATES: NA
SURFACE El.: 170.5 ft. (see note 1)
TOTAL DEPTH: 18 ft.
WEATHER: 30's / Sunny
GROUNDWATER LEVELS:
▽ **DURING DRILLING:** -
▼ **AT END OF DRILLING:** Not encountered
▼ **OTHER:** -

DRILLING SUBCONTRACTOR: Northern Drill Service, Inc.
DRILLING FOREMAN: Jon Beirholm
DRILLING METHOD: Drive and wash with 4-inch casing
DRILL RIG TYPE/MODEL: Mobile Drill B-48
HAMMER TYPE: Automatic
HAMMER WEIGHT: 140 lb.
HAMMER DROP: 30 in.
SPLIT SPOON DIA.: 1.375 in. I.D., 2 in. O.D.
CORE BARREL SIZE: NX
LOGGED BY: TG
CHECKED BY: SD

Depth (ft.)	El. (ft.)	Sample Interval (ft.)	Sample Number	Blow Counts (N Value)	Pen./Rec. (in.)	Remark	Strata	Depth El.(ft.)	Material Description
	170.0	0					Topsoil	0.3 170.2	S1 - Top 4": Topsoil
		0–2	S1	0-0-1-11 (1)	24/6		Subsoil		Bot. 2": SILT with Sand (ML), slightly plastic, ~15% fine sand, trace of organic soil, trace of roots, brownish orange, moist
		2–2.2	S2	38/2"	2/1	1		2.2 168.3	S2 - Similar to S1 Bot. 2", 10-15% fine subangular to angular gravel REMARK 1: Split spoon sampler refusal encountered on rock at depth of 2.2'. Advanced button bit about 0.8' to depth of 3'.
5	165.0	3–8	C1		60/58		Rock		C1 - min/ft: 3.4, 3.4, 2.7, 5.3, 3.8 REC=97%, RQD=69% Very hard, slightly weathered to fresh, moderately fractured to sound, gray, medium-grained, RHYOLITE
10	160.0	8–13	C2		60/60		Rock		C2 - min/ft: 4.6, 3.5, 5.1, 4.3, 5.6 REC=100%, RQD=51% Hard to very hard, slightly weathered to fresh, moderately fractured to sound, gray, medium-grained, RHYOLITE
15	155.0	13–18	C3		60/58	2	Rock	18.0	C3 - min/ft: 5.9, 5.6, 7.7, 11.7, 16.9 REC=97%, RQD=88% Very hard, fresh, moderately fractured to sound, gray, medium-grained, RHYOLITE REMARK 2: Broke a button bit clearing out the borehole after coring.
		18							Bottom of borehole at 18.0 feet. Installed groundwater observation well in borehole
20	150.0								
25									

GENERAL NOTES:

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

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BORING LOG

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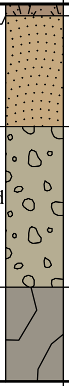
PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 12/10/20 **DATE COMPLETED:** 12/10/20
BORING LOCATION: Along western side of prop. building
COORDINATES: NA
SURFACE El.: 180.7 ft. (see note 1) **TOTAL DEPTH:** 8 ft.
WEATHER: 30's / Sunny
GROUNDWATER LEVELS:
∇ **DURING DRILLING:** -
▼ **AT END OF DRILLING:** 0.8 ft. / El. 179.9 ft.
▼ **OTHER:** -

DRILLING SUBCONTRACTOR: Northern Drill Service, Inc.
DRILLING FOREMAN: Jon Beirholm
DRILLING METHOD: Drive and wash with 4-inch casing
DRILL RIG TYPE/MODEL: Mobile Drill B-48
HAMMER TYPE: Automatic
HAMMER WEIGHT: 140 lb. **HAMMER DROP:** 30 in.
SPLIT SPOON DIA.: 1.375 in. I.D., 2 in. O.D.
CORE BARREL SIZE: NX
LOGGED BY: TG **CHECKED BY:** SD



Depth (ft.)	El. (ft.)	Sample Interval (ft.)	Sample Number	Blow Counts (N Value)	Pen./Rec. (in.)	Remark	Strata	Depth El.(ft.)	Material Description
	180.0	0					Topsoil	0.3 180.5	S1 - Top 3": Topsoil
		0–2	S1	2-1-2-1 (3)	24/7		Subsoil	▼	Bot. 4":Silty SAND (SM), fine to medium, 35-40% fines, 0-5% fine subrounded to angular gravel, trace of organic soil, trace of roots, brownish orange, moist
		2–4	S2	2-2-9-12 (11)	24/13			2.6 178.1	S2 - Top 7": Similar to S1 Bot. 4", 10-15% fine to coarse subrounded to angular gravel
							Sand and Gravel		Bot. 6": Silty SAND with Gravel (SM), fine to coarse, 15-20% fines, ~20% fine to coarse subrounded to subangular gravel, light brown, moist (natural)
5	175.0	4–6	S3	15-16-18-27 (34)	24/13				S3 - Similar to S2 Bot. 6", 20-25% fine to coarse subrounded to subangular gravel
		6				1		6.0 174.7	REMARK 1: Split spoon sampler refusal encountered on rock at depth of 6'.
						2	Rock	8.0	REMARK 2: Advanced button bit for 10 minutes. Advanced button bit from depth of 6' to 8' into rock.
									Bottom of borehole at 8.0 feet. Backfilled borehole with drill cuttings and 1.5 bags of gravel.
10	170.0								
15	165.0								
20	160.0								
25									

GENERAL NOTES:

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

BORING LOG

B-101-OW

PAGE 1 OF 2

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 5/10/21 **DATE COMPLETED:** 5/11/21
BORING LOCATION: Near NW corner of prop. bulding
COORDINATES: NA
SURFACE El.: 172.6 ft. (see note 1) **TOTAL DEPTH:** 36 ft.
WEATHER: 50's / Sunny
GROUNDWATER LEVELS:
▽ **DURING DRILLING:** -
▼ **AT END OF DRILLING:** 5.2 ft. / El. 167.4 ft.
▼ **OTHER:** -

DRILLING SUBCONTRACTOR: Northern Drill Service, Inc.
DRILLING FOREMAN: Jon Beirholm
DRILLING METHOD: Drive and wash with 3-inch casing
DRILL RIG TYPE/MODEL: Mobile Drill B-48
HAMMER TYPE: Automatic
HAMMER WEIGHT: 140 lb. **HAMMER DROP:** 30 in.
SPLIT SPOON DIA.: 1.375 in. I.D., 2 in. O.D.
CORE BARREL SIZE: NX
LOGGED BY: TG **CHECKED BY:** NP

Depth (ft.)	El. (ft.)	Sample Interval (ft.)	Sample Number	Blow Counts (N Value)	Pen./Rec. (in.)	Remark	Strata	Depth El.(ft.)	Material Description
		0 0	S1		0.1/0.1		Forest Mat	0.1 172.5	S1 - Forest Mat
5	170.0	1	C1		60/58	1	Rock		REMARK 1: Spun casing to a depth of 1'. C1 - min/ft: 7.3, 8.1, 12.2, 11.2, 14.7 REC = 97%, RQD = 73% Very hard, slightly weathered to fresh, slightly fractured to sound, gray with white and green mottles, fine-grained to medium-grained, RHYOLITE ▼
10	165.0	6	C2		60/60	2			C2 - min/ft: 19.5, 12.3, 12.8, 16.1, 15.1 REC = 100%, RQD = 46% Very hard, slightly weathered to fresh, extremely fractured to slightly fractured, gray, fine-grained, RHYOLITE REMARK 2: Rock core sampler jammed at depth of 7.8'.
15	160.0	11	C3		60/60	3			C3 - min/ft: 11.1, 10.0, 11.1, 6.1, 5.5 REC = 100%, RQD = 63% Very hard, fresh, extremely fractured to sound, gray with white mottles, fine-grained to medium-grained, RHYOLITE REMARK 3: Lost water at depth of 14' through end of boring.
20	155.0	16	C4		60/60				C4 - min/ft: 3.5, 3.0, 4.6, 4.6, 3.3 REC = 100%, RQD = 80% Hard to very hard, slightly weathered to fresh, extremely fractured to sound, gray with white mottles and green banding, medium-grained, RHYOLITE
25	150.0	21	C5		60/60				C5 - min/ft: 7.3, 8.1, 12.2,11.2, 14.7 REC = 97%, RQD = 73% Very hard, slightly weathered to fresh, slightly fractured to sound, gray with white mottles and green banding, medium-grained, RHYOLITE

GENERAL NOTES:

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

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BORING LOG

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PAGE 2 OF 2

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

Depth (ft.)	El. (ft.)	Sample Interval (ft.)	Sample Number	Blow Counts (N Value)	Pen./Rec. (in.)	Remark	Strata	Depth El.(ft.)	Material Description
		21						172.5	
30	145.0	26	C6		60/60		Rock		C6 - min/ft: 9.0, 8.8, 14.6, 19.1, 2.7 REC = 100%, RQD = 91% Very hard, slightly weathered to fresh, moderately fractured to sound, gray with white mottles and green banding, medium-grained, RHYOLITE
35	140.0	31	C7		60/60				C7 - min/ft: 2.3, 4.7, 5.2, 6.3, 6.5 REC = 100%, RQD = 100% Very hard, slightly weathered to fresh, moderately fractured to sound, gray with white mottles and green banding, fine-grained to medium-grained, RHYOLITE
		36						36.0	Bottom of borehole at 36.0 feet. Backfilled borehole with drill cuttings. Installed groundwater observation well.
	135.0								
40									
	130.0								
45									
	125.0								
50									
	120.0								
55									
	115.0								
60									

BORING LOG

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PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 5/10/21 **DATE COMPLETED:** 5/10/21
BORING LOCATION: Near NE corner of prop. building
COORDINATES: NA
SURFACE El.: 158.7 ft. (see note 1) **TOTAL DEPTH:** 23.5 ft.
WEATHER: 50's / Cloudy
GROUNDWATER LEVELS:
▽ **DURING DRILLING:** 2.5 ft. / El. 156.2 ft. Based on sample moisture.
▼ **AT END OF DRILLING:** -
▼ **OTHER:** -

DRILLING SUBCONTRACTOR: Northern Drill Service, Inc.
DRILLING FOREMAN: Jon Beirholm
DRILLING METHOD: Drive and wash with 4-inch casing
DRILL RIG TYPE/MODEL: Mobile Drill B-48
HAMMER TYPE: Automatic
HAMMER WEIGHT: 140 lb. **HAMMER DROP:** 30 in.
SPLIT SPOON DIA.: 1.375 in. I.D., 2 in. O.D.
CORE BARREL SIZE: NX
LOGGED BY: QV **CHECKED BY:** NP

Depth (ft.)	El. (ft.)	Sample Interval (ft.)	Sample Number	Blow Counts (N Value)	Pen./Rec. (in.)	Remark	Strata	Depth El.(ft.)	Material Description
		0 - 2	S1	1-1-1-12 (2)	24/12		Forest Mat Subsoil	0.5	S1 - Top 5": Forest Mat Bot 7": Silty SAND (SM), fine, trace medium, 35-40% fines, trace of organic soil, trace of roots, brown, moist
		2 - 2.7	S2	22-100/2"	8/4			2.7 ▽	S2 - Well Graded GRAVEL (GW), subangular to angular, ~5% fines, 5-10% medium to coarse sand, light brown, wet
5	155.0	3.5 - 8.5	C1		60/59.5		Rock		C1 - min/ft: 8.9,7.3, 8.0, 8.8, 8.2 REC = 99%, RQD = 95% Very hard, slightly weathered to fresh, moderately fractured to sound, gray, medium-grained, RHYOLITE
10	150.0	8.5 - 13.5	C2		60/55				C2 - min/ft: 10.1, 10.5, 10.7, 18.8, 2.8 REC = 91.7%, RQD = 71.7% Very hard, slightly weathered to fresh, moderately fractured to sound, gray, medium-grained, RHYOLITE
15	145.0	13.5 - 18.5	C3		60/60				C3 - min/ft: 5.7, 6.7, 2.8, 3.7, 6.1 REC = 100%, RQD = 90% Hard, slightly weathered to fresh, moderately fractured to sound, gray with green mottles, medium-grained to coarse-grained, RHYOLITE
20	140.0	18.5 - 23.5	C4		60/60				C4 - min/ft: 3.9, 3.8, 6.8, 6.6, 7.3 REC = 100%, RQD = 96.7% Hard, slightly weathered to fresh, moderately fractured to sound, gray with green and white mottles, medium-grained, RHYOLITE
25	135.0	23.5						23.5	Bottom of borehole at 23.5 feet. Backfilled borehole with drill cuttings.

GENERAL NOTES:

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

LGCI
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BORING LOG

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PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 5/7/21 **DATE COMPLETED:** 5/14/21
BORING LOCATION: Near NW portion of prop. building
COORDINATES: NA
SURFACE El.: 174.6 ft. (see note 1) **TOTAL DEPTH:** 23.5 ft.
WEATHER: 50's / Sunny
GROUNDWATER LEVELS:
- ▽ **DURING DRILLING:** -
- ▼ **AT END OF DRILLING:** 0.1 ft. / El. 174.5 ft.
- ▽ **OTHER:** -

DRILLING SUBCONTRACTOR: Northern Drill Service, Inc.
DRILLING FOREMAN: Jon Beirholm
DRILLING METHOD: Drive and wash with 3-inch casing
DRILL RIG TYPE/MODEL: Mobile Drill B-48
HAMMER TYPE: Automatic
HAMMER WEIGHT: 140 lb. **HAMMER DROP:** 30 in.
SPLIT SPOON DIA.: 1.375 in. I.D., 2 in. O.D.
CORE BARREL SIZE: NX
LOGGED BY: NP / FR **CHECKED BY:** AML

Depth (ft.)	El. (ft.)	Sample Interval (ft.)	Sample Number	Blow Counts (N Value)	Pen./Rec. (in.)	Remark	Strata	Depth El.(ft.)	Material Description
		0 1.8	S1	1-1-2-100/4" (3)	22/7		Forest Mat	▼	S1 - Top 4": Forest Mat, trace of organic soil, trace of roots Bottom 3": Silty SAND (SM), fine to coarse, 20-25% fines, trace of roots, trace of organic soil, trace of pine needles, brown, moist
		1.8 3.5				1	Rock	1.8 172.8	REMARK 1: Split spoon sampler refusal encountered on rock at depth of 1.8'. Advanced to 3.5' to seat casing and started coring. Drilled used series 10 bit to make coring faster.
5	170.0	3.5 8.5	C1		60/55				C1 - min/ft: 19.0, 55.0, 33.0, 7.0, 44.0 REC = 85%, RQD = 40% Hard, slightly weathered to fresh, extremely fractured to slightly fractured, gray, medium-grained, RHYOLITE
10	165.0	8.5 13.5	C2		60/54	2 3			C2 - min/ft: 25.0, 34.5, 14.5, 42.1, 145.0 REC = 90%, RQD = 63.3% Very hard, slightly weathered to fresh, extremely fractured to slightly fractured, gray, medium-grained, RHYOLITE REMARK 2: Rock core sampler jammed at depth of 10'. REMARK 3: Rock core sampler jammed at depth of 12.7'
15	160.0	13.5 18.5	C3		60/60	4			C3 - min/ft: 130.0, 8.0, 6.0, 8.5, 22.0 REC = 100%, RQD = 83.3% Very hard, fresh, moderately fractured to sound, gray, medium-grained, RHYOLITE REMARK 4: Rock became softer and faster to core at depth of 15.5'.
20	155.0	18.5 23.5	C4		60/57			23.5	C4 - min/ft: 18.0, 15.0, 25.0, 8.0, 11.0 REC = 95%, RQD = 88.3% Very hard, slightly weathered to fresh, extremely fractured to sound, gray, medium-grained, RHYOLITE
25	150.0								Bottom of borehole at 23.5 feet. Backfilled borehole with drill cuttings.

GENERAL NOTES:

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

Lahlaf Geotechnical Consulting, Inc.

BORING LOG

B-104-OW
PAGE 1 OF 2

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 5/12/21 **DATE COMPLETED:** 5/12/21
BORING LOCATION: Near southern portion of prop. building
COORDINATES: NA
SURFACE El.: 180.9 ft. (see note 1) **TOTAL DEPTH:** 27 ft.
WEATHER: 50's / Sunny
GROUNDWATER LEVELS:
▽ **DURING DRILLING:** -
▼ **AT END OF DRILLING:** 0.0 ft. / El. 180.9 ft.
▼ **OTHER:** -

DRILLING SUBCONTRACTOR: Northern Drill Service, Inc.
DRILLING FOREMAN: Jon Beirholm
DRILLING METHOD: Drive and wash with 3-inch casing
DRILL RIG TYPE/MODEL: Mobile Drill B-48
HAMMER TYPE: Automatic
HAMMER WEIGHT: 140 lb. **HAMMER DROP:** 30 in.
SPLIT SPOON DIA.: 1.375 in. I.D., 2 in. O.D.
CORE BARREL SIZE: NX
LOGGED BY: NP / FR **CHECKED BY:** AML

Depth (ft.)	El. (ft.)	Sample Interval (ft.)	Sample Number	Blow Counts (N Value)	Pen./Rec. (in.)	Remark	Strata	Depth El.(ft.)	Material Description
	180.0	0 0.7	S1	1-100/2"	8/1	1	Forest Mat	0.7 180.2	S1 - Forest Mat REMARK 1: Split spoon sampler refusal encountered at depth of 8" on rock.
5	175.0	2	C1		60/60		Rock		C1 - min/ft: 5.2, 5.1, 4.1, 3.1, 3.1 REC = 100%, RQD = 76.7% Hard to very hard, slightly weathered to fresh, moderately fractured to sound, gray, fine-grained to medium-grained, RHYOLITE
10	170.0	7	C2		60/59				C2 - min/ft: 2.6, 2.5, 2.5, 2.9, 3.1 REC = 98.3, RQD = 67.5% Hard to very hard, moderately weathered to fresh, moderately fractured to sound, gray, fine-grained to medium-grained, RHYOLITE
15	165.0	12	C3		60/60				C3 - min/ft: 2.7, 2.5, 2.3, 2.7, 3.2 REC = 100%, RQD = 81.7% Hard to very hard, slightly weathered to fresh, moderately fractured to sound, gray, fine-grained to medium-grained, RHYOLITE
20	160.0	17	C4		60/60				C4 - min/ft: 5.2, 5.7, 3.5, 6.0, 7.1 REC = 100%, RQD = 93.3% Hard to very hard, fresh, moderately fractured to sound, gray, fine-grained to medium-grained, RHYOLITE
25		22	C5		60/60				C5 - min/ft: 5.5, 4.5, 5.3, 4.2, 4.5 REC = 100%, RQD = 84.2% Hard to very hard, fresh, moderately fractured to sound, gray, fine-grained to medium-grained, RHYOLITE

GENERAL NOTES:

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

LGCI
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BORING LOG

B-104-OW

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

Depth (ft.)	El. (ft.)	Sample Interval (ft.)	Sample Number	Blow Counts (N Value)	Pen./Rec. (in.)	Remark	Strata	Depth El.(ft.)	Material Description
	155.0	22 27					Rock	180.2 27.0	
									Bottom of borehole at 27.0 feet. Backfilled borehole with drill cuttings. Installed groundwater observation well.
30	150.0								
35	145.0								
40	140.0								
45	135.0								
50	130.0								
55	125.0								
60									

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

B-105
PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 4/26/21 **DATE COMPLETED:** 4/26/21
BORING LOCATION: Near SW corner of prop. building
COORDINATES: NA
SURFACE El.: 161.5 ft. (see note 1) **TOTAL DEPTH:** 17 ft.
WEATHER: 50's / Sunny
GROUNDWATER LEVELS:
▽ **DURING DRILLING:** -
▼ **AT END OF DRILLING:** 2.0 ft. / El. 159.5 ft.
▼ **OTHER:** -

DRILLING SUBCONTRACTOR: Northern Drill Service, Inc.
DRILLING FOREMAN: Jon Beirholm
DRILLING METHOD: Drive and wash with 4-inch casing
DRILL RIG TYPE/MODEL: Diedrich D-25 Track Rig
HAMMER TYPE: Automatic
HAMMER WEIGHT: 140 lb. **HAMMER DROP:** 30 in.
SPLIT SPOON DIA.: 1.375 in. I.D., 2 in. O.D.
CORE BARREL SIZE: NX
LOGGED BY: NP **CHECKED BY:** AML

Depth (ft.)	El. (ft.)	Sample Interval (ft.)	Sample Number	Blow Counts (N Value)	Pen./Rec. (in.)	Remark	Strata	Depth El.(ft.)	Material Description
	160.0	0	S1	1-3-2-3 (5)	24/12		Forest Mat Subsoil	0.3	S1 - Top 4": Forest Mat Bot 8": Silty SAND (SM), fine to medium, 30-35% fines, 5-10% fine subrounded gravel, trace of organic soil, trace of roots, brown, moist
		2	S2	4-33-67	18/11		Sand	2.0 ▼	S2 - Poorly Graded SAND with Silt and Gravel (SP-SM), fine to medium, trace coarse, ~10% fines, ~25% fine to coarse subrounded gravel, light brown, moist (natural)
5	155.0	3.5						3.5	
10	150.0	7	C1		60/57		Rock		C1 - min/ft: 3.5, 5.1, 10.5, 31.2, 32.1 REC = 95%, RQD = 95% Hard to very hard, slightly weathered to fresh, slightly fractured to sound, gray with brown mottles, fine-grained to medium-grained, RHYOLITE
15	145.0	12	C2		60/54	1			REMARK 1: Switched to series 6 turbo rock core bit from a series 4 rock core bit at depth of 12'. C2 - min/ft: 8.1, 8.5, 15.2, 18.1, 19.2 REC = 90%, RQD = 86.7% Hard to very hard, fresh, moderately fractured to sound, gray, fine-grained to medium-grained, RHYOLITE
20	140.0	17						17.0	Bottom of borehole at 17.0 feet. Backfilled borehole with drill cuttings.
25									

GENERAL NOTES:

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

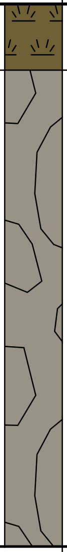
BORING LOG

B-106

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 4/27/21
DATE COMPLETED: 5/14/21
BORING LOCATION: Near SE corner of prop. building
COORDINATES: NA
SURFACE El.: 161.9 ft. (see note 1)
TOTAL DEPTH: 11.5 ft.
WEATHER: 50's / Sunny
GROUNDWATER LEVELS:
▽ **DURING DRILLING:** -
▼ **AT END OF DRILLING:** 1.0 ft. / El. 160.9 ft.
▼ **OTHER:** -

DRILLING SUBCONTRACTOR: Northern Drill Service, Inc.
DRILLING FOREMAN: Jon Beirholm
DRILLING METHOD: Drive and wash with 4-inch casing
DRILL RIG TYPE/MODEL: Deidrich D-25 Track Rig
HAMMER TYPE: Automatic
HAMMER WEIGHT: 140 lb.
HAMMER DROP: 30 in.
SPLIT SPOON DIA.: 1.375 in. I.D., 2 in. O.D.
CORE BARREL SIZE: NX
LOGGED BY: NP / FR
CHECKED BY: AML



Depth (ft.)	El. (ft.)	Sample Interval (ft.)	Sample Number	Blow Counts (N Value)	Pen./Rec. (in.)	Remark	Strata	Depth El.(ft.)	Material Description
		0 1.3	S1	1-3-100/3"	15/4	1	Forest Mat	▼ 1.4 160.5	S1 - Forest Mat REMARK 1: Split spoon sampler refusal encountered on rock at depth of 1.4'.
	160.0								
5		3.5	C1		36/29.5		Rock		C1 - min/ft: 32.9, 65.1, 42.0 REC = 82%, RQD = 75% Hard to very hard, fresh, moderately fractured to sound, gray, fine-grained to medium-grained, RHYOLITE
	155.0	6.5	C2		60/56				C2 - min/ft: 5.5, 5.0, 6.0, 2.5, 6.5 REC = 93%, RQD = 75% Hard to very hard, fresh, extremely fractured to sound, blue, fine-grained to medium-grained, RHYOLITE
10									
	150.0	11.5						11.5	Bottom of borehole at 11.5 feet. Backfilled borehole with drill cuttings.
15									
	145.0								
20									
	140.0								
25									

GENERAL NOTES:

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: "Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

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BORING LOG

B-201

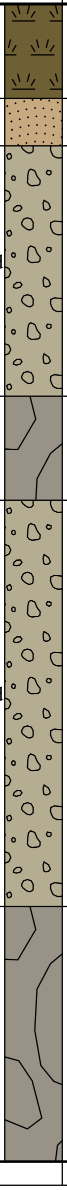
PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 4/28/22 **DATE COMPLETED:** 4/28/22
BORING LOCATION: Near SW corner of prop. building
COORDINATES: NA
SURFACE El.: 167 ft. (see note 1) **TOTAL DEPTH:** 24.5 ft.
WEATHER: 50's / Sunny
GROUNDWATER LEVELS:
▽ **DURING DRILLING:** 3.0 ft. / El. 164.0 ft. Based on sample moisture
▼ **AT END OF DRILLING:** 2.0 ft. / El. 165.0 ft.
▼ **OTHER:** -

DRILLING SUBCONTRACTOR: Northern Drill Service, Inc.
DRILLING FOREMAN: Jon Beirholm
DRILLING METHOD: Drive and wash with 4-inch casing
DRILL RIG TYPE/MODEL: Mobile B-48 ATV Rig
HAMMER TYPE: Automatic
HAMMER WEIGHT: 140 lb. **HAMMER DROP:** 30 in.
SPLIT SPOON DIA.: 1.375 in. I.D., 2 in. O.D.
CORE BARREL SIZE: NX
LOGGED BY: NP **CHECKED BY:** HH

Depth (ft.)	El. (ft.)	Sample Interval (ft.)	Sample Number	Blow Counts (N Value)	Pen./Rec. (in.)	Remark	Strata	Depth El.(ft.)	Material Description
		0	S1	0-0-1-1 (1)	24/8		Forest Mat		S1 - Forest Mat
	165.0	2	S2	1-1-1-2 (2)	24/22		Subsoil	2.0 ▼	S2 - Top 12": Silty SAND (SM), fine, 40-45% slighty plastic fines, trace of organic soil, trace of roots, brown, moist
								3.0 ▽ 164.0	Bot. 10": Silty SAND (SM), fine, 30-35% fines, trace of organic soil, trace of roots, light brown, wet
5		4	S3	9-28-42-34 (70)	24/12		Sand and Gravel		S3 - Silty SAND (SM), mostly fine, 40-45% fines, 10-15% fine subrounded gravel, light brown, wet
	160.0	6	S4	28-42-44-100/3" (86)	21/19				S4 - Silty SAND with Gravel (SM), fine to coarse, 15-20% fines, 20-25% fine subrounded gravel, light brown, wet
		7.8				1			REMARK 1: Split spoon refusal encountered at 7.8' on possible boulder.
		8	S5	100/3"	3/2				S5 - Silty SAND with Gravel (SM), fine to coarse, 20-25% fines, 20-25% fine subangular gravel, light brown, wet
10		8.3				2	Boulder	8.3 158.7	REMARK 2: Split spoon refusal encountered at 8.3' on boulder. Drilled to 10.5' through boulder.
	155.0	10.5	S6	52-65-63-81 (128)	24/17		Sand and Gravel	10.5 156.5	S6 - Similar to S5, 15-20% fines (possible weathered rock)
		12.5							
15		14	S7	39-56-92-100/3" (148)	21/11				S7 - Silty SAND with Gravel (SM), fine to coarse, 15-20% fines, ~35% fine to coarse subangular gravel, light brown, wet (possible weathered rock)
	150.0	15.8							
		19	S8	100/1"	1/1	3		19.1 147.9	S8 - Similar to S7 REMARK 3: Split spoon refusal encountered at 19.1' on rock. Drilled to 19.5' and began rock core.
20	145.0	19.1 19.5	C1		60/55		Rock		C1 - min/ft: 3.0, 3.0, 3.5, 2.5, 2.5 REC = 91.67%, RQD = 11.67% Soft to Hard, moderately weathered to slightly weathered, extremely fractured to lightly fractured, medium-grained, gray, RHYOLITE
25		24.5						24.5	Bottom of borehole at 24.5 feet. Backfilled borehole with drill cuttings.



GENERAL NOTES:

1. The ground surface elevation was interpolated to the nearest foot from drawing titled: "Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by DRA via e-mail on June 3, 2022.

BORING LOG

B-202

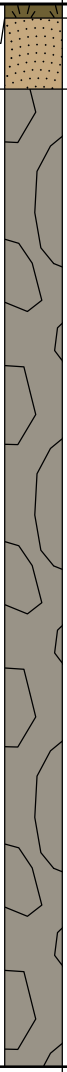
PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 4/27/22 **DATE COMPLETED:** 4/28/22
BORING LOCATION: Near SE corner of prop. building
COORDINATES: NA
SURFACE El.: 176 ft. (see note 1) **TOTAL DEPTH:** 22.5 ft.
WEATHER: 50's/ Cloudy
GROUNDWATER LEVELS:
∇ **DURING DRILLING:** -
▼ **AT END OF DRILLING:** 5.2 ft. / El. 170.8 ft.
▼ **OTHER:** -

DRILLING SUBCONTRACTOR: Northern Drill Service, Inc.
DRILLING FOREMAN: Jon Beirholm
DRILLING METHOD: Drive and wash with 4-inch casing
DRILL RIG TYPE/MODEL: Mobile B-48 ATV Rig
HAMMER TYPE: Automatic
HAMMER WEIGHT: 140 lb. **HAMMER DROP:** 30 in.
SPLIT SPOON DIA.: 1.375 in. I.D., 2 in. O.D.
CORE BARREL SIZE: NX
LOGGED BY: NP **CHECKED BY:** HH

Depth (ft.)	El. (ft.)	Sample Interval (ft.)	Sample Number	Blow Counts (N Value)	Pen./Rec. (in.)	Remark	Strata	Depth El.(ft.)	Material Description
	175.0	0 1.8	S1	0-0-1-100/3" (1)	21/6		Forest Mat Subsoil	0.3 175.7	S1 - Top 4": Forest Mat Bot. 2": Silty SAND with Gravel (SM), fine to coarse, 30-35% fines, 30-35% fine to coarse subrounded gravel, brown to dark brown, moist
		1.8 2.5				1		1.8 174.2	REMARK 1: Split spoon refusal at 1.8' on rock. Drilled to 2.5' and began rock core
5	170.0	2.5 7.5	C1		60/60		Rock		C1 - min/ft: 4.7, 3.2, 3.0, 3.7, 4.8 REC = 100%, RQD = 58.3% Hard, moderately weathered to fresh, extremely fractured to slightly fractured, gray, medium-grained, RHYOLITE ▼
10	165.0	7.5 12.5	C2		60/60				C2 - min/ft: 3.8, 3.1, 3.0, 3.5, 2.8 REC = 100%, RQD = 91.67% Hard, slightly weathered to fresh, moderately fractured to sound, gray, medium-grained, RHYOLITE
15	160.0	12.5 17.5	C3		60/60				C3 - min/ft: 3.5, 4.1, 4.1, 3.8, 4.0 REC = 100%, RQD = 86.67% Hard, slightly weathered to fresh, moderately fractured to sound, gray, medium-grained, RHYOLITE
20	155.0	17.5 22.5	C4		60/60			22.5	C4 - min/ft: 4.8, 4.0, 3.8, 3.6, 3.9 REC = 100%, RQD = 58.33% Hard, slightly weathered to fresh, extremely fractured to slightly fractured, gray, medium-grained, RHYOLITE
25									Bottom of borehole at 22.5 feet. Backfilled borehole with drill cuttings and 2 bags of asphalt.



GENERAL NOTES:

1. The ground surface elevation was interpolated to the nearest foot from drawing titled: "Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by DRA via e-mail on June 3, 2022.

Lahlaf Geotechnical Consulting, Inc.

BORING LOG

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PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.

PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.

LGCI PROJECT NUMBER: 2025

PROJECT LOCATION: Wakefield, MA

DATE STARTED: 5/2/22 **DATE COMPLETED:** 5/6/22

BORING LOCATION: Near eastern side of prop. building

COORDINATES: NA

SURFACE El.: 167 ft. (see note 1) **TOTAL DEPTH:** 11.5 ft.

WEATHER: 50's / Cloudy

GROUNDWATER LEVELS:

▽ **DURING DRILLING:** -

▼ **AT END OF DRILLING:** 1.0 ft. / El. 166.0 ft.

▼ **OTHER:** -

DRILLING SUBCONTRACTOR: Northern Drill Service, Inc.

DRILLING FOREMAN: Jon Beirholm

DRILLING METHOD: Drive and wash with 4-inch casing

DRILL RIG TYPE/MODEL: Mobile Drill B-48 ATV Rig

HAMMER TYPE: Automatic

HAMMER WEIGHT: 140 lb. **HAMMER DROP:** 30 in.

SPLIT SPOON DIA.: 1.375 in. I.D., 2 in. O.D.

CORE BARREL SIZE: NX

LOGGED BY: NP / HO **CHECKED BY:** HH

Depth (ft.)	El. (ft.)	Sample Interval (ft.)	Sample Number	Blow Counts (N Value)	Pen./Rec. (in.)	Remark	Strata	Depth El.(ft.)	Material Description
	165.0	0 2	S1	0-2-3-100 (5)	24/5		Forest Mat Subsoil	0.2 166.8 2.0 165.0	S1 - Top 2": Forest Mat ▼ Bot. 3": Silty SAND with Gravel (SM), fine to coarse, 30-35% fines, 15-20% fine subrounded gravel, dark brown, moist
5	160.0	2.5	C1		60/60	1	Rock		C1 - min/ft: 8.5, 60, 104.9, 211, 16.3 REC = 100%, RQD = 83.33% Very hard, moderately weathered to fresh, moderately fractured to sound, gray, medium-grained, RHYOLITE REMARK 1: Consumed 9 tanks (2900) gallons of water during coring from 5.5' to 6.5'.
10	155.0	7.5 11.5	C2		48/47	2		11.5	C2 - min/ft: 10.2, 14.1, 32.7, 49.6 REC = 97.92%, RQD = 46.88% Very hard, moderately weathered, moderately fractured to slightly fractured, gray, fine-grained to medium-grained, RHYOLITE REMARK 2: Rock core barrel jammed at 7.7' due to core fracure.
15	150.0								Bottom of borehole at 11.5 feet. Backfilled borehole with drill cuttings and 2 bags of gravel.
20	145.0								
25									

GENERAL NOTES:

1. The ground surface elevation was interpolated to the nearest foot from drawing titled: "Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by DRA via e-mail on June 3, 2022.

BORING LOG

B-204-OW

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 5/4/22 **DATE COMPLETED:** 5/4/22
BORING LOCATION: Near center of prop. building
COORDINATES: NA
SURFACE El.: 162 ft. (see note 1) **TOTAL DEPTH:** 25.5 ft.
WEATHER: 50's / Rain
GROUNDWATER LEVELS:
▽ **DURING DRILLING:** 4.0 ft. / El. 158.0 ft. Based on Sample Moisture
▼ **AT END OF DRILLING:** 1.0 ft. / El. 161.0 ft.
▼ **OTHER:** 3.0 ft. / El. 159.0 ft. Monitored on 5/5

DRILLING SUBCONTRACTOR: Northern Drill Service, Inc.
DRILLING FOREMAN: Jon Beirholm
DRILLING METHOD: Drive and wash with 4-inch then 3-inch casing
DRILL RIG TYPE/MODEL: Mobile Drill B-48 ATV Rig
HAMMER TYPE: Automatic
HAMMER WEIGHT: 140 lb. **HAMMER DROP:** 30 in.
SPLIT SPOON DIA.: 1.375 in. I.D., 2 in. O.D.
CORE BARREL SIZE: NX
LOGGED BY: HO **CHECKED BY:** HH

Depth (ft.)	El. (ft.)	Sample Interval (ft.)	Sample Number	Blow Counts (N Value)	Pen./Rec. (in.)	Remark	Strata	Depth El.(ft.)	Material Description
	160.0	0 2	S1	1-1-1-2 (2)	24/10		Forest Mat Subsoil	0.3 161.7 ▼	S1 - Top 4": Forest Mat Bot. 6": SILT with Sand (ML), non-plastic, 25-30% fine to medium sand, trace coarse sand, 0-5% fine subrounded gravel, brown, moist
		2 4	S2	3-14-22-28 (36)	24/16		Sand and Gravel	2.7 159.3 ▼	S2 - Top 8": Similar to S1 Bot. 6" Bot. 8": Well Graded GRAVEL with Silt and Sand (GW-GM), fine to coarse, angular, 5-10% fines, 40-45% fine to coarse sand, brown to gray, moist
5		4 4.3	S3	100/4"	4/4			▽ 4.4 157.6	S3 - Silty SAND with Gravel (SM), fine to coarse, 15-20% fines, 35-40% fine to coarse subrounded gravel, light brown, wet
10	155.0	5.5	C1		60/58	1 2	Rock		C1 - min/ft: 10.2, 7.1, 3.6, 3.1, 6.4 REC = 96.67%, RQD = 25.83% Hard, moderately weathered, extremely fractured to slightly fractured, gray to olive, fine-grained to medium-grained, RHYOLITE REMARK 1: Rock core barrel jammed at depth 6.5' due to core fracture REMARK 2: Rock core barrel jammed at depth 9' due to core fracture
15	150.0	10.5	C2		60/60				C2 - min/ft: 2.8, 3.3, 3.5, 4.3, 5.4 REC = 100%, RQD = 38.33% Hard to very hard, moderately weathered, moderately fractured to slightly fractured, gray to olive, fine-grained to medium-grained, RHYOLITE
20	145.0	15.5	C3		60/60				C3 - min/ft: 5.0, 4.8, 5.0, 7.7, 11.5 REC = 100%, RQD = 82.5% Hard, moderately weathered to fresh, moderately fractured to sound, gray to olive, fine-grained to medium-grained, RHYOLITE
25	140.0	20.5	C4		60/60	3			C4 - min/ft: 12.2, 9.2, 12.0, 16.7, 17.4 REC = 100%, RQD = 69.17% Hard, moderately weathered to slightly weathered, moderately fractured to sound, gray to olive, fine-grained to medium-grained, RHYOLITE REMARK 3: Rock core barrel jammed at depth 24' due to core fracture

GENERAL NOTES:

1. The ground surface elevation was interpolated to the nearest foot from drawing titled: "Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by DRA via e-mail on June 3, 2022.

LGCI

Lahlaf Geotechnical Consulting, Inc.

BORING LOG

B-204-OW

CLIENT: Drummey Rosane Anderson, Inc.

PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.

LGCI PROJECT NUMBER: 2025

PROJECT LOCATION: Wakefield, MA

Depth (ft.)	El. (ft.)	Sample Interval (ft.)	Sample Number	Blow Counts (N Value)	Pen./Rec. (in.)	Remark	Strata	Depth El.(ft.)	Material Description
		20.5 25.5					Rock	157.6 25.5	Bottom of borehole at 25.5 feet. Installed groundwater observation well.
	135.0								
30									
	130.0								
35									
	125.0								
40									
	120.0								
45									
	115.0								
50									
	110.0								
55									
	105.0								
60									

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

B-206

PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 4/28/22
DATE COMPLETED: 4/29/22
BORING LOCATION: Near NW corner of prop. building
COORDINATES: NA
SURFACE El.: 181 ft. (see note 1)
TOTAL DEPTH: 21.5 ft.
WEATHER: 40's/ Sunny
GROUNDWATER LEVELS:
∇ **DURING DRILLING:** -
▼ **AT END OF DRILLING:** 4.5 ft. / El. 176.5 ft.
▼ **OTHER:** -

DRILLING SUBCONTRACTOR: Northern Drill Service, Inc.
DRILLING FOREMAN: Jon Beirholm
DRILLING METHOD: Drive and wash with 4-inch casing
DRILL RIG TYPE/MODEL: Mobile Drill B-48 ATV Rig
HAMMER TYPE: Automatic
HAMMER WEIGHT: 140 lb.
HAMMER DROP: 30 in.
SPLIT SPOON DIA.: 1.375 in. I.D., 2 in. O.D.
CORE BARREL SIZE: NX
LOGGED BY: HO / NP
CHECKED BY: HH

Depth (ft.)	El. (ft.)	Sample Interval (ft.)	Sample Number	Blow Counts (N Value)	Pen./Rec. (in.)	Remark	Strata	Depth El.(ft.)	Material Description
	180.0	0 1.3	S1	1-1-100/4"	16/4		Forest Mat	1.3	S1 - Forest Mat
5	175.0	1.5 6.5	C1		60/60	1 2	Rock		C1 - min/ft: 4.0, 4.2, 3.6, 7.3, 8.1 REC = 100%, RQD = 41.67% Hard to very hard, moderately weathered to fresh, extremely fractured to sound, gray, fine-grained to medium-grained, RHYOLITE REMARK 1: Rock core barrel jammed at 3' due to core fracture ▼ REMARK 2: Rock core barrel jammed at 4.5' due to core fracture
10	170.0	11.5	C2		60/60				C2 - min/ft: 3.6, 3.5, 3.7, 4.3, 4.4 REC = 100%, RQD = 77.5% Hard to very hard, slightly weathered to fresh, moderately fractured to sound, gray, fine-grained to medium-grained, RHYOLITE
15	165.0	16.5	C3		60/60				C3 - min/ft: 4.3, 4.4, 4.3, 6.7, 7.5 REC = 100%, RQD = 86.67% Hard to very hard, slightly weathered to fresh, moderately fractured to sound, gray, fine-grained to medium-grained, RHYOLITE
20	160.0	21.5	C4		60/60			21.5	C4 - min/ft: 5.1, 4.6, 4.5, 5.7, 7.0 REC = 100%, RQD = 95.83% Hard to very hard, slightly weathered to fresh, moderately fractured to sound, gray, fine-grained to medium-grained, RHYOLITE
25									Bottom of borehole at 21.5 feet. Backfilled borehole with drill cuttings and 4 bags of gravel.

GENERAL NOTES:

1. The ground surface elevation was interpolated to the nearest foot from drawing titled: "Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by DRA via e-mail on June 3, 2022.

Lahlaf Geotechnical Consulting, Inc.

BORING LOG

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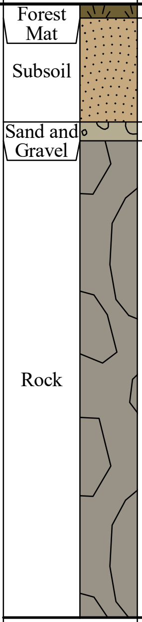
PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 5/5/22 **DATE COMPLETED:** 5/5/22
BORING LOCATION: Near northern side of prop. building
COORDINATES: NA
SURFACE El.: 139 ft. (see note 1) **TOTAL DEPTH:** 13 ft.
WEATHER: 50's / Sunny
GROUNDWATER LEVELS:
∇ **DURING DRILLING:** -
▼ **AT END OF DRILLING:** 2.0 ft. / El. 137.0 ft.
▼ **OTHER:** -

DRILLING SUBCONTRACTOR: Northern Drill Service, Inc.
DRILLING FOREMAN: Jon Beirholm
DRILLING METHOD: Drive and wash with 4-inch casing
DRILL RIG TYPE/MODEL: Mobile Drill B-48 ATV Rig
HAMMER TYPE: Automatic
HAMMER WEIGHT: 140 lb. **HAMMER DROP:** 30 in.
SPLIT SPOON DIA.: 1.375 in. I.D., 2 in. O.D.
CORE BARREL SIZE: NX
LOGGED BY: HO **CHECKED BY:** HH



Depth (ft.)	El. (ft.)	Sample Interval (ft.)	Sample Number	Blow Counts (N Value)	Pen./Rec. (in.)	Remark	Strata	Depth El.(ft.)	Material Description
		0	S1	1-1-2-3 (3)	24/10		Forest Mat Subsoil	0.3 138.7 ▼	S1 - Top 4": Forest Mat Bot. 6": Silty SAND (SM), fine, 25-30% fines, dark brown, moist
		2 2.9	S2	6-100/5"	11/10		Sand and Gravel	2.5 2.9 136.1	S2 - Top 6": Similar to S1 Bot. 6" Bot. 4": Well Graded GRAVEL with Silt and Sand (GW-GM), fine to coarse, angular, 5-10% fines, 20-25% fine to coarse sand, gray to brown, moist
5	135.0	3	C1		60/60	1	Rock		C1 - min/ft: 5.1, 4.7, 7.2, 3.4, 5.2 REC = 100%, RQD = 45% Hard to very hard, moderately weathered, moderately fractured to slightly fractured, gray, fine-grained to medium-grained, RHYOLITE REMARK 1: Rock core barrel jammed at 5.7' due to core fracture
10	130.0	8	C2		60/57				C2 - min/ft: 2.5, 4.8, 5.6, 8.1, 9.7 REC = 95%, RQD = 90% Very hard, moderately weathered to fresh, extremely fractured to sound, gray, fine-grained to medium-grained, RHYOLITE
15	125.0	13						13.0	Bottom of borehole at 13.0 feet. Backfilled borehole with drill cuttings and 2 bags of gravel.
20	120.0								
25	115.0								

GENERAL NOTES:

1. The ground surface elevation was interpolated to the nearest foot from drawing titled: "Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by DRA via e-mail on June 3, 2022.

BORING LOG

B-208-OW

CLIENT: Drummey Rosane Anderson, Inc.

PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.

LGCI PROJECT NUMBER: 2025

PROJECT LOCATION: Wakefield, MA

DATE STARTED: 4/26/22

DATE COMPLETED: 4/27/22

BORING LOCATION: Near western side of prop. building

COORDINATES: NA

SURFACE El.: 193 ft. (see note 1)

TOTAL DEPTH: 37 ft.

WEATHER: 50's / Cloudy

GROUNDWATER LEVELS:

∇ **DURING DRILLING:** -

▼ **AT END OF DRILLING:** 7.0 ft. / El. 186.0 ft.

▼ **OTHER:** -

DRILLING SUBCONTRACTOR: Northern Drill Service, Inc.

DRILLING FOREMAN: Jon Beirholm

DRILLING METHOD: Drive and wash with 4-inch casing

DRILL RIG TYPE/MODEL: Mobile B-48 ATV Rig

HAMMER TYPE: Automatic

HAMMER WEIGHT: 140 lb.

HAMMER DROP: 30 in.

SPLIT SPOON DIA.: 1.375 in. I.D., 2 in. O.D.

CORE BARREL SIZE: NX

LOGGED BY: NP

CHECKED BY: HH

Depth (ft.)	El. (ft.)	Sample Interval (ft.)	Sample Number	Blow Counts (N Value)	Pen./Rec. (in.)	Remark	Strata	Depth El.(ft.)	Material Description
		0 1.5	S1	1-1-100	18/7	1	Forest Mat Subsoil	0.3 192.7 1.5 191.5	S1 - Top 3": Forest Mat Bot. 4": Silty SAND (SM), fine, 25-30% fines, trace organic soil, trace of roots, brown to dark brown, moist REMARK 1: Split spoon refusal encountered at 1.5' on rock. Drilled to 2' and began rock core
5	190.0	2	C1		60/56		Rock		C1 - min/ft: 2.8, 2.8, 3.5, 3.7, 4.2 REC = 93.33%, RQD = 74.16% Hard to very hard, slightly weathered to fresh, moderately fractured to sound, gray, medium-grained, RHYOLITE
10	185.0	7	C2		60/60			▼	C2 - min/ft: 3.5, 3.9, 5.5, 4.5, 4.5 REC = 100%, RQD = 93.33% Very hard, fresh, slightly fractured to sound, gray, medium-grained, RHYOLITE
15	180.0	12	C3		60/60				C3 - min/ft: 3.6, 3.0, 3.2, 3.9, 5.5 REC = 100%, RQD = 86% Very hard, slightly weathered to fresh, moderately fractured to sound, gray, medium-grained, RHYOLITE
20	175.0	17	C4		60/60				C4 - min/ft: 4.5, 3.7, 4.7, 5.7, 4.2 REC = 100%, RQD = 100% Very hard, fresh, slightly fractured to sound, gray, medium-grained, RHYOLITE
25	170.0	22	C5		60/58				C5 - min/ft: 5.2, 5.0, 6.5, 5.1, 7.2 REC = 96.67%, RQD = 80% Hard to very hard, slightly weathered to fresh, extremely fractured to sound, gray, medium-grained, RHYOLITE

GENERAL NOTES:

1. The ground surface elevation was interpolated to the nearest foot from drawing titled: "Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by DRA via e-mail on June 3, 2022.

BORING LOG

B-208-OW

CLIENT: Drummey Rosane Anderson, Inc.

PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.

LGCI PROJECT NUMBER: 2025

PROJECT LOCATION: Wakefield, MA

Depth (ft.)	El. (ft.)	Sample Interval (ft.)	Sample Number	Blow Counts (N Value)	Pen./Rec. (in.)	Remark	Strata	Depth El.(ft.)	Material Description
		22						191.5	
	165.0	27							
30			C6		60/60		Rock		C6 - min/ft: 4.5, 3.9, 3.7, 6.5, 6.1 REC = 100%, RQD = 87.5% Hard to very hard, slightly weathered to fresh, moderately fractured to sound, gray, medium-grained, RHYOLITE
	160.0	32							
35			C7		60/56				C7 - min/ft: 5.8, 4.9, 5.2, 5.0, 5.3 REC = 93.33%, RQD = 88.33% Hard to very hard, slightly weathered to fresh, moderately fractured to sound, gray, medium-grained, RHYOLITE
		37						37.0	Bottom of borehole at 37.0 feet. Installed groundwater observation well.
	155.0								
40									
	150.0								
45									
	145.0								
50									
	140.0								
55									
	135.0								
60									

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BORING LOG

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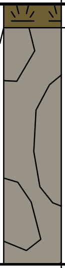
PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 4/29/22
DATE COMPLETED: 4/29/22
BORING LOCATION: Near southern side of prop. building
COORDINATES: NA
SURFACE El.: 152 ft. (see note 1)
TOTAL DEPTH: 5.5 ft.
WEATHER: 40's / Sunny
GROUNDWATER LEVELS:
▽ **DURING DRILLING:** -
▼ **AT END OF DRILLING:** Not encountered
▼ **OTHER:** -

DRILLING SUBCONTRACTOR: Northern Drill Service, Inc.
DRILLING FOREMAN: Jon Beirholm
DRILLING METHOD: Drive and wash with 4-inch casing
DRILL RIG TYPE/MODEL: Mobile Drill B-48 ATV Rig
HAMMER TYPE: Automatic
HAMMER WEIGHT: 140 lb.
HAMMER DROP: 30 in.
SPLIT SPOON DIA.: 1.375 in. I.D., 2 in. O.D.
CORE BARREL SIZE: NX
LOGGED BY: HO
CHECKED BY: HH



Depth (ft.)	El. (ft.)	Sample Interval (ft.)	Sample Number	Blow Counts (N Value)	Pen./Rec. (in.)	Remark	Strata	Depth El.(ft.)	Material Description
		0 0.5	S1	100	6/6		Forest Mat	0.5	S1 - Forest Mat
	150.0		C1		60/52		Rock		C1 - min/ft: 3.1, 3.9, 5.1, 5.7, 5.3, REC = 86.67%, RQD = 86.67% Very hard, fresh, slightly fractured to sound, gray, fine-grained to medium-grained, RHYOLITE
5		5.5						5.5	
	145.0								Bottom of borehole at 5.5 feet. Backfilled borehole with drill cuttings and 1 bag of gravel.
10									
	140.0								
15									
	135.0								
20									
	130.0								
25									

GENERAL NOTES:

1. The ground surface elevation was interpolated to the nearest foot from drawing titled: "Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by DRA via e-mail on June 3, 2022.

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BORING LOG

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PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 5/9/22 **DATE COMPLETED:** 5/9/22
BORING LOCATION: Near SE side of prop. soccer field
COORDINATES: NA
SURFACE El.: 80 ft. (see note 1) **TOTAL DEPTH:** 10 ft.
WEATHER: 50's / Sunny
GROUNDWATER LEVELS:
▽ **DURING DRILLING:** -
▼ **AT END OF DRILLING:** 1.0 ft. / El. 79.0 ft.
▼ **OTHER:** -

DRILLING SUBCONTRACTOR: Northern Drill Service, Inc.
DRILLING FOREMAN: Jon Beirholm
DRILLING METHOD: Drive and wash with 4-inch casing
DRILL RIG TYPE/MODEL: Mobile Drill B-48 ATV Rig
HAMMER TYPE: Automatic
HAMMER WEIGHT: 140 lb. **HAMMER DROP:** 30 in.
SPLIT SPOON DIA.: 1.375 in. I.D., 2 in. O.D.
CORE BARREL SIZE: NA
LOGGED BY: HO **CHECKED BY:** HH

Depth (ft.)	El. (ft.)	Sample Interval (ft.)	Sample Number	Blow Counts (N Value)	Pen./Rec. (in.)	Remark	Strata	Depth El.(ft.)	Material Description
		0	S1	15-11-9-8 (20)	24/11		Asphalt	0.3 79.7	S1 - Top 3": Asphalt ▼ Bot. 8": Silty SAND with Gravel (SM), fine to medium, ~15% fines, 30-35% fine to coarse subangular gravel, brown, moist
		2	S2	14-17-10-12 (27)	24/11		Fill		S2 - Silty SAND with Gravel (SM), fine to coarse, 20-25% fines, 15-20% fine to coarse subangular gravel, trace of bricks, brown to orange, moist
5	75.0	4	S3	12-29-37-49 (66)	24/19			4.8 75.2	S3 - Top 10": Well Graded SAND with Silt and Gravel (SW-SM), fine to coarse, 5-10% fines, 15-20% fine to coarse subangular gravel, trace of brick, brown, moist
		6				1	Sand and Gravel		Bot. 9": Similar to S3 Top 10", 25-30% fine to coarse subangular gravel REMARK 1: Drill rig chattering from 6' to 7' on possible cobbles
						2	Rock	8.0 72.0	REMARK 2: Casing refusal at 8'
10	70.0					3		10.0	REMARK 3: Advanced roller bit from 8' to 10' to confirm presence of rock Bottom of borehole at 10.0 feet. Backfilled borehole with drill cuttings and 1 bag of gravel. Ground surface restored with asphalt cold patch.
15	65.0								
20	60.0								
25	55.0								

GENERAL NOTES:

1. The ground surface elevation was interpolated to the nearest foot from drawing titled: "Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by DRA via e-mail on June 3, 2022.

Lahlaf Geotechnical Consulting, Inc.

BORING LOG

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PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 5/9/22 **DATE COMPLETED:** 5/9/22
BORING LOCATION: Near southern side of prop. soccer field
COORDINATES: NA
SURFACE El.: 79 ft. (see note 1) **TOTAL DEPTH:** 20.1 ft.
WEATHER: 50's / Sunny
GROUNDWATER LEVELS:
▽ **DURING DRILLING:** 9.0 ft. / El. 70.0 ft. Based on sample moisture
▼ **AT END OF DRILLING:** 6.1 ft. / El. 72.9 ft.
▼ **OTHER:** -

DRILLING SUBCONTRACTOR: Northern Drill Service, Inc.
DRILLING FOREMAN: Jon Beirholm
DRILLING METHOD: Drive and wash with 4-inch casing
DRILL RIG TYPE/MODEL: Mobile Drill B-48 ATV Rig
HAMMER TYPE: Automatic
HAMMER WEIGHT: 140 lb. **HAMMER DROP:** 30 in.
SPLIT SPOON DIA.: 1.375 in. I.D., 2 in. O.D.
CORE BARREL SIZE: NA
LOGGED BY: HO **CHECKED BY:** HH

Depth (ft.)	El. (ft.)	Sample Interval (ft.)	Sample Number	Blow Counts (N Value)	Pen./Rec. (in.)	Remark	Strata	Depth El.(ft.)	Material Description
		0					Topsoil	0.5 78.5	S1 - Top 6": Topsoil
		0 2	S1	1-2-3-8 (5)	24/13		Fill		Bot. 7": Silty SAND with Gravel (SM), fine to medium, 15-20% fines, 30-35% fine to coarse subangular gravel, trace of organic soil, brown, moist
		2 4	S2	16-13-14-20 (27)	24/10		Sand and Gravel	2.4 76.6	S2 - Top 5": Similar to S1 Bot. 7", ~15% fine subangular gravel Bot. 5": Poorly Graded SAND with Silt and Gravel (SP-SM), fine to medium, 5-10% fines, 30-35% fine to coarse angular to subangular gravel, brown, moist
5	75.0	4 6	S3	13-27-35-56 (62)	24/13				S3 - Well Graded SAND with SIlt and Gravel (SW-SM), fine to coarse, 5-10% fines, 30-35% fine to coarse angular to subangular gravel, brown, moist
								▼	
10	70.0	9 11	S4	51-22-19-17 (41)	24/13			▽	S4 - Top 4": Silty SAND (SM), fine to medium, ~15% fines, 15-20% fine angular gravel, brown, wet Bot. 9": Silty SAND (SM), fine to medium, trace coarse, 15-20% fines, brown, wet
						1			REMARK 1: Drill rig chattering from 12.5' to 13.5' on possible cobbles
15	65.0	14 16	S5	23-12-18-29 (30)	24/12				S5 - Silty SAND with Gravel (SM), fine to medium, 15-20% fines, 20-25% fine to coarse angular gravel, brown, wet
						2			REMARK 2: Drill rig chattering from 18' to 19' on possible cobbles
20	60.0	19 20.1	S6	39-69-31/1"	13/10			20.1	S6 - Well Graded GRAVEL with Silt and Sand (GW-GM), fine to coarse, angular, 10-15% fines, 20-25% fine to coarse sand, brown wet
									Bottom of borehole at 20.1 feet. Backfilled borehole with drill cuttings and 1 bag of gravel.
25	55.0								

GENERAL NOTES:

1. The ground surface elevation was interpolated to the nearest foot from drawing titled: "Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by DRA via e-mail on June 3, 2022.

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BORING LOG

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PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 5/9/22 **DATE COMPLETED:** 5/9/22
BORING LOCATION: Near SW side of prop. soccer field
COORDINATES: NA
SURFACE El.: 83 ft. (see note 1) **TOTAL DEPTH:** 11 ft.
WEATHER: 50's / Sunny
GROUNDWATER LEVELS:
∇ **DURING DRILLING:** 9.0 ft. / El. 74.0 ft. Based on sample moisture
▼ **AT END OF DRILLING:** 3.5 ft. / El. 79.5 ft.
▼ **OTHER:** -

DRILLING SUBCONTRACTOR: Northern Drill Service, Inc.
DRILLING FOREMAN: Jon Beirholm
DRILLING METHOD: Drive and wash with 4-inch casing
DRILL RIG TYPE/MODEL: Mobile Drill B-48 ATV Rig
HAMMER TYPE: Automatic
HAMMER WEIGHT: 140 lb. **HAMMER DROP:** 30 in.
SPLIT SPOON DIA.: 1.375 in. I.D., 2 in. O.D.
CORE BARREL SIZE: NA
LOGGED BY: HO **CHECKED BY:** HH

Depth (ft.)	El. (ft.)	Sample Interval (ft.)	Sample Number	Blow Counts (N Value)	Pen./Rec. (in.)	Remark	Strata	Depth El.(ft.)	Material Description
		0					Asphalt	0.5 82.5	S1 - Top 6": Asphalt
		0–2	S1	64-12-22-24 (34)	24/17		Fill		Bot. 6": Well Graded GRAVEL with Silt and Sand (GW-GM), fine to coarse, angular, 5-10% fines, 20-25% fine to medium sand, brown, moist
	80.0	2–4	S2	20-10-5-15 (15)	24/7			▼ 4.0 79.0	S2 - Similar to S1 Bot. 6", 40-45% fine to coarse sand, trace of asphalt
5		4–6	S3	18-17-18-16 (35)	24/10		Sand and Gravel		S3 - Silty SAND with Gravel (SM), fine to medium, ~15% fines, 30-35 fine to coarse subangular gravel, brown, moist
	75.0	6–8	S4	20-27-39-39 (66)	24/15				S4 - Top 7": Silty SAND (SM), fine to coarse, 15-20% fines, 0-5% fine subrounded gravel, brown, moist Bot. 8": Well Graded SAND with Silt and Gravel (SW-SM), fine to coarse, 5-10% fines, 30-35% fine to coarse angular gravel, brown, moist
10		9–9.8	S5	56-100/4"	10/7	1		∇ 11.0	S5 - Well Graded GRAVEL with Silt and Sand (GW-GM), fine to coarse, angular to subangular, 5-10% fines, 30-35% fine to coarse sand, brown, wet REMARK 1: Advanced roller bit from 9.8' to 11' to confirm presence of Sand and Gravel Strata
									Bottom of borehole at 11.0 feet. Backfilled borehole with drill cuttings. Ground surface restored with asphalt cold patch.
	70.0								
15									
	65.0								
20									
	60.0								
25									

GENERAL NOTES:

1. The ground surface elevation was interpolated to the nearest foot from drawing titled: "Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by DRA via e-mail on June 3, 2022.

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

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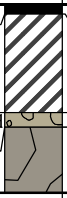
PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 5/9/22
DATE COMPLETED: 5/9/22
BORING LOCATION: Near western side of prop. soccer field
COORDINATES: NA
SURFACE El.: 85 ft. (see note 1)
TOTAL DEPTH: 4 ft.
WEATHER: 50's / Sunny
GROUNDWATER LEVELS:
▽ **DURING DRILLING:** -
▼ **AT END OF DRILLING:** Not encountered
▼ **OTHER:** -

DRILLING SUBCONTRACTOR: Northern Drill Service, Inc.
DRILLING FOREMAN: Jon Beirholm
DRILLING METHOD: Drive and wash with 4-inch casing
DRILL RIG TYPE/MODEL: Mobile Drill B-48 ATV Rig
HAMMER TYPE: Automatic
HAMMER WEIGHT: 140 lb.
HAMMER DROP: 30 in.
SPLIT SPOON DIA.: 1.375 in. I.D., 2 in. O.D.
CORE BARREL SIZE: NA
LOGGED BY: HO
CHECKED BY: HH

Depth (ft.)	El. (ft.)	Sample Interval (ft.)	Sample Number	Blow Counts (N Value)	Pen./Rec. (in.)	Remark	Strata	Depth El.(ft.)	Material Description
		0	S1	12-11-16-21 (27)	24/11		Asphalt	0.2 84.8	S1 - Top 2": Asphalt
							Fill		Bot. 9": Poorly Graded SAND with Silt and Gravel (SP-SM), fine to medium, 5-10% fines, 40-45% fine to coarse subangular gravel, brown, moist
		2	S2	70-100/1"	7/7			2.3	S2 - Top 4": Well Graded SAND with Silt, (SW-SM), fine to coarse, 5-10% fines, 10-15% fine angular gravel, brown, moist
		2.6				1	Sand and Gravel	2.6 82.4	Bot. 3": Well Graded GRAVEL with Sand (GW), fine to coarse, angular, 0-5% fines, 20-25% fine to medium sand, white, moist
							Rock	4.0	REMARK 1: Advanced roller bit from 2.7' to 4' to confirm presence of rock
									Bottom of borehole at 4.0 feet. Backfilled borehole with drill cuttings and 0.5 bags of gravel. Ground surface restored with asphalt cold patch.
5	80.0								
10	75.0								
15	70.0								
20	65.0								
25	60.0								



GENERAL NOTES:

1. The ground surface elevation was interpolated to the nearest foot from drawing titled: "Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by DRA via e-mail on June 3, 2022.

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

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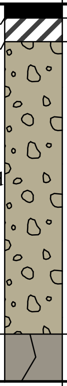
PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 5/10/22 **DATE COMPLETED:** 5/10/22
BORING LOCATION: Near NW side of prop. soccer field
COORDINATES: NA
SURFACE El.: 201 ft. (see note 1) **TOTAL DEPTH:** 8 ft.
WEATHER: 50's /Sunny
GROUNDWATER LEVELS:
▽ **DURING DRILLING:** -
▼ **AT END OF DRILLING:** Not encountered
▼ **OTHER:** -

DRILLING SUBCONTRACTOR: Northern Drill Service, Inc.
DRILLING FOREMAN: Jon Beirholm
DRILLING METHOD: Drive and wash with 4-inch casing
DRILL RIG TYPE/MODEL: Mobile Drill B-48 ATV Rig
HAMMER TYPE: Automatic
HAMMER WEIGHT: 140 lb. **HAMMER DROP:** 30 in.
SPLIT SPOON DIA.: 1.375 in. I.D., 2 in. O.D.
CORE BARREL SIZE: NA
LOGGED BY: HO **CHECKED BY:** HH



Depth (ft.)	El. (ft.)	Sample Interval (ft.)	Sample Number	Blow Counts (N Value)	Pen./Rec. (in.)	Remark	Strata	Depth El.(ft.)	Material Description
		0					Asphalt	0.3	S1 - Top 3": Asphalt
	200.0		S1	21-10-11-15 (21)	24/12		Fill	0.8 200.2	Mid. 6": Well Graded SAND with Silt and Gravel (SW-SM), fine to coarse, 5-10% fines, 20-25% coarse subangular to subrounded gravel, trace of asphalt, brown, moist
		2					Sand and Gravel		Bot. 3": Well Graded GRAVEL with Sand (GW), fine to coarse, angular, 0-5% fines, 30-35% fine to coarse sand, weathered rock, gray, moist
			S2	15-16-16-27 (32)	24/10				S2 - Similar to S1 Bot. 3", 25-30% fine to coarse sand
		4							S3 - Similar to S1 Bot. 3", 20-25% medium to coarse sand
5			S3	25-24-16-16 (40)	24/9				
	195.0	6							
						1	Rock	7.0	REMARK 1: Casing refusal at 7'
						2		8.0	REMARK 2: Advanced roller bit from 7' to 8' to confirm presence of rock Bottom of borehole at 8.0 feet. Backfilled borehole with drill cuttings. Ground surface restored with asphalt cold patch.
10									
	190.0								
15									
	185.0								
20									
	180.0								
25									

GENERAL NOTES:

1. The ground surface elevation was interpolated to the nearest foot from drawing titled: "Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by DRA via e-mail on June 3, 2022.

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

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PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 5/10/22 **DATE COMPLETED:** 5/10/22
BORING LOCATION: Near NE side of prop. soccer field
COORDINATES: NA
SURFACE El.: 89 ft. (see note 1) **TOTAL DEPTH:** 8.5 ft.
WEATHER: 50's / Sunny
GROUNDWATER LEVELS:
∇ **DURING DRILLING:** -
▼ **AT END OF DRILLING:** 4.9 ft. / El. 84.1 ft.
▼ **OTHER:** -

DRILLING SUBCONTRACTOR: Northern Drill Service, Inc.
DRILLING FOREMAN: Jon Beirholm
DRILLING METHOD: Drive and wash with 4-inch casing
DRILL RIG TYPE/MODEL: Mobile Drill B-48 ATV Rig
HAMMER TYPE: Automatic
HAMMER WEIGHT: 140 lb. **HAMMER DROP:** 30 in.
SPLIT SPOON DIA.: 1.375 in. I.D., 2 in. O.D.
CORE BARREL SIZE: NX
LOGGED BY: HO **CHECKED BY:** HH

Depth (ft.)	El. (ft.)	Sample Interval (ft.)	Sample Number	Blow Counts (N Value)	Pen./Rec. (in.)	Remark	Strata	Depth El.(ft.)	Material Description
		0	S1	21-10-11-27 (21)	24/13		Asphalt	0.3 88.7	S1 - Top 3": Asphalt
							Fill		Bot. 10": Poorly Graded SAND with Silt and Gravel (SP-SM), fine to medium, 5-10% fines, 20-25% fine to coarse angular gravel, brown, moist
		2	S2	52-60-40/4"	16/12				S2 - Well Graded SAND with Silt and Gravel (SW-SM), fine to coarse, 5-10% fines, 20-25% fine to coarse angular gravel, brown, moist
		3.3						3.3 85.7	
	85.0	3.5	C1		60/56	1	Rock		C1 - min/ft: 8.2, 6.0, 5.7, 3.2, 3.4 REC = 93.33%, RQD = 15% ▼ Hard, moderately weathered, extremely fractured to slightly fractured, gray, fine-grained to medium-grained, RHYOLITE REMARK 1: Rock core barrel jammed at 6.5' due to core fracture
5									
		8.5						8.5	Bottom of borehole at 8.5 feet. Backfilled borehole with drill cuttings and 1 bag of gravel. Ground surface restored with asphalt cold patch.
	80.0								
10									
	75.0								
15									
	70.0								
20									
	65.0								
25									

GENERAL NOTES:

1. The ground surface elevation was interpolated to the nearest foot from drawing titled: "Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by DRA via e-mail on June 3, 2022.

BORING LOG

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PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 5/10/22 **DATE COMPLETED:** 5/10/22
BORING LOCATION: Near eastern side of prop. soccer field
COORDINATES: NA
SURFACE El.: 89 ft. (see note 1) **TOTAL DEPTH:** 4 ft.
WEATHER: 50's / Sunny
GROUNDWATER LEVELS:
∇ **DURING DRILLING:** -
▼ **AT END OF DRILLING:** 2.0 ft. / El. 87.0 ft.
▼ **OTHER:** -

DRILLING SUBCONTRACTOR: Northern Drill Service, Inc.
DRILLING FOREMAN: Jon Beirholm
DRILLING METHOD: Drive and wash with 4-inch casing
DRILL RIG TYPE/MODEL: Mobile Drill B-48 ATV Rig
HAMMER TYPE: Automatic
HAMMER WEIGHT: 140 lb. **HAMMER DROP:** 30 in.
SPLIT SPOON DIA.: 1.375 in. I.D., 2 in. O.D.
CORE BARREL SIZE: NA
LOGGED BY: HO **CHECKED BY:** HH

Depth (ft.)	El. (ft.)	Sample Interval (ft.)	Sample Number	Blow Counts (N Value)	Pen./Rec. (in.)	Remark	Strata	Depth El.(ft.)	Material Description
		0					Asphalt	0.3	S1 - Top 3": Asphalt
		0–2	S1	23-13-20-64 (33)	24/13		Fill	1.0 88.0	Mid. 9": Poorly Graded SAND with Silt and Gravel (SP-SM), fine to medium, 5-10% fines, 15-20% fine subangular gravel, brown, moist
		2–3.3	S2	34-51-51/3"	15/7		Sand and Gravel	3.5	▼ Bot. 1": Well Graded GRAVEL with Sand (GW), fine to coarse, angular, 0-5% fines, 20-25% fine to coarse sand, weathered rock, gray, moist S2 - Similar to S1 Bot. 1"
						1			REMARK 1: Casing refusal at 3.5'
	85.0					2	Rock	4.0	REMARK 2: Advanced roller bit from 3.5' to 4' to confirm presence of rock Bottom of borehole at 4.0 feet. Backfilled borehole with drill cuttings. Ground surface restored with asphalt cold patch.
5									
	80.0								
10									
	75.0								
15									
	70.0								
20									
	65.0								
25									

GENERAL NOTES:

1. The ground surface elevation was interpolated to the nearest foot from drawing titled: "Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by DRA via e-mail on June 3, 2022.

BORING LOG

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PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 5/10/22 **DATE COMPLETED:** 5/11/22
BORING LOCATION: Near NE side of prop. football field
COORDINATES: NA
SURFACE El.: 88 ft. (see note 1) **TOTAL DEPTH:** 11 ft.
WEATHER: 50's / Sunny
GROUNDWATER LEVELS:
∇ **DURING DRILLING:** 4.0 ft. / El. 84.0 ft. Based on sample moisture
▼ **AT END OF DRILLING:** 10.7 ft. / El. 77.3 ft.
▼ **OTHER:** -

DRILLING SUBCONTRACTOR: Northern Drill Service, Inc.
DRILLING FOREMAN: Jon Beirholm
DRILLING METHOD: Drive and wash with 4-inch casing
DRILL RIG TYPE/MODEL: Mobile Drill B-48 ATV Rig
HAMMER TYPE: Automatic
HAMMER WEIGHT: 140 lb. **HAMMER DROP:** 30 in.
SPLIT SPOON DIA.: 1.375 in. I.D., 2 in. O.D.
CORE BARREL SIZE: NX
LOGGED BY: HO **CHECKED BY:** HH

Depth (ft.)	El. (ft.)	Sample Interval (ft.)	Sample Number	Blow Counts (N Value)	Pen./Rec. (in.)	Remark	Strata	Depth El.(ft.)	Material Description
		0 2	S1	19-14-15-17 (29)	24/13		Asphalt Fill	0.3 87.7 2.0	S1 - Top 3": Asphalt Bot. 10": Well Graded SAND with Gravel (SW), fine to medium, 0-5% fines, 15-20% fine to coarse angular gravel, brown, moist
	85.0	2 4	S2	14-6-4-5 (10)	24/11		Subsoil	86.0 4.0 ∇	S2 - Silty SAND with Gravel (SM), fine to medium, trace coarse, 35-40% fines, 20-25% mostly fine subangular gravel, trace of organic soil, brown, moist
5		4 5.3	S3	11-11-90/4"	16/7		Sand and Gravel	84.0 5.3	S3 - Poorly Graded GRAVEL with Silt and Sand (GP-GM), mostly coarse, angular, 10-15% fines, 20-25% fine to coarse sand, trace of weathered rock, light brown, wet
10	80.0	6 11	C1		60/59	1 2	Rock	82.7 11.0 ▼	C1 - min/ft: 4.2, 2.5, 6.3, 2.5, 2.1 REC = 98.33%, RQD = 15% Hard, moderately weathered, extremely fractured to slightly fractured, gray, fine-grained, RHYOLITE REMARK 1: Rock core barrel jammed at 6.5' due to core fracture REMARK 2: Rock core barrel jammed at 8.5' due to core fracture
									Bottom of borehole at 11.0 feet. Installed groundwater observation well.
	75.0								
15									
	70.0								
20									
	65.0								
25									

GENERAL NOTES:

1. The ground surface elevation was interpolated to the nearest foot from drawing titled: "Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by DRA via e-mail on June 3, 2022.

Lahlaf Geotechnical Consulting, Inc.

BORING LOG

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PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 5/11/22 **DATE COMPLETED:** 5/11/22
BORING LOCATION: Near SE side of prop. football field
COORDINATES: NA
SURFACE El.: 79 ft. (see note 1) **TOTAL DEPTH:** 21 ft.
WEATHER: 50's / Sunny
GROUNDWATER LEVELS:
▽ **DURING DRILLING:** 4.0 ft. / El. 75.0 ft. Based on sample moisture
▼ **AT END OF DRILLING:** 11.6 ft. / El. 67.4 ft.
▼ **OTHER:** -

DRILLING SUBCONTRACTOR: Northern Drill Service, Inc.
DRILLING FOREMAN: Jon Beirholm
DRILLING METHOD: Drive and wash with 4-inch casing
DRILL RIG TYPE/MODEL: Mobile Drill B-48 ATV Rig
HAMMER TYPE: Automatic
HAMMER WEIGHT: 140 lb. **HAMMER DROP:** 30 in.
SPLIT SPOON DIA.: 1.375 in. I.D., 2 in. O.D.
CORE BARREL SIZE: NA
LOGGED BY: HO **CHECKED BY:** HH

Depth (ft.)	El. (ft.)	Sample Interval (ft.)	Sample Number	Blow Counts (N Value)	Pen./Rec. (in.)	Remark	Strata	Depth El.(ft.)	Material Description
		0 – 2	S1	31-17-25-21 (42)	24/13		Asphalt Fill	0.3 78.7	S1 - Top 3": Asphalt Mid. 9": Poorly Graded SAND with Silt and Gravel (SP-SM), fine to medium, 5-10% fines, 15-20% fine to coarse angular gravel, brown, moist Bot. 1": Well Graded GRAVEL with Silt and Sand (GW-GM), fine to coarse, angular, 5-10% fines, 25-30% fine to coarse sand, brown, moist
		2 – 4	S2	30-24-20-15 (44)	24/12				S2 - Similar to S1 Bot. 1", 30-35% fine to coarse sand
5	75.0	4 – 6	S3	5-4-3-3 (7)	24/4	1	Sand and Gravel	4.0 ▽ 75.0	REMARK 1: Drilled 3" sppon from 4' to 8' S3 - Well Graded GRAVEL with Silt and Sand (GW-GM), fine to coarse, angular, 5-10% fines, ~15% fine to coarse sand, brown, wet
		6 – 8	S4	4-7-9-12 (16)	24/4				S4 - Similar to S3 3" spoon sample from 4' to 8': similar to S3, 20-25% fine to coarse sand
10	70.0	8 – 10	S5	3-3-6-17 (9)	24/3				S5 - Similar to S3, 20-25% fine to coarse sand
		10 – 12	S6	13-10-8-6 (18)	24/7			▼	S6 - Similar to S3, 25-30% fine to coarse sand
		12 – 14							
15	65.0	14 – 16	S7	12-8-6-5 (14)	24/2				S7 - Well Graded GRAVEL (GW), fine to coarse, subangular to subrounded, 0-5% fines, 5-10% medium to coarse sand, brown, wet
		16 – 18	S8	10-14-9-17 (23)	24/15				S8 - Poorly Graded SAND with Silt (SP-SM), fine to medium, 5-10% fines, brown, wet
		18 – 19							
20	60.0	19	S9	100/0"	0/0	2	Rock	19.0 60.0 21.0	REMARK 2: Advanced roller bit from 19' to 21' to confirm presence of rock S9 - No recovery
25	55.0								Bottom of borehole at 21.0 feet. Backfilled borehole with drill cuttings and 2 bags of gravel. Ground surface restored with asphalt cold patch.

GENERAL NOTES:

1. The ground surface elevation was interpolated to the nearest foot from drawing titled: "Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by DRA via e-mail on June 3, 2022.

Lahlaf Geotechnical Consulting, Inc.

BORING LOG

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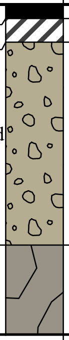
PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 5/11/22 **DATE COMPLETED:** 5/11/22
BORING LOCATION: Near southern side of prop. football field
COORDINATES: NA
SURFACE El.: 76 ft. (see note 1) **TOTAL DEPTH:** 7 ft.
WEATHER: 50's / Sunny
GROUNDWATER LEVELS:
∇ **DURING DRILLING:** -
▼ **AT END OF DRILLING:** Not encountered
▼ **OTHER:** -

DRILLING SUBCONTRACTOR: Northern Drill Service, Inc.
DRILLING FOREMAN: Jon Beirholm
DRILLING METHOD: Drive and wash with 4-inch casing
DRILL RIG TYPE/MODEL: Mobile Drill B-48 ATV Rig
HAMMER TYPE: Automatic
HAMMER WEIGHT: 140 lb. **HAMMER DROP:** 30 in.
SPLIT SPOON DIA.: 1.375 in. I.D., 2 in. O.D.
CORE BARREL SIZE: NA
LOGGED BY: HO **CHECKED BY:** HH



Depth (ft.)	El. (ft.)	Sample Interval (ft.)	Sample Number	Blow Counts (N Value)	Pen./Rec. (in.)	Remark	Strata	Depth El.(ft.)	Material Description
	75.0	0	S1	49-24-32-35 (56)	24/13		Asphalt	0.3	S1 - Top 4": Asphalt
							Fill	0.8 75.2	Mid. 6": Well Graded Sand with Silt and Gravel (SW-SM), fine to coarse, 10-15% fines, 20-25% fine to coarse subangular gravel, brown, moist
							Sand and Gravel		Bot. 3": Well Graded SAND with Gravel (SW), fine to coarse, 0-5% fines, 30-35% fine to coarse angular gravel, white, moist
		2	S2	33-15-18-12 (33)	24/6				S2 - Well Graded GRAVEL with Sand (GW), fine to coarse, angular, 0-5% fines 20-25% fine to coarse sand, white, moist
5		4	S3	28-43-100/1"	13/5				S3 - Well Graded GRAVEL with Silt an Sand (GW-GM), fine to coarse, angular, 5-10% fines, ~15% fine to coarse sand, brown, moist
		5.1				1		5.1 70.9	REMARK 1: Split spoon refusal encountered at 5.1'
	70.0						Rock		
						1		7.0	REMARK 1: Advanced roller bit from 5.1' to 7' to confirm presence of rock Bottom of borehole at 7.0 feet. Backfilled borehole with 2 bags of gravel. Ground surface restored with asphalt cold patch.
10	65.0								
15	60.0								
20	55.0								
25									

GENERAL NOTES:

1. The ground surface elevation was interpolated to the nearest foot from drawing titled: "Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by DRA via e-mail on June 3, 2022.

Lahlaf Geotechnical Consulting, Inc.

BORING LOG

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PAGE 1 OF 1

CLIENT: Drummey Rosane Anderson, Inc.
PROJECT NAME: Prop. Northeast Metro Reg. Vocational Tech. H.S.
LGCI PROJECT NUMBER: 2025
PROJECT LOCATION: Wakefield, MA

DATE STARTED: 5/10/22 **DATE COMPLETED:** 5/10/22
BORING LOCATION: Near southern side of prop. soccer field
COORDINATES: NA
SURFACE El.: 78 ft. (see note 1) **TOTAL DEPTH:** 13.5 ft.
WEATHER: 50's / Sunny
GROUNDWATER LEVELS:
∇ **DURING DRILLING:** 3.5 ft. / El. 74.5 ft. Based on Sample Moisture
▼ **AT END OF DRILLING:** 10.0 ft. / El. 68.0 ft.
▼ **OTHER:** -

DRILLING SUBCONTRACTOR: Northern Drill Service, Inc.
DRILLING FOREMAN: Jon Beirholm
DRILLING METHOD: Drive and wash with 4-inch casing
DRILL RIG TYPE/MODEL: Mobile Drill B-48 ATV Rig
HAMMER TYPE: Automatic
HAMMER WEIGHT: 140 lb. **HAMMER DROP:** 30 in.
SPLIT SPOON DIA.: 1.375 in. I.D., 2 in. O.D.
CORE BARREL SIZE: NA
LOGGED BY: HO **CHECKED BY:** HH

Depth (ft.)	El. (ft.)	Sample Interval (ft.)	Sample Number	Blow Counts (N Value)	Pen./Rec. (in.)	Remark	Strata	Depth El.(ft.)	Material Description
		0 2	S1	22-10-10-15 (20)	24/7		Asphalt Fill	0.4 77.6	S1 - Top 5": Asphalt Bot. 2": Silty SAND (SM), fine to coarse ~15% fines, 10-15% fine subangular gravel, trace of asphalt, brown, moist
	75.0	2 3.5	S2	24-68-12	18/8		Sand and Gravel	2.3 75.7	S2 - Top 4": Poorly Graded SAND with Silt (SP-SM), fine to medium, 10-15% fines, 10-15% fine to coarse subangular gravel, trace of asphalt, brown, moist ∇ Bot. 4": Well Graded GRAVEL with Sand (GW), fine to coarse, angular, 0-5% fines, 30-35% fine to coarse sand, brown to gray moist
5		3.5 5.5	S3	7-6-6-10 (12)	24/3	1			REMARK 1: Drove 3" split spoon from 3.5' to 7.5' to obtain sample S3 - Similar to S2 Bot. 4", 15-20% coarse sand, wet
		5.5 7.5	S4	15-4-9-4 (13)	24/4				S4 - Well Graded GRAVEL with Silt (GW-GM), fine to coarse, angular, 5-10% fines, 10-15% fine to coarse sand, brown to gray, wet 3" spoon sample from 3.5' to 7.5': Similar to S4, 5-10% fine to medium sand
	70.0	7.5 9.5	S5	9-5-4-4 (9)	24/4	2			REMARK 2: Drove 3" split spoon from 7.5' to 11.5' to obtain sample S5 - Well Graded GRAVEL (GW), fine to coarse, angular, 10-15% coarse sand, gray, wet
10		9.5 11.5	S6	5-11-6-4 (17)	24/3				▼ S6 - Similar to S5, 0-5% fines, 20-25% fine to coarse sand 3" spoon sample from 7.5' to 11': Well Graded GRAVEL (GW), fine to coarse, angular, 0-5% fines, 0-5% coarse sand, gray, wet
	65.0	11.5 13.5	S7	5-7-7-9 (14)	24/8			13.5	S7 - Poorly Graded SAND with Silt and Gravel (SP-SM), fine to medium, 5-10% fines, 25-30% fine to coarse angular gravel, brown, moist
									Bottom of borehole at 13.5 feet. Backfilled borehole with drill cuttings. Ground surface restored with asphalt cold patch.
15									
	60.0								
20									
	55.0								
25									

GENERAL NOTES:

1. The ground surface elevation was interpolated to the nearest foot from drawing titled: "Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to us by DRA via e-mail on June 3, 2022.

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

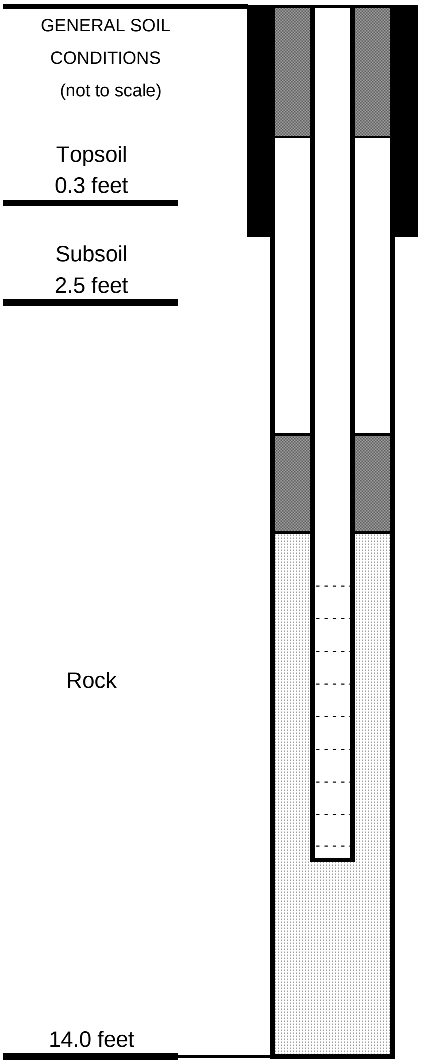
Boring No. : **B-1-OW**

Project Name: **Proposed Northeast Metro Regional Vocational Technical High School, Wakefield, MA**

LGCI Project Number: **2025**

Client: **Drummey Rosane Anderson, Inc.**

Drilling Subcontractor: Northern Drill Services, Inc.	Date Started: 12/10/20
Drilling Foreman: Jon Beirholm	Date Completed: 12/10/20
LGCI Engineer: Tom Greenwood	Location: Near NW corner of proposed building
Ground Surface Elevation: 184.5 feet	Total Depth of Boring: 14 feet
Groundwater Depth: 10 feet below ground surface	Drill Rig Type: Mobile Drill B-48
	Drilling Method: Drive and wash with 4-inch casing



Riser Stickup 3.1 feet above ground surface

THICKNESS OF SURFACE SEAL	1 foot
TYPE OF SURFACE SEAL	Concrete
TYPE OF SURFACE CASING	Riser pipe
ID OF SURFACE CASING	4 inch
DEPTH TO BOTTOM OF CASING	1.0 foot
ID OF RISER PIPE	2 inch
TYPE OF RISER PIPE	Schedule 40 PVC
TYPE OF BACKFILL AROUND RISER PIPE	Filter sand
DEPTH TO TOP OF SEAL	2.0 feet
TYPE OF SEAL	Bentonite
DEPTH TO BOTTOM OF SEAL	3.0 feet
DEPTH TO TOP OF PERVIOUS SECTION	4.0 feet
TYPE OF PERVIOUS SECTION	Schedule 40 PVC
DESCRIBE OPENINGS	0.01 inch slots
ID OF PERVIOUS SECTION	2 inch
TYPE OF BACKFILL AROUND PERVIOUS SECTION	Filter sand (Holliston sand)
DEPTH TO BOTTOM OF PERVIOUS SECTION	14.0 feet
DEPTH TO BOTTOM OF SAND COLUMN	14.0 feet
TYPE OF BACKFILL BELOW PERVIOUS SECTION	Filter sand (Holliston sand)
DIAMETER OF BOREHOLE	4 inch
DEPTH TO BOTTOM OF BOREHOLE	14.0 feet

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: “Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA,” prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

Lahlaf Geotechnical Consulting, Inc.

GROUNDWATER OBSERVATION WELL
INSTALLATION REPORT

Boring No. : **B-3-OW**

Page 1/1

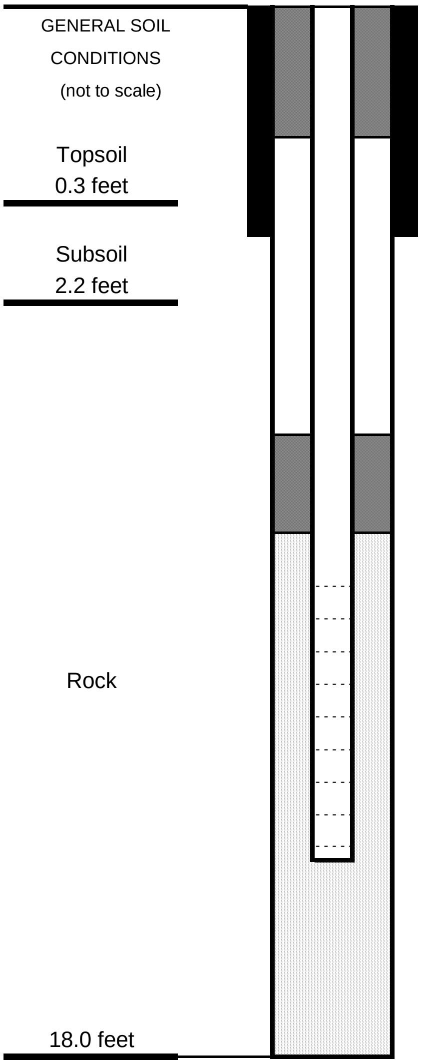
Project Name: **Proposed Northeast Metro Regional Vocational Technical High School, Wakefield, MA**

LGCI Project Number: **2025**

Client: **Drummey Rosane Anderson, Inc.**

Drilling Subcontractor: Northern Drill Services, Inc.	Date Started: 12/10/20
Drilling Foreman: Jon Beirholm	Date Completed: 12/11/20
LGCI Engineer: Tom Greenwood	Location: Near SE corner of proposed building
Ground Surface Elevation: 170.5 feet	Total Depth of Boring: 18 feet
Groundwater Depth: 4.9 feet below ground surface	Drill Rig Type: Mobile Drill B-48
	Drilling Method: Drive and wash with 4-inch casing

Riser Stickup 3.1 feet above ground surface



THICKNESS OF SURFACE SEAL	1 foot
TYPE OF SURFACE SEAL	Concrete
TYPE OF SURFACE CASING	Riser pipe
ID OF SURFACE CASING	4 inch
DEPTH TO BOTTOM OF CASING	1.0 foot
ID OF RISER PIPE	2 inch
TYPE OF RISER PIPE	Schedule 40 PVC
TYPE OF BACKFILL AROUND RISER PIPE	Filter sand
DEPTH TO TOP OF SEAL	4.0 feet
TYPE OF SEAL	Bentonite
DEPTH TO BOTTOM OF SEAL	6.0 feet
DEPTH TO TOP OF PERVIOUS SECTION	8.0 feet
TYPE OF PERVIOUS SECTION	Schedule 40 PVC
DESCRIBE OPENINGS	0.01 inch slots
ID OF PERVIOUS SECTION	2 inch
TYPE OF BACKFILL AROUND PERVIOUS SECTION	Filter sand (Holliston sand)
DEPTH TO BOTTOM OF PERVIOUS SECTION	18.0 feet
DEPTH TO BOTTOM OF SAND COLUMN	18.0 feet
TYPE OF BACKFILL BELOW PERVIOUS SECTION	Filter sand (Holliston sand)
DIAMETER OF BOREHOLE	4 inch
DEPTH TO BOTTOM OF BOREHOLE	18.0 feet

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: “Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA,” prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

Lahlaf Geotechnical Consulting, Inc.

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

Boring No. : **B-101-OW**

Page 1/1

Project Name: **Proposed Northeast Metro Regional Vocational Technical High School, Wakefield, MA**

LGCI Project Number: **2025**

Client: **Drummey Rosane Anderson, Inc.**

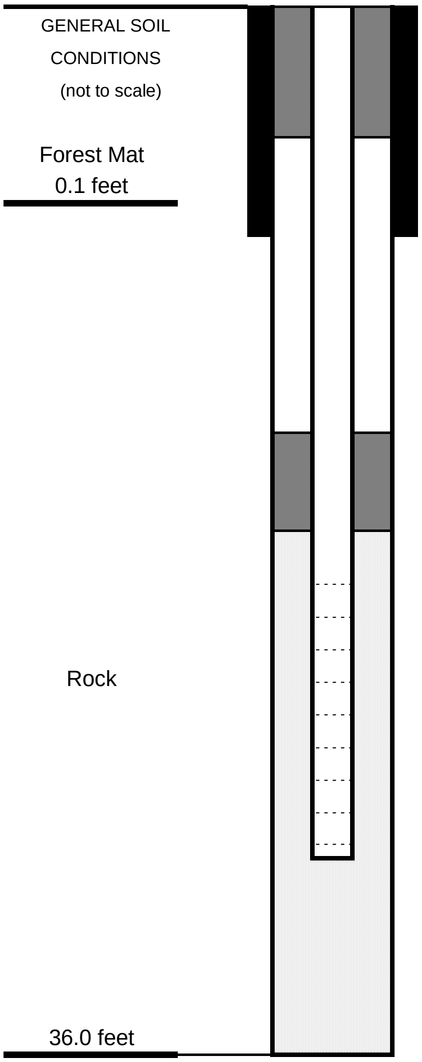
Drilling Subcontractor: Northern Drill Services, Inc.
Drilling Foreman: Jon Beirholm
LGCI Engineer: Tom Greenwood

Date Started: 5/10/21
Date Completed: 5/11/21
Location: Near NW corner of proposed building

Ground Surface Elevation: 172.6 feet
Groundwater Depth: 5.2 feet below ground surface

Total Depth of Boring: 36 feet
Drill Rig Type: Mobile Drill B-48
Drilling Method: Drive and wash with 3-inch casing

Riser Stickup 3.8 feet above ground surface



THICKNESS OF SURFACE SEAL	1 foot
TYPE OF SURFACE SEAL	Concrete
TYPE OF SURFACE CASING	Riser pipe
ID OF SURFACE CASING	4 inch
DEPTH TO BOTTOM OF CASING	1.0 foot
ID OF RISER PIPE	2 inch
TYPE OF RISER PIPE	Schedule 40 PVC
TYPE OF BACKFILL AROUND RISER PIPE	Filter sand
DEPTH TO TOP OF SEAL	1.0 foot
TYPE OF SEAL	Bentonite
DEPTH TO BOTTOM OF SEAL	2.0 feet
DEPTH TO TOP OF PERVIOUS SECTION	16.0 feet
TYPE OF PERVIOUS SECTION	Schedule 40 PVC
DESCRIBE OPENINGS	0.01 inch slots
ID OF PERVIOUS SECTION	2 inch
TYPE OF BACKFILL AROUND PERVIOUS SECTION	Filter sand (Holliston sand)
DEPTH TO BOTTOM OF PERVIOUS SECTION	36.0 feet
DEPTH TO BOTTOM OF SAND COLUMN	36.0 feet
TYPE OF BACKFILL BELOW PERVIOUS SECTION	Filter sand (Holliston sand)
DIAMETER OF BOREHOLE	3 inch
DEPTH TO BOTTOM OF BOREHOLE	36.0 feet

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: “Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA,” prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

LGCI
Lahlaf Geotechnical Consulting, Inc.

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

Boring No. : **B-104-OW**

Page 1/1

Project Name: **Proposed Northeast Metro Regional Vocational Technical High School, Wakefield, MA**

LGCI Project Number: **2025**

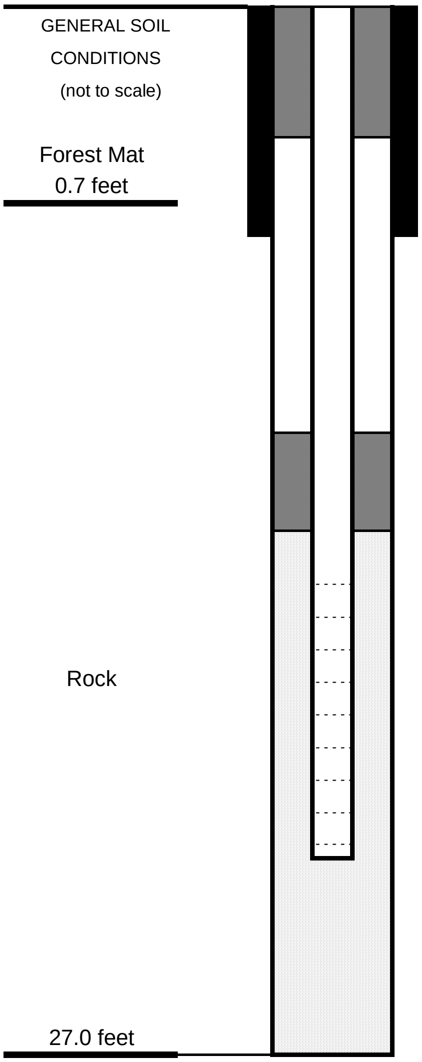
Client: **Drummey Rosane Anderson, Inc.**

Drilling Subcontractor: Northern Drill Services, Inc.
Drilling Foreman: Jon Beirholm
LGCI Engineer: Nicholas Proulx

Date Started: 5/12/21
Date Completed: 5/12/21
Location: Southern portion of proposed building

Ground Surface Elevation: 180.9 feet
Groundwater Depth: 0.0 feet below ground surface

Total Depth of Boring: 27 feet
Drill Rig Type: Mobile Drill B-48
Drilling Method: Drive and wash with 3-inch casing



Riser Stickup 4.2 feet above ground surface

THICKNESS OF SURFACE SEAL	1 foot
TYPE OF SURFACE SEAL	Concrete
TYPE OF SURFACE CASING	Riser pipe
ID OF SURFACE CASING	4 inch
DEPTH TO BOTTOM OF CASING	1.0 foot
ID OF RISER PIPE	2 inch
TYPE OF RISER PIPE	Schedule 40 PVC
TYPE OF BACKFILL AROUND RISER PIPE	Filter sand
DEPTH TO TOP OF SEAL	1.0 foot
TYPE OF SEAL	Bentonite
DEPTH TO BOTTOM OF SEAL	2.0 feet
DEPTH TO TOP OF PERVIOUS SECTION	7.0 feet
TYPE OF PERVIOUS SECTION	Schedule 40 PVC
DESCRIBE OPENINGS	0.01 inch slots
ID OF PERVIOUS SECTION	2 inch
TYPE OF BACKFILL AROUND PERVIOUS SECTION	Filter sand (Holliston sand)
DEPTH TO BOTTOM OF PERVIOUS SECTION	27.0 feet
DEPTH TO BOTTOM OF SAND COLUMN	27.0 feet
TYPE OF BACKFILL BELOW PERVIOUS SECTION	Filter sand (Holliston sand)
DIAMETER OF BOREHOLE	3 inch
DEPTH TO BOTTOM OF BOREHOLE	27.0 feet

1. The ground surface elevation was surveyed by Nitsch Engineering, Inc. (Nitsch) and was obtained by LGCI from drawings EX-1 to EX-13 titled: “Topographic Survey, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA,” prepared by Nitsch and provided to us by Nitsch via e-mail on June 4, 2021.

Lahlaf Geotechnical Consulting, Inc.

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

Boring No. : **B- 204-OW**

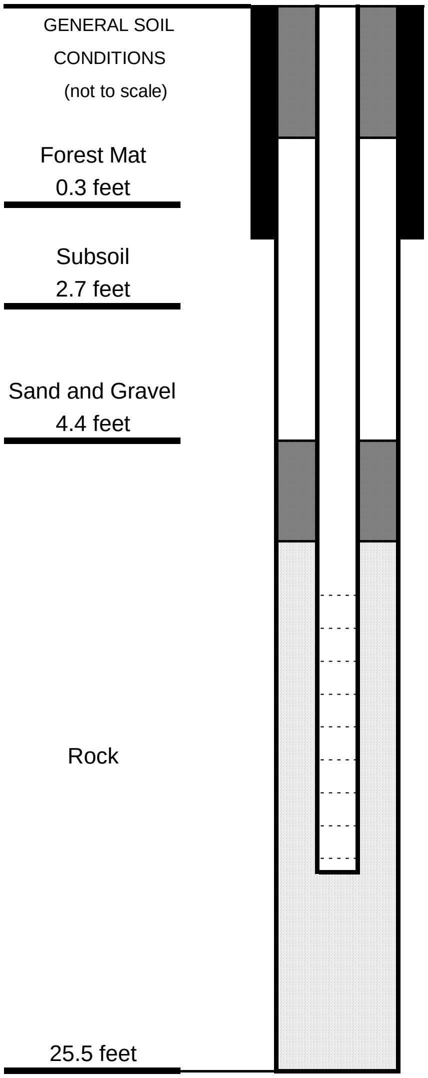
Page 1/1

Project Name: **Prop. Northeast Metro Regional Vocational Technical High School, Wakefield, MA**

LGCI Project Number: **2025**

Client: **Drummey Rosane Anderson, Inc.**

Drilling Subcontractor: Northern Drill Services, Inc.	Date Started: 5/4/22
Drilling Foreman: Jon Beirholm	Date Completed: 5/4/22
LGCI Engineer: Husham Osman	Location: Near center of proposed building
Ground Surface Elevation: 162.0 feet	Total Depth of Boring: 25.5 feet
Groundwater Depth: 1.0 feet below ground surface	Drill Rig Type: Mobile Drill ATV B-48
	Drilling Method: Drive and wash with 4-inch then 3-inch casing



Riser Stickup 2.9 feet above ground surface

THICKNESS OF SURFACE SEAL	1 foot
TYPE OF SURFACE SEAL	Concrete
TYPE OF SURFACE CASING	Riser Pipe
ID OF SURFACE CASING	4 inch
DEPTH TO BOTTOM OF CASING	1.0 foot
ID OF RISER PIPE	2 inch
TYPE OF RISER PIPE	Schedule 40 PVC
TYPE OF BACKFILL AROUND RISER PIPE	Filter sand (Holliston sand)
DEPTH TO TOP OF SEAL	11.0 feet
TYPE OF SEAL	Bentonite Chips
DEPTH TO BOTTOM OF SEAL	13.0 feet
DEPTH TO TOP OF PERVIOUS SECTION	15.5 feet
TYPE OF PERVIOUS SECTION	Schedule 40 PVC
DESCRIBE OPENINGS	0.01 inch slots
ID OF PERVIOUS SECTION	2 inch
TYPE OF BACKFILL AROUND PERVIOUS SECTION	Filter sand (Holliston sand)
DEPTH TO BOTTOM OF PERVIOUS SECTION	25.5 feet
DEPTH TO BOTTOM OF SAND COLUMN	25.5 feet
TYPE OF BACKFILL BELOW PERVIOUS SECTION	Filter sand (Holliston sand)
DIAMETER OF BOREHOLE	4 inch
DEPTH TO BOTTOM OF BOREHOLE	25.5 feet

NOTES: The ground surface elevation was interpolated to the nearest foot from drawing titled: " Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to LGCI by DRA via e-mail on June 3, 2022.

Lahlaf Geotechnical Consulting, Inc.

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

Boring No. : **B- 208-OW**

Page 1/1

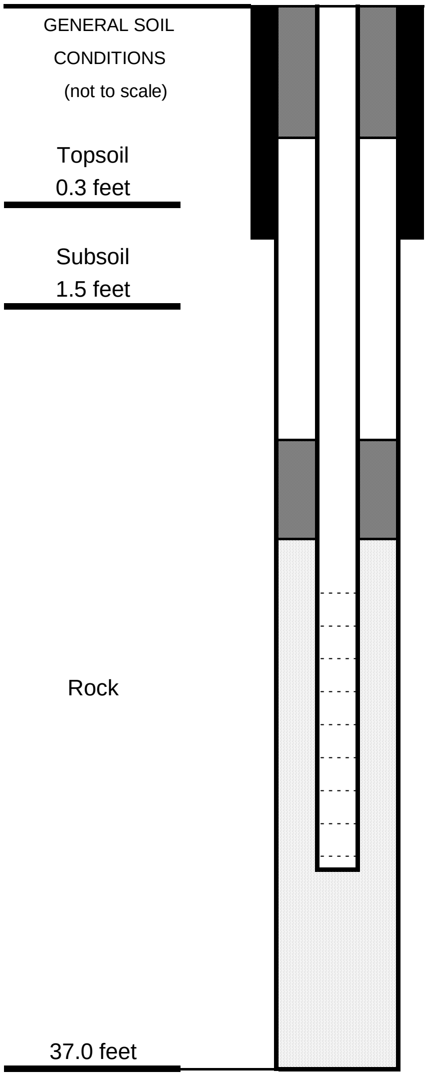
Project Name: **Prop. Northeast Metro Regional Vocational Technical High School, Wakefield, MA**

LGCI Project Number: **2025**

Client: **Drummey Rosane Anderson, Inc.**

Drilling Subcontractor: Northern Drill Services, Inc.	Date Started: 4/26/22
Drilling Foreman: Jon Beirholm	Date Completed: 4/27/22
LGCI Engineer: Husham Osman	Location: Near western side of proposed building
Ground Surface Elevation: 193.0 feet	Total Depth of Boring: 37.0 feet
Groundwater Depth: 7.0 feet below ground surface	Drill Rig Type: Mobile Drill ATV B-48
	Drilling Method: Drive and wash with 4-inch casing

Riser Stickup 3.4 feet above ground surface



THICKNESS OF SURFACE SEAL	1 foot
TYPE OF SURFACE SEAL	Concrete
TYPE OF SURFACE CASING	Riser Pipe
ID OF SURFACE CASING	4 inch
DEPTH TO BOTTOM OF CASING	1.0 foot
ID OF RISER PIPE	2 inch
TYPE OF RISER PIPE	Schedule 40 PVC
TYPE OF BACKFILL AROUND RISER PIPE	Filter sand (Holliston sand)
DEPTH TO TOP OF SEAL	5.0 feet
TYPE OF SEAL	Bentonite Chips
DEPTH TO BOTTOM OF SEAL	7.0 feet
DEPTH TO TOP OF PERVIOUS SECTION	16.2 feet
TYPE OF PERVIOUS SECTION	Schedule 40 PVC
DESCRIBE OPENINGS	0.01 inch slots
ID OF PERVIOUS SECTION	2 inch
TYPE OF BACKFILL AROUND PERVIOUS SECTION	Filter sand (Holliston sand)
DEPTH TO BOTTOM OF PERVIOUS SECTION	36.2 feet
DEPTH TO BOTTOM OF SAND COLUMN	37.0 feet
TYPE OF BACKFILL BELOW PERVIOUS SECTION	Filter sand (Holliston sand)
DIAMETER OF BOREHOLE	4 inch
DEPTH TO BOTTOM OF BOREHOLE	37.0 feet

NOTES: The ground surface elevation was interpolated to the nearest foot from drawing titled: " Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to LGCI by DRA via e-mail on June 3, 2022.

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

Boring No. : **B- 220-OW**

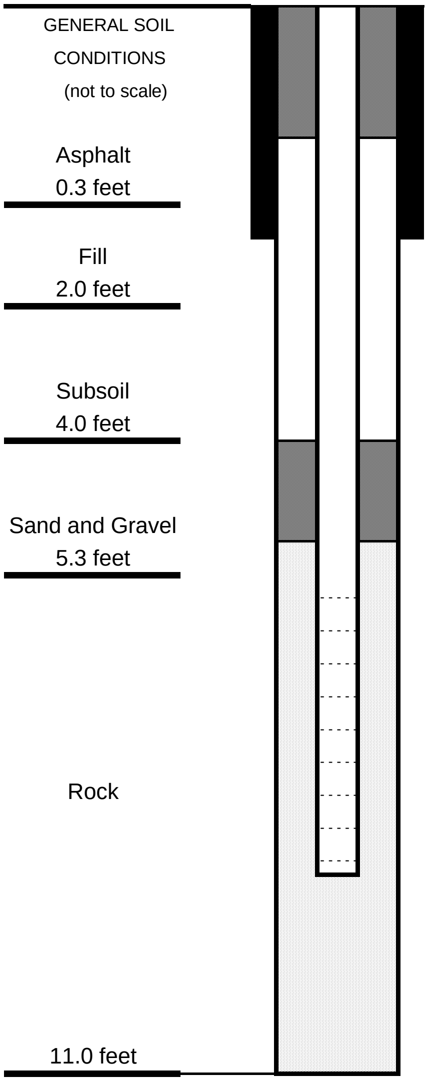
Project Name: **Prop. Northeast Metro Regional Vocational Technical High School, Wakefield, MA**

LGCI Project Number: **2025**

Client: **Drummey Rosane Anderson, Inc.**

Drilling Subcontractor: Northern Drill Services, Inc.	Date Started: 5/10/22
Drilling Foreman: Jon Beirholm	Date Completed: 5/11/22
LGCI Engineer: Husham Osman	Location: Near NE side of proposed football field
Ground Surface Elevation: 88.0 feet	Total Depth of Boring: 11.0 feet
Groundwater Depth: 4.0 feet below ground surface	Drill Rig Type: Mobile Drill ATV B-48
	Drilling Method: Drive and wash with 4-inch casing

Riser Stickup 0.0 feet above ground surface



THICKNESS OF SURFACE SEAL	1 foot
TYPE OF SURFACE SEAL	Concrete
TYPE OF SURFACE CASING	Roadway Box
ID OF SURFACE CASING	4 inch
DEPTH TO BOTTOM OF CASING	1.0 foot
ID OF RISER PIPE	2 inch
TYPE OF RISER PIPE	Schedule 40 PVC
TYPE OF BACKFILL AROUND RISER PIPE	Filter sand
DEPTH TO TOP OF SEAL	2.0 feet
TYPE OF SEAL	Bentonite Chips
DEPTH TO BOTTOM OF SEAL	3.0 feet
DEPTH TO TOP OF PERVIOUS SECTION	4.0 feet
TYPE OF PERVIOUS SECTION	Schedule 40 PVC
DESCRIBE OPENINGS	0.01 inch slots
ID OF PERVIOUS SECTION	2 inch
TYPE OF BACKFILL AROUND PERVIOUS SECTION	Filter sand (Holliston sand)
DEPTH TO BOTTOM OF PERVIOUS SECTION	11.0 feet
DEPTH TO BOTTOM OF SAND COLUMN	11.0 feet
TYPE OF BACKFILL BELOW PERVIOUS SECTION	Filter sand (Holliston sand)
DIAMETER OF BOREHOLE	4 inch
DEPTH TO BOTTOM OF BOREHOLE	11.0 feet

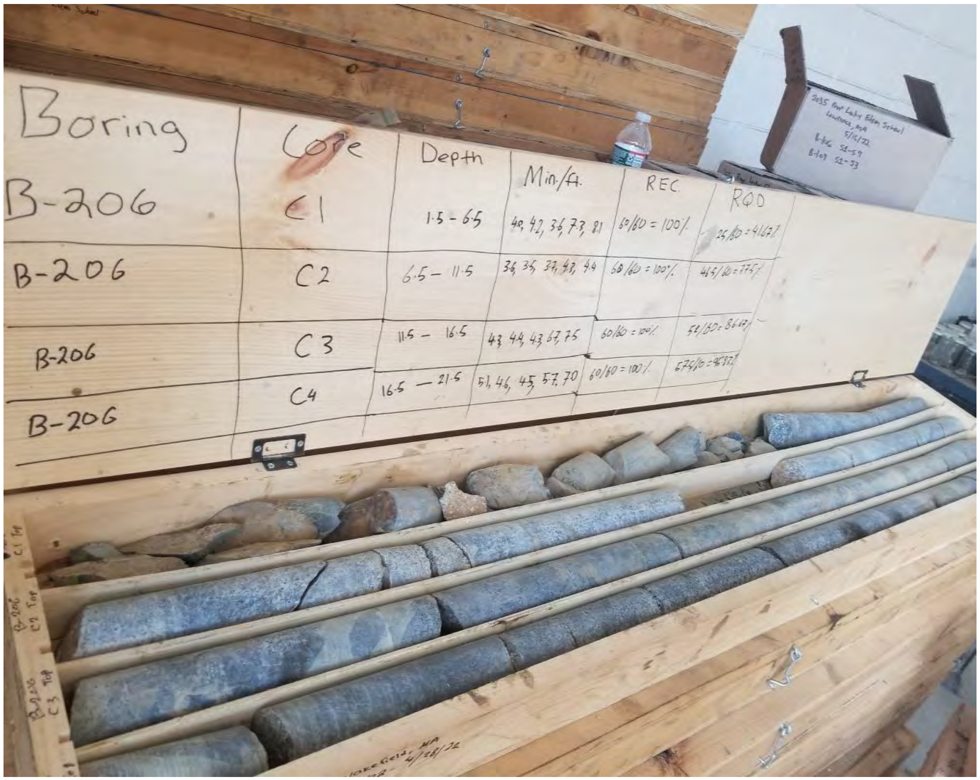
NOTES: The ground surface elevation was interpolated to the nearest foot from drawing titled: " Explorations Exhibit Plan, Northeast Metropolitan Regional Vocational High School, 100 Hemlock Road, Wakefield, MA," prepared by Nitsch and provided to LGCI by DRA via e-mail on June 3, 2022.

Core Photos (from top): B-1-C1, B-1-C2, B-3-C1, B-3-C2

Core Photos (from top): B-1-C1, B-1-C2, B-3-C1, B-3-C2

Core Photos (from top): B-104-OW-C1 to C4

Core Photos (from top): B-105-C1, B-105-C2, B-106-C1



Core Photos: B-206-C1 to C4

Core Photos (from top): B-203-C2, B-216-C1, and B-220-OW-C1

Core Photos (from top): B-208-C1 to C4

Core Photos (from top): B-208-C5 to C7, B-202-C1

APPENDIX E – Borehole Geophysical Logging - Data Report

HAGER-RICHTER
GEOSCIENCE, INC.

GEOPHYSICS FOR THE ENGINEERING COMMUNITY
SALEM, NEW HAMPSHIRE
Tel: 603.893.9944
FORDS, NEW JERSEY
Tel: 732.661.0555

BOREHOLE GEOPHYSICAL LOGGING - DATA REPORT
BOREHOLES B-206 & B-208
NORTHEAST METRO TECH HIGH SCHOOL
WAKEFIELD, MASSACHUSETTS

Prepared for:

Lahlaf Geotechnical Consulting, Inc.
100 Chelmsford Road, Suite 2
Billerica, Massachusetts 01862

Prepared by:

Hager-Richter Geoscience, Inc.
8 Industrial Way - D10
Salem, New Hampshire 03079

File 22RG48
June 2022

Tadpole	Structure Category (Symbol Color)	Description
●	Fracture Rank 1 (Light Blue)	Minor Fracture - not distinct and may not be continuous around the borehole
●	Fracture Rank 2 (Blue)	Intermediate Fracture - distinct and continuous around the borehole with little or no apparent aperture
●	Fracture Rank 3 (Light Green)	Intermediate Fracture - distinct and continuous around the borehole with some apparent aperture
●	Fracture Rank 4 (Red)	Major Fracture - distinct with continuous apparent aperture around the borehole
◀	Foliation or Vein (Orange)	Planar geologic feature interpreted as foliation or a vein

Figure 1. Key to bedrock structure categories.

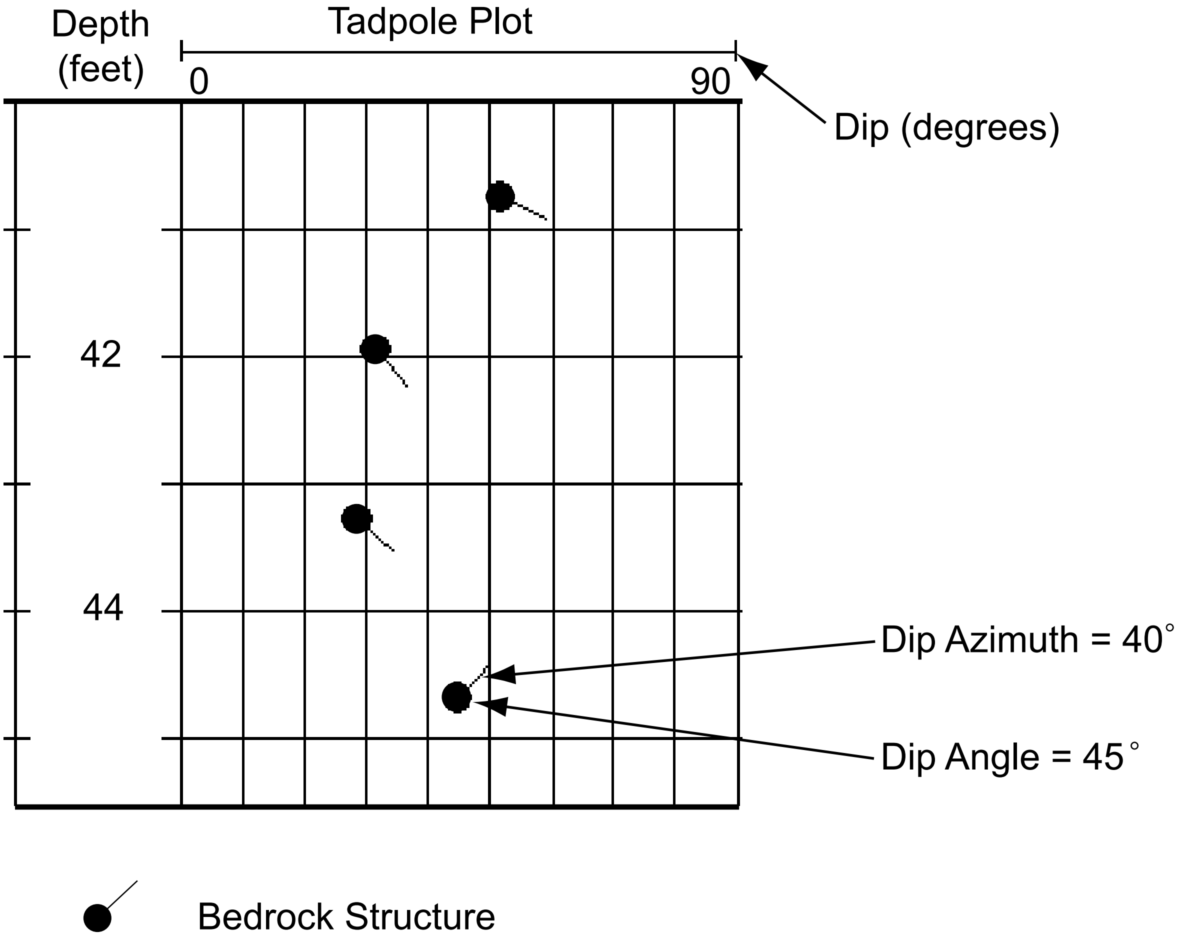


Figure 2. Tadpole plot explanation. The orientation of the bedrock structures is graphically displayed by a tadpole consisting of a circle, the head, and a line, the tail. The position of the head, left to right on the tadpole plot, gives the dip angle of the structure. The left side of the track indicates a dip angle of 0°, and the right side of the track indicates a dip angle of 90° from horizontal. The orientation of the tail gives the dip azimuth of the structure and can be read like a compass. The tail pointing directly up is 0°, north.

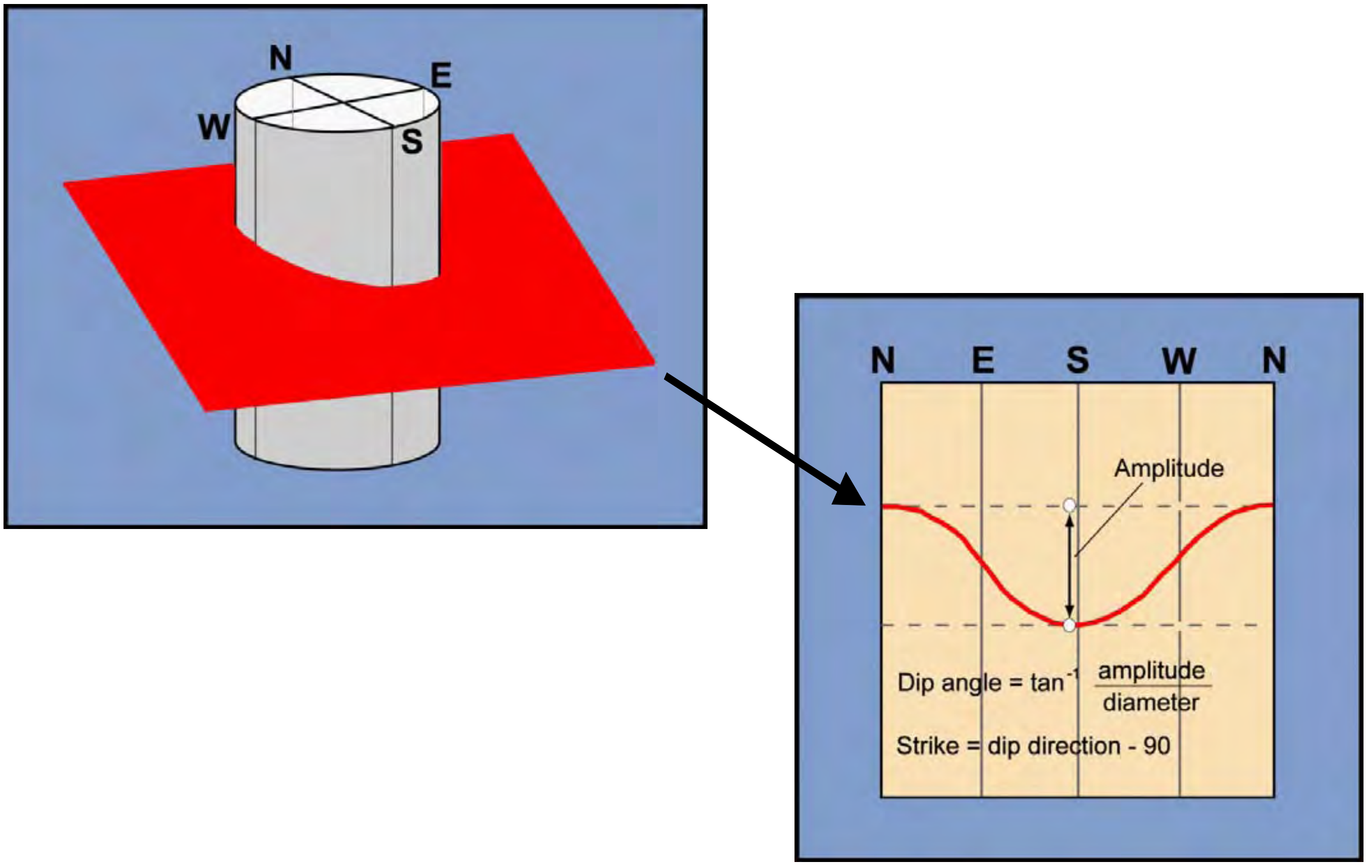


Figure 3. Televiewer Explanation Figure. The image on the left depicts a planar structure in red, such as a fracture or bedding plane, intersected by a borehole. The image on the right depicts the same structure unwrapped as it would be displayed in an optical televiewer (OTV) or acoustic televiewer (ATV) log.

Figure modified from: Garfield, R.L., Day-Lewis, F.D., Gray, M.B., Johnson, C.D., Williams, J.H. and Day-Lewis, A.D.F., 2003, Fractured-Rock Aquifer Characterization within a Regional Geologic Context: Results from the Bucknell University Hydrogeophysics Test Site, GSA Northeastern Section, 38th Annual Meeting, Paper No. 25-19.

HAGER-RICHTER GEOSCIENCE, INC.

Salem, New Hampshire
Tel: 603.893.9944

Fords, New Jersey
Tel: 732.661.0555

B-206 - BOREHOLE GEOPHYSICAL LOGS

DATE(S) LOGGED: May 5, 2022

CLIENT: Lahlaf Geotechnical Consulting, Inc.
PROJECT: Northeast Metro Tech High School
LOCATION: Wakefield, Massachusetts
LOGGING GEOPHYSICIST(S): Nick DeCristofaro & Justin Covert
PROJECT REP(S) ON-SITE: Husham Osman

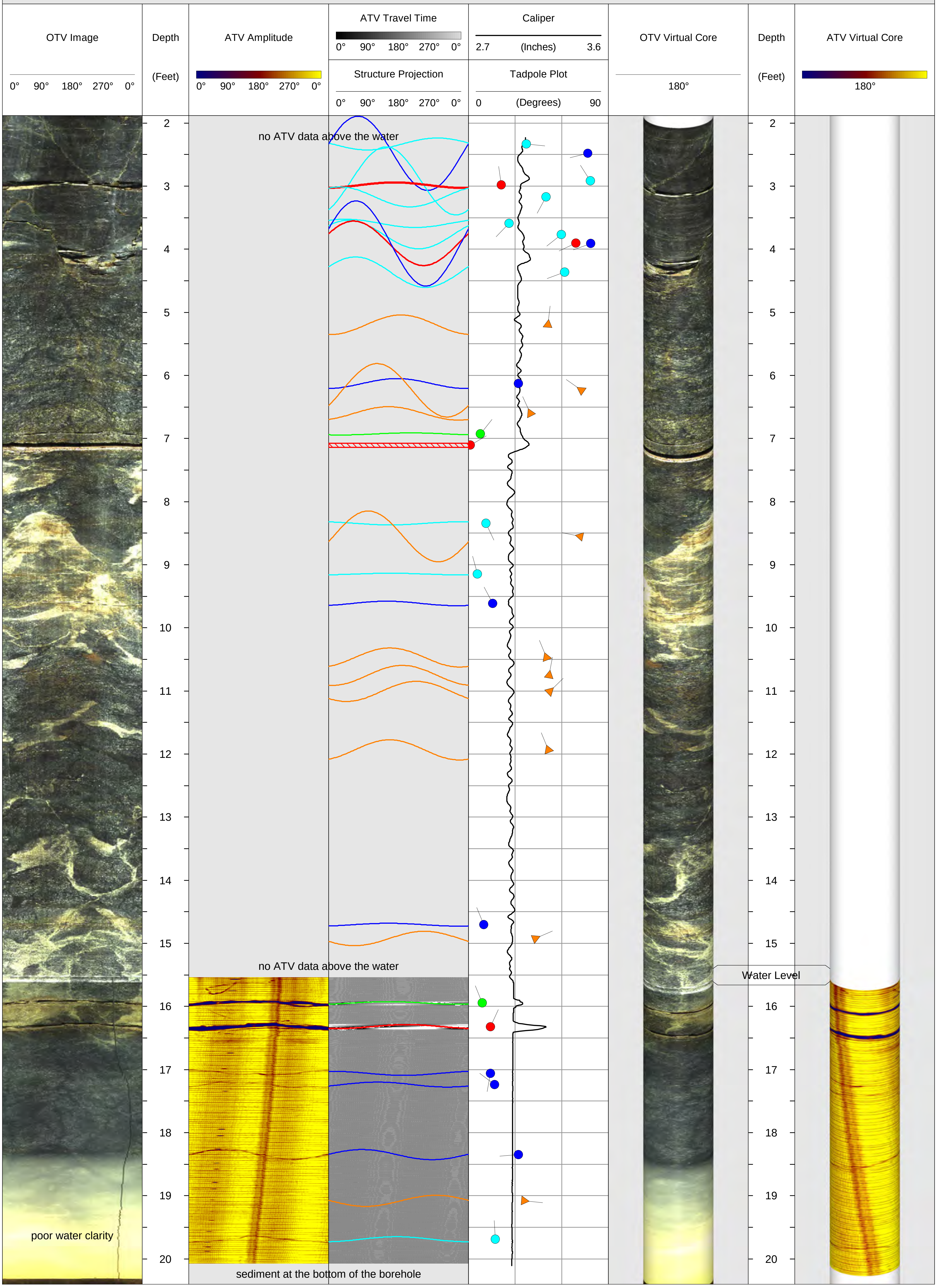
HRGS FILE: 22RG48
LOG DATUM: Ground Surface
ORIENTATION REFERENCE: True North (Magnetic Declination = 14.3° West)
BOREHOLE DIAMETER: 3 Inches
LOGS PROCESSED BY: Robert Garfield, P.G. & Nick DeCristofaro

STRUCTURE LEGEND

● Fracture Rank 1 ● Fracture Rank 2 ● Fracture Rank 3 ● Fracture Rank 4 ▼ Foliation / Vein

NOTES: ATV and acoustic caliper data can only be acquired in the water-filled portion of the borehole. The caliper data plotted in the logs below are 3-arm caliper data in the air-filled portion of the borehole and acoustic caliper data in the water-filled portion of the borehole.

B-206 - Borehole Geophysical Logs



HAGER-RICHTER GEOSCIENCE, INC.

Salem, New Hampshire
Tel: 603.893.9994

Fords, New Jersey
Tel: 732.661.0555

B-208 - BOREHOLE GEOPHYSICAL LOGS

DATE(S) LOGGED: May 5, 2022

CLIENT: Lahlaf Geotechnical Consulting, Inc.
PROJECT: Northeast Metro Tech High School
LOCATION: Wakefield, Massachusetts
LOGGING GEOPHYSICIST(S): Nick DeCristofaro & Justin Covert
PROJECT REP(S) ON-SITE: Husham Osman

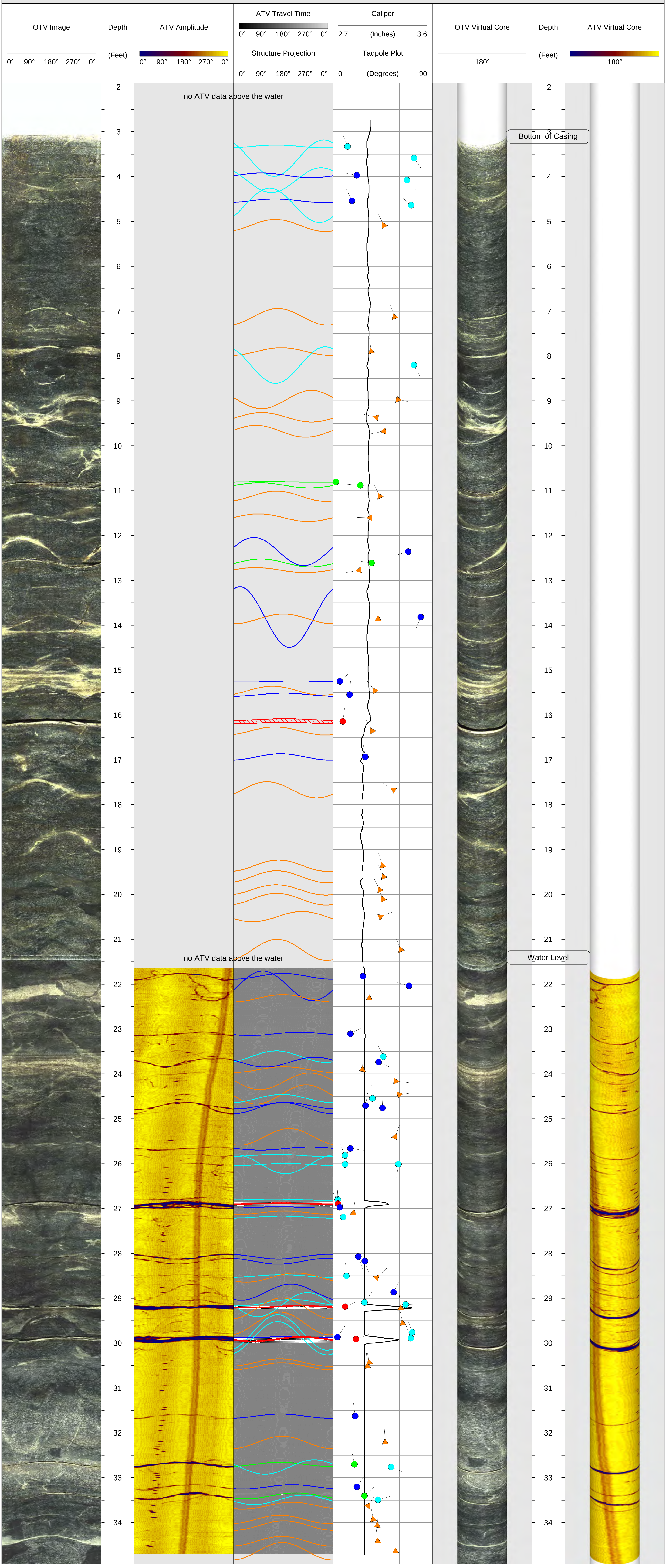
HRGS FILE: 22RG48
LOG DATUM: Ground Surface
ORIENTATION REFERENCE: True North (Magnetic Declination = 14.3° West)
BOREHOLE DIAMETER: 3 Inches
LOGS PROCESSED BY: Robert Garfield, P.G. & Nick DeCristofaro

STRUCTURE LEGEND

● Fracture Rank 1 ● Fracture Rank 2 ● Fracture Rank 3 ● Fracture Rank 4 ◣ Foliation / Vein

NOTES: ATV and acoustic caliper data can only be acquired in the water-filled portion of the borehole. The caliper data plotted in the logs below are 3-arm caliper data in the air-filled portion of the borehole and acoustic caliper data in the water-filled portion of the borehole.

B-208 - Borehole Geophysical Logs



HAGER-RICHTER GEOSCIENCE, INC.

Salem, New Hampshire
Tel: 603.893.9944

Fords, New Jersey
Tel: 732.661.0555

B-206 & B-208 - BEDROCK STRUCTURE STATISTICS PLOTS WITH CONTOURED STEREOGRAMS

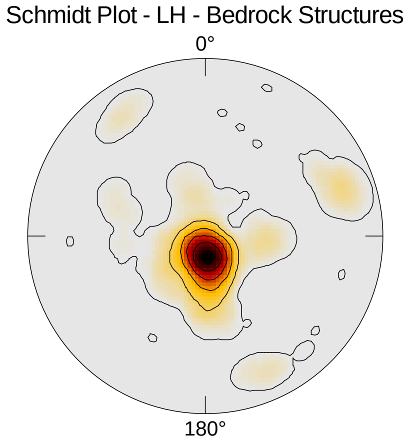
DATE(S) LOGGED: May 5, 2022

CLIENT:	Lahlaf Geotechnical Consulting, Inc.	HRGS FILE:	22RG48
PROJECT:	Northeast Metro Tech High School	ORIENTATION REFERENCE:	True North
LOCATION:	Wakefield, Massachusetts	MAGNETIC DECLINATION:	14.3° West

STRUCTURE LEGEND

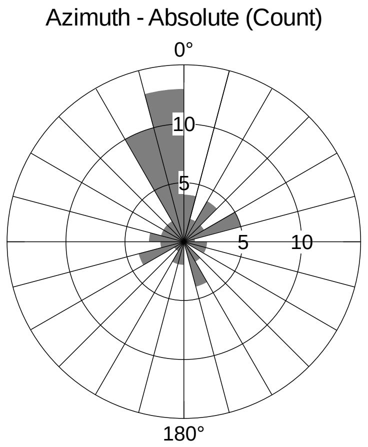
● Fracture Rank 1 ● Fracture Rank 2 ● Fracture Rank 3 ● Fracture Rank 4 ◀ Foliation / Vein

Stereogram - Lower Hemisphere of Bedrock Fractures



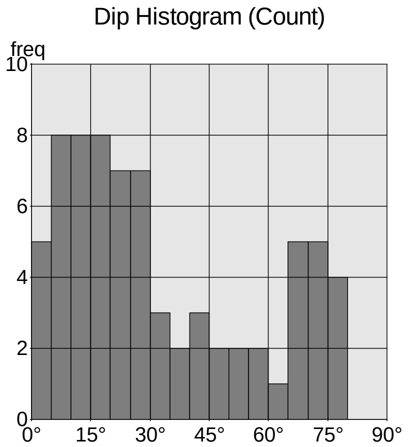
	Counts	Dip[deg]	Azi[deg]
Mean	72	32.26	351.87
●	28	41.64	355.22
●	29	30.97	342.76
●	8	18.08	24.85
●	7	18.12	331.94

Dip Azimuth Rose Diagram of Bedrock Fractures



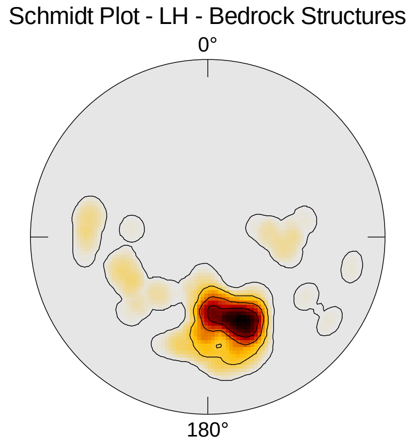
Components:	Azimuth
Counts:	72.00
Mean (2D):	351.87
Std.Dev.:	82.20
Min:	3.06
Max:	358.99

Dip Angle Histogram of Bedrock Fractures



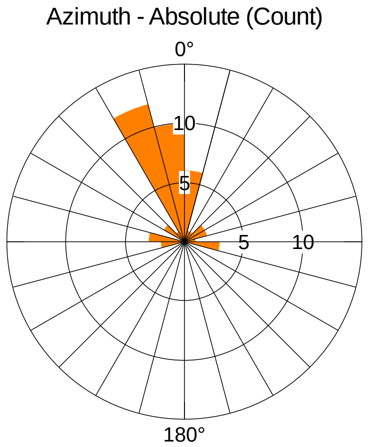
Counts:	72.00
Mean (2D):	32.26
Std.Dev.:	24.30
Min:	1.18
Max:	79.54

Stereogram - Lower Hemisphere of Foliation & Veins



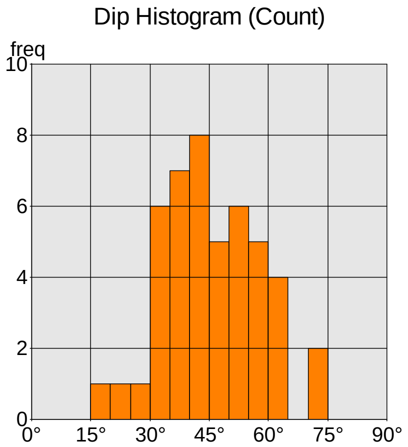
	Counts	Dip[deg]	Azi[deg]
Mean	46	45.28	352.24
▶	46	45.28	352.24

Dip Azimuth Rose Diagram of Foliation & Veins



Components:	Azimuth
Counts:	46.00
Mean (2D):	352.24
Std.Dev.:	47.27
Min:	0.43
Max:	358.62

Dip Angle Histogram of Foliation & Veins



Counts:	46.00
Mean (2D):	45.28
Std.Dev.:	11.83
Min:	18.54
Max:	72.76

HAGER-RICHTER GEOSCIENCE, INC.

Salem, New Hampshire
Tel: 603.893.9944

Fords, New Jersey
Tel: 732.661.0555

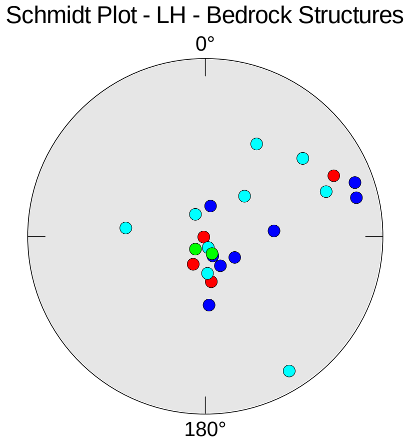
B-206 - BEDROCK STRUCTURE STATISTICS PLOTS

DATE(S) LOGGED:	May 5, 2022
CLIENT:	Lahlaf Geotechnical Consulting, Inc.
PROJECT:	Northeast Metro Tech High School
LOCATION:	Wakefield, Massachusetts
HRGS FILE:	22RG48
ORIENTATION REFERENCE:	True North
MAGNETIC DECLINATION:	14.3° West

STRUCTURE LEGEND

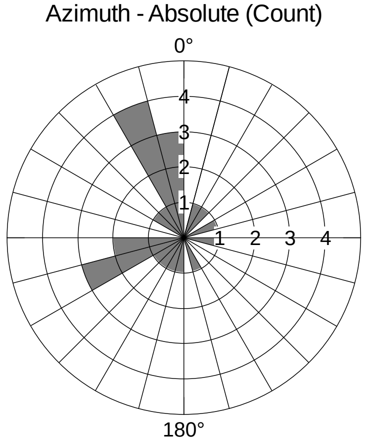
● Fracture Rank 1 ● Fracture Rank 2 ● Fracture Rank 3 ● Fracture Rank 4 ◀ Foliation / Vein

Stereogram - Lower Hemisphere of Bedrock Fractures



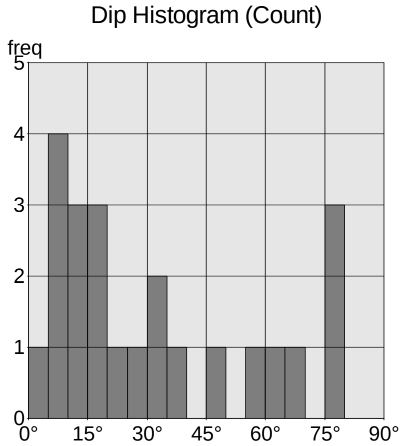
	Counts	Dip[deg]	Azi[deg]
Mean	23	31.82	304.99
●	9	38.50	252.15
●	8	33.67	290.08
●	4	25.57	6.93
●	2	8.32	8.09

Dip Azimuth Rose Diagram of Bedrock Fractures



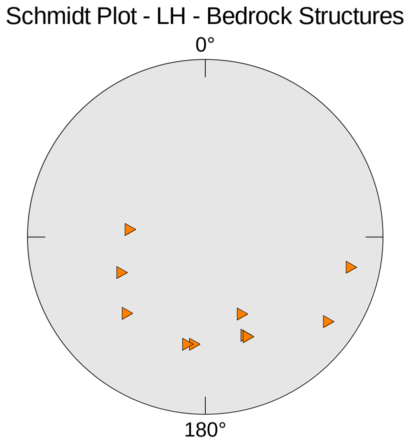
Components:	Azimuth
Counts:	23.00
Mean (2D):	304.99
Std.Dev.:	82.50
Min:	24.36
Max:	356.53

Dip Angle Histogram of Bedrock Fractures



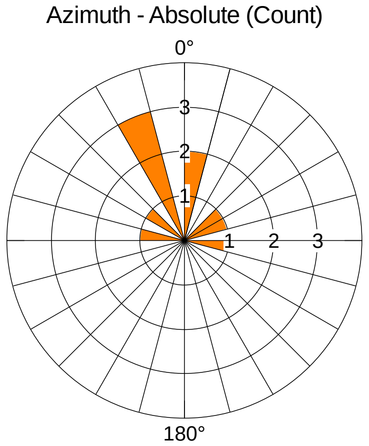
Counts:	23.00
Mean (2D):	31.82
Std.Dev.:	25.68
Min:	1.18
Max:	78.66

Stereogram - Lower Hemisphere of Foliation & Veins



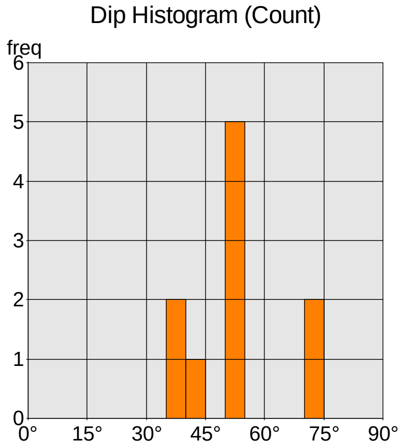
	Counts	Dip[deg]	Azi[deg]
Mean	10	51.96	359.58
▶	10	51.96	359.58

Dip Azimuth Rose Diagram of Foliation & Veins



Components:	Azimuth
Counts:	10.00
Mean (2D):	359.58
Std.Dev.:	53.19
Min:	6.68
Max:	338.10

Dip Angle Histogram of Foliation & Veins



Counts:	10.00
Mean (2D):	51.96
Std.Dev.:	11.52
Min:	35.80
Max:	72.76

HAGER-RICHTER GEOSCIENCE, INC.

Salem, New Hampshire
Tel: 603.893.9944

Fords, New Jersey
Tel: 732.661.0555

B-208 - BEDROCK STRUCTURE STATISTICS PLOTS

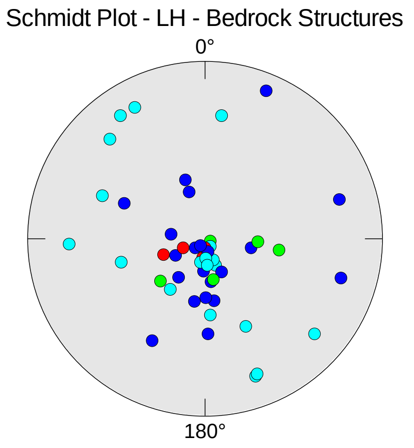
DATE(S) LOGGED: May 5, 2022

CLIENT:	Lahlaf Geotechnical Consulting, Inc.	HRGS FILE:	22RG48
PROJECT:	Northeast Metro Tech High School	ORIENTATION REFERENCE:	True North
LOCATION:	Wakefield, Massachusetts	MAGNETIC DECLINATION:	14.3° West

STRUCTURE LEGEND

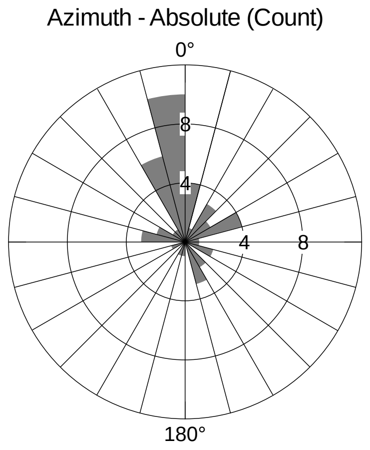
● Fracture Rank 1 ● Fracture Rank 2 ● Fracture Rank 3 ● Fracture Rank 4 ◀ Foliation / Vein

Stereogram - Lower Hemisphere of Bedrock Fractures



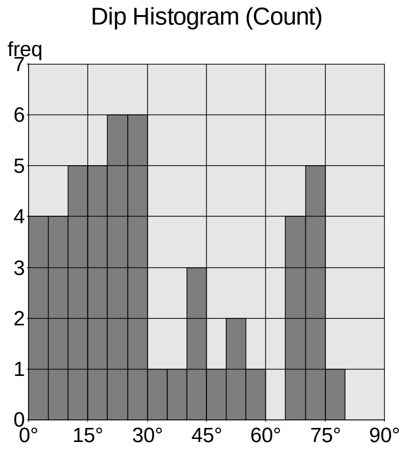
	Counts	Dip[deg]	Azi[deg]
Mean	49	32.47	8.33
●	19	43.15	13.74
●	21	29.98	11.24
●	5	22.09	313.89
●	4	11.28	35.31

Dip Azimuth Rose Diagram of Bedrock Fractures



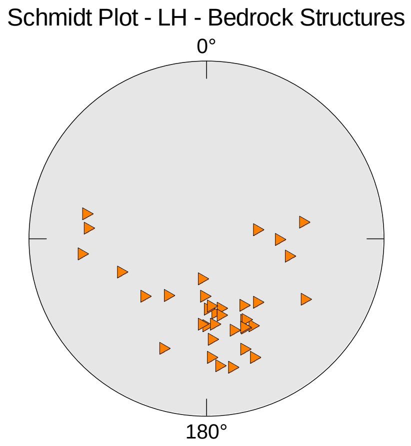
Components:	Azimuth
Counts:	49.00
Mean (2D):	8.33
Std.Dev.:	74.56
Min:	3.06
Max:	358.99

Dip Angle Histogram of Bedrock Fractures



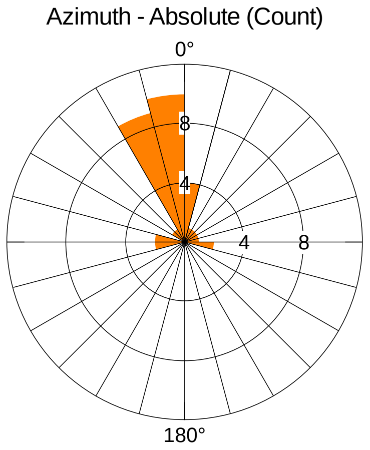
Counts:	49.00
Mean (2D):	32.47
Std.Dev.:	23.63
Min:	2.73
Max:	79.54

Stereogram - Lower Hemisphere of Foliation & Veins



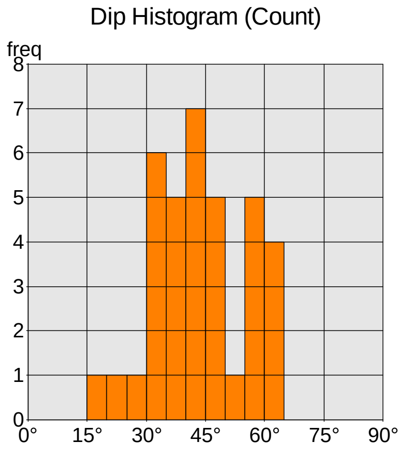
	Counts	Dip[deg]	Azi[deg]
Mean	36	43.44	350.44
▶	36	43.44	350.44

Dip Azimuth Rose Diagram of Foliation & Veins



Components:	Azimuth
Counts:	36.00
Mean (2D):	350.44
Std.Dev.:	45.40
Min:	0.43
Max:	358.62

Dip Angle Histogram of Foliation & Veins



Counts:	36.00
Mean (2D):	43.44
Std.Dev.:	11.23
Min:	18.54
Max:	63.04

HAGER-RICHTER GEOSCIENCE, INC.	
B-206 - TABLE OF BEDROCK STRUCTURES	
CLIENT	Lahlaf Geotechnical Consulting, Inc.
PROJECT	Northeast Metro Tech High School
LOCATION	Wakefield, Massachusetts
HRGS FILE	22RG48
DATE LOGGED	May 5, 2022
LOG DATUM	Ground Surface
DIP AZIMUTH	True North (Magnetic Declination = 14.3° West)
DIP ANGLE	Measured from Horizontal

B-206 - TABLE OF BEDROCK STRUCTURES

Depth (Feet)	Dip Azimuth (Degrees)	Dip Angle (Degrees)	Bedrock Structure Category
2.3	96	37	Fracture Rank 1
2.5	256	77	Fracture Rank 2
2.9	328	78	Fracture Rank 1
3.0	352	21	Fracture Rank 4
3.2	209	50	Fracture Rank 1
3.6	225	26	Fracture Rank 1
3.8	231	60	Fracture Rank 1
3.9	245	69	Fracture Rank 4
3.9	250	79	Fracture Rank 2
4.4	250	62	Fracture Rank 1
5.2	7	51	Foliation / Vein
6.1	357	32	Fracture Rank 2
6.2	305	73	Foliation / Vein
6.6	335	40	Foliation / Vein
6.9	38	8	Fracture Rank 3
7.1	60	1	Fracture Rank 4
8.3	155	11	Fracture Rank 1
8.6	282	72	Foliation / Vein
9.2	345	6	Fracture Rank 1
9.6	332	15	Fracture Rank 2
10.5	338	50	Foliation / Vein
10.8	10	52	Foliation / Vein
11.0	46	52	Foliation / Vein
11.9	337	51	Foliation / Vein
14.7	338	10	Fracture Rank 2
14.9	67	43	Foliation / Vein
16.0	338	9	Fracture Rank 3
16.3	24	14	Fracture Rank 4
17.1	190	14	Fracture Rank 2
17.2	306	17	Fracture Rank 2
18.4	266	32	Fracture Rank 2
19.1	96	36	Foliation / Vein
19.7	356	17	Fracture Rank 1

HAGER-RICHTER GEOSCIENCE, INC.	
B-208 - TABLE OF BEDROCK STRUCTURES	
CLIENT	Lahlaf Geotechnical Consulting, Inc.
PROJECT	Northeast Metro Tech High School
LOCATION	Wakefield, Massachusetts
HRGS FILE	22RG48
DATE LOGGED	May 5, 2022
LOG DATUM	Ground Surface
DIP AZIMUTH	True North (Magnetic Declination = 14.3° West)
DIP ANGLE	Measured from Horizontal

B-208 - TABLE OF BEDROCK STRUCTURES

Depth (Feet)	Dip Azimuth (Degrees)	Dip Angle (Degrees)	Bedrock Structure Category
3.3	338	13	Fracture Rank 1
3.6	146	73	Fracture Rank 1
4.0	281	22	Fracture Rank 2
4.1	136	67	Fracture Rank 1
4.5	333	17	Fracture Rank 2
4.6	311	71	Fracture Rank 1
5.1	332	46	Foliation / Vein
7.1	341	56	Foliation / Vein
7.9	353	35	Foliation / Vein
8.2	152	73	Fracture Rank 1
9.0	102	59	Foliation / Vein
9.4	282	39	Foliation / Vein
9.7	260	46	Foliation / Vein
10.8	293	3	Fracture Rank 3
10.9	274	25	Fracture Rank 3
11.1	335	42	Foliation / Vein
11.6	271	34	Foliation / Vein
12.4	254	68	Fracture Rank 2
12.6	279	35	Fracture Rank 3
12.8	260	24	Foliation / Vein
13.8	203	80	Fracture Rank 2
13.9	0	41	Foliation / Vein
15.3	49	6	Fracture Rank 2
15.5	321	38	Foliation / Vein
15.6	3	15	Fracture Rank 2
16.1	8	9	Fracture Rank 4
16.4	331	36	Foliation / Vein
16.9	351	29	Fracture Rank 2
17.7	302	55	Foliation / Vein
19.4	343	45	Foliation / Vein
19.6	337	46	Foliation / Vein
19.9	334	42	Foliation / Vein
20.1	337	45	Foliation / Vein
20.5	69	43	Foliation / Vein
21.2	338	61	Foliation / Vein
21.8	359	27	Fracture Rank 2

B-208 - TABLE OF BEDROCK STRUCTURES

Depth (Feet)	Dip Azimuth (Degrees)	Dip Angle (Degrees)	Bedrock Structure Category
22.0	286	69	Fracture Rank 2
22.3	359	33	Foliation / Vein
23.1	61	16	Fracture Rank 2
23.6	335	46	Fracture Rank 1
23.7	114	41	Fracture Rank 2
23.9	3	27	Foliation / Vein
24.2	95	57	Foliation / Vein
24.5	83	60	Foliation / Vein
24.6	356	36	Fracture Rank 1
24.7	10	29	Fracture Rank 2
24.8	358	45	Fracture Rank 2
25.4	21	56	Foliation / Vein
25.7	98	16	Fracture Rank 2
25.8	338	11	Fracture Rank 1
26.0	188	59	Fracture Rank 1
26.0	11	11	Fracture Rank 1
26.8	325	4	Fracture Rank 1
26.9	358	4	Fracture Rank 4
27.0	347	6	Fracture Rank 2
27.1	7	19	Foliation / Vein
27.2	356	9	Fracture Rank 1
28.1	161	23	Fracture Rank 2
28.2	161	29	Fracture Rank 2
28.5	355	12	Fracture Rank 1
28.5	47	40	Foliation / Vein
28.9	28	55	Fracture Rank 2
29.1	35	29	Fracture Rank 1
29.1	87	66	Fracture Rank 1
29.2	67	11	Fracture Rank 4
29.2	354	61	Foliation / Vein
29.6	348	63	Foliation / Vein
29.8	340	72	Fracture Rank 1
29.9	34	4	Fracture Rank 2
29.9	339	71	Fracture Rank 1
29.9	69	21	Fracture Rank 4
30.4	348	33	Foliation / Vein
30.5	356	31	Foliation / Vein
31.6	352	20	Fracture Rank 2
32.2	357	47	Foliation / Vein
32.7	348	19	Fracture Rank 3
32.8	113	53	Fracture Rank 1
33.2	34	22	Fracture Rank 2
33.4	47	29	Fracture Rank 3
33.5	74	41	Fracture Rank 1
33.6	34	32	Foliation / Vein
33.9	349	36	Foliation / Vein

B-208 - TABLE OF BEDROCK STRUCTURES

Depth (Feet)	Dip Azimuth (Degrees)	Dip Angle (Degrees)	Bedrock Structure Category
34.1	3	40	Foliation / Vein
34.4	355	40	Foliation / Vein
34.6	357	57	Foliation / Vein

HAGER-RICHTER GEOSCIENCE, INC.	
B-206 - TABLE OF BEDROCK STRUCTURES	
CLIENT	Lahlaf Geotechnical Consulting, Inc.
PROJECT	Northeast Metro Tech High School
LOCATION	Wakefield, Massachusetts
HRGS FILE	22RG48
DATE LOGGED	May 5, 2022
LOG DATUM	Ground Surface
DIP AZIMUTH	True North (Magnetic Declination = 14.3° West)
DIP ANGLE	Measured from Horizontal

B-206 - TABLE OF BEDROCK STRUCTURES

Depth (Feet)	Dip Azimuth (Degrees)	Dip Angle (Degrees)	Bedrock Structure Category
2.3	96	37	Fracture Rank 1
2.5	256	77	Fracture Rank 2
2.9	328	78	Fracture Rank 1
3.0	352	21	Fracture Rank 4
3.2	209	50	Fracture Rank 1
3.6	225	26	Fracture Rank 1
3.8	231	60	Fracture Rank 1
3.9	245	69	Fracture Rank 4
3.9	250	79	Fracture Rank 2
4.4	250	62	Fracture Rank 1
5.2	7	51	Foliation / Vein
6.1	357	32	Fracture Rank 2
6.2	305	73	Foliation / Vein
6.6	335	40	Foliation / Vein
6.9	38	8	Fracture Rank 3
7.1	60	1	Fracture Rank 4
8.3	155	11	Fracture Rank 1
8.6	282	72	Foliation / Vein
9.2	345	6	Fracture Rank 1
9.6	332	15	Fracture Rank 2
10.5	338	50	Foliation / Vein
10.8	10	52	Foliation / Vein
11.0	46	52	Foliation / Vein
11.9	337	51	Foliation / Vein
14.7	338	10	Fracture Rank 2
14.9	67	43	Foliation / Vein
16.0	338	9	Fracture Rank 3
16.3	24	14	Fracture Rank 4
17.1	190	14	Fracture Rank 2
17.2	306	17	Fracture Rank 2
18.4	266	32	Fracture Rank 2
19.1	96	36	Foliation / Vein
19.7	356	17	Fracture Rank 1

HAGER-RICHTER GEOSCIENCE, INC.

B-208 - TABLE OF BEDROCK STRUCTURES

CLIENT	Lahlaf Geotechnical Consulting, Inc.
PROJECT	Northeast Metro Tech High School
LOCATION	Wakefield, Massachusetts
HRGS FILE	22RG48
DATE LOGGED	May 5, 2022
LOG DATUM	Ground Surface
DIP AZIMUTH	True North (Magnetic Declination = 14.3° West)
DIP ANGLE	Measured from Horizontal

B-208 - TABLE OF BEDROCK STRUCTURES

Depth (Feet)	Dip Azimuth (Degrees)	Dip Angle (Degrees)	Bedrock Structure Category
3.3	338	13	Fracture Rank 1
3.6	146	73	Fracture Rank 1
4.0	281	22	Fracture Rank 2
4.1	136	67	Fracture Rank 1
4.5	333	17	Fracture Rank 2
4.6	311	71	Fracture Rank 1
5.1	332	46	Foliation / Vein
7.1	341	56	Foliation / Vein
7.9	353	35	Foliation / Vein
8.2	152	73	Fracture Rank 1
9.0	102	59	Foliation / Vein
9.4	282	39	Foliation / Vein
9.7	260	46	Foliation / Vein
10.8	293	3	Fracture Rank 3
10.9	274	25	Fracture Rank 3
11.1	335	42	Foliation / Vein
11.6	271	34	Foliation / Vein
12.4	254	68	Fracture Rank 2
12.6	279	35	Fracture Rank 3
12.8	260	24	Foliation / Vein
13.8	203	80	Fracture Rank 2
13.9	0	41	Foliation / Vein
15.3	49	6	Fracture Rank 2
15.5	321	38	Foliation / Vein
15.6	3	15	Fracture Rank 2
16.1	8	9	Fracture Rank 4
16.4	331	36	Foliation / Vein
16.9	351	29	Fracture Rank 2
17.7	302	55	Foliation / Vein
19.4	343	45	Foliation / Vein
19.6	337	46	Foliation / Vein
19.9	334	42	Foliation / Vein
20.1	337	45	Foliation / Vein
20.5	69	43	Foliation / Vein

B-208 - TABLE OF BEDROCK STRUCTURES

Depth (Feet)	Dip Azimuth (Degrees)	Dip Angle (Degrees)	Bedrock Structure Category
21.2	338	61	Foliation / Vein
21.8	359	27	Fracture Rank 2
22.0	286	69	Fracture Rank 2
22.3	359	33	Foliation / Vein
23.1	61	16	Fracture Rank 2
23.6	335	46	Fracture Rank 1
23.7	114	41	Fracture Rank 2
23.9	3	27	Foliation / Vein
24.2	95	57	Foliation / Vein
24.5	83	60	Foliation / Vein
24.6	356	36	Fracture Rank 1
24.7	10	29	Fracture Rank 2
24.8	358	45	Fracture Rank 2
25.4	21	56	Foliation / Vein
25.7	98	16	Fracture Rank 2
25.8	338	11	Fracture Rank 1
26.0	188	59	Fracture Rank 1
26.0	11	11	Fracture Rank 1
26.8	325	4	Fracture Rank 1
26.9	358	4	Fracture Rank 4
27.0	347	6	Fracture Rank 2
27.1	7	19	Foliation / Vein
27.2	356	9	Fracture Rank 1
28.1	161	23	Fracture Rank 2
28.2	161	29	Fracture Rank 2
28.5	355	12	Fracture Rank 1
28.5	47	40	Foliation / Vein
28.9	28	55	Fracture Rank 2
29.1	35	29	Fracture Rank 1
29.1	87	66	Fracture Rank 1
29.2	67	11	Fracture Rank 4
29.2	354	61	Foliation / Vein
29.6	348	63	Foliation / Vein
29.8	340	72	Fracture Rank 1
29.9	34	4	Fracture Rank 2
29.9	339	71	Fracture Rank 1
29.9	69	21	Fracture Rank 4
30.4	348	33	Foliation / Vein
30.5	356	31	Foliation / Vein
31.6	352	20	Fracture Rank 2
32.2	357	47	Foliation / Vein
32.7	348	19	Fracture Rank 3
32.8	113	53	Fracture Rank 1
33.2	34	22	Fracture Rank 2

B-208 - TABLE OF BEDROCK STRUCTURES

Depth (Feet)	Dip Azimuth (Degrees)	Dip Angle (Degrees)	Bedrock Structure Category
33.4	47	29	Fracture Rank 3
33.5	74	41	Fracture Rank 1
33.6	34	32	Foliation / Vein
33.9	349	36	Foliation / Vein
34.1	3	40	Foliation / Vein
34.4	355	40	Foliation / Vein
34.6	357	57	Foliation / Vein

Appendix F – Ground Penetrating Radar Geophysical Survey

BEDROCK DEPTH INVESTIGATION
NORTHEAST METRO REGIONAL TECHNICAL HIGH SCHOOL
WAKEFIELD, MA

July 22th, 2022
File 2022031

Prepared for:
Lahlaf Geotechnical Consulting, Inc
100 Chelmsford Road, Suite 2
Billerica, MA 01862

TABLE OF CONTENTS

PLATE

APPENDIX

1.0 INTRODUCTION

This report details the results of a geophysical investigation conducted by Hager GeoScience (HGI) for Lahlaf Geotechnical Consulting, Inc. (LGCI) at the Proposed Northeast Metro Regional Vocational Technical High School in Wakefield, Massachusetts. Field data acquisition was performed on July14th and 15th, 2022. An additional 1.5 days was necessary to clear the vegetation along the lines. The survey objective was to map the depth to bedrock along Line 1 (~780') and Line 2 (~1950') for a total length of 2750 linear feet.

Based on borehole and test pit information provided by LGCI, Ground Penetrating Radar (GPR)was chosen as a preferred method, considering the average shallow bedrock depth reported.

2.0 DATA ACQUISITION

2.1 GPR Survey

Due to dense vegetation and irregular topography, Lines 1 and 2 were split into multiple segments, in order to reduce the effect of survey wheel distance errors. Specifically:

- Line 1 has been segmented in three sections because of dense vegetation between L1-A and L1-B, and outcrop crossing between L1-B and L1-C. The resulted total line length covered is 765 feet.
- BH-206 and BH-208 information were used to calibrate the GPR data and assign the more adequate dielectric constant along Line 1.
- Line 2 has been segmented in ten sections due to difficult topography, resulting in distance error assigned to the GPR data, and obstacles along the line.
- TP-204 and TP-206 information were used to calibrate the GPR data and assign the more adequate dielectric constant along Line 2.

GPR survey locations are shown on Plate 1, an AutoCAD Map3D 2021 plot created from HGI field notes, GPR data, GPS measurements, and a base map provided by LGCI. Red and Blue colors were used to differentiate transects along Lines 1 and 2.

GPR data were collected as two-way travel time and reflection amplitude, in which measurements are made of the time for the input radar wave pulse to travel to a subsurface change in electrical properties and reflect back to the antenna at the ground surface, and the relative energy of the reflected signal. Depths to interfaces are determined from the recorded travel-time data using radar propagation velocities estimated through migration calculations and from material-specific velocity tables and published data.

HGI used a Geophysical Survey Systems Inc. (GSSI) SIR-4000 acquisition system with a 350 and 200-MHz antennas. The combination of a lower and higher frequency antenna allowed to image depth up to 40' below ground surface, and at the same time to maintain high resolution on shallower boundaries. The data acquisition parameters used for the GPR survey are shown in Table 1 below.

Table 1 - GPR Survey Acquisition Parameters

Antenna Frequency (MHz)	Range (ns)	Survey Mode[1]	Scan Rate (scans/s)	Scan Interval (ft)	Samples/ Trace	Approx. Signal Depth (ft)
200	300	SW	177	24	512	40
350	200	SW	120	28	512	25

[1] SW-Survey Wheel

2.2 GPS Survey

Hager Geoscience used its Sokkia RTK GRX2 GPS system to locate surface features, transects, and other features of interest. Where an RTK solution was achieved, the Sokkia system provided a relative accuracy of around 0.0328 feet horizontally and 0.0492 feet vertically. All points were collected in MA83F State Plane coordinate system.

3.0 DATA REDUCTION AND ANALYSIS

Following the field data collection, the geophysical data were downloaded to a PC at the office, where they were archived, processed, and analyzed using the following proprietary software:

- GPR data processing: GSSI's RADAN® 7
- Graphic presentations: Microsoft Excel®, Golden Software Surfer© 23, AutoCAD® Map3D 2021

3.1 GPR Survey

GPR data were processed and analyzed using GSSI's RADAN® 7 software. Prior to analysis, the raw GPR data required processing to reduce the detrimental effects of site-specific noise associated with interfering background frequency signals, destructive reflections from surface and/or buried objects, and general signal attenuation. Several iterations of GPR data processing and analysis were necessary to mitigate the detrimental effects.

The processed profiles were analyzed for the location, depth, and orientation of reflective features relating to changes in soil and bedrock stratigraphy. Reflective boundaries interpreted as reflections from the bedrock surface were "picked" to produce a database of depth points for spatial mapping. The depths to GPR reflectors were calculated using two-way travel times to the GPR reflector and propagation velocities estimated using a priori information and experience.

Bedrock depth information from BH-206, BH-208, TP-204 and TP-206 were used to calibrate the GPR results interpreted for Lines 1 and 2.

4.0 RESULTS

As stated in Section 1.0 Introduction, the survey objective was to map the depth to bedrock along Line 1 (~780') and Line 2 (~1950') for a total length of 2750 linear feet.

The bedrock profiles along Lines 1 and 2 (shown in Figures G-1 to G13) reveal an undulating glacially eroded bedrock surface. GPR data indicate the presence of a variable weathering profile along the bedrock surface. In order to provide a consistent interpretation of the bedrock surface, the top of weathered bedrock was selected to represent the bedrock surface in areas where a weathered bedrock profile was observed.

The thickness of weathered bedrock has not been interpreted but most likely is less than 3 to 5 feet and consists of fractured vs. decomposed rock. The rippability of the bedrock surface can be determined from a seismic refraction survey.

The maximum depth to bedrock calculated for Line 1 is less than 4 feet below ground surface. Bedrock outcrop occurs between Line1-B and Line1-C. The maximum depth to bedrock calculated for Line 2 is less than 10 feet below ground surface.

5.0 THE GEOPHYSICAL METHODS

5.1 Ground Penetrating Radar (GPR)

5.1.1 Description of the Method. The principle of ground penetrating radar (GPR) is the same as that used by police radar, except that GPR transmits electromagnetic energy into the ground. The energy is reflected back to the surface from interfaces between materials with contrasting electrical (dielectric and conductivity) and physical properties. The greater the contrast between two materials in the subsurface, the stronger the reflection observed on the GPR record. The depth of GPR signal penetration depends on the properties of the subsurface materials and the frequency of the antenna used to collect radar data. Lower frequency antennas provide greater signal penetration, but result in lower object resolution.

5.1.2 Data Collection. HGI collects GPR data using a Geophysical Survey Systems (GSSI) SIR 2, 20, 2000, 3000, or 4000 ground penetrating radar system. Data are digitally recorded on the internal hard drive or flash memory of the GPR system. System controls allow the GPR operator to filter out noise, attributed to coupling noise caused by conductive soil conditions, spurious noise caused by local EMF fields, and internal system noise. For shallow surveys, we use antennas with center frequencies ranging from 2000- to 400-megahertz (MHz). For deeper penetration, we use lower frequency antennas ranging from 350 MHz to 15 MHz, depending on the anticipated target depth and the degree of signal penetration. All of these antenna configurations can collect data in continuous mode, distance mode, or as discrete point measurements using signal-stacking techniques. Since there is a trade-off between signal penetration and resolution, test data are sometimes collected using antennas with several different frequencies, with the highest frequency antenna that produces the highest quality data used. In some cases, data are collected with several antenna frequencies.

The horizontal scale of the GPR record shows distance along the survey traverse. In the continuous data collection mode, the horizontal scale on each GPR record is determined by the antenna speed along the surface. When a survey wheel is used, the GPR system records data with a fixed number of traces per unit distance. The GPR record is automatically marked at specified distance intervals along the survey line. The vertical scale of the radar record is determined by the velocity of the transmitted signal in the media under study and the range setting, or recording time window of the GPR system. The recording time interval, or range, represents the maximum two-way travel time in which data are recorded. The conversion of the two-way travel time of the transmitted signals to depth is determined by the propagation velocity of the GPR signal, which is site (media) specific. When little or no information is available about the makeup of subsurface materials, we estimate propagation velocities from handbook values and experience at similar sites or by CDP velocity surveys with a bi-static antenna.

5.1.3 Data Processing. After completion of data collection, the GPR data are transferred to a PC for review and processing using RADAN® 7 software. When appropriate, we prepare 3D models of GPR data, which can be sliced in the X, Y, and Z directions.

The size, shape, and amplitude of GPR reflections are used to interpret GPR data. Objects such as metallic UST's and utilities produce reflections with high amplitude and distinctive hyperbolic shapes. Clay, concrete pipes, boulders and other in-situ features may produce radar signatures of similar shape but lower amplitude. The boundaries between saturated and unsaturated materials such as sand and clay, bedrock and overburden, generally also produce strong reflections.

5.1.4 Limitations of the Method. GPR signal penetration is site-specific and is determined by the dielectric properties of local soil and fill materials. GPR signals propagate well in resistive materials such as sand and gravel; however, soils containing clay, ash- or cinder-laden fill or fill saturated with brackish or otherwise electrically conductive groundwater cause GPR signal attenuation and loss of target resolution. Concrete containing rebar or wire mesh also inhibits signal penetration.

The interpreted depths of objects detected using GPR are based on on-site calibration, handbook values, and/or estimated GPR signal propagation velocities from similar sites. GPR velocities and depth estimates may vary if the medium under investigation or soil water content is not uniform throughout the site.

Utilities are interpreted on the basis of reflections of similar size and depth that exhibit a linear trend; however, GPR cannot unambiguously determine that all such reflectors are related. Fiberglass USTs or utilities composed of plastic or clay may be difficult to detect if situated in soils with similar electromagnetic properties, or if situated in fill with other reflecting targets that generate "clutter" or signal scattering and thus obscure other deeper reflectors. Objects buried beneath reinforced concrete pads or slabs may also be difficult, but possible, to detect.

As a rule of thumb, GPR can resolve utilities with a diameter of 1" per foot of depth (i.e., a 1"-diameter utility can be detected to a burial depth of 1 foot).

Changes in the speed at which the GPR antenna is moved along the surface causes slight variations in the horizontal scale of the recorded traverse. Distance interpolation may be performed to minimize the error in interpreted object positions. The variation in the horizontal scale of the GPR record may be controlled, to a certain extent, with a distance encoder or survey wheel. The GPR antenna produces a cone-shaped signal pattern that emanates approximately 45 degrees from horizontal front and back of the antenna. Therefore, buried objects may be detected before the antenna is located directly over them. GPR anomalies may appear larger than actual target dimensions.

GPR interpretation is more subjective than other geophysical methods. The interpretive method is based on the identification of reflection patterns that do not uniquely identify a subsurface target. Borings, test pits, site utility plans and other ground-truth are recommended to verify the interpreted GPR results.

5.2 RTK GNSS Global Positioning System (GPS)

5.2.1 Description of the Method. The RTK GPS system consists of a base (reference) receiver and a roving receiver. The base receiver remains stationary during a survey and is mounted on a tribrach and tripod. A rover receiver is used to record points remotely and can be mounted on a staff, vehicle, or other object. The base provides real-time corrections to the rover over a radio connection. The system can produce accuracy on a centimeter scale, but the level of accuracy depends on factors that include the geometry of the transmitting satellites and the receivers' view of the horizons (e.g., the density of buildings and trees). The data can be collected as quickly as 5 Hz or 5 readings per second.

5.2.2 Data Collection and Processing. We perform our GPS surveys using a Sokkia RTK GRX3 GPS system. The base station can be set up over a known or unknown point, with the position taken from satellite information. Once the system has achieved a fixed solution for the rover receiver, data points can be collected with survey-grade (centimeter-scale) precision. When GPS points are being collected at a site where the fixed solution is constantly lost and gained, points are checked multiple times for precision. All data points are saved to a Carlson Surveyor 2 field computer.

The GPS data are corrected automatically by the base receiver in the field prior to being recorded. If the base station is located on an unknown point that is later defined, the GPS data can be corrected in the office to fit the real world coordinates.

5.2.3 Limitations of the Method. The quality of the GPS signal is site-specific. The base and rover receiver need to have clear views of the horizon and good satellite geometry to achieve the highest level of accuracy and precision. Although a fixed solution can be achieved in wooded environments or sites with taller buildings, it may take more time to achieve the solutions, the fixed solution may be lost frequently when moving the rover, and in some cases the fixed solution may be wrong. Each of these situations requires longer to locate data points accurately and precisely. When the point is too close to a building, beneath a building overhang, under a tree, or obscured by some other object, a fixed solution may not be possible.

When the base station is set up over an unknown point, the survey data location can be at least several tens of meters from the real world location. The data points will have survey grade precision relative to the location of the base station and other data points, but will have a real world accuracy discrepancy.

HGI does not guarantee to produce a surveyor-quality map from its GPS data, as this is not its profession. If survey-level accuracy is critical for a project, we recommend hiring professional surveyors for that purpose.

Legend

GPRTransect

◐ HGI - Identified Borehole

▚ HGI - Identified Test Pit

▨ HGI - Identified Outcrop

N

0 120 240
Feet

PLATE 1

July 2022	File #2022031

Bedrock Depth Investigation
Northeast Metro Regional
Technical High School
Wakefield, MA
Location of GPR Transects

NOTES:
1.) The base map was created from HGI field notes, GPS and the file "2022-07-01_NEMT_DD_Cost Est_Site Plan.dwg" provided by LGCI.
2.) HGI's contributions to the base map are listed in the legend. All other features are from the file listed above and have been grayed.
3.) Shape and extension of HGI's Identified Outcrops are approximate.
4.) Blue and red colors are been used to identify different GPR sections along Lines 1 and 2.

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(781) 935-8111 hgi@hagergeoscience.com

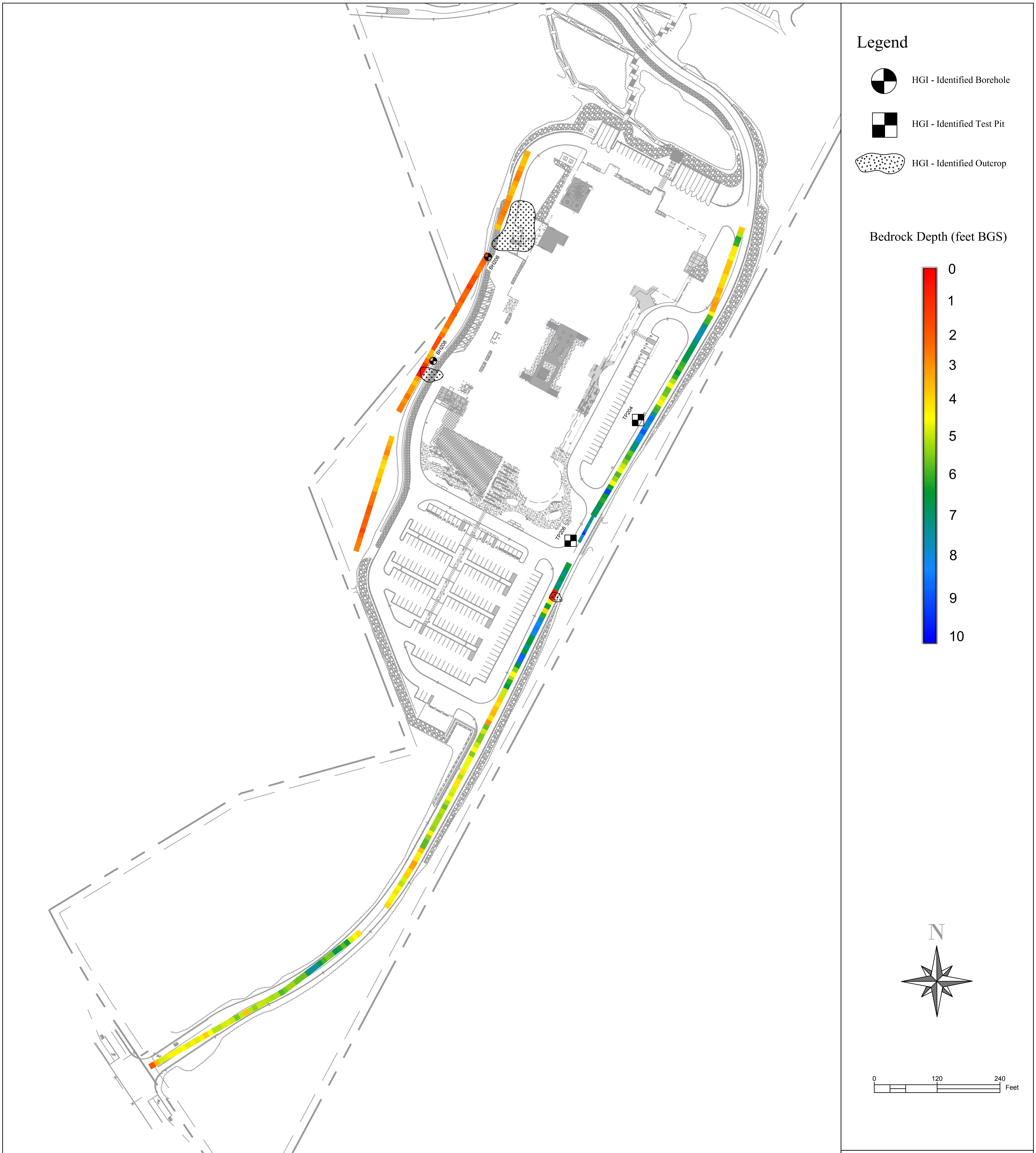

PLATE 2

July 2022 | File #2022031

Bedrock Depth Investigation
Northeast Metro Regional
Technical High School
Wakefield, MA
Bedrock Depth Plot

NOTES:
1.) The base map was created from HGI field notes, GPS and the file "2022-07-01_NEMT_DD_Cost Est_Site Plan.dwg" provided by LGCI.
2.) HGI's contributions to the base map are listed in the legend. All other features are from the file listed above and have been grayed.
3.) Shape and extension of HGI's Identified Outcrops are approximate.

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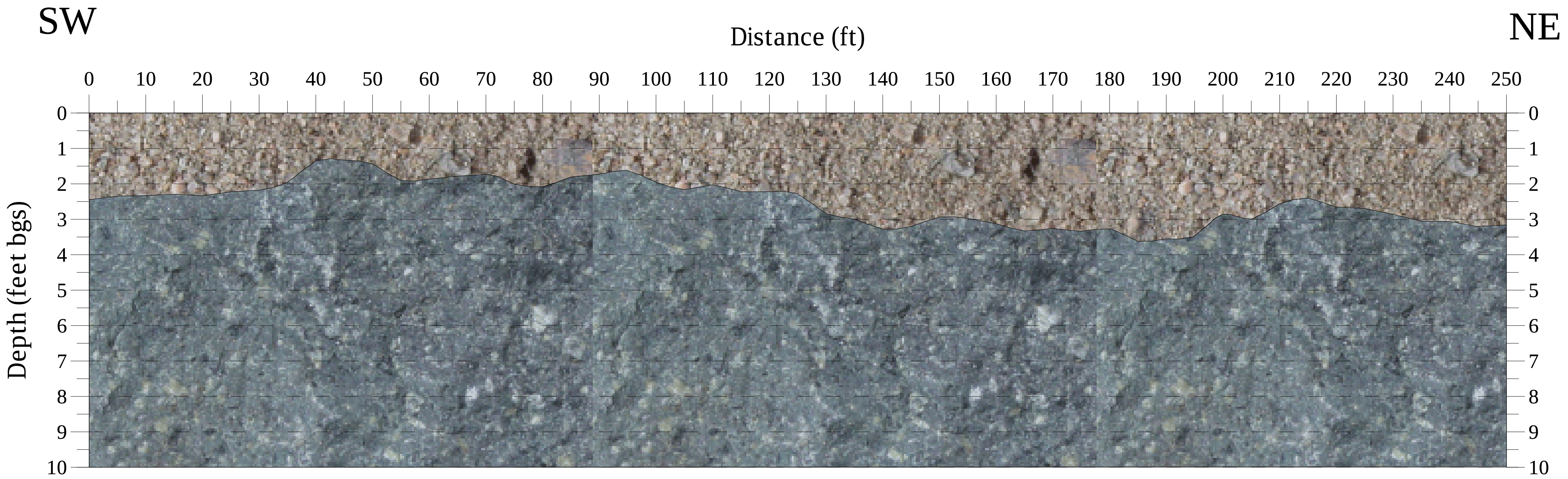
A Collier Geophysics Company
596 Main Street, Woburn, MA 01801
(781) 935-8111 hgi@hagergeoscience.com

Appendix A

Figure G1-G3

Line 1 Bedrock Depth Models

Figure G1
GPR Bedrock Depth Model
Line 1-A



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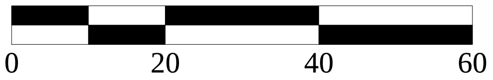
V.E. x 6.25



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A Collier Geophysics Company
596 Main Street
Woburn, MA 01801
(781) 935-8111 hgi@hagergeoscience.com

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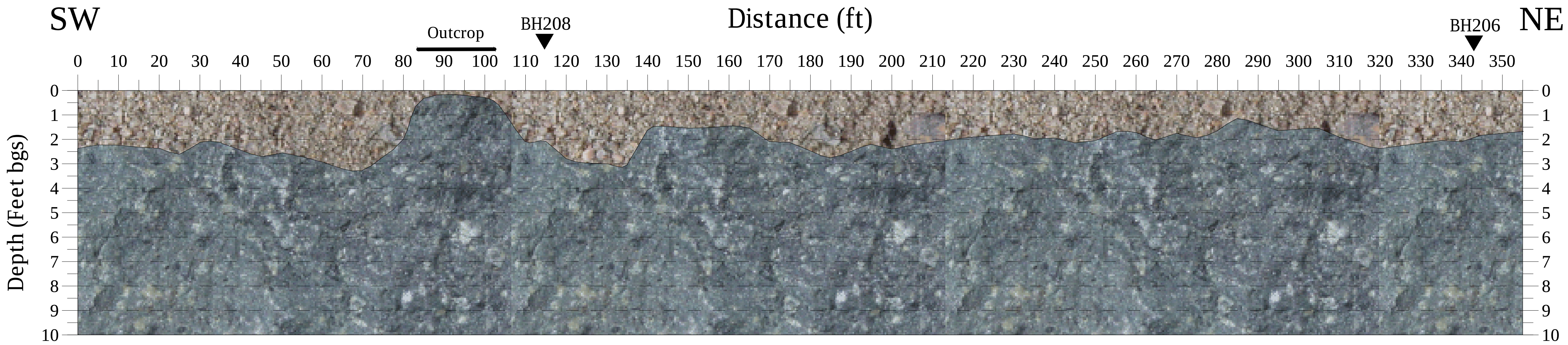
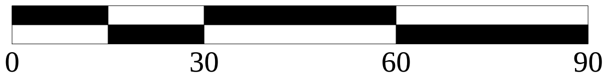
Figure G2
GPR Bedrock Depth Model
Line 1-B



V.E. x 6



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Woburn, MA 01801
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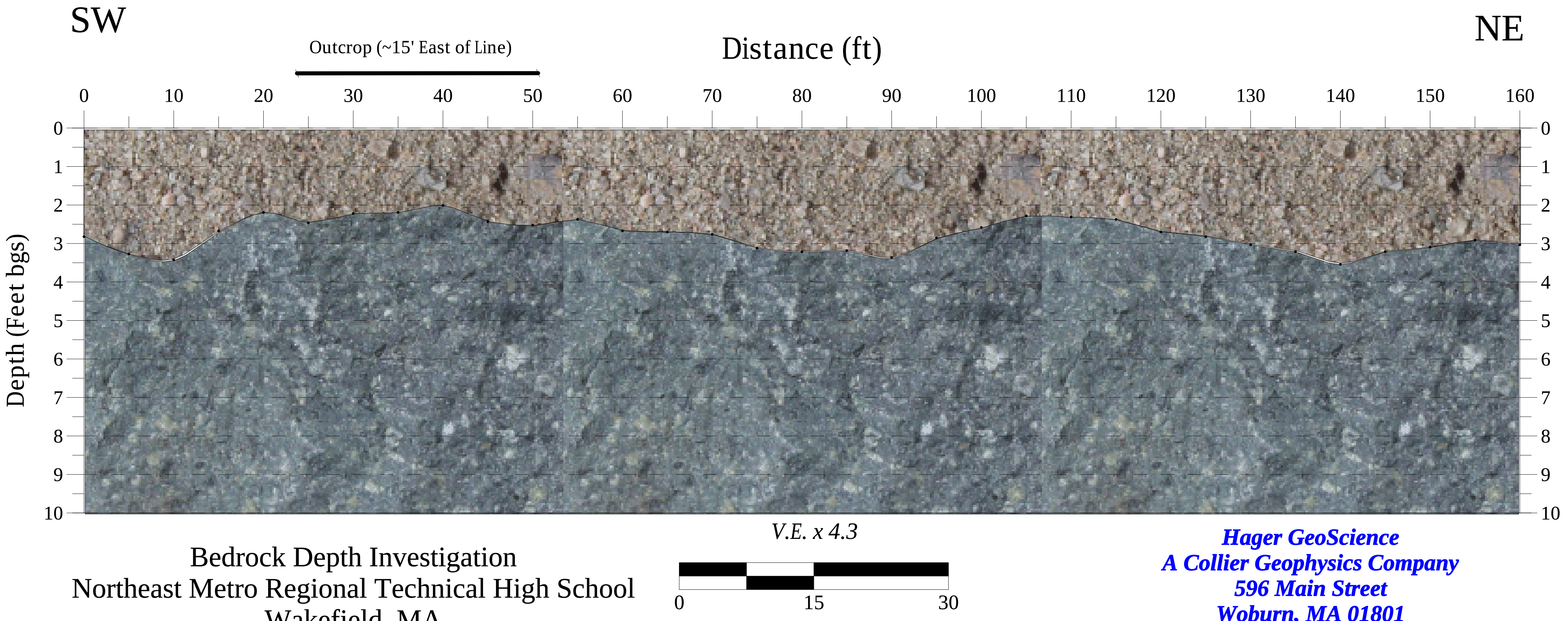
Figure G3
GPR Bedrock Depth Model
Line 1-C



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Woburn, MA 01801
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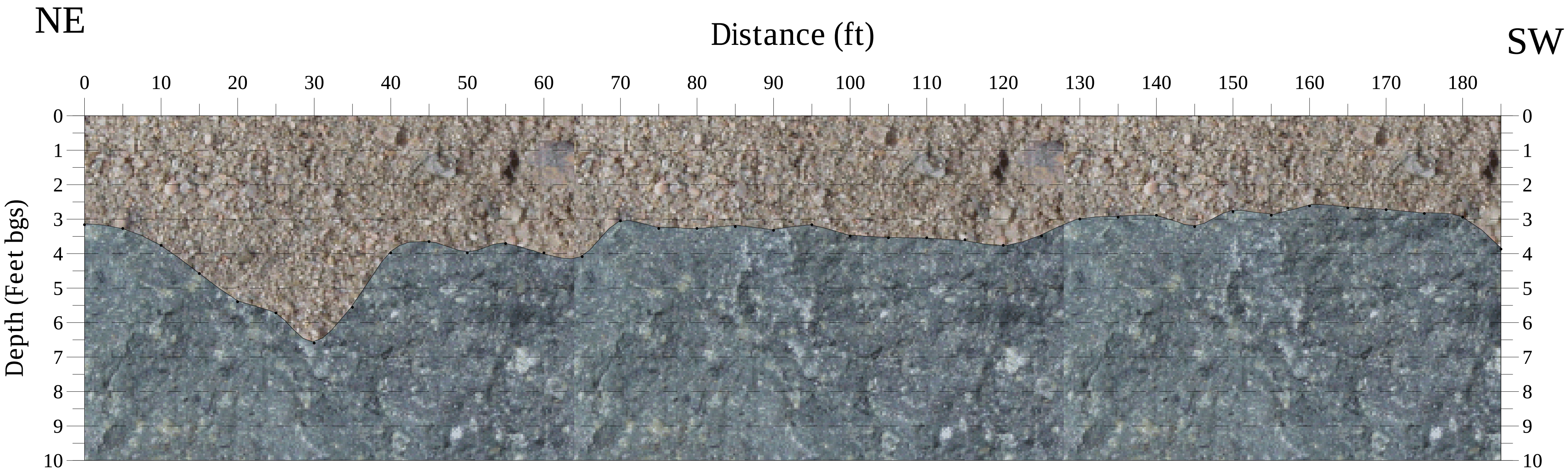
Appendix B

Figure G4-G13

Line 2 Bedrock Depth Models

Figure G4
GPR Bedrock Depth Model
Line 2-A



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V.E. x 4.5

0 18 36

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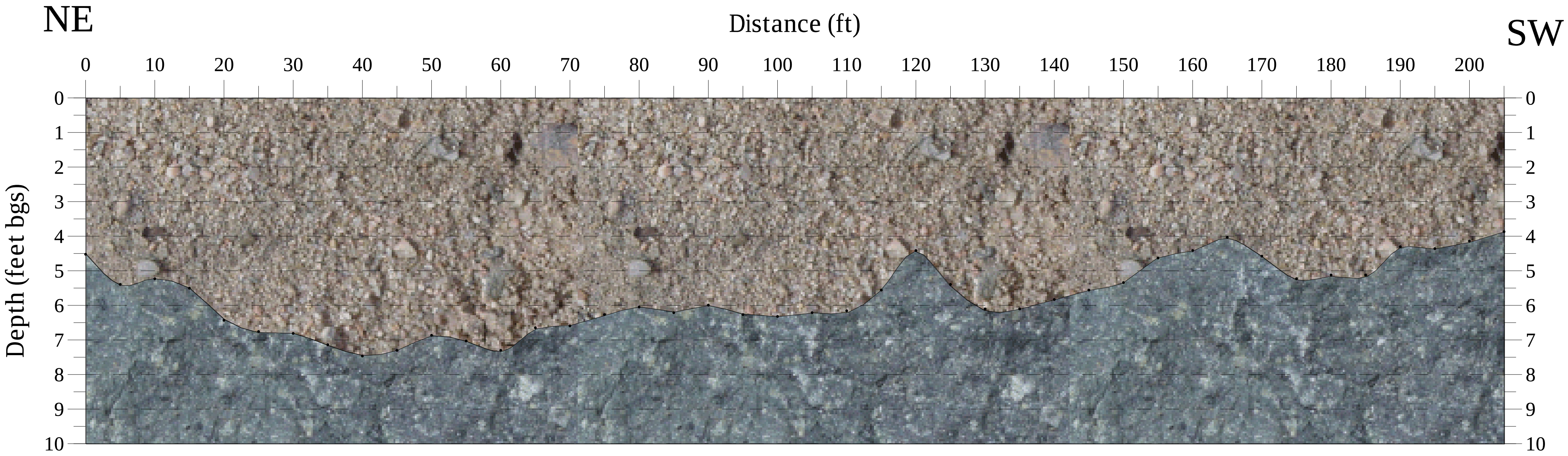
Figure G5
GPR Bedrock Depth Model
Line 2-B



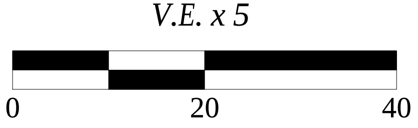


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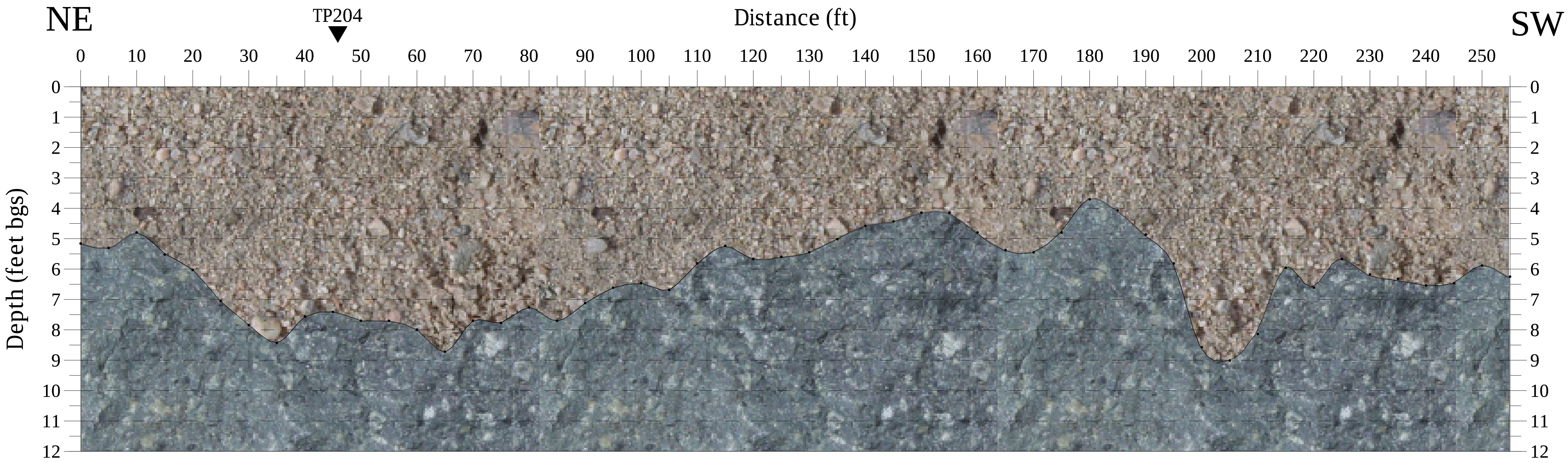
Figure G6
GPR Bedrock Depth Model
Line 2-C



V.E. x 5.75

0 23 46

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Woburn, MA 01801
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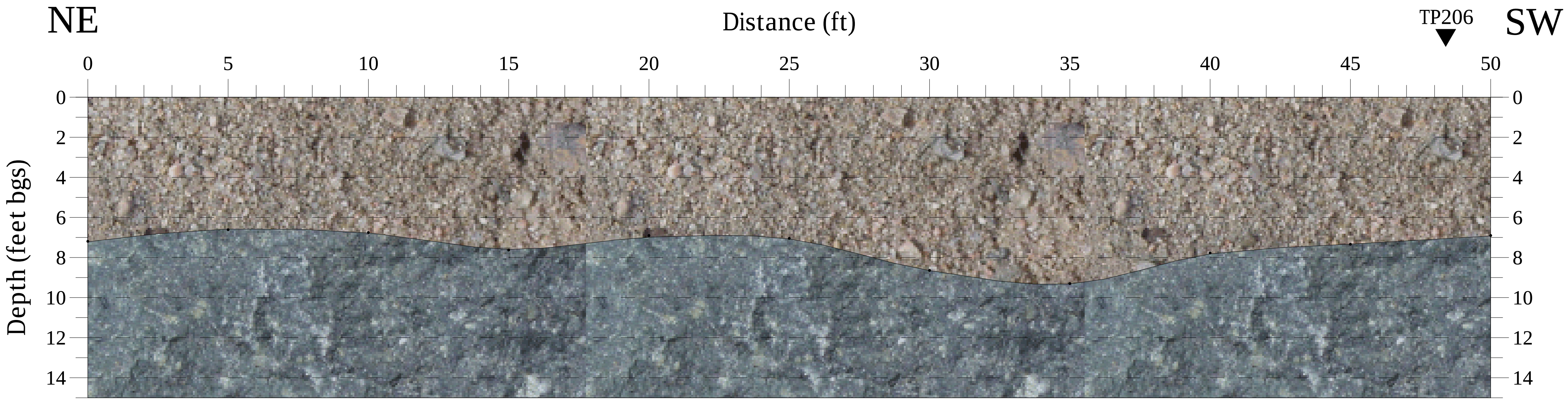
Figure G7
GPR Bedrock Depth Model
Line 2-D



V.E. x 0.7

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Figure G8
GPR Bedrock Depth Model
Line 2-E

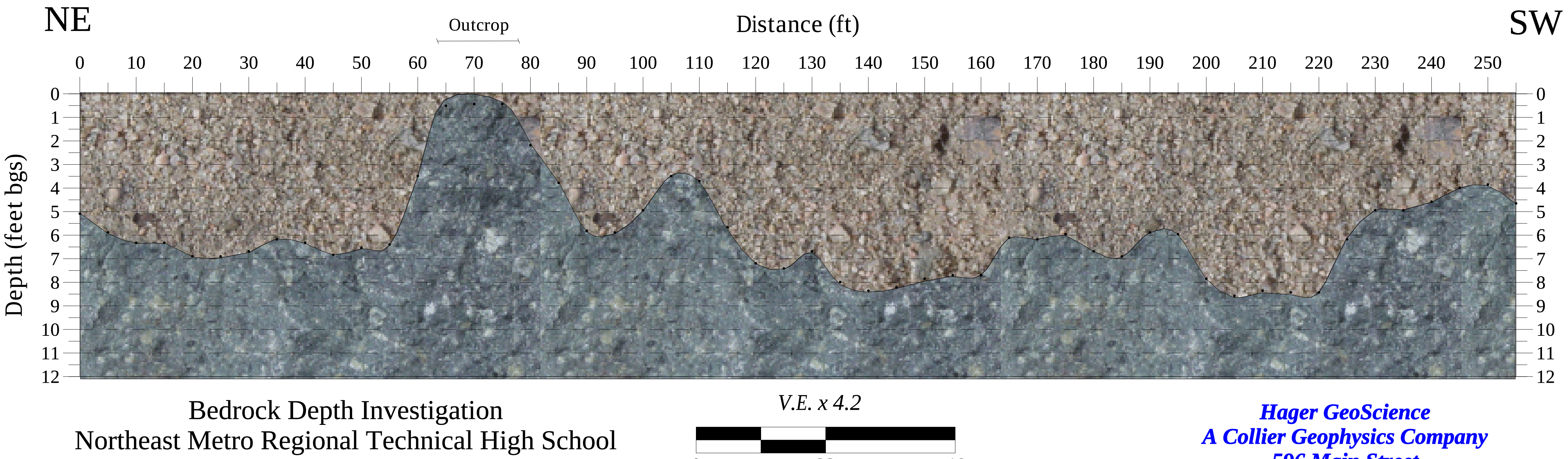

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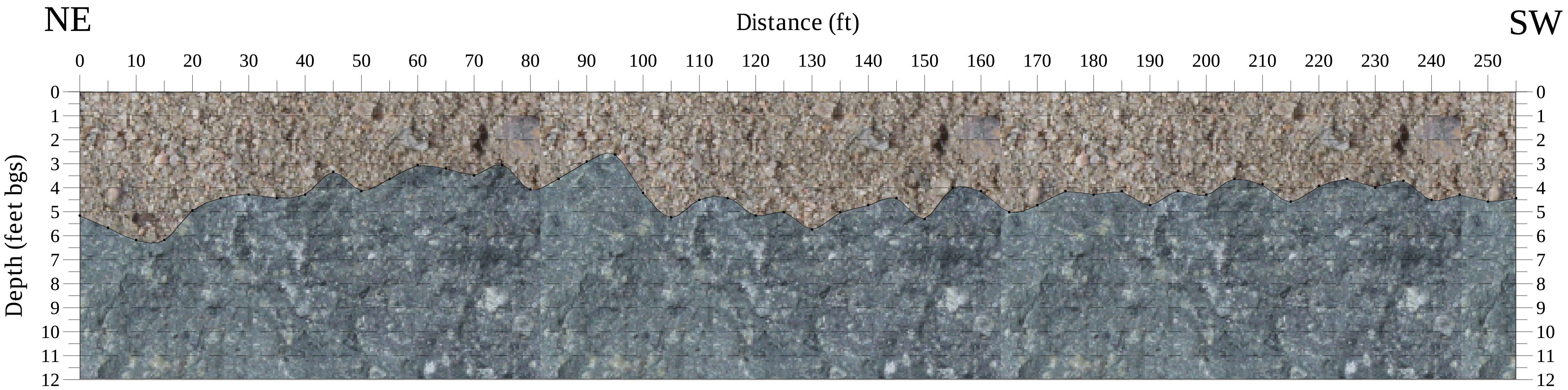
Figure G9
GPR Bedrock Depth Model
Line 2-F



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V.E. x 4.25

0 23 46

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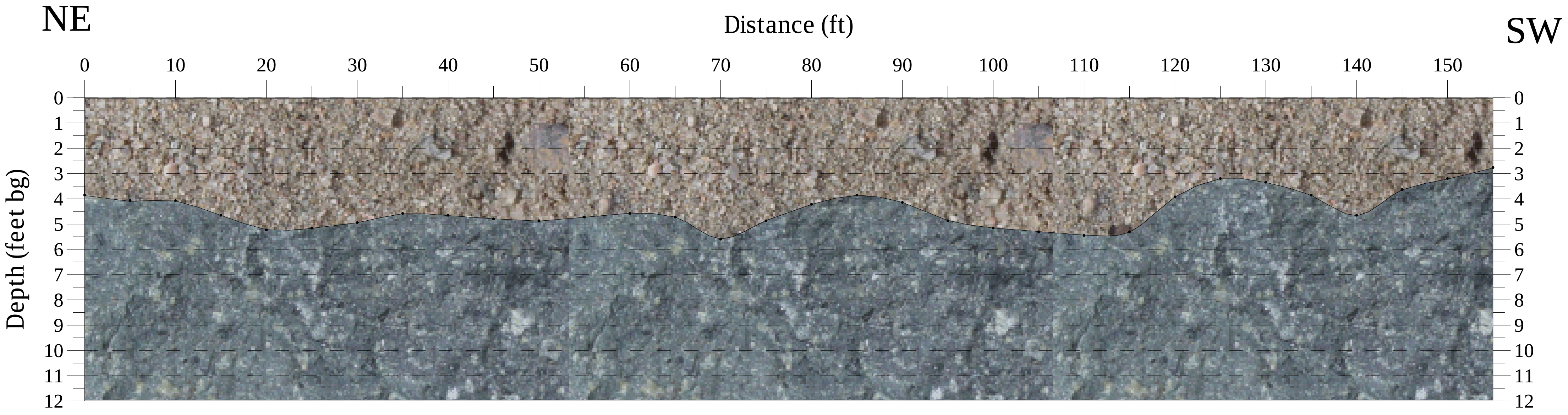
Figure G10
GPR Bedrock Depth Model
Line 2-G



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Woburn, MA 01801
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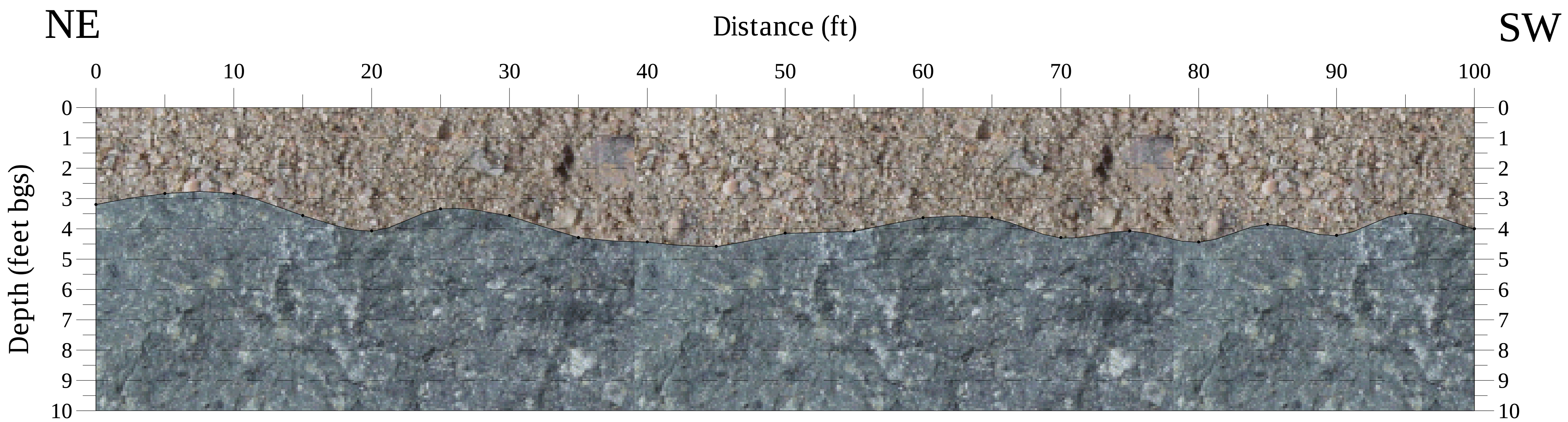
Figure G11
GPR Bedrock Depth Model
Line 2-H



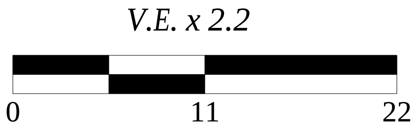


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Figure G12
GPR Bedrock Depth Model
Line 2-I

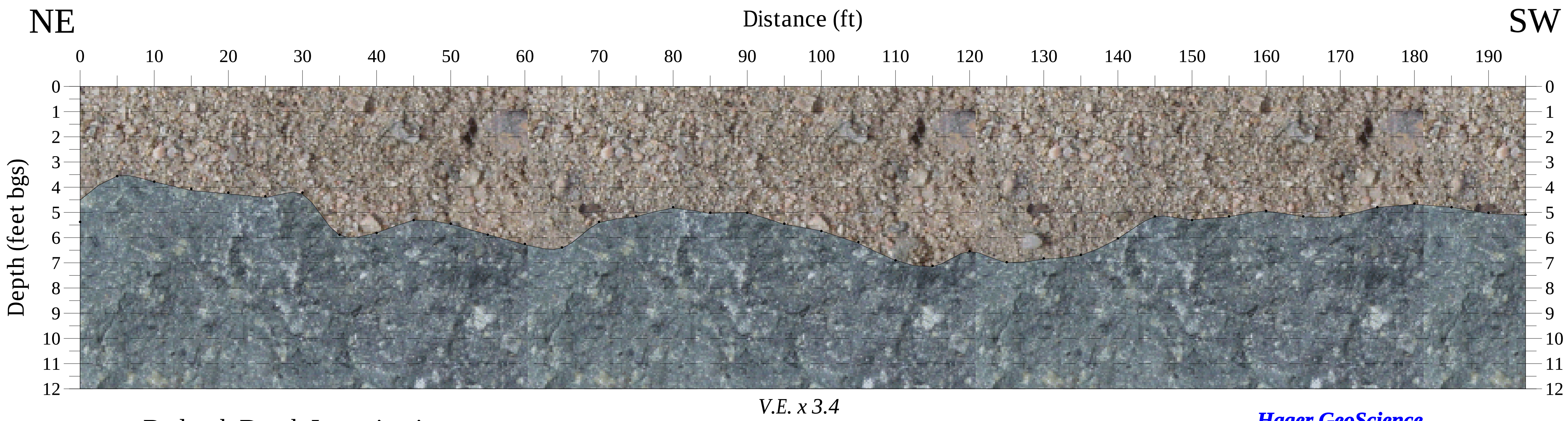

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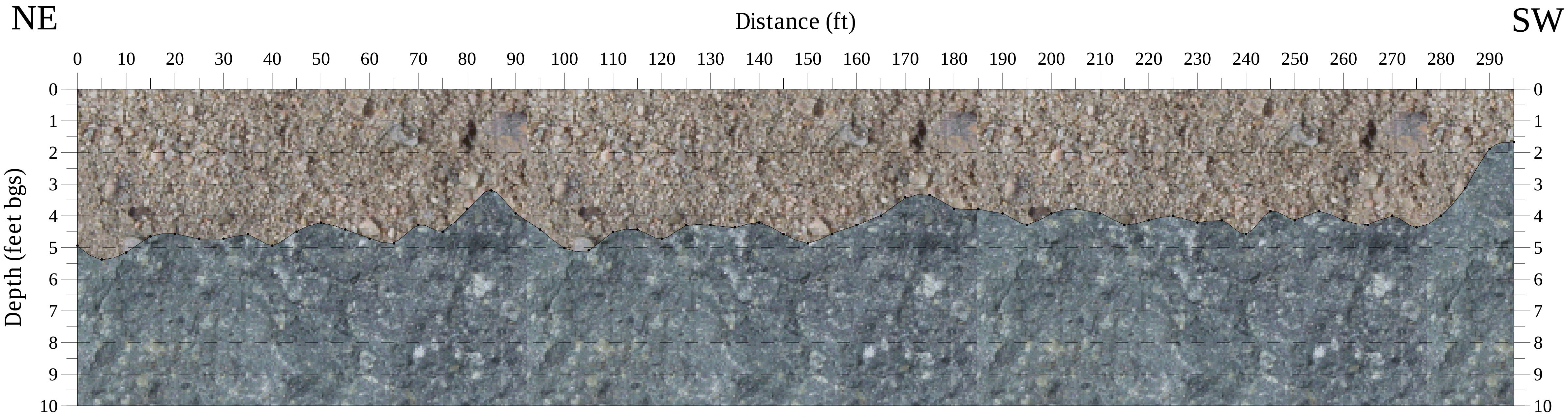
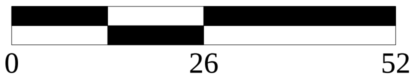
Figure G13
GPR Bedrock Depth Model
Line 2-K



V.E. x 6.5



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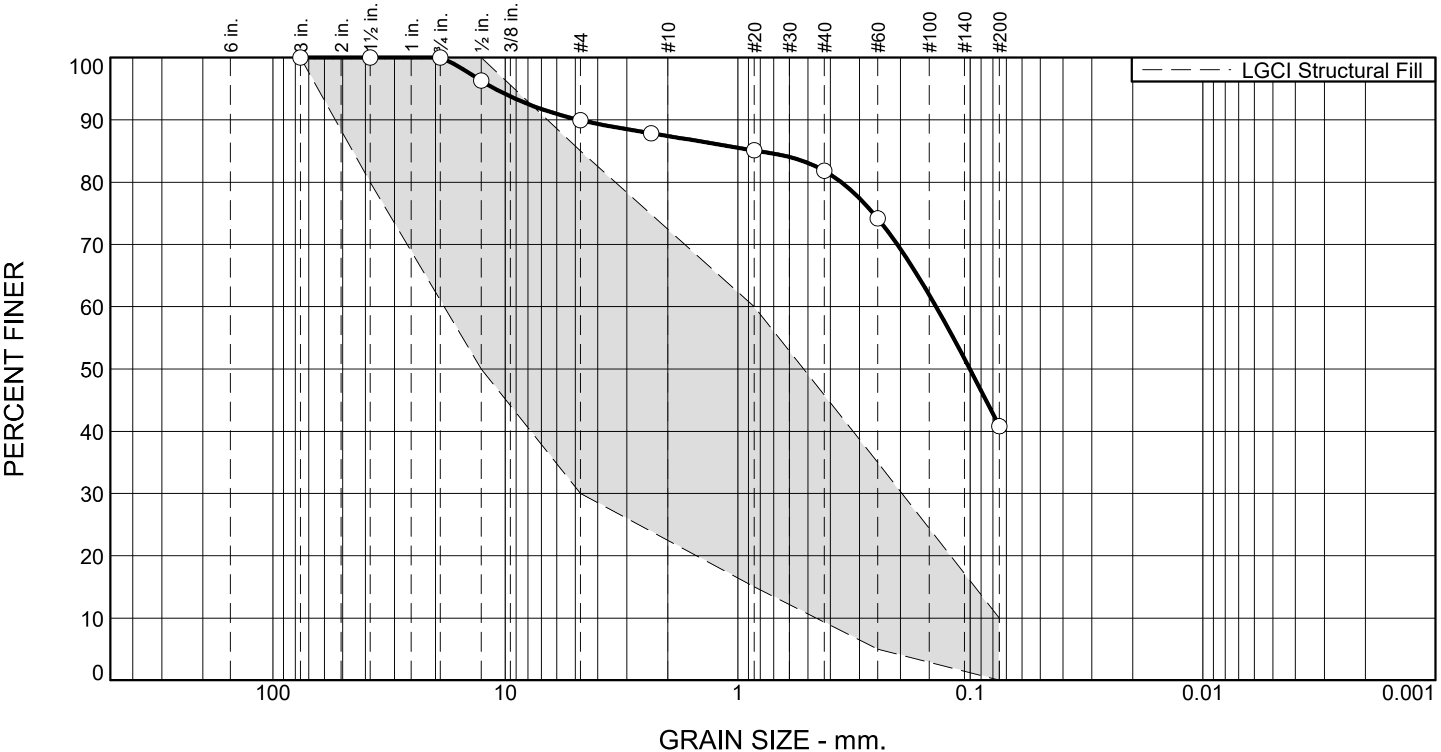
Appendix G – Results of Grain-size Analyses

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	10.0	2.6	5.6	41.0	40.8	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3"	100.0	100.0	
1.5"	100.0	80.0 - 100.0	
0.75"	100.0		
0.5"	96.3	50.0 - 100.0	
#4	90.0	30.0 - 85.0	X
#8	87.9		
#20	85.1	15.0 - 60.0	X
#40	81.8		
#60	74.2	5.0 - 35.0	X
#200	40.8	0.0 - 10.0	X

* LGCI Structural Fill

Material Description

ASTM (D 2488) Classification: Silty SAND (SM), mostly fine, 40-45% fines, 10-15% fine subrounded gravel, light brown

Atterberg Limits (ASTM D 4318)

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

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}=	4.8085	D_{85}=	0.8141	D_{60}=	0.1403
D_{50}=	0.1004	D_{30}=		D_{15}=	
D_{10}=		C_u=		C_c=	

Remarks

Sand and Gravel Sample

Date Received: 04/28/2022 **Date Tested:** 05/03/2022

Tested By: RF

Checked By: TG

Location: Boring B-201
Sample Number: S3 **Depth:** 4.0'-6.0'

Date Sampled: 04/28/2022

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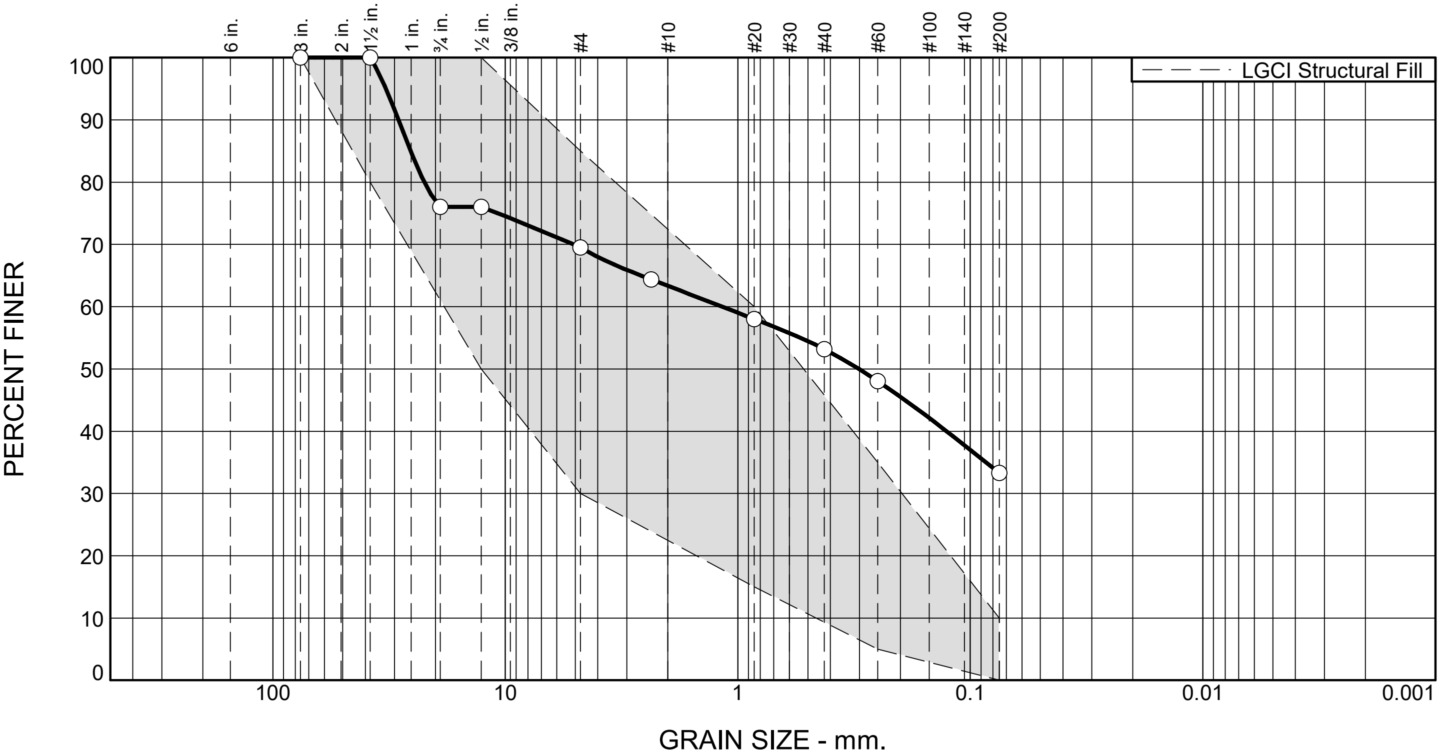
Lahlaf Geotechnical Consulting, Inc.

Client: Drummey Rosane Anderson, Inc.
Project: Prop. Northeast Metropolitan Regional Vocational Technical High School, Wakefield MA
Project No: 2025 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	24.0	6.5	6.1	10.2	19.9	33.3	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3"	100.0	100.0	
1.5"	100.0	80.0 - 100.0	
0.75"	76.0		
0.5"	76.0	50.0 - 100.0	
#4	69.5	30.0 - 85.0	
#8	64.4		
#20	58.0	15.0 - 60.0	
#40	53.2		
#60	48.1	5.0 - 35.0	X
#200	33.3	0.0 - 10.0	X

* LGCI Structural Fill

Material Description

ASTM (D 2488) Classification: Silty SAND with Gravel (SM) , fine to coarse, 30-35% fines, 30-35% fine to coarse subrounded gravel, brown to dark-brown

Atterberg Limits (ASTM D 4318)

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

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 28.7958 D_{85}= 25.5251 D_{60}= 1.1681
D_{50}= 0.3010 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Subsoil Sample

Date Received: 4/27/22 **Date Tested:** 6/9/22
Tested By: HH
Checked By: RF

Location: Boring B-202
Sample Number: S1 Bot. 2" **Depth:** 0.3'-1.8'
Date Sampled: 4/27/22

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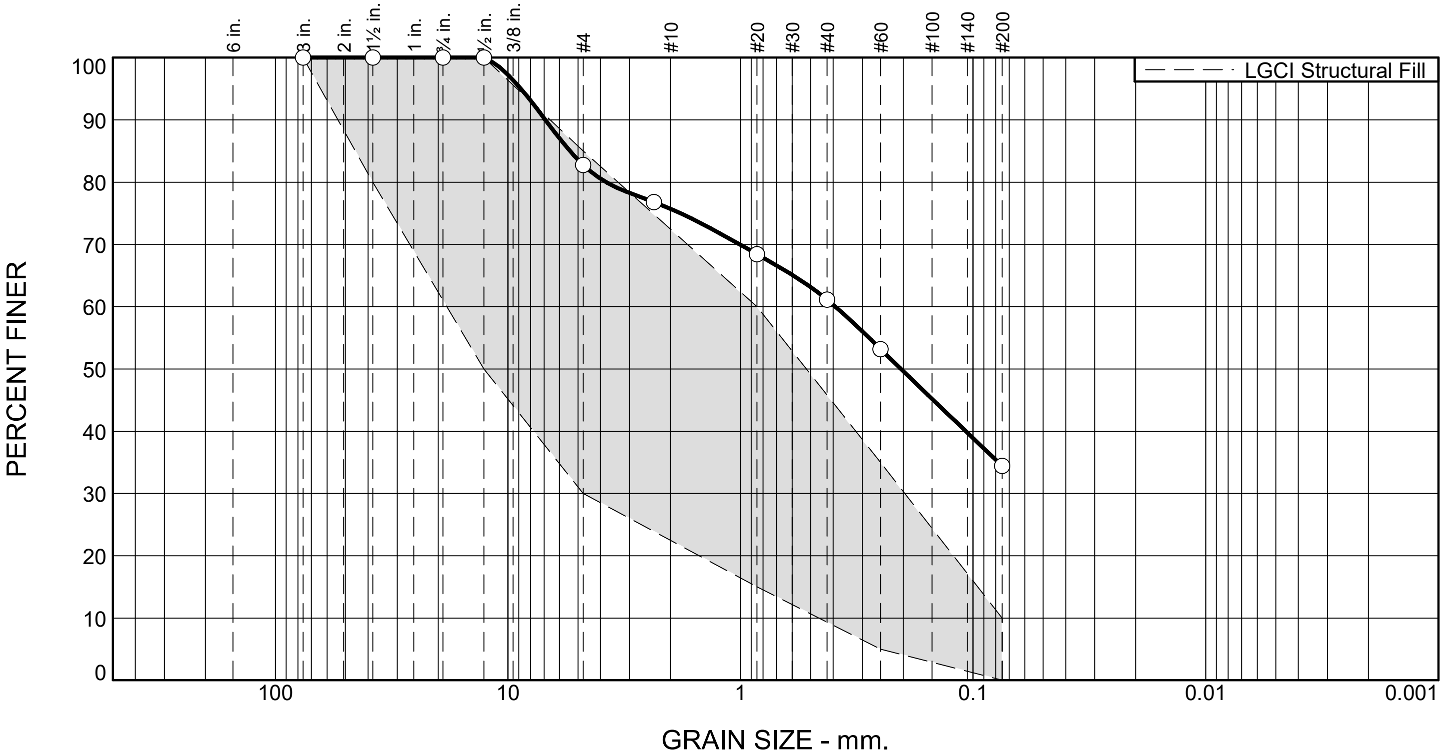
Lahlaf Geotechnical Consulting, Inc.

Client: Drummey Rosane Anderson, Inc.
Project: Prop. Northeast Metropolitan Regional Vocational Technical High School, Wakefield MA
Project No: 2025 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	17.2	7.1	14.6	26.7	34.4	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3"	100.0	100.0	
1.5"	100.0	80.0 - 100.0	
0.75"	100.0		
0.5"	100.0	50.0 - 100.0	
#4	82.8	30.0 - 85.0	
#8	76.8		
#20	68.4	15.0 - 60.0	X
#40	61.1		
#60	53.2	5.0 - 35.0	X
#200	34.4	0.0 - 10.0	X

* LGCI Structural Fill

Material Description

ASTM (D 2488) Classification: Silty SAND with Gravel (SM) , fine to coarse, 30-35% fines, 15-20% fine subrounded gravel, dark brown

Atterberg Limits (ASTM D 4318)

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

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}=	6.9003	D_{85}=	5.4064	D_{60}=	0.3904
D_{50}=	0.2041	D_{30}=		D_{15}=	
D_{10}=		C_u=		C_c=	

Remarks

Subsoil Sample

Date Received: 5/2/22 **Date Tested:** 6/9/22

Tested By: HH

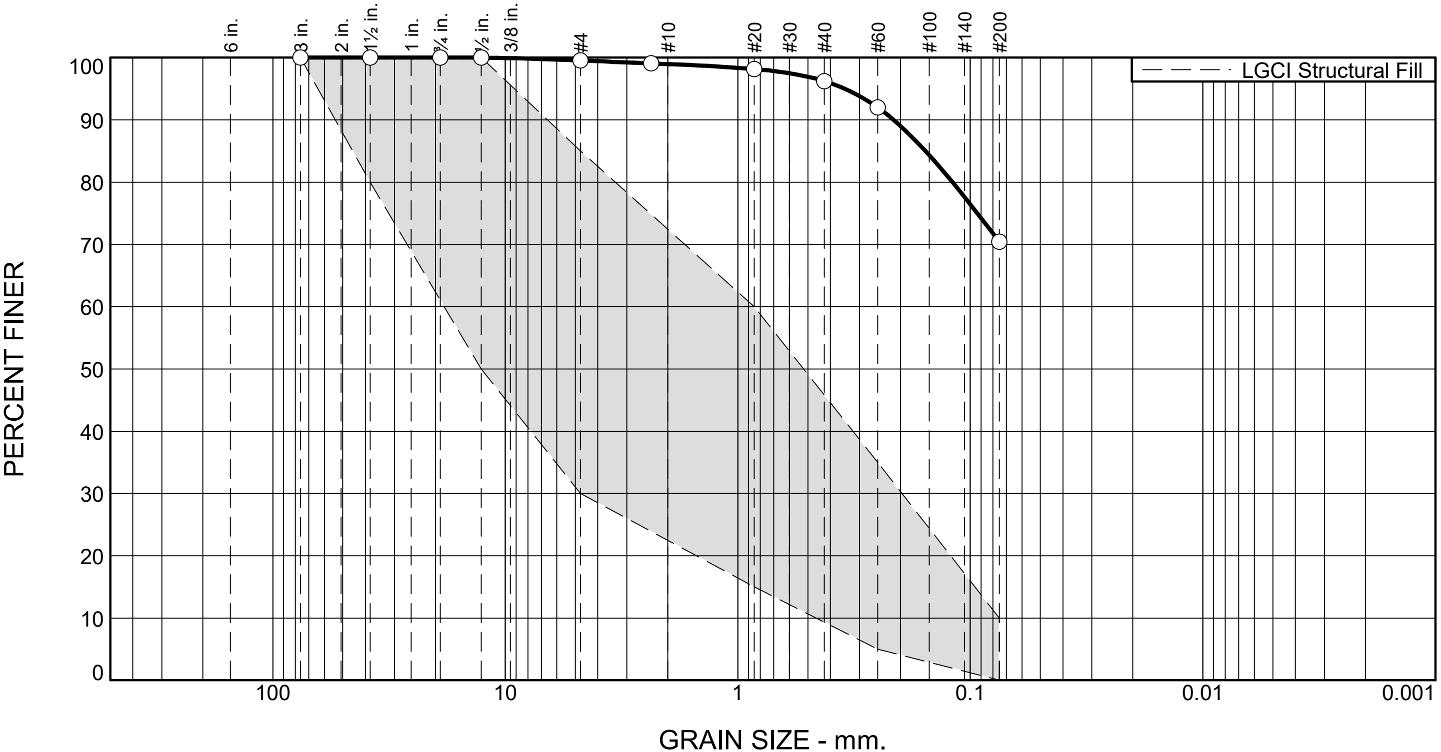
Checked By: RF

Location: Boring B-203
Sample Number: S1 Bot. 3" **Depth:** 0.2'-2.0'
Date Sampled: 5/2/22

LGCI
Lahlaf Geotechnical Consulting, Inc.

Client: Drummey Rosane Anderson, Inc.
Project: Prop. Northeast Metropolitan Regional Vocational Technical High School, Wakefield MA
Project No: 2025 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.5	0.5	2.8	25.8	70.4	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3"	100.0	100.0	
1.5"	100.0	80.0 - 100.0	
0.75"	100.0		
0.5"	100.0	50.0 - 100.0	
#4	99.5	30.0 - 85.0	X
#8	99.1		
#20	98.2	15.0 - 60.0	X
#40	96.2		
#60	92.0	5.0 - 35.0	X
#200	70.4	0.0 - 10.0	X

* LGCI Structural Fill

Material Description

ASTM (D 2488) Classification: SILT with Sand (ML), non-plastic, 25-30% fine to medium sand, trace coarse sand, 0-5% fine subrounded gravel, brown

Atterberg Limits (ASTM D 4318)

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

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 0.2135	D_{85}= 0.1557	D_{60}=
D_{50}=	D_{30}=	D_{15}=
D_{10}=	C_u=	C_c=

Remarks

Subsoil Sample

Date Received: 5/4/22 **Date Tested:** 6/9/22

Tested By: HH

Checked By: NP

Location: Boring B-204-OW

Sample Number: S1 Bot. 6" **Depth:** 0.3'-2.0'

Date Sampled: 5/4/22

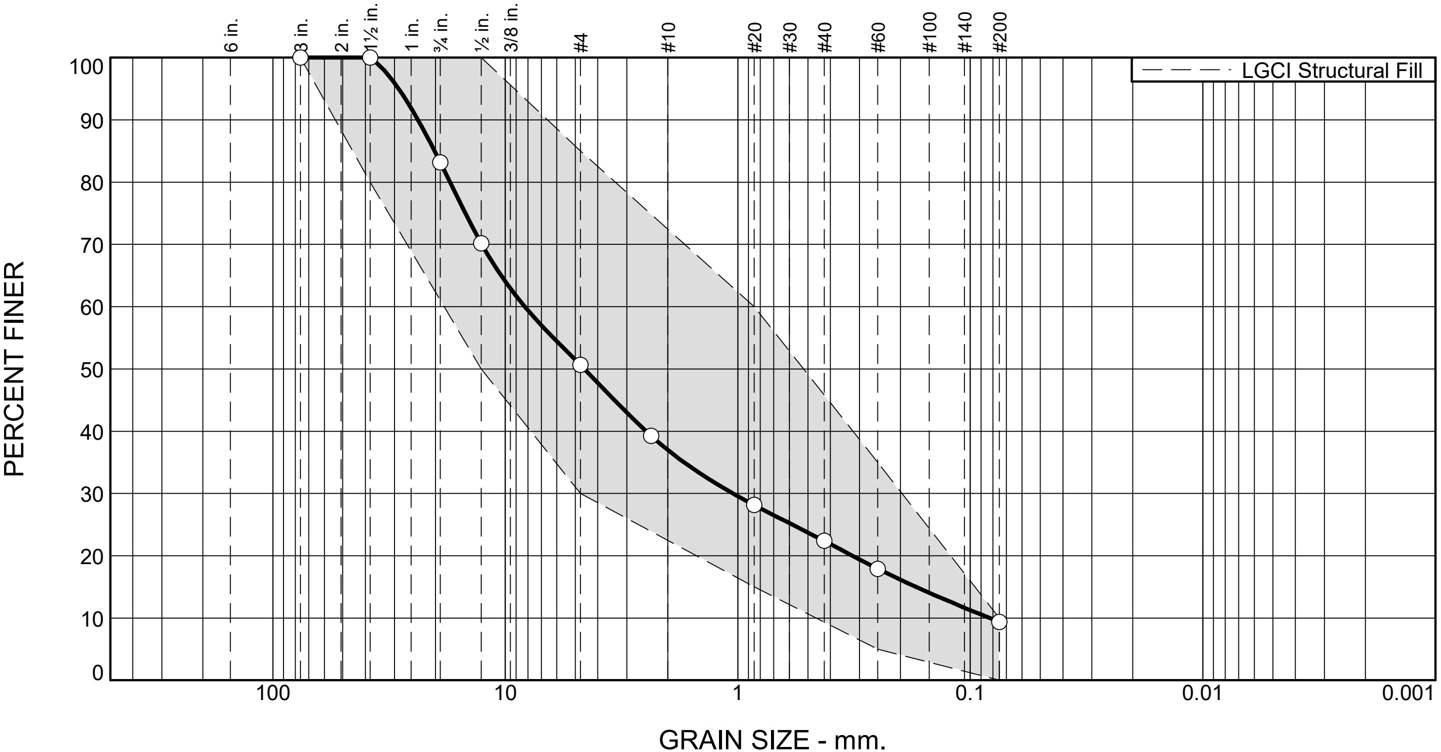
LGCI
Lahlaf Geotechnical Consulting, Inc.

Client: Drummey Rosane Anderson, Inc.

Project: Prop. Northeast Metropolitan Regional Vocational Technical High School, Wakefield MA

Project No: 2025 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	16.8	32.6	13.6	14.6	13.0	9.4	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3"	100.0	100.0	
1.5"	100.0	80.0 - 100.0	
0.75"	83.2		
0.5"	70.2	50.0 - 100.0	
#4	50.6	30.0 - 85.0	
#8	39.3		
#20	28.1	15.0 - 60.0	
#40	22.4		
#60	17.9	5.0 - 35.0	
#200	9.4	0.0 - 10.0	

* LGCI Structural Fill

Material Description

ASTM (D 2488) Classification: Well Graded GRAVEL with Silt and Sand (GW-GM), fine to coarse, angular, 5-10% fines, 40-45% fine to coarse sand, brown to gray

Atterberg Limits (ASTM D 4318)

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

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 23.7504	D_{85}= 20.1500	D_{60}= 8.2328
D_{50}= 4.5687	D_{30}= 1.0480	D_{15}= 0.1713
D_{10}= 0.0827	C_u= 99.59	C_c= 1.61

Remarks

Sand and Gravel Sample

Date Received: 5/4/22 **Date Tested:** 6/9/22

Tested By: HH

Checked By: RF

Location: Boring B-204-OW **Date Sampled:** 5/4/22

Sample Number: S2 Bot. 8" **Depth:** 2.7'-4.0'

LGCI
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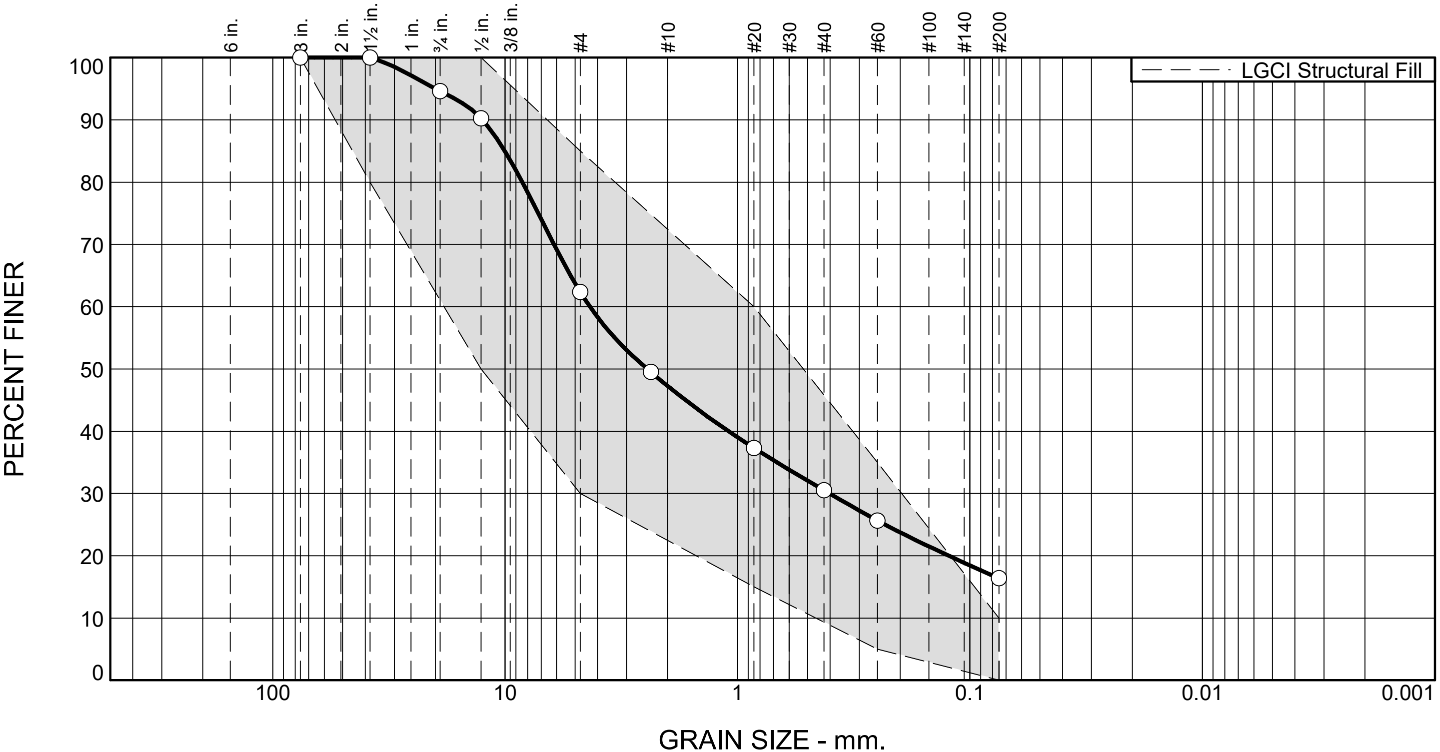
Client: Drummey Rosane Anderson, Inc.

Project: Prop. Northeast Metropolitan Regional Vocational Technical High School, Wakefield MA

Project No: 2025 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	5.4	32.2	15.1	16.8	14.1	16.4	

TEST RESULTS			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3"	100.0	100.0	
1.5"	100.0	80.0 - 100.0	
0.75"	94.6		
0.5"	90.3	50.0 - 100.0	
#4	62.4	30.0 - 85.0	
#8	49.5		
#20	37.3	15.0 - 60.0	
#40	30.5		
#60	25.7	5.0 - 35.0	
#200	16.4	0.0 - 10.0	X

* LGCI Structural Fill

Material Description

ASTM (D 2488) Classification: Silty SAND with Gravel (SM), fine to coarse, 15-20% fines, 35-40% fine to coarse subrounded gravel, light brown

Atterberg Limits (ASTM D 4318)

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

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}=	12.5165	D_{85}=	10.0255	D_{60}=	4.3151
D_{50}=	2.4445	D_{30}=	0.4013	D_{15}=	
D_{10}=		C_u=		C_c=	

Remarks

Sand and Gravel sample

Date Received: 5/4/2022 **Date Tested:** 6/15/2022

Tested By: YSP

Checked By: RF

Location: Boring B-204-0W

Sample Number: S3 **Depth:** 4.0'-4.3'

Date Sampled: 5/4/2022

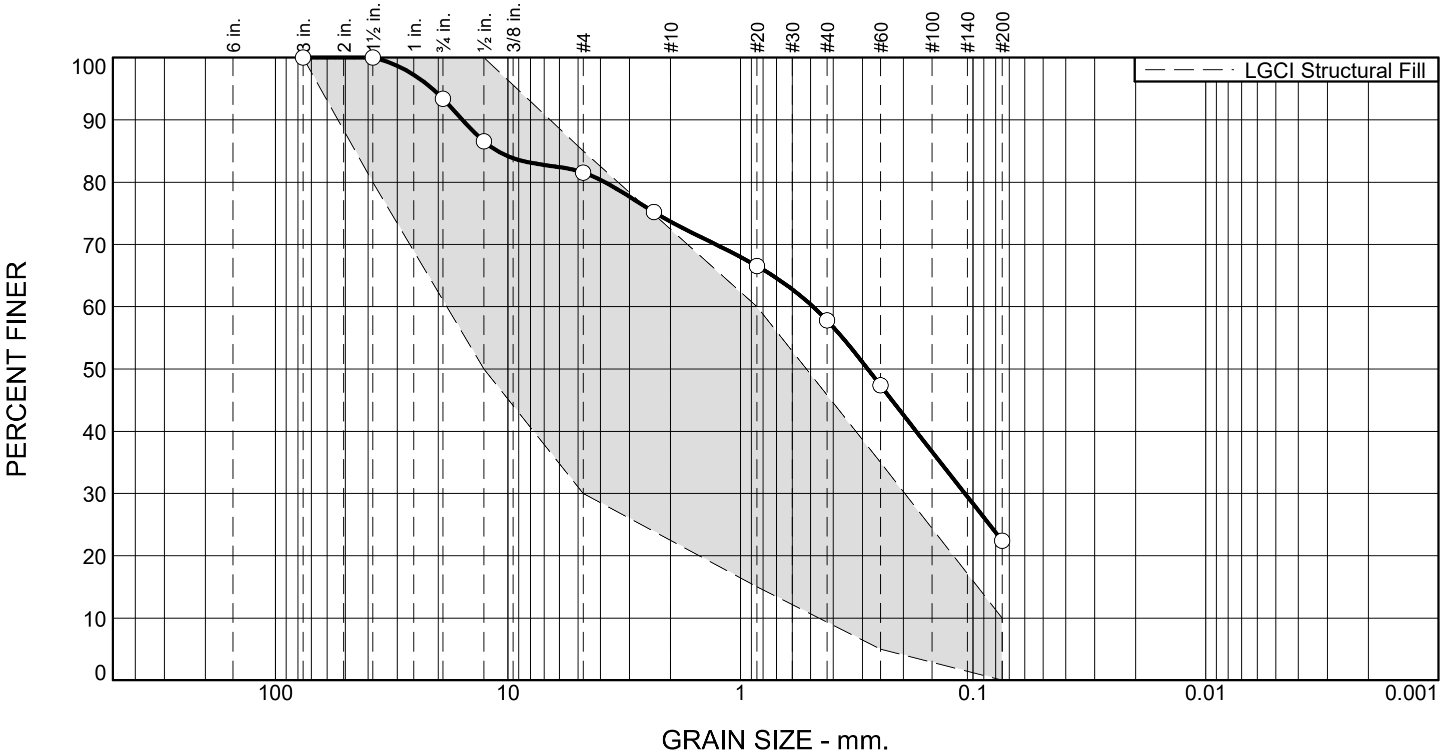
LGCI
Lahlaf Geotechnical Consulting, Inc.

Client: Drummey Rosane Anderson, Inc.

Project: Prop. Northeast Metropolitan Regional Vocational Technical High School, Wakefield MA

Project No: 2025 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	6.6	11.9	7.8	15.9	35.4	22.4	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3"	100.0	100.0	
1.5"	100.0	80.0 - 100.0	
0.75"	93.4		
0.5"	86.5	50.0 - 100.0	
#4	81.5	30.0 - 85.0	
#8	75.2		
#20	66.5	15.0 - 60.0	X
#40	57.8		
#60	47.4	5.0 - 35.0	X
#200	22.4	0.0 - 10.0	X

* LGCI Structural Fill

Material Description

ASTM (D 2488) Classification: Silty SAND with Gravel (SM), fine to coarse, 20-25% fines, 15-20% fine to coarse subangular gravel, trace of bricks, brown to orange

Atterberg Limits (ASTM D 4318)

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

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 15.6948	D_{85}= 11.0897	D_{60}= 0.4879
D_{50}= 0.2836	D_{30}= 0.1084	D_{15}=
D_{10}=	C_u=	C_c=

Remarks

Fill Sample

Date Received: 5/9/2022 **Date Tested:** 6/15/2022

Tested By: YSP

Checked By: RF

Location: Boring B-210

Sample Number: S2 **Depth:** 2.0'-4.0'

Date Sampled: 5/9/2022

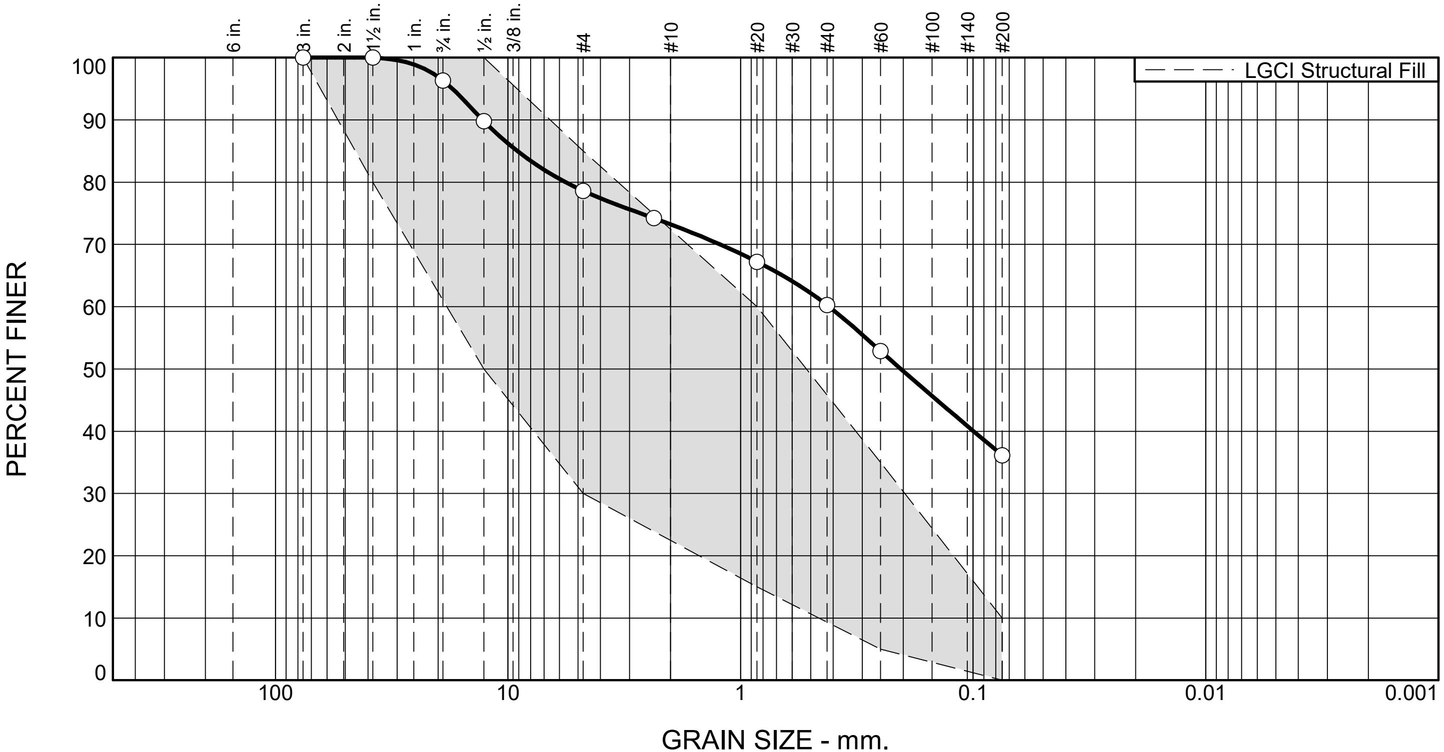
LGCI
Lahlaf Geotechnical Consulting, Inc.

Client: Drummey Rosane Anderson, Inc.

Project: Prop. Northeast Metropolitan Regional Vocational Technical High School, Wakefield MA

Project No: 2025 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	3.7	17.7	5.4	12.9	24.2	36.1	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3"	100.0	100.0	
1.5"	100.0	80.0 - 100.0	
0.75"	96.3		
0.5"	89.8	50.0 - 100.0	
#4	78.6	30.0 - 85.0	
#8	74.2		
#20	67.2	15.0 - 60.0	X
#40	60.3		
#60	52.9	5.0 - 35.0	X
#200	36.1	0.0 - 10.0	X

* LGCI Structural Fill

Material Description

ASTM (D 2488) Classification: Silty SAND with Gravel (SM), fine to medium, trace coarse, 35-40% fines, 20-25% mostly fine subangular gravel, trace of organic soil, brown

Atterberg Limits (ASTM D 4318)

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

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 12.8435 D_{85}= 9.1075 D_{60}= 0.4161
D_{50}= 0.2043 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Subsoil sample.

Date Received: 5/10/22 **Date Tested:** 6/17/22
Tested By: NP
Checked By: YSP

Location: Boring B-220-OW
Sample Number: S2 **Depth:** 2.0'-4.0'
Date Sampled: 5/10/22

LGCI
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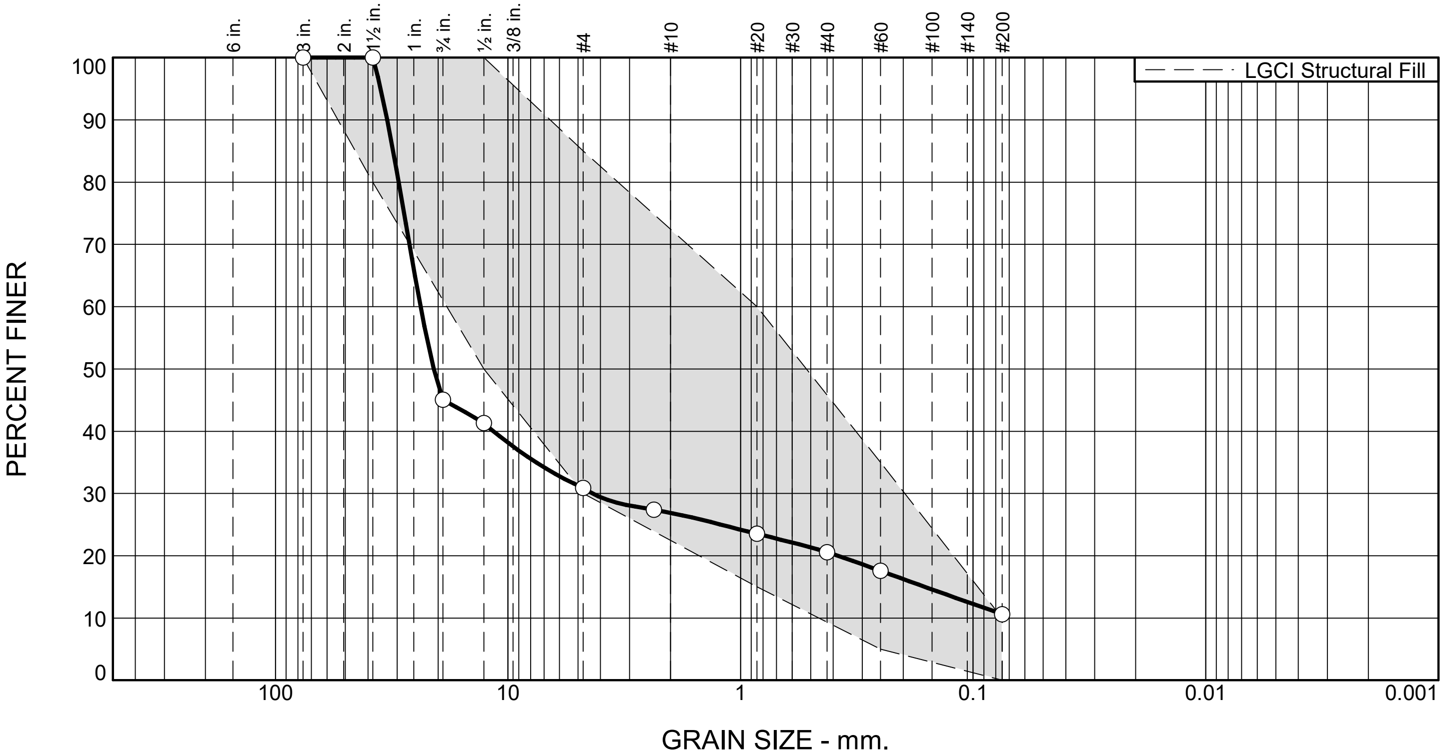
Client: Drummey Rosane Anderson, Inc.
Project: Prop. Northeast Metropolitan Regional Vocational Technical High School, Wakefield MA
Project No: 2025 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	55.0	14.1	4.0	6.3	10.0	10.6	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3"	100.0	100.0	
1.5"	100.0	80.0 - 100.0	
0.75"	45.0		
0.5"	41.3	50.0 - 100.0	X
#4	30.9	30.0 - 85.0	
#8	27.4		
#20	23.5	15.0 - 60.0	
#40	20.6		
#60	17.6	5.0 - 35.0	
#200	10.6	0.0 - 10.0	X

* LGCI Structural Fill

Material Description

ASTM (D 2488) Classification: Poorly Graded GRAVEL with Silt and Sand (GP-GM), mostly coarse, angular, 10-15% fines, 20-25% fine to coarse sand, trace of weathered rock, light brown

Atterberg Limits (ASTM D 4318)

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

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 33.0450 D_{85}= 31.1752 D_{60}= 23.7632
D_{50}= 20.8577 D_{30}= 4.3250 D_{15}= 0.1611
D_{10}= C_u= C_c=

Remarks

Natural sand and gravel sample.

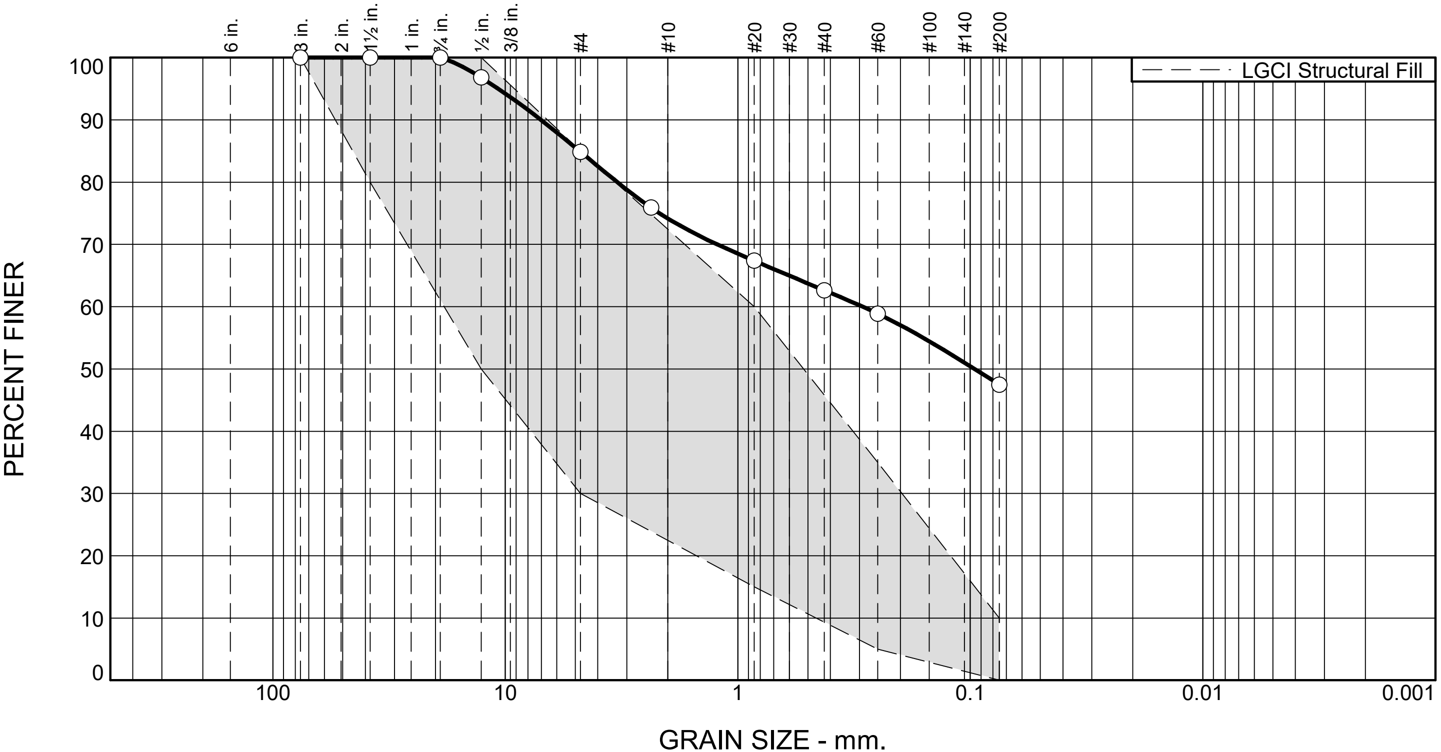
Date Received: 5/10/22 **Date Tested:** 6/17/22
Tested By: NP
Checked By: YSP

Location: Boring B-220-OW
Sample Number: S3 **Depth:** 4.0'-5.3'
Date Sampled: 5/10/22

LGCI
Lahlaf Geotechnical Consulting, Inc.

Client: Drummey Rosane Anderson, Inc.
Project: Prop. Northeast Metropolitan Regional Vocational Technical High School, Wakefield MA
Project No: 2025 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	15.1	10.7	11.6	15.1	47.5	

TEST RESULTS			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3"	100.0	100.0	
1.5"	100.0	80.0 - 100.0	
0.75"	100.0		
0.5"	96.8	50.0 - 100.0	
#4	84.9	30.0 - 85.0	
#8	75.9		
#20	67.4	15.0 - 60.0	X
#40	62.6		
#60	58.9	5.0 - 35.0	X
#200	47.5	0.0 - 10.0	X

* LGCI Structural Fill

Material Description

ASTM (D 2488) Classification: Silty SAND with Gravel (SM), fine to coarse, 45-50% fines, 15-20% fine subangular gravel, light brown

Atterberg Limits (ASTM D 4318)

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

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 7.0182	D_{85}= 4.7886	D_{60}= 0.2899
D_{50}= 0.0958	D_{30}=	D_{15}=
D_{10}=	C_u=	C_c=

Remarks

Natural sand and gravel sample.

Date Received: 4/20/21 **Date Tested:** 6/17/22

Tested By: NP

Checked By: YSP

Location: Test Pit TP-103

Sample Number: Grab **Depth:** 2.4'-5.5'

Date Sampled: 4/20/21

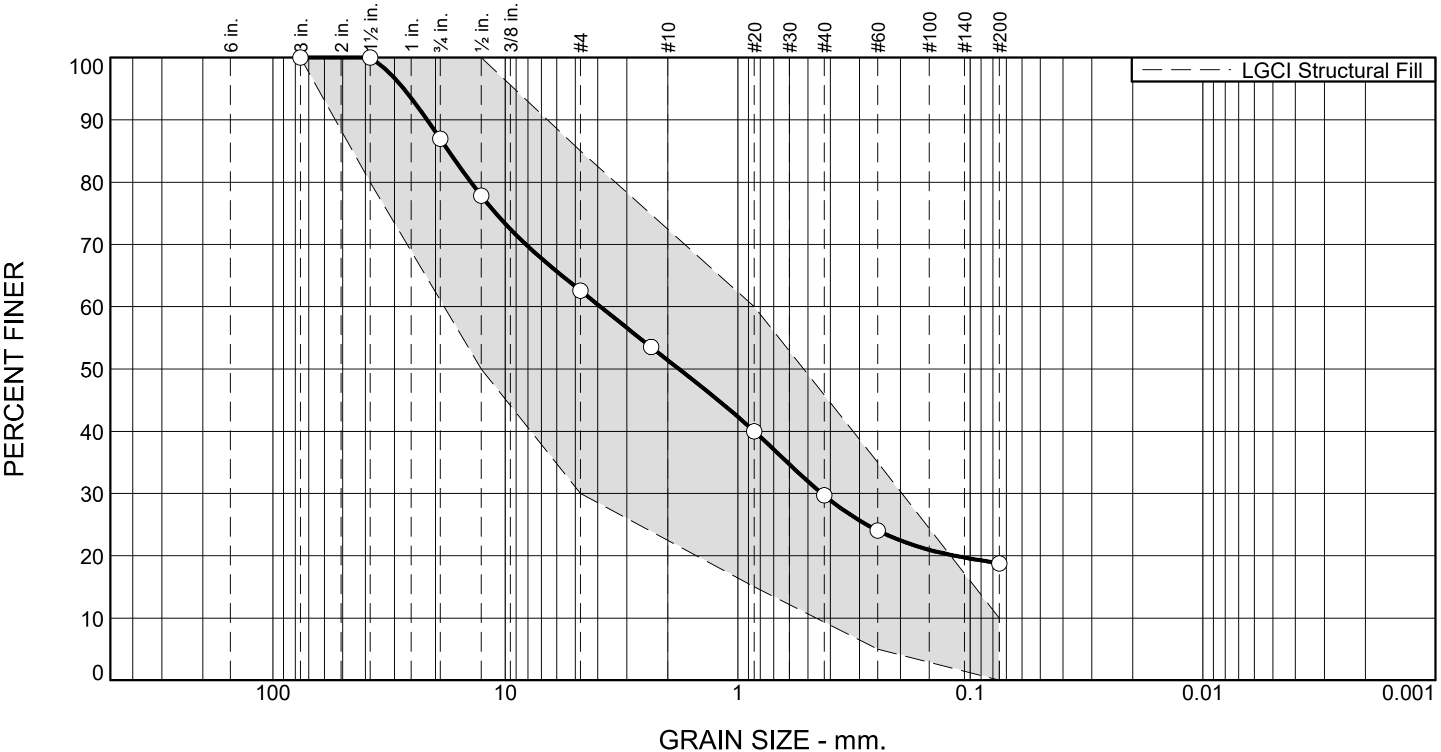
LGCI
Lahlaf Geotechnical Consulting, Inc.

Client: Drummey Rosane Anderson, Inc.

Project: Prop. Northeast Metropolitan Regional Vocational Technical High School, Wakefield MA

Project No: 2025 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	13.0	24.4	11.2	21.7	10.9	18.8	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3"	100.0	100.0	
1.5"	100.0	80.0 - 100.0	
0.75"	87.0		
0.5"	77.8	50.0 - 100.0	
#4	62.6	30.0 - 85.0	
#8	53.5		
#20	40.0	15.0 - 60.0	
#40	29.7		
#60	24.1	5.0 - 35.0	
#200	18.8	0.0 - 10.0	X

* LGCI Structural Fill

Material Description

ASTM (D 2488) Classification: Silty SAND with Gravel (SM), fine to coarse, 15-20% fines, 35-40% fine to coarse subrounded gravel, trace of roots, trace of organic soil, brown

Atterberg Limits (ASTM D 4318)

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

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 21.6946 D_{85}= 17.5239 D_{60}= 3.8979

D_{50}= 1.7886 D_{30}= 0.4348 D_{15}=

D_{10}= C_u= C_c=

Remarks

Fill Sample

Date Received: 4/27/22 **Date Tested:** 6/15/22

Tested By: RF

Checked By: YSP

Location: Test Pit TP-201
Depth: 1.0'-2.0'

Date Sampled: 4/27/22

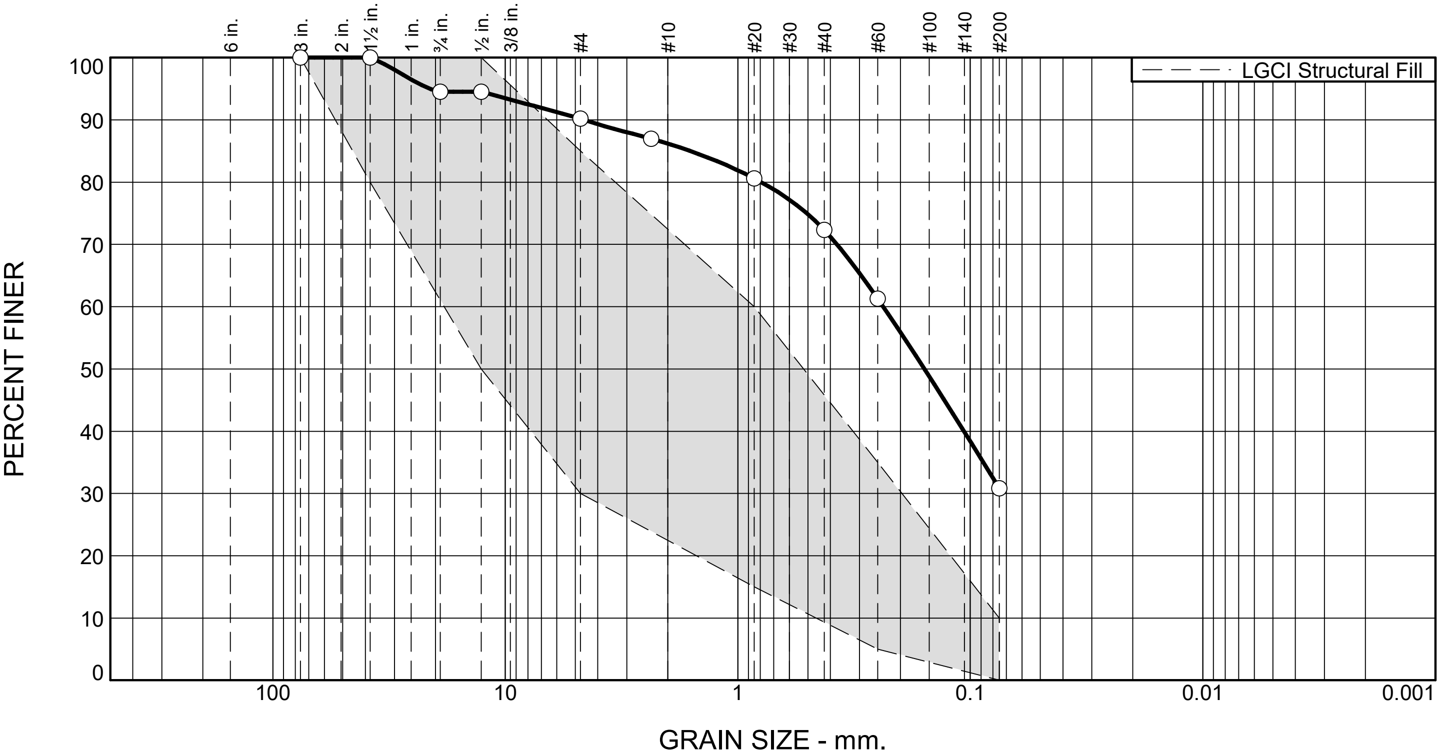
LGCI
Lahlaf Geotechnical Consulting, Inc.

Client: Drummey Rosane Anderson, Inc.

Project: Prop. Northeast Metropolitan Regional Vocational Technical High School, Wakefield MA

Project No: 2025 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	5.5	4.3	4.0	13.9	41.5	30.8	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3"	100.0	100.0	
1.5"	100.0	80.0 - 100.0	
0.75"	94.5		
0.5"	94.5	50.0 - 100.0	
#4	90.2	30.0 - 85.0	X
#8	87.0		
#20	80.6	15.0 - 60.0	X
#40	72.3		
#60	61.3	5.0 - 35.0	X
#200	30.8	0.0 - 10.0	X

* LGCI Structural Fill

Material Description

ASTM (D 2488) Classification: Silty SAND (SM), fine to medium, trace coarse, 30-35% fines, 5-10% fine to coarse subangular gravel, trace of roots, gray

Atterberg Limits (ASTM D 4318)

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

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 4.5883	D_{85}= 1.5997	D_{60}= 0.2369
D_{50}= 0.1573	D_{30}=	D_{15}=
D_{10}=	C_u=	C_c=

Remarks

Subsoil Sample

Date Received: 4/27/22 **Date Tested:** 6/15/22

Tested By: RF

Checked By: YSP

Location: TP-202
Depth: 2.0'-2.5'

Date Sampled: 4/27/22

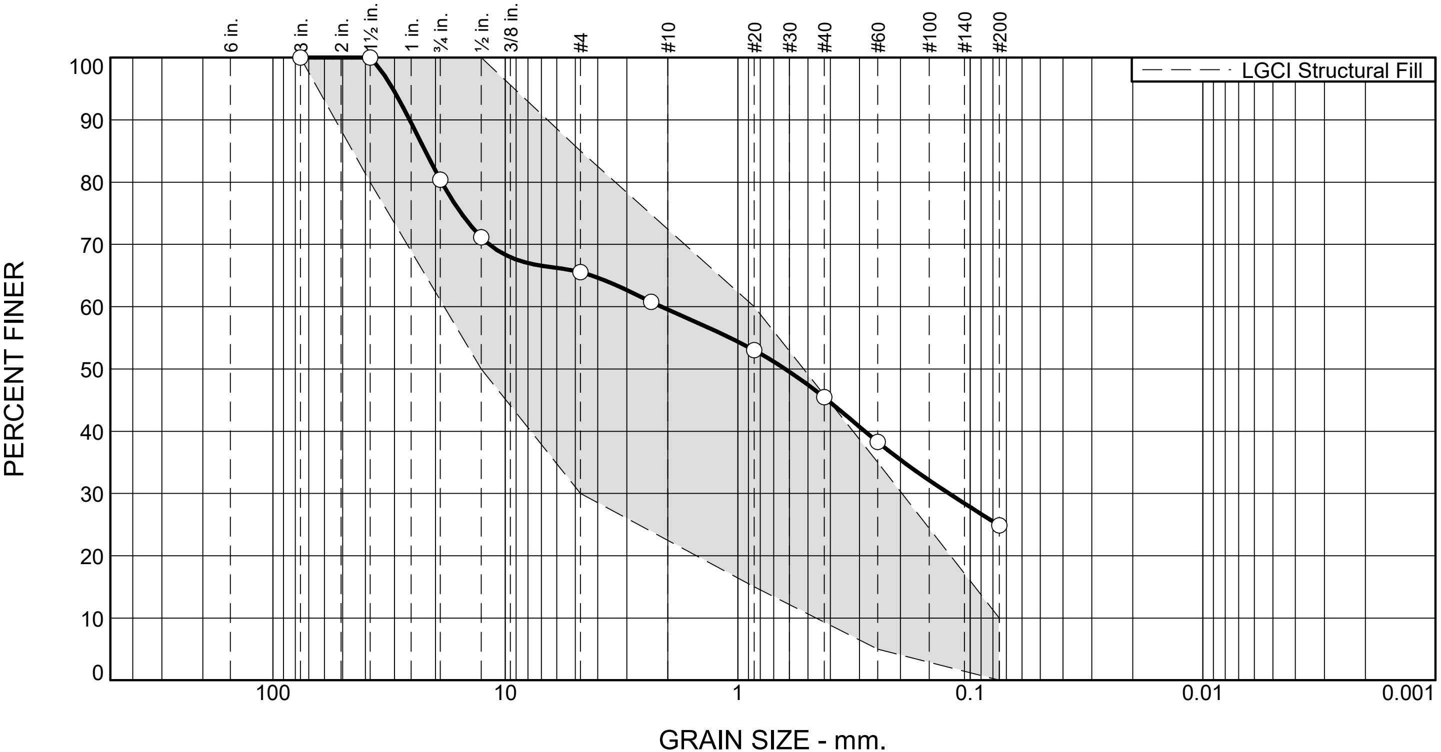
LGCI
Lahlaf Geotechnical Consulting, Inc.

Client: Drummey Rosane Anderson, Inc.

Project: Prop. Northeast Metropolitan Regional Vocational Technical High School, Wakefield MA

Project No: 2025 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	19.6	14.9	6.0	14.1	20.5	24.9	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3"	100.0	100.0	
1.5"	100.0	80.0 - 100.0	
0.75"	80.4		
0.5"	71.2	50.0 - 100.0	
#4	65.5	30.0 - 85.0	
#8	60.8		
#20	53.0	15.0 - 60.0	
#40	45.4		
#60	38.3	5.0 - 35.0	X
#200	24.9	0.0 - 10.0	X

* LGCI Structural Fill

Material Description

ASTM (D 2488) Classification: Silty SAND with Gravel (SM), fine to coarse, 20-25% fines, 30-35% fine to coarse subrounded gravel, trace of roots, light brown

Atterberg Limits (ASTM D 4318)

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

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 25.7860 **D_{85}=** 22.0841 **D_{60}=** 2.1306
D_{50}= 0.6256 **D_{30}=** 0.1234 **D_{15}=**
D_{10}= **C_u=** **C_c=**

Remarks

Subsoil sample

Date Received: 04/26/2022 **Date Tested:** 05/03/2022

Tested By: RF

Checked By: HO

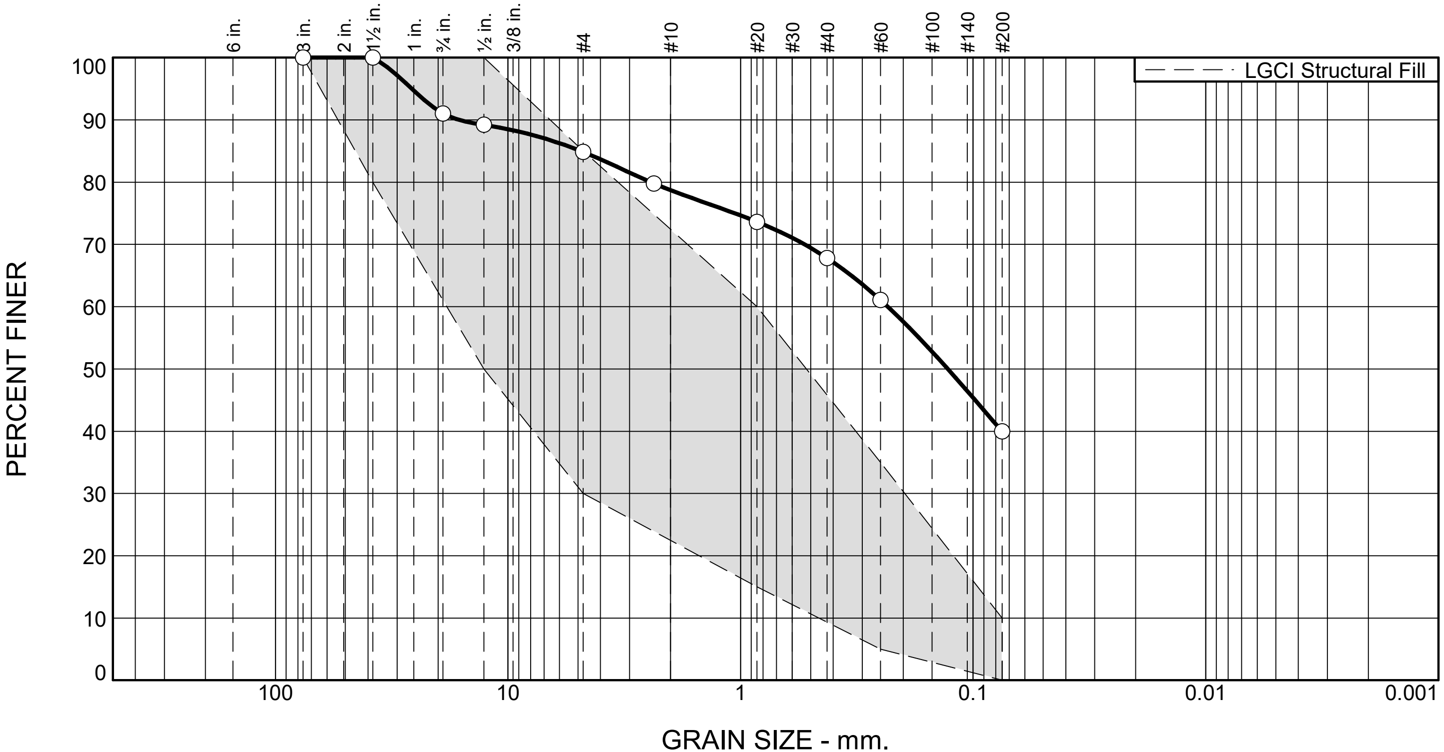
Location: Test Pit TP-204
Depth: 0.5'-3.0'

Date Sampled: 04/26/2022

LGCI
Lahlaf Geotechnical Consulting, Inc.

Client: Drummey Rosane Anderson, Inc.
Project: Prop. Northeast Metropolitan Regional Vocational Technical High School, Wakefield MA
Project No: 2025 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	8.9	6.2	6.2	10.9	27.9	39.9	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3"	100.0	100.0	
1.5"	100.0	80.0 - 100.0	
0.75"	91.1		
0.5"	89.2	50.0 - 100.0	
#4	84.9	30.0 - 85.0	
#8	79.8		
#20	73.6	15.0 - 60.0	X
#40	67.8		
#60	61.1	5.0 - 35.0	X
#200	39.9	0.0 - 10.0	X

* LGCI Structural Fill

Material Description

ASTM (D 2488) Classification: Silty SAND with Gravel (SM), fine to coarse, 35-40% fines, 15-20% fine to coarse subrounded gravel, trace of roots, trace of organic soil, orange brown

Atterberg Limits (ASTM D 4318)

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

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 16.2834 D_{85}= 4.8523 D_{60}= 0.2326
D_{50}= 0.1284 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Subsoil Sample

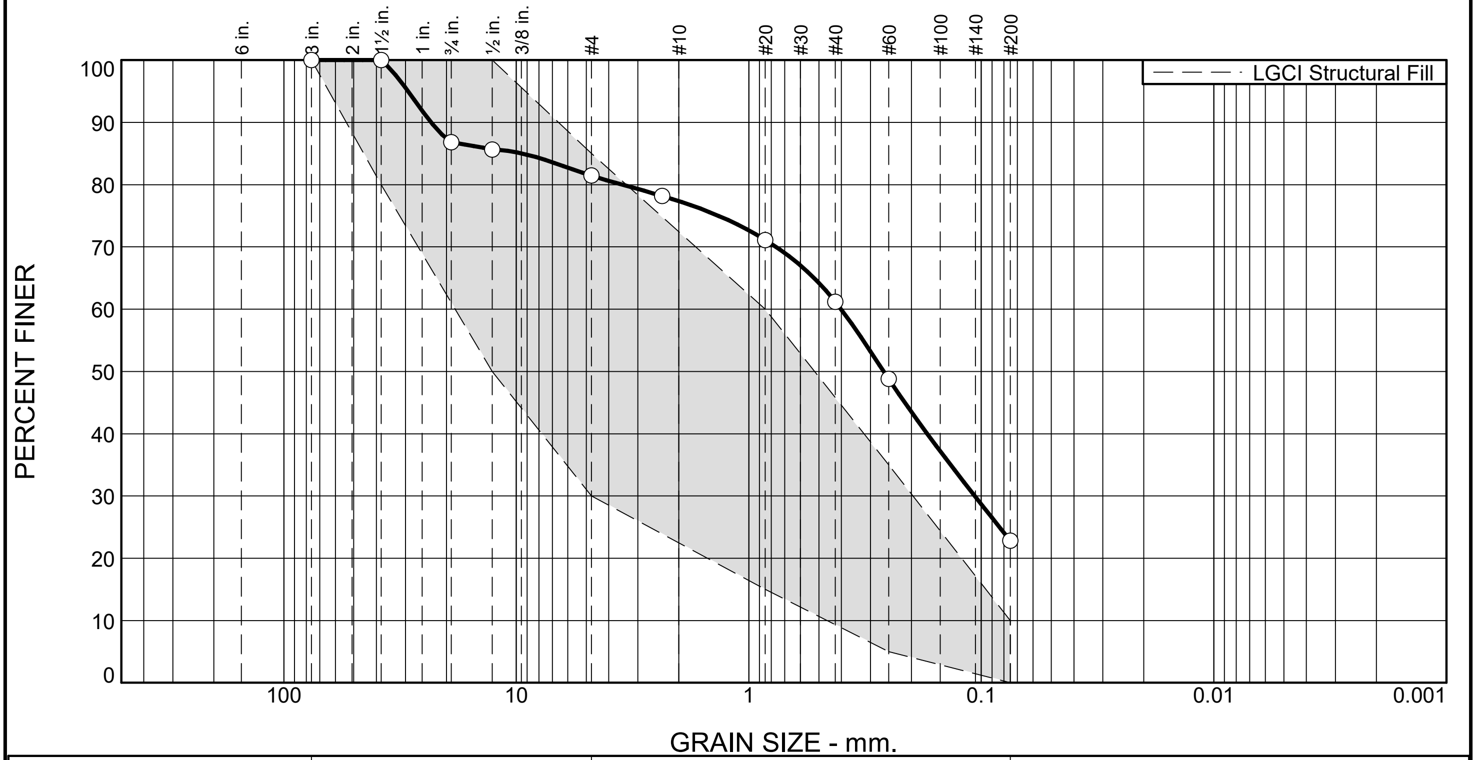
Date Received: 4/26/22 **Date Tested:** 6/15/22
Tested By: RF
Checked By: YSP

Location: TP-207
Depth: 0.5'-3.0'
Date Sampled: 4/26/22

LGCI
Lahlaf Geotechnical Consulting, Inc.

Client: Drummey Rosane Anderson, Inc.
Project: Prop. Northeast Metropolitan Regional Vocational Technical High School, Wakefield MA
Project No: 2025 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	13.2	5.3	4.1	16.2	38.4	22.8	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3"	100.0	100.0	
1.5"	100.0	80.0 - 100.0	
0.75"	86.8		
0.5"	85.6	50.0 - 100.0	
#4	81.5	30.0 - 85.0	
#8	78.2		
#20	71.1	15.0 - 60.0	X
#40	61.2		
#60	48.8	5.0 - 35.0	X
#200	22.8	0.0 - 10.0	X

* LGCI Structural Fill

Material Description

ASTM (D 2488) Classification: Silty SAND with Gravel (SM), fine to medium, 20-25% fines, 15-20% fine to coarse subangular gravel, light brown

Atterberg Limits (ASTM D 4318)

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

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}=	23.2680	D_{85}=	9.4282	D_{60}=	0.4009
D_{50}=	0.2627	D_{30}=	0.1066	D_{15}=	
D_{10}=		C_u=		C_c=	

Remarks

Natural sand and gravel sample.

Date Received: 4/26/22 **Date Tested:** 6/17/22

Tested By: NP

Checked By: YSP

Location: Test Pit TP-207

Sample Number: Grab **Depth:** 3.0'-3.5'

Date Sampled: 4/26/22

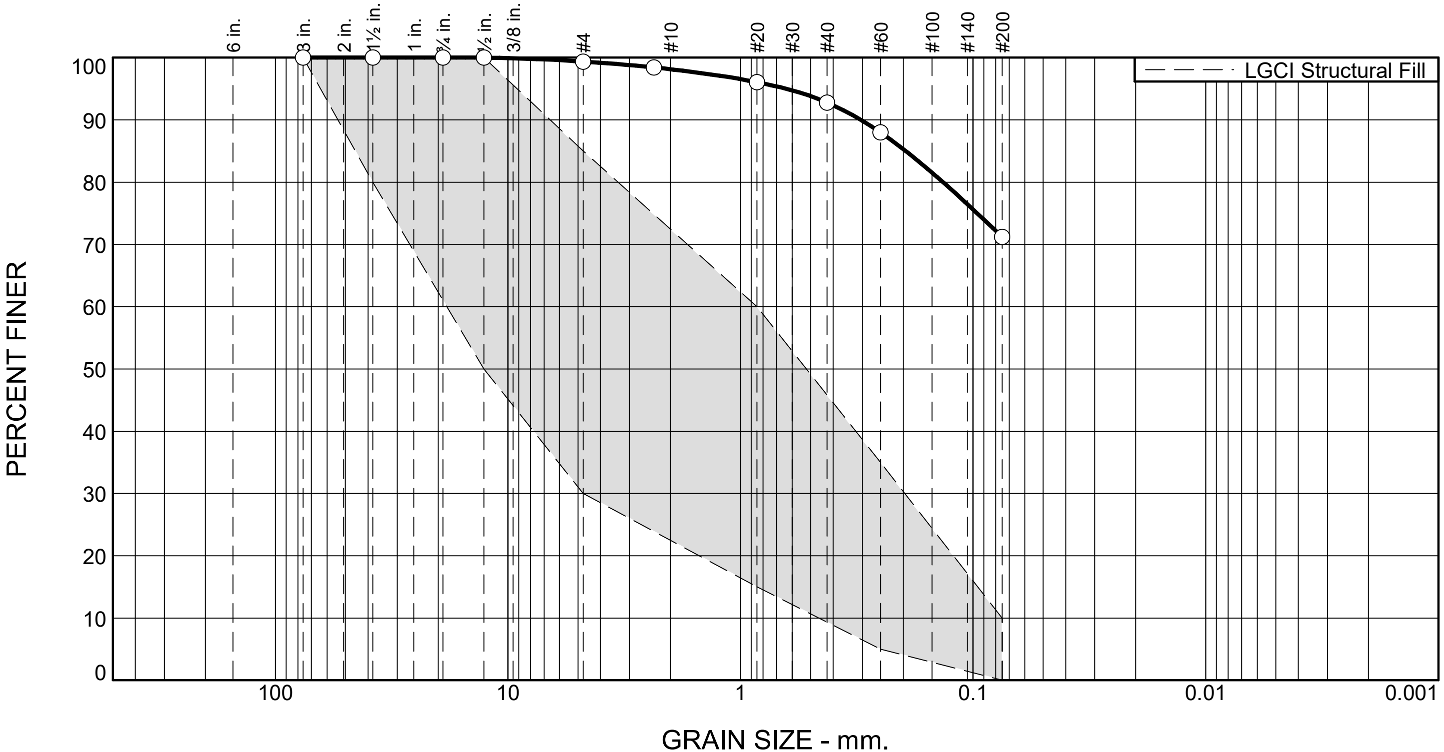
LGCI
Lahlaf Geotechnical Consulting, Inc.

Client: Drummey Rosane Anderson, Inc.

Project: Prop. Northeast Metropolitan Regional Vocational Technical High School, Wakefield MA

Project No: 2025 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.6	1.3	5.3	21.6	71.2	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3"	100.0	100.0	
1.5"	100.0	80.0 - 100.0	
0.75"	100.0		
0.5"	100.0	50.0 - 100.0	
#4	99.4	30.0 - 85.0	X
#8	98.4		
#20	96.1	15.0 - 60.0	X
#40	92.8		
#60	88.0	5.0 - 35.0	X
#200	71.2	0.0 - 10.0	X

* LGCI Structural Fill

Material Description

ASTM (D 2488) Classification: SILT with Sand (ML), slightly plastic, 25-30% fine to medium sand, trace coarse sand, trace fine subrounded gravel, trace of roots, trace of organic soil, brown

Atterberg Limits (ASTM D 4318)

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

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}=	0.3034	D_{85}=	0.1945	D_{60}=	
D_{50}=		D_{30}=		D_{15}=	
D_{10}=		C_u=		C_c=	

Remarks

Subsoil Sample

Date Received: 4/27/22 **Date Tested:** 6/15/22

Tested By: RF

Checked By: YSP

Location: Test Pit TP-B-205

Depth: 0.5'-1.5'

Date Sampled: 4/27/22

LGCI

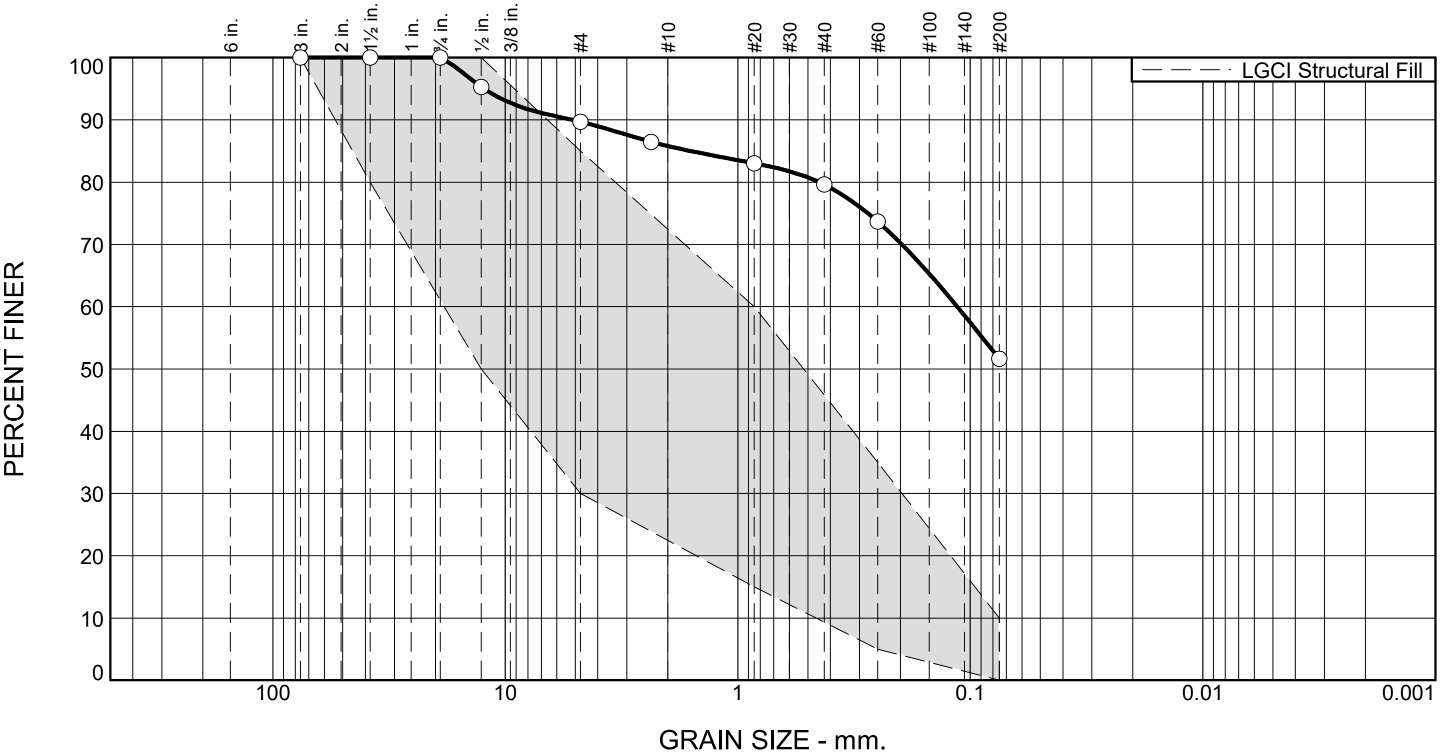
Lahlaf Geotechnical Consulting, Inc.

Client: Drummey Rosane Anderson, Inc.

Project: Prop. Northeast Metropolitan Regional Vocational Technical High School, Wakefield MA

Project No: 2025 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	10.3	3.9	6.2	28.0	51.6	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3"	100.0	100.0	
1.5"	100.0	80.0 - 100.0	
0.75"	100.0		
0.5"	95.3	50.0 - 100.0	
#4	89.7	30.0 - 85.0	X
#8	86.5		
#20	83.0	15.0 - 60.0	X
#40	79.6		
#60	73.7	5.0 - 35.0	X
#200	51.6	0.0 - 10.0	X

* LGCI Structural Fill

Material Description

ASTM (D 2488) Classification: Sandy SILT (ML), 35-40% fine sand, 10-15% fine subrounded gravel, trace of organic soil, trace of roots, trace of wood, brown, wet

Atterberg Limits (ASTM D 4318)

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

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 5.1253	D_{85}= 1.5952	D_{60}= 0.1137
D_{50}=	D_{30}=	D_{15}=
D_{10}=	C_u=	C_c=

Remarks

Subsoil

Date Received: 12/3/2020 **Date Tested:** 12/9/2020

Tested By: TG

Checked By: AML

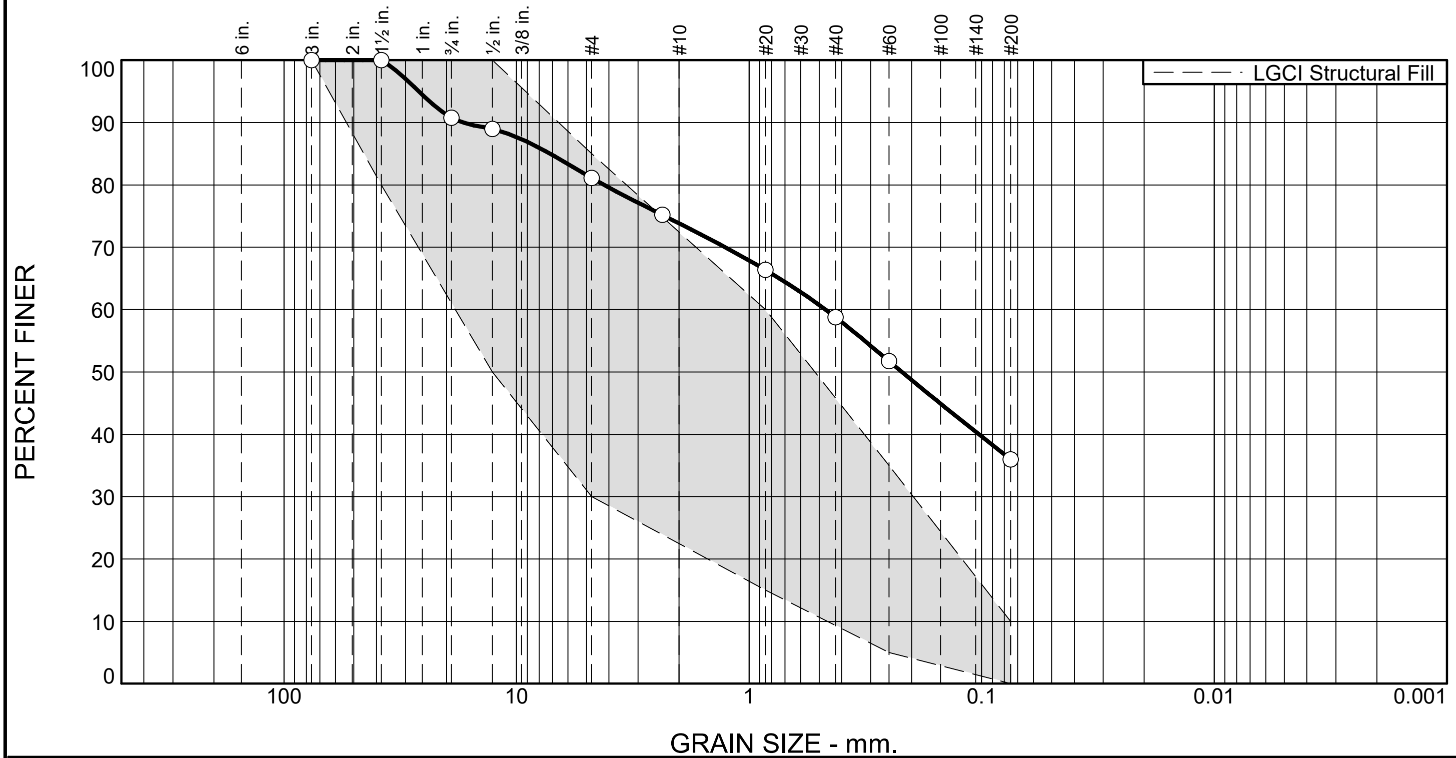
Location: Test Pit TP-1
Depth: 0.7' - 3.5'

Date Sampled: 12/3/2020

LGCI
Lahlaf Geotechnical Consulting, Inc.

Client: Drummey Rosane Anderson, Inc.
Project: Proposed Northeast Metro Reg. Vocational Tech. H.S., Wakefield, MA
Project No: 2025 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	9.2	9.7	7.3	15.0	22.9	35.9	

TEST RESULTS			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3"	100.0	100.0	
1.5"	100.0	80.0 - 100.0	
0.75"	90.8		
0.5"	89.0	50.0 - 100.0	
#4	81.1	30.0 - 85.0	
#8	75.2		
#20	66.4	15.0 - 60.0	X
#40	58.8		
#60	51.7	5.0 - 35.0	X
#200	35.9	0.0 - 10.0	X

* LGCI Structural Fill

Material Description

ASTM (D 2488) Classification: Silty SAND with Gravel, fine to coarse, 35-40% fines, 15-20% fine to coarse subrounded gravel, trace of organic soil, trace of roots, light brown, moist

Atterberg Limits (ASTM D 4318)

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

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}=	16.9724	D_{85}=	7.1728	D_{60}=	0.4689
D_{50}=	0.2202	D_{30}=		D_{15}=	
D_{10}=		C_u=		C_c=	

Remarks

Subsoil

Date Received: 12/3/2020 **Date Tested:** 12/9/2020

Tested By: TG

Checked By: AML

Location: Test Pit TP-5

Depth: 0.5'- 3.5'

Date Sampled: 12/3/2020

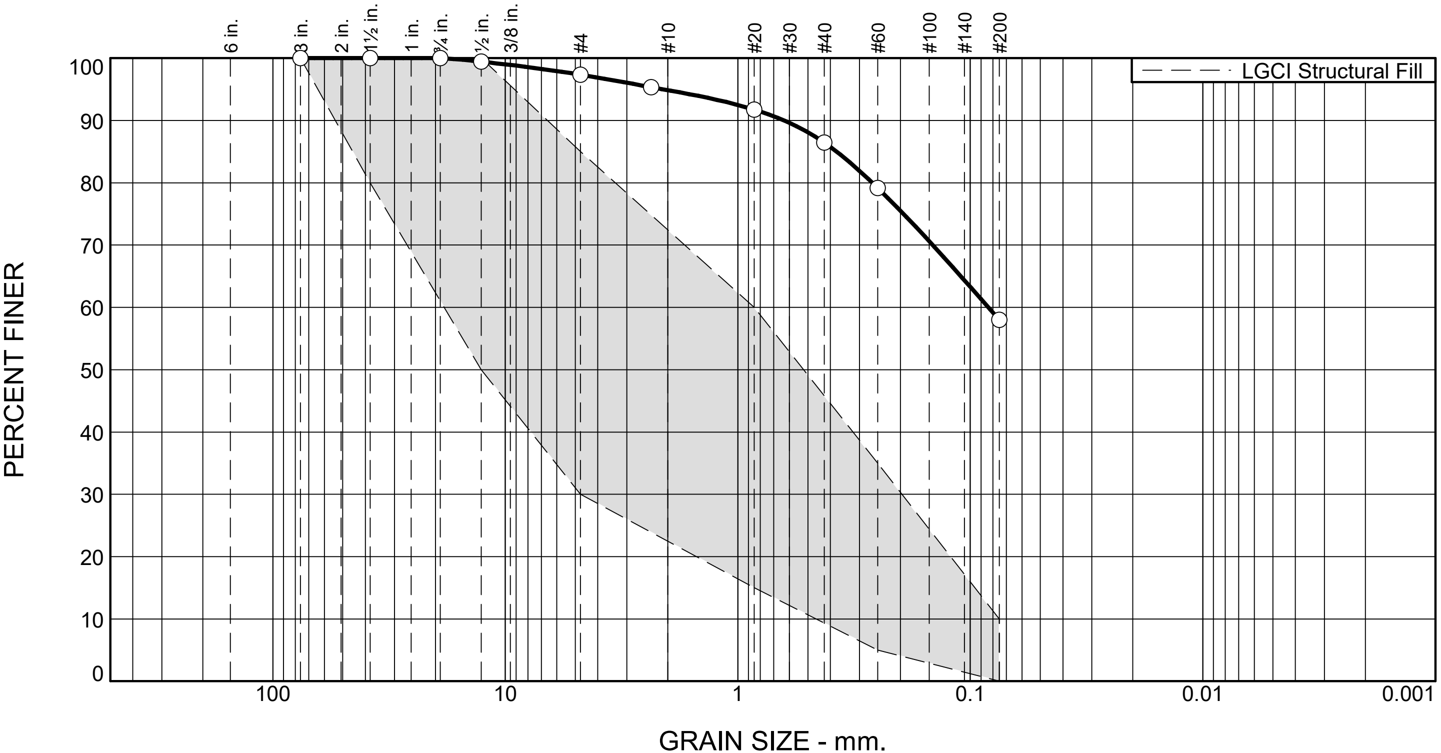
LGCI
Lahlaf Geotechnical Consulting, Inc.

Client: Drummey Rosane Anderson, Inc.

Project: Proposed Northeast Metro Reg. Vocational Tech. H.S., Wakefield, MA

Project No: 2025 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	2.6	2.5	8.4	28.5	58.0	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3"	100.0	100.0	
1.5"	100.0	80.0 - 100.0	
0.75"	100.0		
0.5"	99.4	50.0 - 100.0	
#4	97.4	30.0 - 85.0	X
#8	95.4		
#20	91.7	15.0 - 60.0	X
#40	86.5		
#60	79.2	5.0 - 35.0	X
#200	58.0	0.0 - 10.0	X

* LGCI Structural Fill

Material Description

ASTM (D 2488) Classification: Sandy SILT (ML), 35-40% fine sand, 0-5% fine subrounded gravel, trace of organic soil, trace of roots, 0-5% cobbles, brown

Atterberg Limits (ASTM D 4318)

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

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 0.6334	D_{85}= 0.3753	D_{60}= 0.0836
D_{50}=	D_{30}=	D_{15}=
D_{10}=	C_u=	C_c=

Remarks

Subsoil

Date Received: 12/3/2020 **Date Tested:** 12/9/2020

Tested By: TG

Checked By: AML

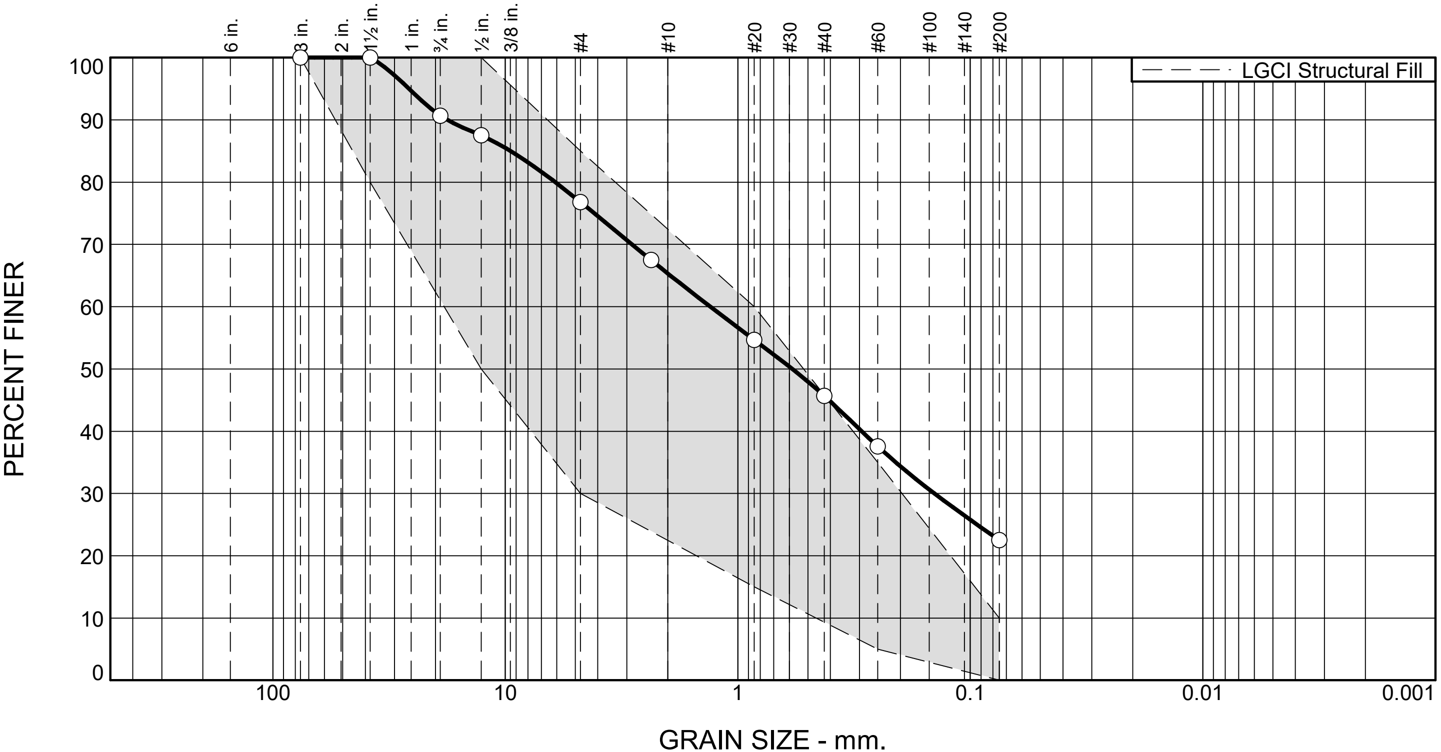
Location: Test Pit TP-6
Depth: 0.5' - 3'

Date Sampled: 12/3/2020

LGCI
Lahlaf Geotechnical Consulting, Inc.

Client: Drummey Rosane Anderson, Inc.
Project: Proposed Northeast Metro Reg. Vocational Tech. H.S., Wakefield, MA
Project No: 2025 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	9.3	13.9	11.5	19.6	23.2	22.5	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3"	100.0	100.0	
1.5"	100.0	80.0 - 100.0	
0.75"	90.7		
0.5"	87.5	50.0 - 100.0	
#4	76.8	30.0 - 85.0	
#8	67.5		
#20	54.7	15.0 - 60.0	
#40	45.7		
#60	37.6	5.0 - 35.0	X
#200	22.5	0.0 - 10.0	X

* LGCI Structural Fill

Material Description

ASTM (D 2488) Classification: Silty SAND with Gravel (SM), fine to coarse, 20-25% fines, 20-25% fine to coarse subrounded gravel, gray, moist

Atterberg Limits (ASTM D 4318)

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

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}=	17.7802	D_{85}=	9.4700	D_{60}=	1.3106
D_{50}=	0.5834	D_{30}=	0.1424	D_{15}=	
D_{10}=		C_u=		C_c=	

Remarks

Sand

Date Received: 12/4/2020 **Date Tested:** 12/9/2020

Tested By: TG

Checked By: AML

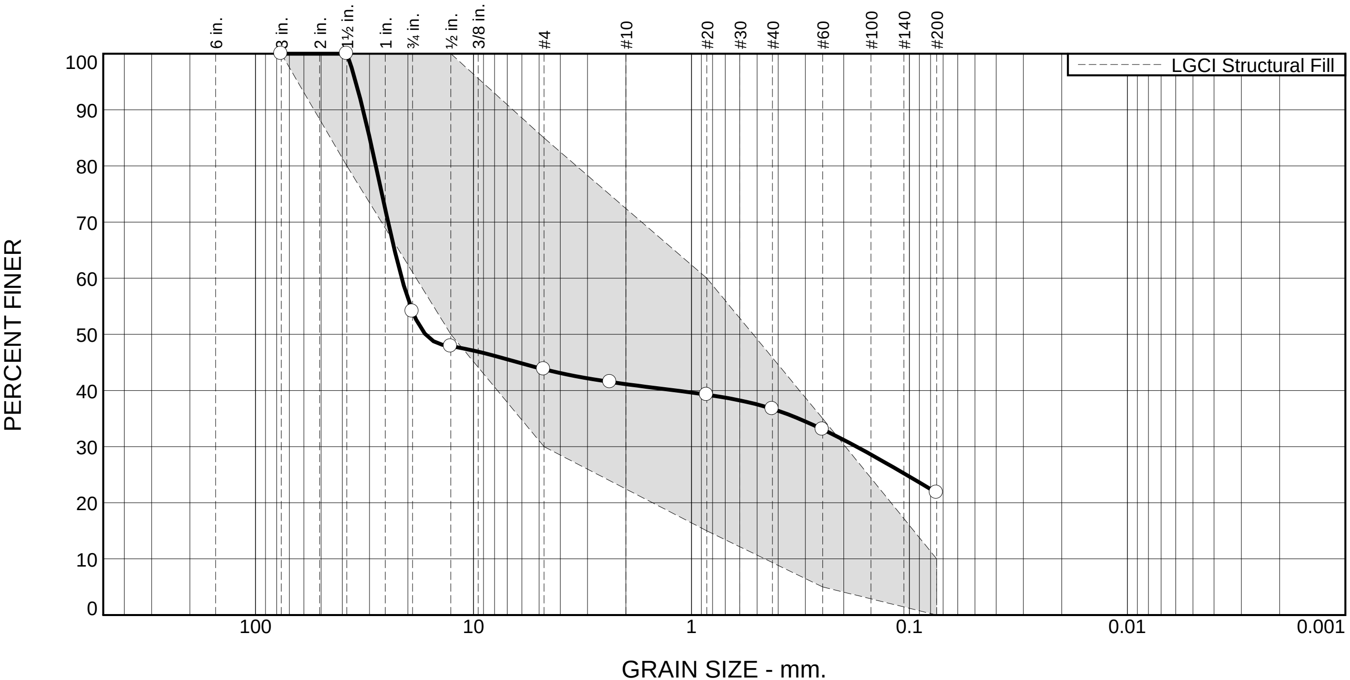
Location: Test Pit TP-9
Depth: 1.9' - 6.2'

Date Sampled: 12/4/2020

LGCI
Lahlaf Geotechnical Consulting, Inc.

Client: Drummey Rosane Anderson, Inc.
Project: Proposed Northeast Metro Reg. Vocational Tech. H.S., Wakefield, MA
Project No: 2025 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	45.9	10.3	2.7	4.4	14.9	21.8	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3"	100.0	100.0	
1.5"	100.0	80.0 - 100.0	
0.75"	54.1		
0.5"	47.9	50.0 - 100.0	X
#4	43.8	30.0 - 85.0	
#8	41.5		
#20	39.2	15.0 - 60.0	
#40	36.7		
#60	33.1	5.0 - 35.0	
#200	21.8	0.0 - 10.0	X

* LGCI Structural Fill

Material Description

ASTM (D 2488) Classification: Silty GRAVEL with Sand (GM), fine to coarse, 20-25% fines, 20-25% fine to coarse sand, trace of organic soil, trace of roots, brown, moist

Atterberg Limits (ASTM D 4318)

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

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 32.1157 D_{85}= 29.9725 D_{60}= 21.3315
D_{50}= 16.6162 D_{30}= 0.1750 D_{15}=
D_{10}= C_u= C_c=

Remarks

Subsoil

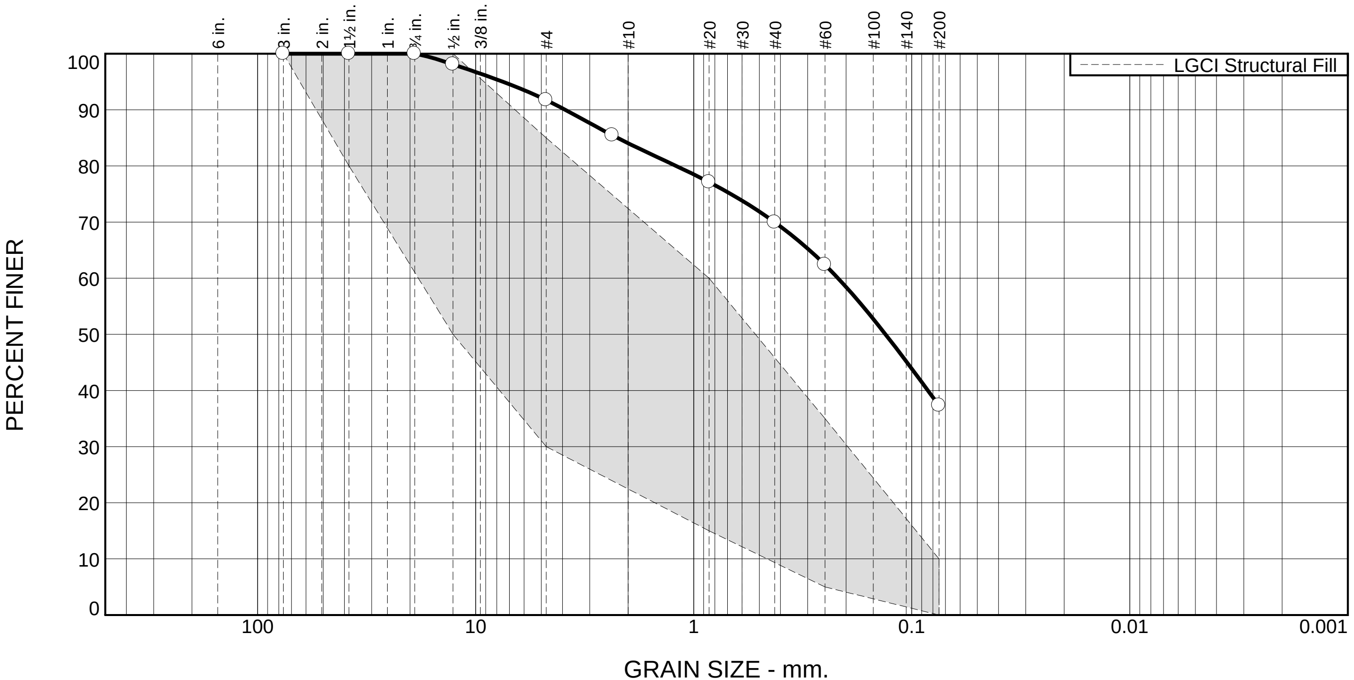
Date Received: 4/19/21 **Date Tested:** 5/17/21
Tested By: KK
Checked By: IM

Location: TP-104
Depth: 0.5'-2.5'
Date Sampled: 4/19/21

LGCI
Lahlaf Geotechnical Consulting, Inc.

Client: Drummey Rosane Anderson, Inc.
Project: Prop. Northeast Metropolitan Regional Vocational Technical High School, Wakefield MA
Project No: 2025 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	8.3	7.6	14.1	32.7	37.3	

TEST RESULTS			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3"	100.0	100.0	
1.5"	100.0	80.0 - 100.0	
0.75"	100.0		
0.5"	98.1	50.0 - 100.0	
#4	91.7	30.0 - 85.0	X
#8	85.5		
#20	77.1	15.0 - 60.0	X
#40	70.0		
#60	62.4	5.0 - 35.0	X
#200	37.3	0.0 - 10.0	X

* LGCI Structural Fill

Material Description

ASTM (D 2488) Classification: Silty SAND (SM), fine to coarse, 35-40% fines, 5-10% fine gravel, trace of organic soil, trace of roots, brown, moist

Atterberg Limits (ASTM D 4318)

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

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}=	3.8810	D_{85}=	2.2358	D_{60}=	0.2178
D_{50}=	0.1319	D_{30}=		D_{15}=	
D_{10}=		C_u=		C_c=	

Remarks

Subsoil

Date Received: 4/20/2021 **Date Tested:** 5/17/2021

Tested By: KK

Checked By: IM

Location: TP-106
Depth: 0.5'-3.2'

Date Sampled: 4/20/2021

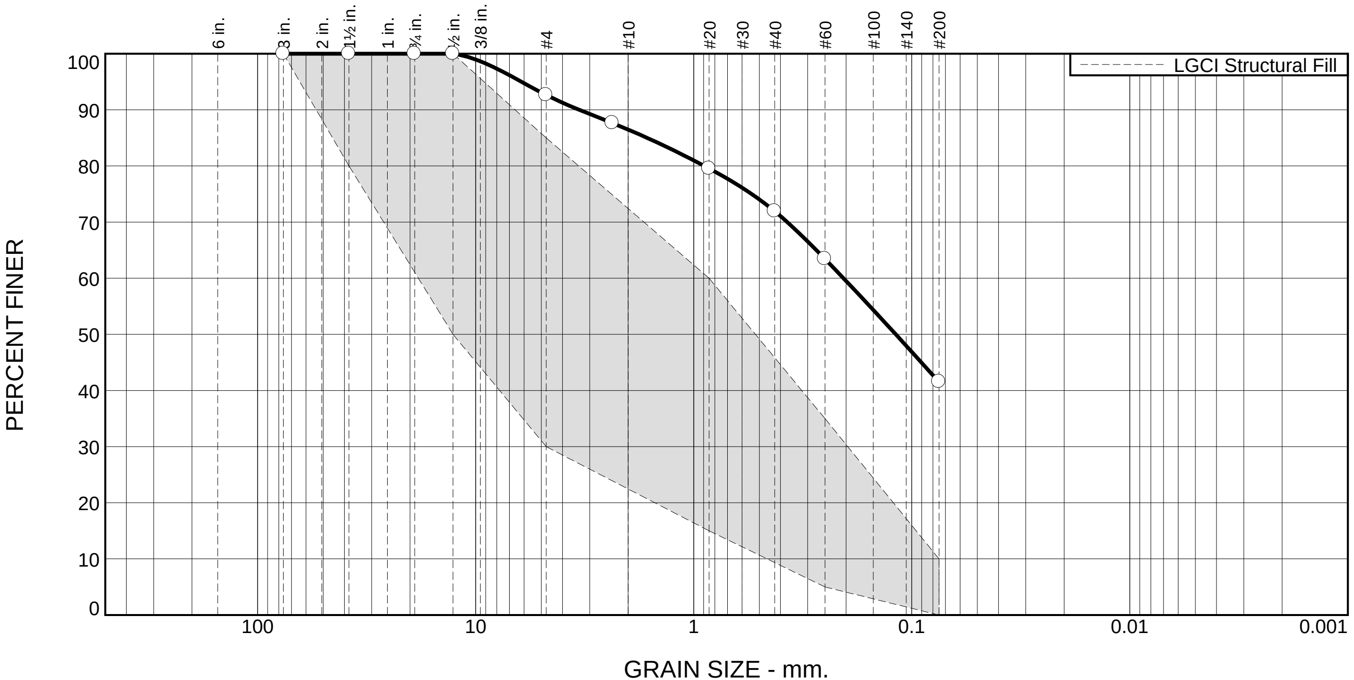
LGCI
Lahlaf Geotechnical Consulting, Inc.

Client: Drummey Rosane Anderson, Inc.

Project: Prop. Northeast Metropolitan Regional Vocational Technical High School, Wakefield MA

Project No: 2025 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	7.4	6.1	14.6	30.4	41.5	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3"	100.0	100.0	
1.5"	100.0	80.0 - 100.0	
0.75"	100.0		
0.5"	100.0	50.0 - 100.0	
#4	92.6	30.0 - 85.0	X
#8	87.6		
#20	79.6	15.0 - 60.0	X
#40	71.9		
#60	63.4	5.0 - 35.0	X
#200	41.5	0.0 - 10.0	X

* LGCI Structural Fill

Material Description

ASTM (D 2488) Classification: Silty SAND (SM), fine to coarse, 40-45% fines, 5-10% fine subrounded to subangular gravel, gray, moist to wet

Atterberg Limits (ASTM D 4318)

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

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}=	3.3466	D_{85}=	1.6352	D_{60}=	0.2056
D_{50}=	0.1184	D_{30}=		D_{15}=	
D_{10}=		C_u=		C_c=	

Remarks

Natural Sand

Date Received: 4/20/2021 **Date Tested:** 5/17/2021

Tested By: KK

Checked By: IM

Location: TP-107
Depth: 2.1'-3.1'

Date Sampled: 4/20/2021

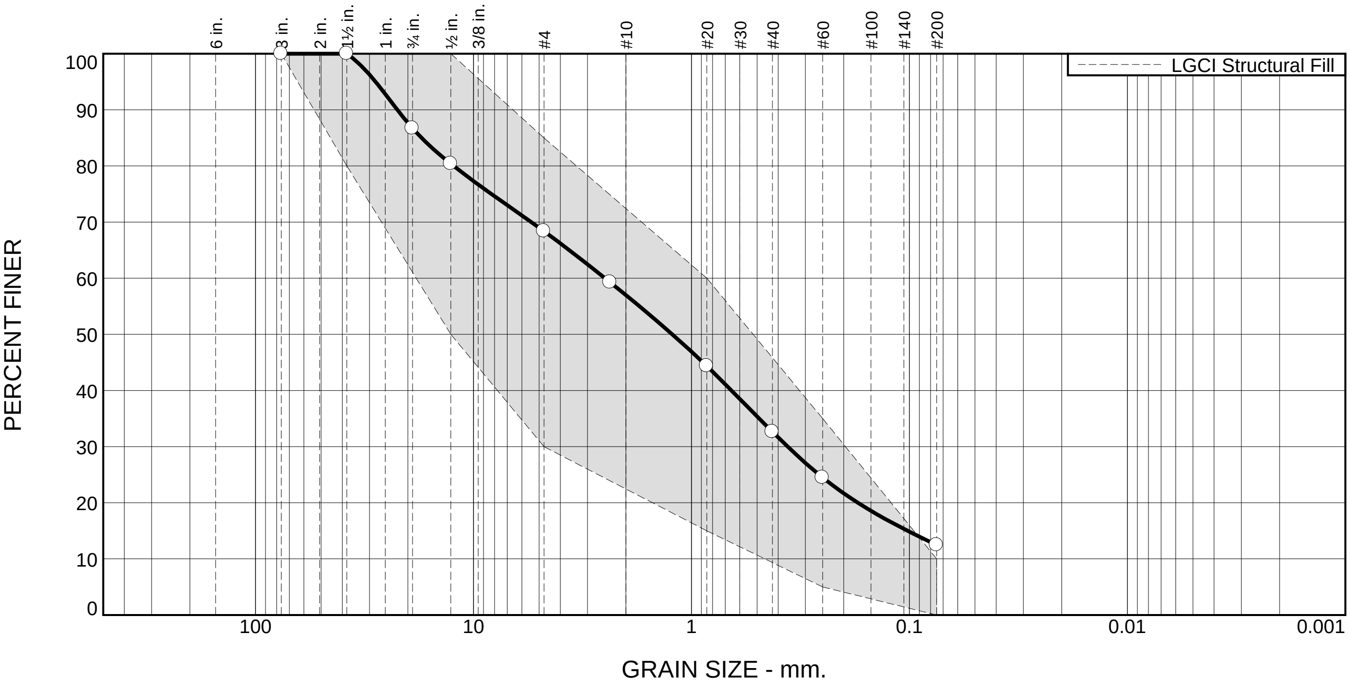
LGCI
Lahlaf Geotechnical Consulting, Inc.

Client: Drummey Rosane Anderson, Inc.

Project: Prop. Northeast Metropolitan Regional Vocational Technical High School, Wakefield MA

Project No: 2025 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	13.3	18.3	11.4	24.4	20.1	12.5	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3"	100.0	100.0	
1.5"	100.0	80.0 - 100.0	
0.75"	86.7		
0.5"	80.4	50.0 - 100.0	
#4	68.4	30.0 - 85.0	
#8	59.3		
#20	44.3	15.0 - 60.0	
#40	32.6		
#60	24.5	5.0 - 35.0	
#200	12.5	0.0 - 10.0	X

* LGCI Structural Fill

Material Description

ASTM (D 2488) Classification: Well Graded SAND with Silt and Gravel (SW-SM), fine to corse, 10-15% fines, 30-35% fine to coarse subrounded gravel, trace of roots, light brown, moist

Atterberg Limits (ASTM D 4318)

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

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}=	22.3370	D_{85}=	17.3210	D_{60}=	2.4930
D_{50}=	1.2241	D_{30}=	0.3617	D_{15}=	0.1018
D_{10}=		C_u=		C_c=	

Remarks

Natural Sand

Date Received: 4/19/2021 **Date Tested:** 5/17/2021

Tested By: KK

Checked By: IM

Location: TP-113
Depth: 0.5'-3.0'

Date Sampled: 4/19/2021

LGCI
Lahlaf Geotechnical Consulting, Inc.

Client: Drummey Rosane Anderson, Inc.

Project: Prop. Northeast Metropolitan Regional Vocational Technical High School, Wakefield MA

Project No: 2025 **Figure**

Appendix H – Results of Compressive Strength Tests

Client:	Lahlaf Geotechnical Consulting				
Project:	Prop. NE Metro. Reg. Voc. HS				
Location:	Wakefield, MA			Project No:	GTX-315626
Boring ID:	---	Sample Type:	---	Tested By:	tlm
Sample ID:	---	Test Date:	07/07/22	Checked By:	smd
Depth :	---	Test Id:	672853		

Bulk Density and Compressive Strength of Rock Core Specimens by ASTM D7012 Method C

Boring ID	Sample Number	Depth	Bulk Density, pcf	Compressive strength, psi	Failure Type	Meets ASTM D4543	Note(s)
C1	B-202	3.28-3.66 ft	186	18713	3	Yes	---
C2	B-206	8.73-9.13 ft	174	17340	1	Yes	---

Notes: Density determined on core samples by measuring dimensions and weight and then calculating.

All specimens tested at the approximate as-received moisture content and at standard laboratory temperature.

The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.

Failure Type: 1 = Intact Material Failure; 2 = Discontinuity Failure; 3 = Intact Material and Discontinuity Failure
(See attached photographs)

GeoTesting EXPRESS

Client:	Lahlaf Geotechnical Consulting	Test Date:	6/28/2022
Project Name:	Prop. NE Metro. Reg. Voc. HS	Tested By:	bp
Project Location:	Wakefield, MA	Checked By:	smd
GTX #:	315626		
Boring ID:	C1		
Sample ID:	B-202		
Depth:	3.28-3.66 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average
Specimen Length, in:	4.45	4.45	4.45
Specimen Diameter, in:	2.00	2.00	2.00
Specimen Mass, g:	685.64		
Bulk Density, lb/ft^3	186		
Length to Diameter Ratio:	2.2		

Minimum Diameter Tolerence Met? YES

Length to Diameter Ratio Tolerance Met? YES

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:

Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? YES

END FLATNESS AND PARALLELISM (Procedure FP1)

END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Diameter 2, in (rotated 90^o)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Difference between max and min readings, in:

0° = 0.00000 90° = 0.00000

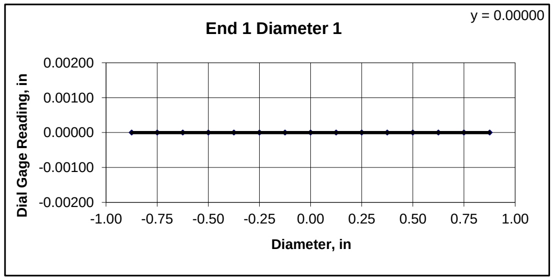
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00020	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Diameter 2, in (rotated 90^o)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

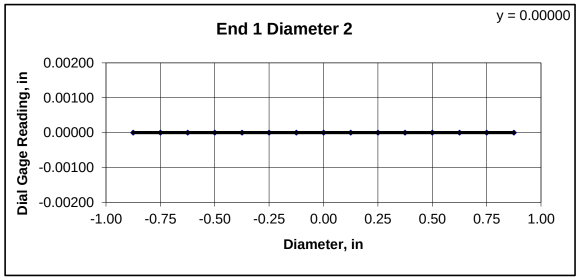
Difference between max and min readings, in:

0° = 0.0002 90° = 0

Maximum difference must be < 0.0020 in. Difference = ± 0.00010

Flatness Tolerance Met? YES





DIAMETER 1

End 1:

Slope of Best Fit Line 0.00000

Angle of Best Fit Line: 0.00000

End 2:

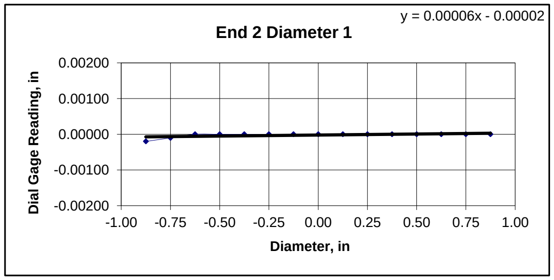
Slope of Best Fit Line 0.00006

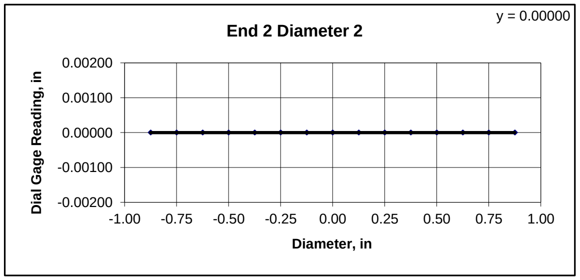
Angle of Best Fit Line: 0.00327

Maximum Angular Difference: 0.00327

Parallelism Tolerance Met? YES

Spherically Seated





DIAMETER 2

End 1:

Slope of Best Fit Line 0.00000

Angle of Best Fit Line: 0.00000

End 2:

Slope of Best Fit Line 0.00000

Angle of Best Fit Line: 0.00000

Maximum Angular Difference: 0.00000

Parallelism Tolerance Met? YES

Spherically Seated

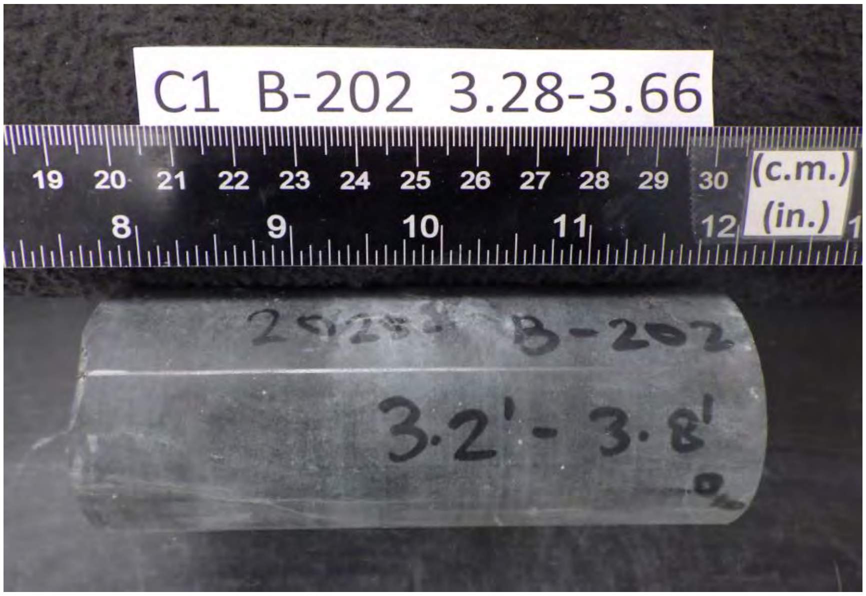
PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00000	2.000	0.00000	0.000	YES
Diameter 2, in (rotated 90^o)	0.00000	2.000	0.00000	0.000	YES
END 2					
Diameter 1, in	0.00020	2.000	0.00010	0.006	YES
Diameter 2, in (rotated 90^o)	0.00000	2.000	0.00000	0.000	YES

Maximum angle of departure must be ≤ 0.25°

Perpendicularity Tolerance Met? YES

Client:	Lahlaf Geotechnical Consulting
Project Name:	Prop. NE Metro. Reg. Voc. HS
Project Location:	Wakefield, MA
GTX #:	315626
Test Date:	6/29/2022
Tested By:	bp
Checked By:	smd
Boring ID:	B-202
Sample ID:	C1
Depth, ft:	3.28-3.66



After cutting and grinding

After break

Client:	Lahlaf Geotechnical Consulting	Test Date:	6/28/2022
Project Name:	Prop. NE Metro. Reg. Voc. HS	Tested By:	bp
Project Location:	Wakefield, MA	Checked By:	smd
GTX #:	315626		
Boring ID:	C2		
Sample ID:	B-206		
Depth:	8.73-9.13 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average
Specimen Length, in:	4.32	4.32	4.32
Specimen Diameter, in:	2.00	2.00	2.00
Specimen Mass, g:	619.43		
Bulk Density, lb/ft^3	174	**Minimum Diameter Tolerence Met?**	YES
Length to Diameter Ratio:	2.2	**Length to Diameter Ratio Tolerance Met?**	YES

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:

Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? YES

END FLATNESS AND PARALLELISM (Procedure FP1)

END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Diameter 2, in (rotated 90^o)	-0.00030	-0.00020	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Difference between max and min readings, in:

0° = 0.00000 90° = 0.00030

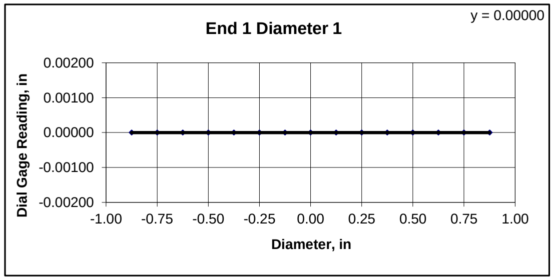
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00020	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Diameter 2, in (rotated 90^o)	0.00010	0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00020	-0.00030

Difference between max and min readings, in:

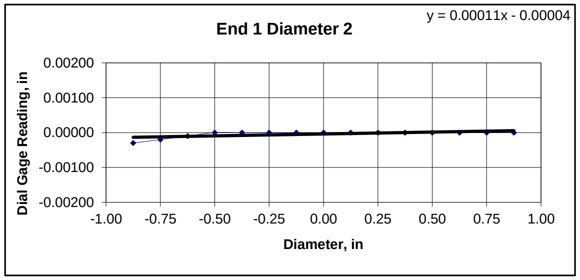
0° = 0.0002 90° = 0.0004

Maximum difference must be < 0.0020 in. Difference = ± 0.00020

Flatness Tolerance Met? YES



End 1 Diameter 1



End 1 Diameter 2

DIAMETER 1

End 1:

Slope of Best Fit Line	0.00000
Angle of Best Fit Line:	0.00000

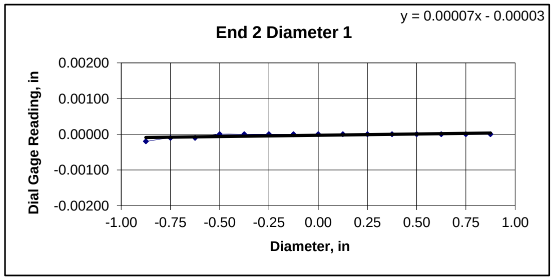
End 2:

Slope of Best Fit Line	0.00007
Angle of Best Fit Line:	0.00409

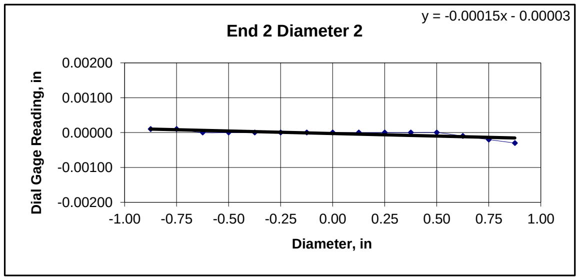
Maximum Angular Difference: 0.00409

Parallelism Tolerance Met? YES

Spherically Seated



End 2 Diameter 1



End 2 Diameter 2

DIAMETER 2

End 1:

Slope of Best Fit Line	0.00011
Angle of Best Fit Line:	0.00622

End 2:

Slope of Best Fit Line	0.00015
Angle of Best Fit Line:	0.00835

Maximum Angular Difference: 0.00213

Parallelism Tolerance Met? YES

Spherically Seated

PERPENDICULARITY (Procedure P1)

(Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00000	2.000	0.00000	0.000	YES
Diameter 2, in (rotated 90^o)	0.00030	2.000	0.00015	0.009	YES
END 2					
Diameter 1, in	0.00020	2.000	0.00010	0.006	YES
Diameter 2, in (rotated 90^o)	0.00040	2.000	0.00020	0.011	YES

Maximum angle of departure must be ≤ 0.25°

Perpendicularity Tolerance Met? YES

Client:	Lahlaf Geotechnical Consulting
Project Name:	Prop. NE Metro. Reg. Voc. HS
Project Location:	Wakefield, MA
GTX #:	315626
Test Date:	6/29/2022
Tested By:	bp
Checked By:	smd
Boring ID:	C2
Sample ID:	B-206
Depth, ft:	8.73-9.13

After cutting and grinding

After break

Appendix I – Results of Loam Analyses

Soil and Plant Nutrient Testing Laboratory
203 Paige Laboratory
161 Holdsworth Way
University of Massachusetts
Amherst, MA 01003
Phone: (413) 545-2311
e-mail: soiltest@umass.edu
website: soiltest.umass.edu

Soil Test Report

Sample Information:
Sample ID: Topsoil Sample # 1+2

Order Number: 61477
Lab Number: S220617-129
Area Sampled:
Received: 6/21/2022
Reported: 6/24/2022

Prepared For:
Madjid Lahlaf
Lahlaf Geotechnical Consulting, Inc.
100 Chelmsford Road, Suite 2
Billerica, MA 01862

madjid.lahlaf@lgcinc.net
978-330-5912

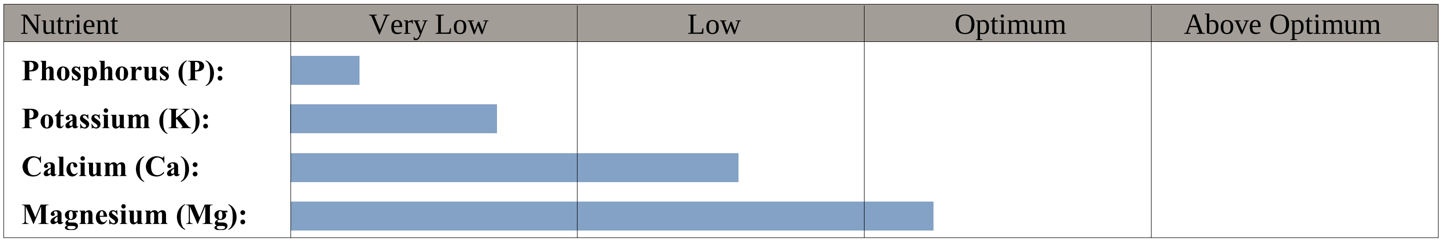
Results

Analysis	*Value Found*	*Optimum Range*
Soil pH (1:1, H2O)	6.0	
Modified Morgan extractable, ppm		
Macronutrients		
Phosphorus (P)	0.5	4-14
Potassium (K)	36	100-160
Calcium (Ca)	784	1000-1500
Magnesium (Mg)	66	50-120
Sulfur (S)	8.7	>10
Micronutrients *		
Boron (B)	0.0	0.1-0.5
Manganese (Mn)	1.0	1.1-6.3
Zinc (Zn)	0.7	1.0-7.6
Copper (Cu)	0.1	0.3-0.6
Iron (Fe)	11.8	2.7-9.4
Aluminum (Al)	173	<75
Lead (Pb)	2.2	<22

Analysis	*Value Found*	*Optimum Range*
Cation Exch. Capacity, meq/100g	10.3	
Exch. Acidity, meq/100g	5.7	
Base Saturation, %		
Calcium Base Saturation	38	50-80
Magnesium Base Saturation	5	10-30
Potassium Base Saturation	1	2.0-7.0
Scoop Density, g/cc	0.92	
Optional tests		
Soil Organic Matter (LOI), %	5.2	
Soluble Salts (1:2), dS/m	0.04	<0.6
Nitrate-N (NO3-N), ppm	2	

* *Micronutrient deficiencies rarely occur in New England soils; therefore, an Optimum Range has never been defined. Values provided represent the normal range found in soils and are for reference only.*

Soil Test Interpretation



Recommendations for Sports Turf/Golf Fairway-Establishment

Limestone (Target pH of 6.5)	Nitrogen, N	Phosphorus, P2O5	Potassium, K2O
lbs / 1000 sq ft			
100	2 - 4	2.5	5

Comments:

-For instructions on converting nutrient recommendations to fertilizer applications in lawns, see Reference "Step-by-Step Fertilizer Guide for Lawns" (listed below).
-For best results, split the N, P2O5, and K2O recommendations above into three to four applications over the course of the growing season at six to eight week intervals, beginning in mid- to late-April.
-Many fertilizer sources and rates may be combined to provide acceptable turfgrass fertilty.
-The lead level in this soil is less than 22 ppm, which falls below the listed optimum level. However, many variables affect this result, and safety thresholds vary by location and soil use. There is still a potential risk of lead exposure for soils used for growing food or as play areas for children. Our Total Sorbed Metals test provides an accurate measurement of soil lead. For more information about lead levels in soil, see the fact sheet entitled "Soil Lead: Testing, Interpretation, & Recommendations," listed under General References at the end of this report. ATTN: The Total Sorbed Metals Test is currently unavailable. We apologize for any inconvenience.

References:

UMass Lawn and Landscape Turf Best Management Practices	http://extension.umass.edu/turf/publications-resources/best-management-practices
Step-by-Step Fertilizer Guide for Lawns	http://ag.umass.edu/soil-plant-nutrient-testing-laboratory/fact-sheets/fertilizer-guide-for-lawns

Recommendations for Sports Turf/Golf Fairway-Maintenance

Limestone (Target pH of 6.5)	Nitrogen, N	Phosphorus, P2O5	Potassium, K2O
lbs / 1000 sq ft			
100	3 - 5	2	5

Comments:

-Do not topdress with more than 50 lb limestone per 1000 sq ft at one time. Split the above application between early spring and mid-autumn.
-For instructions on converting nutrient recommendations to fertilizer applications in lawns, see Reference "Step-by-Step Fertilizer Guide for Lawns" (listed below).
-Many fertilizer sources and rates may be combined to provide acceptable turfgrass fertilty.
-For best results, split the N, P2O5, and K2O recommendations above into three to four applications over the course of the growing season at six to eight week intervals, beginning in mid- to late-April.
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General References:

Interpreting Your Soil Test Results	http://soiltest.umass.edu/fact-sheets/interpreting-your-soil-test-results
Soil Lead: Testing, Interpretation & Recommendations	http://ag.umass.edu/soil-plant-nutrient-testing-laboratory/fact-sheets/soil-lead-fact-sheet
For current information and order forms, please visit	http://soiltest.umass.edu/
UMass Extension Nutrient Management	http://ag.umass.edu/agriculture-resources/nutrient-management

Soil and Plant Nutrient Testing Laboratory
203 Paige Laboratory
161 Holdsworth Way
University of Massachusetts
Amherst, MA 01003
Phone: (413) 545-2311
e-mail: soiltest@umass.edu
website: soiltest.umass.edu

Soil Test Report

Prepared For:
Madjid Lahlaf
Lahlaf Geotechnical Consulting, Inc.
100 Chelmsford Road, Suite 2
Billerica, MA 01862

madjid.lahlaf@lgcinc.net
978-330-5912

Sample Information:
Sample ID: Topsoil Sample #3

Order Number: 61477
Lab Number: S220617-130
Area Sampled:
Received: 6/21/2022
Reported: 6/24/2022

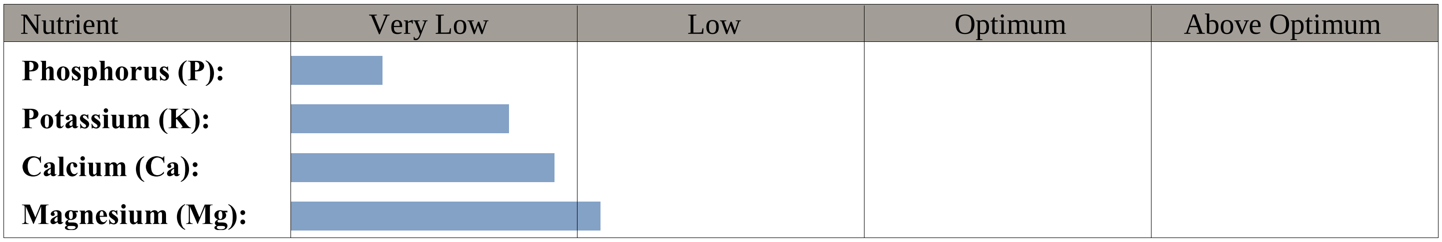
Results

Analysis	*Value Found*	*Optimum Range*
Soil pH (1:1, H2O)	5.2	
Modified Morgan extractable, ppm		
Macronutrients		
Phosphorus (P)	0.6	4-14
Potassium (K)	38	100-160
Calcium (Ca)	467	1000-1500
Magnesium (Mg)	27	50-120
Sulfur (S)	7.5	>10
Micronutrients *		
Boron (B)	0.0	0.1-0.5
Manganese (Mn)	0.7	1.1-6.3
Zinc (Zn)	1.1	1.0-7.6
Copper (Cu)	0.2	0.3-0.6
Iron (Fe)	15.2	2.7-9.4
Aluminum (Al)	150	<75
Lead (Pb)	2.6	<22

Analysis	*Value Found*	*Optimum Range*
Cation Exch. Capacity, meq/100g	12.1	
Exch. Acidity, meq/100g	9.4	
Base Saturation, %		
Calcium Base Saturation	19	50-80
Magnesium Base Saturation	2	10-30
Potassium Base Saturation	1	2.0-7.0
Scoop Density, g/cc	1.12	
Optional tests		
Soil Organic Matter (LOI), %	5.8	
Soluble Salts (1:2), dS/m	0.03	<0.6
Nitrate-N (NO3-N), ppm	3	

* *Micronutrient deficiencies rarely occur in New England soils; therefore, an Optimum Range has never been defined. Values provided represent the normal range found in soils and are for reference only.*

Soil Test Interpretation



Recommendations for Sports Turf/Golf Fairway-Establishment

Limestone (Target pH of 6.5)	Nitrogen, N	Phosphorus, P2O5	Potassium, K2O
lbs / 1000 sq ft			
175	2 - 4	2.5	5

Comments:

-Your magnesium level is low. Dolomitic limestone is recommended.
-For instructions on converting nutrient recommendations to fertilizer applications in lawns, see Reference "Step-by-Step Fertilizer Guide for Lawns" (listed below).
-For best results, split the N, P2O5, and K2O recommendations above into three to four applications over the course of the growing season at six to eight week intervals, beginning in mid- to late-April.
-Many fertilizer sources and rates may be combined to provide acceptable turfgrass fertilty.
-The lead level in this soil is less than 22 ppm, which falls below the listed optimum level. However, many variables affect this result, and safety thresholds vary by location and soil use. There is still a potential risk of lead exposure for soils used for growing food or as play areas for children. Our Total Sorbed Metals test provides an accurate measurement of soil lead. For more information about lead levels in soil, see the fact sheet entitled "Soil Lead: Testing, Interpretation, & Recommendations," listed under General References at the end of this report. ATTN: The Total Sorbed Metals Test is currently unavailable. We apologize for any inconvenience.

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Step-by-Step Fertilizer Guide for Lawns	http://ag.umass.edu/soil-plant-nutrient-testing-laboratory/fact-sheets/fertilizer-guide-for-lawns

Recommendations for Sports Turf/Golf Fairway-Maintenance

Limestone (Target pH of 6.5)	Nitrogen, N	Phosphorus, P2O5	Potassium, K2O
lbs / 1000 sq ft			
175	3 - 5	2	5

Comments:

-Do not topdress with more than 50 lb limestone per 1000 sq ft at one time. Split the above application between early spring and mid-autumn.
-Your magnesium level is low. Dolomitic limestone is recommended.
-For instructions on converting nutrient recommendations to fertilizer applications in lawns, see Reference "Step-by-Step Fertilizer Guide for Lawns" (listed below).
-Many fertilizer sources and rates may be combined to provide acceptable turfgrass fertilty.
-For best results, split the N, P2O5, and K2O recommendations above into three to four applications over the course of the growing season at six to eight week intervals, beginning in mid- to late-April.
-The lead level in this soil is less than 22 ppm, which falls below the listed optimum level. However, many variables affect this result, and safety thresholds vary by location and soil use. There is still a potential risk of lead exposure for soils used for growing food or as play areas for children. Our Total Sorbed Metals test provides an accurate measurement of soil lead. For more information about lead levels in soil, see the fact sheet entitled "Soil Lead: Testing, Interpretation, & Recommendations," listed under General References at the end of this report. ATTN: The Total Sorbed Metals Test is currently unavailable. We apologize for any inconvenience.

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University of Massachusetts
Amherst, MA 01003
Phone: (413) 545-2311
e-mail: soiltest@umass.edu
website: soiltest.umass.edu

Soil Test Report

Sample Information:
Sample ID: Topsoil Sample #4

Order Number: 61477
Lab Number: S220617-131
Area Sampled:
Received: 6/21/2022
Reported: 6/24/2022

Prepared For:
Madjid Lahlaf
Lahlaf Geotechnical Consulting, Inc.
100 Chelmsford Road, Suite 2
Billerica, MA 01862

madjid.lahlaf@lgcinc.net
978-330-5912

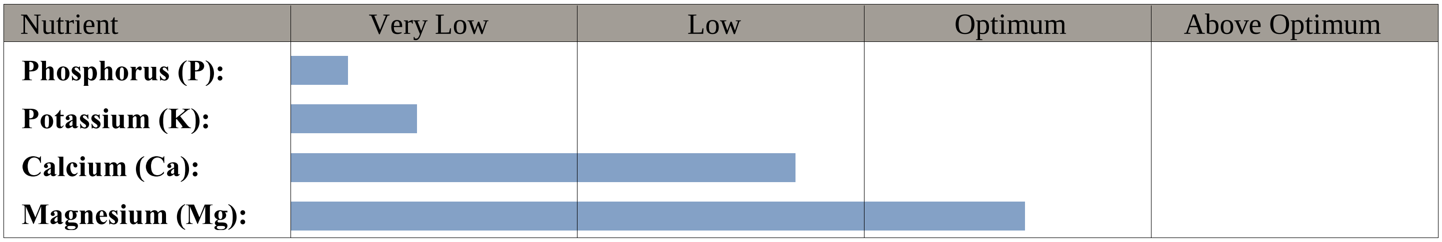
Results

Analysis	*Value Found*	*Optimum Range*
Soil pH (1:1, H2O)	6.3	
Modified Morgan extractable, ppm		
Macronutrients		
Phosphorus (P)	0.4	4-14
Potassium (K)	22	100-160
Calcium (Ca)	880	1000-1500
Magnesium (Mg)	90	50-120
Sulfur (S)	9.0	>10
Micronutrients *		
Boron (B)	0.0	0.1-0.5
Manganese (Mn)	0.7	1.1-6.3
Zinc (Zn)	2.7	1.0-7.6
Copper (Cu)	0.4	0.3-0.6
Iron (Fe)	9.6	2.7-9.4
Aluminum (Al)	134	<75
Lead (Pb)	2.9	<22

Analysis	*Value Found*	*Optimum Range*
Cation Exch. Capacity, meq/100g	10.1	
Exch. Acidity, meq/100g	4.9	
Base Saturation, %		
Calcium Base Saturation	43	50-80
Magnesium Base Saturation	7	10-30
Potassium Base Saturation	1	2.0-7.0
Scoop Density, g/cc	1.02	
Optional tests		
Soil Organic Matter (LOI), %	5.2	
Soluble Salts (1:2), dS/m	0.03	<0.6
Nitrate-N (NO3-N), ppm	3	

* *Micronutrient deficiencies rarely occur in New England soils; therefore, an Optimum Range has never been defined. Values provided represent the normal range found in soils and are for reference only.*

Soil Test Interpretation



Recommendations for Sports Turf/Golf Fairway-Establishment

Limestone (Target pH of 6.5)	Nitrogen, N	Phosphorus, P2O5	Potassium, K2O
	lbs / 1000 sq ft		
75	2 - 4	2.5	5

Comments:

-For instructions on converting nutrient recommendations to fertilizer applications in lawns, see Reference "Step-by-Step Fertilizer Guide for Lawns" (listed below).
-For best results, split the N, P2O5, and K2O recommendations above into three to four applications over the course of the growing season at six to eight week intervals, beginning in mid- to late-April.
-Many fertilizer sources and rates may be combined to provide acceptable turfgrass fertilty.
-The lead level in this soil is less than 22 ppm, which falls below the listed optimum level. However, many variables affect this result, and safety thresholds vary by location and soil use. There is still a potential risk of lead exposure for soils used for growing food or as play areas for children. Our Total Sorbed Metals test provides an accurate measurement of soil lead. For more information about lead levels in soil, see the fact sheet entitled "Soil Lead: Testing, Interpretation, & Recommendations," listed under General References at the end of this report. ATTN: The Total Sorbed Metals Test is currently unavailable. We apologize for any inconvenience.

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Recommendations for Sports Turf/Golf Fairway-Maintenance

Limestone (Target pH of 6.5)	Nitrogen, N	Phosphorus, P2O5	Potassium, K2O
	lbs / 1000 sq ft		
75	3 - 5	2	5

Comments:

-Do not topdress with more than 50 lb limestone per 1000 sq ft at one time. Split the above application between early spring and mid-autumn.
-For instructions on converting nutrient recommendations to fertilizer applications in lawns, see Reference "Step-by-Step Fertilizer Guide for Lawns" (listed below).
-Many fertilizer sources and rates may be combined to provide acceptable turfgrass fertilty.
-For best results, split the N, P2O5, and K2O recommendations above into three to four applications over the course of the growing season at six to eight week intervals, beginning in mid- to late-April.
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Soil Lead: Testing, Interpretation & Recommendations	http://ag.umass.edu/soil-plant-nutrient-testing-laboratory/fact-sheets/soil-lead-fact-sheet
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Phone: (413) 545-2311
e-mail: soiltest@umass.edu
website: soiltest.umass.edu

Particle Size Analysis - Comprehensive

Sample Information:
Sample ID: TopSoil Sample #1&2

Order Number:	61529
Lab Number:	X220621-103
Received:	6/21/2022
Reported:	6/28/2022

Prepared For:
Abdelmadjid Lahlaf
Lahlaf GeoTechnical Consulting Inc
100 Chelmsford Rd, Suite 2
Billerica, MA 01821

madjid.lahlaf@lgcinc.net
978-330-5912

USDA Size Fraction

Main Fractions	Size (mm)	Percent
Sand	0.05-2.0	68.8
Silt	0.002-0.05	22.4
Clay	<0.002	8.8

Sand Fractions	Size (mm)	Percent
Very Coarse	1.0-2.0	4.4
Coarse	0.5-1.0	12.2
Medium	0.25-0.5	26.6
Fine	0.10-0.25	17.5
Very Fine	0.05-0.10	8.2

Silt Fractions	Size (mm)	Percent
Coarse	0.02-0.05	17.0
Medium	0.005-0.02	5.0
Fine	0.002-0.005	0.4

Percent of Whole Sample Passing

Size (mm)	Sieve #	Whole Sample % of Sample Passing
2.00	#10	88.1
1.00	#18	84.2
0.50	#35	73.4
0.25	#60	50.0
0.10	#140	34.6
0.053	#270	27.5
0.02	20 um	12.5
0.005	5 um	8.1
0.002	2 um	7.7

USDA Textural Class: sandy loam

Gravel Content: (%) 11.9

Soil and Plant Nutrient Testing Laboratory
203 Paige Laboratory
161 Holdsworth Way
University of Massachusetts
Amherst, MA 01003
Phone: (413) 545-2311
e-mail: soiltest@umass.edu
website: soiltest.umass.edu

Particle Size Analysis - Comprehensive

Sample Information:
Sample ID: Topsoil Sample #3

Prepared For:
Abdelmadjid Lahlaf
Lahlaf GeoTechnical Consulting Inc
100 Chelmsford Rd, Suite 2
Billerica, MA 01821

madjid.lahlaf@lgcinc.net
978-330-5912

Order Number: 61529
Lab Number: X220621-104
Received: 6/21/2022
Reported: 6/28/2022

USDA Size Fraction

Main Fractions	Size (mm)	Percent
Sand	0.05-2.0	61.2
Silt	0.002-0.05	27.3
Clay	<0.002	11.5

Sand Fractions	Size (mm)	Percent
Very Coarse	1.0-2.0	7.4
Coarse	0.5-1.0	12.7
Medium	0.25-0.5	21.6
Fine	0.10-0.25	13.3
Very Fine	0.05-0.10	6.2

Silt Fractions	Size (mm)	Percent
Coarse	0.02-0.05	17.8
Medium	0.005-0.02	6.2
Fine	0.002-0.005	3.3

Percent of Whole Sample Passing

Size (mm)	Sieve #	Whole Sample % of Sample Passing
2.00	#10	89.6
1.00	#18	82.9
0.50	#35	71.5
0.25	#60	52.2
0.10	#140	40.3
0.053	#270	34.7
0.02	20 um	18.8
0.005	5 um	13.2
0.002	2 um	10.3

USDA Textural Class: sandy loam

Gravel Content: (%) 10.4

UMass Extension

Soil and Plant Nutrient Testing Laboratory
203 Paige Laboratory
161 Holdsworth Way
University of Massachusetts
Amherst, MA 01003
Phone: (413) 545-2311
e-mail: soiltest@umass.edu
website: soiltest.umass.edu

Particle Size Analysis - Comprehensive

Sample Information:
Sample ID: Topsoil Sample #4

Order Number:	61529
Lab Number:	X220621-105
Received:	6/21/2022
Reported:	6/28/2022

Prepared For:
Abdelmadjid Lahlaf
Lahlaf GeoTechnical Consulting Inc
100 Chelmsford Rd, Suite 2
Billerica, MA 01821

madjid.lahlaf@lgcinc.net
978-330-5912

USDA Size Fraction

Main Fractions	Size (mm)	Percent
Sand	0.05-2.0	58.3
Silt	0.002-0.05	30.8
Clay	<0.002	10.9

Sand Fractions	Size (mm)	Percent
Very Coarse	1.0-2.0	5.0
Coarse	0.5-1.0	11.1
Medium	0.25-0.5	17.8
Fine	0.10-0.25	16.0
Very Fine	0.05-0.10	8.4

Silt Fractions	Size (mm)	Percent
Coarse	0.02-0.05	18.5
Medium	0.005-0.02	10.2
Fine	0.002-0.005	2.1

Percent of Whole Sample Passing

Size (mm)	Sieve #	Whole Sample % of Sample Passing
2.00	#10	88.2
1.00	#18	83.7
0.50	#35	74.0
0.25	#60	58.3
0.10	#140	44.2
0.053	#270	36.7
0.02	20 um	20.4
0.005	5 um	11.5
0.002	2 um	9.6

USDA Textural Class: sandy loam

Gravel Content: (%) 11.8

Appendix J – Rock Engineering Design and Recommendations

Scarptec, Inc.
P.O. Box 326
Monument Beach, MA.
02553-0326

Tel: 603.361.0397
www.scarptec.com

25 July 2022
Internal Project No. 22-05

07/25/22

DAVID J.
SCARPATO
CIVIL
NO. 51735

Lahlaf Geotechnical Consulting, Inc.
100 Chelmsford Road, Suite 2
Billerica, MA 01862

Attention: Abdelmadjid M. Lahlaf, Ph.D., P.E.
Principal

Subject: Rock Engineering Design & Construction Recommendations
New Northeast Regional Metro Voc. Tech. High School
Proposed Cut Slope "A"
100 Hemlock Road, Wakefield, Massachusetts

Dear Mr. Lahlaf,

We would like to thank Lahlaf Geotechnical Consulting, Inc. ("LGCI") for reaching out to Scarptec, Inc. ("Scarptec") for this assignment. This report summarizes our findings and recommendations relative to a proposed rock cut at the Northeast Metro Regional Vocational Technical High School (NMRVT) Project in Wakefield, Massachusetts. We understand that your client, Drummey Rosane Anderson, Inc. ("DRA"), has requested that LGCI (Project Geotechnical Engineer) assess potential rock slope cut angle configurations and slope stabilization/rockfall mitigation measures at the site, and that you have retained Scarptec to complete these technical evaluations, as set forth in this Report. Our work was completed in general accordance with our agreement titled: *Agreement for Subconsulting Services*, dated 5 July 2022, as executed by Scarptec on 7 July 2022.

1. Introduction

Based on discussions with you and our review of project documents provided by LGCI, proposed cuts in igneous (rhyolite/rhyodacite and granodiorite) bedrock are expected to be on the order of 30- to 35-feet high (max.) by approximately 650 feet long, situated along the north and west side of the proposed new school building. The location and extents of the proposed rock excavation (herein referred to as Rock Cut "A") are shown on the site Grading Plan (Ref. 1) as being approximately 375 feet south of the existing Hemlock Road parking area at the Vocational Technical ("Voc-Tech") High School, and about 900 feet east of Farm Street, as shown in Figure 1A. We understand the architect has shown the approximate slope cut line as a series of reverse curves in plan, with the range of orientations being between 0 deg. (due north) and 40 deg. (northeast), based on north relative to the Massachusetts State Plane Coordinate System.

We understand that bedrock will comprise the significant portion of the total exposed slope height and that the preliminary rock slope cut angle was initially anticipated to be nearly vertical (8V:1H); however, in order to advance the cut slope angle, the proposed slope geometry needed to be further evaluated relative to the presence of structural geologic "discontinuities" within the rock mass. Discontinuities include joints, bedding planes, shears/faults, foliations and other fractures, all of which may exert a pronounced influence on the long-term behavior of a rock slope.

There is a tradeoff between slope angle and the extent (and cost) of remedial measures required to provide a safe, stable and reliable slope. An over-steepened slope with respect to controlling geologic structure(s) may result in increased remedial measures (e.g., rock bolts, mesh, shotcrete) and long-term maintenance (i.e., increased long- and short-term costs). Such a slope may also require a larger rockfall catchment ditch at the toe of the slope and thus may consume additional premium space at the site. Alternatively, an overly flattened slope may impact abutters up at the crest. For these reasons, we recommended to LGCI that the slope angle be evaluated with respect to rock mass conditions, including the presence of controlling geologic structures.

We understand that the project is in the late stages of the Design Development (DD) phase and that quantity and cost estimates for construction are being actively developed. As part of these evaluations, the project design team wishes to understand final proposed cut slope angles in order to estimate rock cut volumes and rock slope reinforcement quantities, and the potential costs relative to both items. The remainder of this Report summarizes our findings from the field and recommendations for rock slope cut angles. We have also included recommendations and baseline quantities relative to scaling and rock reinforcement with passive (untensioned) rock dowels.

2. Engineering Geologic Site Evaluation

2.1 Regional & Site Geology

The north end of the proposed rock excavation (Rock Cut "A") extends approximately 375 feet south of the existing school parking area along Hemlock Road, as shown in Figure 1A. The current paved parking area is bordered by a 15- to 20-foot-high rock cut constructed presumably when the existing Voc-Tech School was developed. Based on a review of Bedrock Geologic Maps of the Boston North, Boston South and Newton Quadrangles compiled by Clifford Kaye between 1975 and 1979 and published in 1980 by the U.S. Geological Survey (Ref. 2), the proposed site excavation appears to straddle two of the mapped units shown on the attached Figure 1B. The two mapped units include rhyolite and rhyodacite of the Precambrian-aged *Lynn Volcanic Complex* ("3VSI") that is mapped near the crest of the hill where the cut will be developed, and a plutonic tonalite and granodiorite unit ("VGTG") that represents an intrusive chilled contact facies.

The rhyodacitic unit was observed by us in the field and appeared to be dark gray to locally green in color, having a relatively high hardness, and breaking semi-conchoidally (i.e., brittle fracture). The granodiorite unit was also identified by us at the existing parking lot cut. The contact elevation between these two units appears to be variable; however, the horizontal extent of the contact appears to extend from the existing parking area and south-southwesterly up the hill approximately 350 to 400 feet, as inferred on the referenced geologic maps. The slightly younger granodiorite is fine to medium grained in texture and reportedly contains relict fragments of wall rock (i.e., host country rock that the igneous magma was injected through) that we also observed as "xenoliths" in the parking area rock cut.

Note that published geologic maps of the area infer the presence of localized steeply dipping joints as well as locally faulted bedrock around the perimeter of the site. A dike-filled fault associated with the contact was mapped by USGS between 350 and 400 feet up the hill from the parking area and trending east-west. This feature was not observed by us in the field and did not appear obvious within the boring logs we reviewed; however, it's inferred 100- to 110-deg. strike azimuth appears to be nearly perpendicular to the proposed cut. (Note: We provide guidance on how to deal with this apparent "fault" feature in the *Recommendations* Section below)

2.2 General Site Observations

We met with representatives of LGCI on the morning of Wednesday, 6 July 2022, just prior to our field mapping and site reconnaissance activities. The proposed site was moderately to highly vegetated and generally increases in elevation (sloping upward) from the existing parking lot of the Voc-Tech School, with numerous rock outcrops visible throughout the wooded area. We observed that the topographic ground surface was undulating and hummocky and, in several places, the proposed cuts are likely to have surface water intermittently draining into/over the slope. The upper portions of the slopes may experience "backbreak" (i.e., overbreak) because the top part of the rock column has experienced "ringing-off" with postglacial isostatic rebound and appears to have a higher degree of fracturing, as also evidenced by locally reduced RQD values in the upper 4 to 8 feet of the LGCI borings.

As observed in the existing parking area cut and in the outcrops in the Voc-Tech school location, the two rock units appeared generally massive in nature with well-defined joint sets established by stress redistribution from a combination of post-glacial rebound and previous volcanic activity. It is noteworthy that during our mapping of the parking area cut, only one half-barrel cast (i.e., rock drillhole trace) was observed near to toe of the existing parking lot slope and had an inclination of roughly 86 degrees (from horizontal plane). Portions of the parking area slope angle along of Hemlock Road ranged from 50 to 60 degrees, suggesting either that the joints in the upper 5 to 10 feet of rock are more prevalent and the slope developed its own stable configuration; or, that the previous blasting was relatively uncontrolled and gas travel during blasting broke portions of the final slope back to between 50 to 60 degrees. This suggests perimeter control measures during blasting of the existing parking lot slope were ineffective or were not used.

2.3 Surface Outcrop Discontinuity Mapping

During our 6 July site visit, we collected discontinuity data from five surface outcrop locations within the general vicinity of the proposed cut slope. These five "window mapping" locations are herein referred to as OC-1 through OC-5. Mapping was completed using an azimuthal Brunton® Geologic Compass and approximate outcrop positions were measured with respect to adjacent boring and observation well locations. Outcrop photos are included as Figures 1C through 1G of Attachment No. 1. In addition to general observations relative to rock mass quality, we collected discontinuity dip direction and dip angle measurements (n=35 points) for subsequent comparison with acoustic and optical televiewer logs produced by Hager-Richter Geoscience. Our field mapping data is attached as Table I at the end of this report. An assessment of field mapped structural data orientations is included as part of Section 2.5 below.

Based on our mapping observations and review of boring and lab testing data provided by LGCI (Refs. 3, and 4), we assess that the bedrock at the site can be described as moderately fractured, fresh to slightly weathered, very strong to extremely strong, granodiorite and rhyodacite. Zones with locally reduced intact rock uniaxial compressive strength (Ref. 5) values are possible in the upper 5 to 10 feet of the rock due to physical and chemical weathering and long-term mineral alteration. Reductions to intact, joint wall and overall rock mass strength values may also be coincident with locations of faults, shears or persistent high aperture discontinuities, especially those producing water.

2.4 Boring Logs, Core Photos and Downhole Optical and Acoustic Televiewer Logs

Scarptec reviewed boring logs and available core box photographs prepared by LGCI (Ref. 6), as well as geophysical logs of acoustic and optical televiewer (A/O TV) scans (Ref. 7) of core borings B206 and B208-OW, both of which are located on the proposed plan slope alignment. The core box photos appear to demonstrate that the dominant lithology is in the vicinity of the proposed slope is granodiorite with rhyodacite stockwork. Boring B208-OW was primarily granodiorite for the full 37-foot corehole depth, while Boring B206 appears to show evidence of mixing between granodiorite and rhyodacite stocks (i.e., dikes and sills). Rock Quality Designation (RQD) measurements of the cores showed the rock is generally massive and strong with RQDs mostly above 70% with locally reduced RQDs generally in the 40% range in near-surface cores.

Hager-Richter Geoscience, Inc. (HRG) completed A/O TV logging for the project. Televiewer logs were developed initially for the oil industry and are now commonly used for geotechnical and mining applications where detailed core logs and fracture analyses are required. The sondes include a rotating camera lens or acoustic transmitter that scans the corehole wall as the sonde is slowly raised in the corehole. The images developed from the scans are merged to prepare a virtual corehole wall image or core. Sloping fractures and beds can be measured for dip and dip direction assuming a sinusoidal wave pattern in the scanned trace of a discontinuity. Processing of the scans incorporates data from an internal accelerometer, compass and magnetometer to provide an oriented virtual core that can be corrected for compass declination. Optical scans are possible in open holes with clean or no water; acoustic televiewer sondes are used below the water table to couple the acoustic impulse to the rock via the fluid and can be used in murky or muddy water.

The A/O TV log scans generally appeared to show that the majority of open discontinuities were north-northwest dipping sub-horizontal joints which appear to be dissolution joints where mineral-healed fractures had been dissolved by groundwater. Steeper features had little to no obvious apertures and appeared generally tight. The data from the A/O TV logs is summarized and included as Table II which is attached at the end of this report.

2.5 Stereographic Projections

Stereographic projections, commonly referred to as "stereonets", are used to graphically present the orientation of discontinuities in a rock mass and evaluate the population(s) of the discontinuities relative to orientation (i.e., azimuth and inclination), and what major orientations are present and their relative prevalence. The most common types of stereonets seek to either display the trace of a discontinuity plane in a lower hemisphere projection (i.e., dip vector with plane penetrating the lower half of a sphere and passing through its center and both edges); or alternatively, as a single point in the case of a "pole" plot. By definition, a pole represents the normal to a discontinuity plane and is located 180 deg. out of phase with respect to dip direction (and $90 - \theta$ with respect to dip angle) on a stereonet. The plotted poles can be contoured for density of poles (statistical distribution) and divided into major discontinuity "sets".

A series of stereonets were generated using Rocscience's DIPS software to summarize the structural geologic discontinuities observed at the site, based on comparison of the field mapping data and the A/O TV logs. As was expected, the stereonet of field surface mapping data (n=35 data points) displayed a significantly wider distribution of joints sets given the distance between available outcrop locations (Figure 4C); however, the importance of the surface mapping data is that it helps to confirm joint sets that are well represented across the site. There appears to be relatively good agreement between the three-dimensional field mapping data and that shown in the A/O TV data, which is closer to a two-dimensional (vertically biased) scanline survey.

The A/O TV data from B206 (n=33) and B208-OW (n=85) show relatively good agreement between each other. Boring B206 and B208-OW each have five distinguishable discontinuity sets, although the correlation strength varies between both data sets because B208-OW has nearly three times the quantity of data points in comparison to B206, so additional discontinuity population intensities are reflected by the larger data set. The field mapping data indicated that there are at least eight discontinuity sets across the area of interest; however, out of those eight mapped sets, there are only two sets that a strongly correlated to what is reflected in the A/O TV data.

In order to characterize the full suite of discontinuity sets at the site, we combined data from both A/O TV logs with our outcrop mapping data (n=153), as shown on Figures 4F and 4G. Based on the combined structural geologic data set, we estimate that there are 13 joint sets represented across the site; however, there are two very well represented joint sets that we anticipate will exert a strong influence on overall slope behavior, those being:

- Joint Set J1 – Dips at relatively shallow angles (10 to 15 deg.) to the north. This set is anticipated to dip parallel to oblique with respect to the strike of the slope;
- Joint Sets J3 & J4 – Likely part of the same set given the "smearing" of the data in this region of the net. This combined set generally dips moderately to the north-northwest at between 33 and 46 deg. This set is also anticipated to dip parallel to oblique with respect to the strike of the slope.

Less statistically represented, yet still present sets that may locally influence slope behavior include the following:

- Joint Set J2 – Dips at shallow angles to the east;
- Joint Set J5 – Dips a shallow to moderate angles to the west;
- Joint Set J6 – Dips at shallow to moderate angles to the northeast;
- Joint Set J7 – Dips steeply to the west-southwest;
- Joint Set J10 – Dips steeply to the southeast. Potential daylighting set.
- Joint Set J11 – Dips to moderately to steeply to the east. Potential daylighting set.

The next section details how these sets could influence slope stability failure modes based on their intersection with proposed slope geometry.

2.6 Kinematic Evaluations of Proposed Cut Slope

Kinematic analysis of discontinuity data is an iterative form of geometric analysis without consideration of disturbing forces and consists of looking at proposed slope orientation(s) with respect to discontinuities plotted on the same stereonet. Incorporating the estimated base (or design) friction angle of the rock joint planes, inclination of the proposed slope and dip and dip direction of the discontinuity sets facilitates identification of potentially unstable planes or plane intersections in a proposed rock face. Common failure modes include the following:

- *Planar (Sliding) Failures* - Discontinuities dipping the same direction but less steeply than the proposed slope angle (i.e., "daylighting") yet dipping steeper than their inherent friction angle can result in planar (sliding) failures;

- *Wedge (Sliding) Failures* - For potential wedge failures forming on the proposed rock cut, the dip (or "plunge") of the angle of intersection between two planes must exceed the composite friction angle of the planes and be less than 20 to 25 degrees oblique to the cut to be kinematically capable of sliding;
- *Toppling Failures* – Toppling blocks or slabs form when their center of gravity extends outward beyond the base of a block inducing rotation, and where secondary "release" planes along the base and sides of the block are also present;
- *Overall (Global) Rock Mass Failures* – Can result when there is a very large quantity of joint sets at many different orientations and low rock mass strength. Overall failure planes or "slip surfaces" tend to be curved, semi-curved or curvilinear if mixed mode failures coexist.
- *Complex (Hybrid) Failures* – Complex failures are mixed mode failure mechanisms coexisting as part of an (usually large scale) instability.

Convexly curved slopes negate the positive effects of oblique joints (self-buttressing) and provide more opportunity to align adverse joint orientations with a given slope. As such, linear cuts or inward curving slope orientations are generally most stable. To minimize convexities and reverse curves of the slope, we have shown four slope segments with strike orientations ranging from nearly due north to an azimuth of 40 deg. (bearing of N40E) with respect to the Mass. State Plane Coordinate System, as shown in Figure 1H. These four segments, their strike orientation (or bearing) and their approximate respective lengths are summarized below based on the following:

- **Segment 1** – 29 deg. with plan length of approx. 80 feet;
- **Segment 2** – 3 deg. with length of approx. 175 linear feet;
- **Segment 3** – 37 deg. with plan length of approx. 220 feet;
- **Segment 4** – 15 deg. and length of approx. 200 feet.

For kinematic analyses, we assumed cohesion is effectively zero and selected an average slope azimuth of 20 deg. (i.e., N20E) and a conservative value for base friction angle (ϕ) of 35 degrees. We varied slope face angles relative to known joint sets and joint set intersections to assess potential instability modes. The slope orientations and segments are generally consistent with what we discussed with the design team on our Monday, 18 July 2022 teleconference call. Based on our evaluations with respect to the proposed segment orientations noted above, we summarize the following conclusions relative to potential modes of rock slope instability along the segments comprising Rock Cut Slope A:

1. *Overall Rock Mass Failure and Complex Failures* – Very low probability given the distribution of poles shown on the stereonets and the hard, brittle nature of the rock mass; however, isolated "shatter" zones are always possible with volcanic emplacements containing highly brittle, previously stressed rock.

2. *Planar Sliding Failures* – Low probability given the quantity of potential sliding pole vectors indicated on Figure 4H. Additionally, approximately one third of the poles that fall within the red shaded area known as “Markland’s Critical Zone” are intact “foliations” and may be healed or non-throughgoing features; however, given the location and orientation of the cut, we cannot rule out the possibility of localized sliding blocks that may require rock dowels for enhanced shear resistance along suspect sliding planes.

3. *Wedge Failures* – The probability of wedge sliding along joint plane intersections is anticipated to be relatively low given the low population of pole vectors comprising sets with great circles with intersections that plunge out of the proposed slope, as indicated on Figures 4L and 4M. Localized wedge intersections are kinematically admissible, however, and we cannot rule out the possibility that such wedges may be encountered and require rock dowels for long-term stabilization.

4. *Toppling Failures* – Although flexural toppling is unlikely given the high intact rock strength and low distribution of poles falling in the critical zone, we assess that there is a moderate probability of direct and oblique block toppling along the proposed slope orientations, as depicted in Figure 4J. Notably, such toppling failure blocks may consist of blocks of varying size and, given ice action and the brittle nature of the rock, routine small to medium size rock blocks may become a maintenance concern for the catchment features. Detailed slope scaling is required to mitigate the hazards from toppling blocks. Spot rock dowels are also required to secure larger toppling blocks to the slope. We cannot rule out the possible need for localized underblock support in the form of “dental shotcrete”, dependent on the exposed cantilever arm length.

Based on the results of our iterative kinematic analyses, we conclude that the preliminary 8V:1H slope face angle is excessively steep and we recommend a rock cut slope angle of 3V:1H (approx. 71 deg. from horizontal). This proposed slope angle is based on reducing the chances that planar sliding joint sets steeper than 70 to 71 deg. will daylight from the slope. The proposed slope angle also reduces the chances for high-angle toppling failures. Based on our assessment at the “pinch point” of the lot line and zoning setback, angles shallower that 3V:1H may extend beyond the shown 15-foot setback line. Based on our estimate, it appears that there would be approximately 6 to 8 feet between the setback line corner and the crest of the proposed 3V:1H rock slope at the pinch point (25-foot cut height shown).

We also note based on our experience that drill holes steeper than about 4V:1H on slopes greater than 15- to 20-feet in height are frequently subject to drillhole wander during execution of blast hole drilling. This can result in a vertical or even partially overhanging final slope, which would require very tight perimeter control tolerances (e.g., line drilling or closely spaced presplit holes) to mitigate.

2.7 Rockfall & Icefall Hazards

The current catchment ditch width based on the Grading Plan (Ref. 1) is shown as 10 feet wide. Based on the Oregon Dept. of Transportation (ODOT)/FHWA study titled: *Rockfall Catchment Area Design Guide* (Ref. 11), a 15-foot-wide catchment ditch (assuming 6H:1V foreslope batter) is ideal for the proposed 3V:1H cut slope, as shown in the graphical aids included as Attachment No. 5. We understand that there are lot line and zoning restrictions at the top of the cut, as previously established above. Alternatively, a 12-foot-wide ditch with a 4H:1V foreslope batter would also work; however, this could add an additional 2- to 3-feet of rock excavation depth at the base of the slope. The catchment feature should be fitted with a guiderail or "rock rail" (Thrie-beam guiderail with a double beam behind as used by New York State) or similar to help capture rockfall and to help keep unauthorized persons from entry within the ditch. This approach assumes adequate scaling and rock reinforcement needs are addressed during construction

Long-term weathering from water and ice action may result in localized erosion, raveling and degradation of the slope and overlying backslope soils. Exposure of the rock mass to physical and chemical weathering and slope destressing necessitates periodic scaling of the completed rock slopes and monitoring of the rock reinforcement installed during construction.

Due to expected surface water runoff and episodic fracture-controlled hydraulic conductivity, localized ice buildup on the new slopes is likely. Ice build-up can induce ice jacking forces on the rock, which can in turn increase the chances of rockfall. During the spring thaw, icefalls can also occur when the temporary adfreeze bond strength of ice slabs melts back and is diminished. As such, it is prudent to drain (or direct) surface runoff away from the crests of the cut slopes. Additionally, drainage at the slope toe will be required and is typically handled as part of the catchment ditch hydraulic/grading requirements.

3. Recommendations

Based on our site observations, review of Hager-Richter's Report and the results of our technical evaluations noted above, we provide the following recommendations relative to the design and construction of proposed Rock Cut Slope A:

1. Slope Angle and Orientation: Slope angle should be cut at 3V:1H (approx. 71 deg. from horizontal). We have provided recommended approximate slope orientations as shown in Sec. 2.6 above. The number of individual cut slope segments should be reduced to the fullest extent practical. Proposed reverse curvature with cuts should also be minimized, including cuts resulting in "convex" slope profiles.

2. Rock Reinforcement Elements: Passive (untensioned) rock dowels are intended to increase the shear resistance along potential sliding planes and are recommended as

outlined below. Post-tensioned rock anchors for slope stabilization are not anticipated for this project.

<u>*Spot Rock Dowels:*</u> Should be installed at locations determined by Scarptec during project construction. We recommend that the Project Owner carry 800 linear feet of 1-1/4-in. (#10) nom. dia. Grade 75 hot-dip galvanized, continuous threadbar by Williams Form Engineering, Dywidag® Systems International of equivalent. Dowel lengths will be determined by Scarptec in the field based on post-scaled slope conditions; however, we anticipate min. length of 10 ft. and max. length of 20 ft. Dowels shall be tremie grouted in-place using neat cement grout. Appropriate specification language and details will be included in Field Engineering Design Drawing sheets submitted upon completion of excavation and slope scaling. We can provide contact info for rock bolt installation contractors upon request (frequently same company as the one completing the scaling work). Depending on the blaster's means and methods and experience with rock reinforcement construction, rock dowels may also be installed during "top-down" excavation of individual lifts; however, the blaster will need to demonstrate (via submittal) in their Work Plan that blasting of subsequent lifts will not result in damaged rock dowels.

<u>*Pattern (Grid) Rock Dowels:*</u> Because the slope orientation varies along its length and joints are generally favorable at the proposed slope angle, pattern rock bolting is not anticipated for this project.

3. <u>Slope Drainage:</u> Given the presence of water in the Observation Well (OW) data provided by LGCI, we recommend that a small quantity of slope drains be included, with locations TBD based on post-excavation conditions. Assume min. 10 ft. long, max. 20 ft. long drain holes at 4H:1V upward batter. Include 200 linear ft. of drilled slope drains. Min. 3.5-in. dia. hole with lower (exposed) 5-ft. of hole sleeved with solid wall Sch. 40 PVC and extended 6 in. beyond final slope face. To mitigate potentially hazardous icefalls, scour/raveling/erosion of the slope and accelerated bedrock weathering, grade slope crest and backslope areas such that surface water drainage is directed away from the slope face, wherever possible.

4. <u>Rock Blasting & Excavation Considerations:</u> As noted above, the bedrock at the site is expected to be very hard and brittle. The blaster selected for the project will need to consider the use less (rather than more) explosives during presplit blast design to avoid excessive gas travel and backbreak that could create a shallower slope. Use of Perimeter Control Methods is recommended, and in particular, Precision Pre-splitting should be considered for final slope (neat) line development. This may include reducing the spacing of presplit holes and reducing the charge weights to avoid backbreak and excessive gas travel. Blasthole bore tracking and/or slope scanning should be implemented to minimize drillhole deviation and produce pre-split holes that do not deviate more than 6 inches out

of alignment over the full maximum vertical lift height. The blaster should be advised that localized silica-rich zones of bedrock may be encountered, and that drill bit selection should take into account the brittle, high strength and abrasive nature of the bedrock. The blasting contractor should also be made aware of the potential for encountering two different lithologies (i.e., rhyodacite and granodiorite). The mapped volcanic and igneous intrusive rocks may behave somewhat differently and require some adjustment of perimeter control blasting technique, especially where the lithology changes. The selected blasting contractor is ultimately responsible for the Blast Design and should submit a Blasting Plan for review of the project team. A blasting "test section" (i.e., test blast) should be included in the blaster's work requirements.

5. Special Note: As noted herein, there appears to be a mapped fault feature located within the limits of the overall project site. This feature, if exposed within the limits of the proposed cut during construction, may require additional drainage or slope stabilization elements. Once the slope is excavated, we will observe slope conditions to assess potential impacts to rock mass integrity from historic or otherwise relic faulting.

6. Overburden Soils: Strip soils back min. 8 ft. from final slope crest. Slope back overburden soils to max. 2H:1V with revegetated slope face and use of geosynthetic matting, if required to maintain the slope and resist erosion.

7. Vegetation and Tree Removal: To preclude long term root-jacking forces, cut trees and vegetation within 15 ft. of the proposed slope crest.

8. Slope Scaling: Based upon the localized relatively low RQD values observed in borings at the top 5 to 10 ft. of the slope, we recommend that the slope be thoroughly scaled during and after development/excavation, as needed based on exposed field conditions and real-time construction safety considerations. We can provide contact info for experienced slope high scalers upon request. Detailed scaling will mitigate long-term rockfall hazards posed by raveling and erosion of rock slope surfaces subjected to weathering and ice jacking forces. Use of onsite construction equipment such as back hoes, excavators or similar, to "scrape" down the final slope face is not recommended. (Note: We noticed some loose rock in the lower (existing) parking area and recommend that the slope be scaled if it is not excavated for the new school project)

9. Long-Term Slope Monitoring & Maintenance (M&M): Like all natural earth materials, slopes are subject to long-term deterioration from physical/mechanical and chemical weathering. Periodic slope maintenance, including additional scaling (and possibly even supplemental rock reinforcement elements) will be required based on geotechnical monitoring visits and reporting. Scarptec will submit a brief (2 to 3 page) M&M recommendations letter upon completion of the slope construction work, which can be

referenced by the Owner for consideration of long-term slope observations and periodic maintenance.

10. <u>Ditch Geometry:</u> We recommend a min. 12-foot-wide ditch with a 4H:1V foreslope batter. The catchment ditch should be fitted with a guiderail or "rock rail" (Thrie-beam guiderail with a double beam behind as used by New York State) or similar to help capture rockfall and to help keep unauthorized persons from entry within the ditch. The ditch should be backfilled with a min. of 18-inches of ¾-inch crushed stone. Rockfall catchment ditches at the toe of the slope also need to direct water away from excavation areas and should be evaluated by the site/civil engineer with respect to site drainage design and hydraulic considerations. Note that there are alternative ways to achieve the recommended ditch geometry, including use of an embedded barrier or wall type feature at/near the edge of pavement. We recommend that you reach out to us to discuss the range of possible alternatives as the site grading and drainage details become finalized.

11. <u>Site Access Restrictions & Safety Protocols:</u> Owner should provide security fences and signage up top so that people are warned about fall hazards and excluded from the slope crest area. Additionally, a fence/barrier structure like a guiderail or "rock rail" (Figure 1I) should be installed and maintained along the outboard (roadway) side of the catchment ditch. Unauthorized persons should be excluded from entry within the catchment ditch and signage should be utilized to minimize entry. Vehicles should not be parked up against the slope or directly adjacent to the proposed catchment ditch.

12. <u>Field Engineering Support During Construction:</u> Scarptec will evaluate the slope for scaling and rock reinforcement needs after blasting and subsequent excavation of the slope face. Rock dowel locations will be determined after the slope is adequately scaled and cleaned of debris that could obscure potentially unstable rock blocks and their perimeter joint networks. We cannot rule out the possibility that additional localized rockfall mitigation measures will be required, including dental shotcrete or draped/anchored mesh.

Assumptions & Limitations

This Report is based on the following key assumptions and limitations:

1. LGCI has provided us with relevant photos, site excavation/topographic plans, boring logs, previous geotechnical reports and other relevant historical or geotechnical documents for our review and understanding of site issues.
2. We have made use of structural geologic data that has been corrected for magnetic north (-14 deg. west declination). Our kinematic slope stability evaluations and recommended slope orientations were determined relative to relative to the Massachusetts State Plane Coordinate System north arrow shown on the referenced site plan drawings. We have

assumed that LGCI will notify us in the event the project coordinate system changes or if construction documents will show rotated or alternative coordinate systems.

3. We have no control over the quality and means and methods of rock excavation, including use of any blasting techniques. The final integrity of the slope face and ultimate quantity of rock slope stabilization elements will be strongly correlated with rock excavation technique. Scarptec provides no guarantee or warranty with respect to final as-constructed slope or rock mass conditions, or proposed slope stabilization quantities provided in this Report.
4. Scarptec did not assess potential rockfall hazards outside of the general limits of the Proposed Cut Slope A, including areas beyond inferred lot lines.
5. Our authorized Scope of Work (SOW) did not include design of shotcrete, anchored/draped mesh or rockfall barriers, if required. Our SOW provides for field determined design drawings and for field engineering during scaling and installation of rock dowels only, both during the construction phase. Design and Field Engineering services for additional rock slope stabilization and/or rockfall mitigation elements (if required based on actual slope conditions exposed) will require an agreement amendment.
6. A/O TV geophysical data was collected by others and was shared with us for our own internal technical assessments.
7. Our SOW did not provide for evaluation of bearing surfaces to receive structural concrete for the proposed new buildings. Likewise, blast and vibration monitoring were not included. Design of proposed cut and fill slopes in soils were also excluded from our Scope.
8. Scope of Work area includes the portion of the site along the north/west side of the proposed access roadway next to the new school building (Fig. 1A), where rock cuts are anticipated. Cuts outside this area were outside our SOW area and were excluded from our evaluations.
9. Development of bid quality contract documents (e.g., pre-bid drawings and specifications) were not included in our Scope.
10. No subconsultants, subcontractors or laboratory/materials testing were included with our Scope. Permitting, surveying, pavement design, storm/wastewater, foundation analyses and forensic/expert services were also excluded.

We appreciate the opportunity to submit this Report to LGCI and look forward to our further work with you on this project. Please contact the undersigned if you wish to discuss any aspect of this Report.

Sincerely,
SCARPTEC, INC.

David J. Scarpato, P.E. (MA)
President & Principal Rock Engineer

Peter C. Ingraham, P.E.
Senior Rock Engineer Consultant

Cc: (none) existing

Attachments:

1. Annotated Photographs (10 Sheets)
2. Table I - Field Mapping Data (1 sheet)
3. Table II - A/O TV Structural Geologic Data (1 Sheet)
4. Stereonets of Structural Data & Kinematic Evaluations (14 Sheets)
5. ODOT/FHWA Catchment Ditch Design Criteria Charts (2 Sheets)

C:\Users\Dave\Desktop\Scarptec\Projects & Leads\Billable Projects\22-05_LGCI_Wakefield Voc Tech HS_Rock Slope Design_MA\Deliverables\Final

References

1. Site Plan of proposed Northeast Metropolitan Regional Vocation High School, prepared by Drummey Rosane Anderson, Inc. (DRA) titled: *Grading Plan* (L401.1), dated 15 February 2022. Prelim. Limits of Proposed Rock Cut shown by RED line.

2. *Bedrock Geologic Maps of the Boston North, Boston South and Newton Quadrangles*, compiled by Clifford Kaye, published in 1980 by the U.S. Geological Survey (USGS).

3. Boring Logs for Prop. Northeast Metro Reg. Vocational Tech. H.S., prepared by LGCI, 33 sheets.

4. Boring Location Map titled: *Figure 3B –Test Pit and Boring Location Plan for Proposed Building*, prepared by LGCI, dated June 2022.

5. UCS Lab Test Data titled: *Bulk Density and Compressive Strength of Rock Core Specimens by ASTM D7012 Method C*, results for five test core samples, 12 pages.

6. Select Core Box Photos, prepared by LGCI, 5 pages.

7. Report titled: BOREHOLE GEOPHYSICAL LOGGING - DATA REPORT. BOREHOLES B-206 & B-208, NORTHEAST METRO TECH HIGH SCHOOL, WAKEFIELD, MASSACHUSETTS, produced by Hager-Richter Geoscience, Inc., dated June 2022, 13 pages.

8. Test Pit Logs for Prop. Northeast Metro Reg. Vocational Tech. H.S., produced by LGCI, 40 sheets.

9. Report titled: *Draft Geotechnical Report, Proposed Northeast Metropolitan Regional Vocational Technical High School, Wakefield, Massachusetts*, produced by LGCI, dated 23 June 2022, 232 pages.

10. Groundwater Monitoring Data Table titled: *Table 3 - Summary of LGCI Groundwater Measurements, Proposed Northeast Metro Regional Vocational Technical High School, Wakefield, Massachusetts*, undated, 1 sheet.

11. Pierson, L.A., et al. (2001), ODOT/FHWA Pooled Research Study Report titled: *Rockfall Catchment Area Design Guide, Final Report No. SPR-3(032)*, 92 pages. (Design Charts)

ATTACHMENT NO. 1

ANNOTATED PHOTOGRAPHS & FIGURES

25 JULY 2022

INT. PROJ. NO. 22-05

PROJECT: PROP. NORTHEAST METRO. REGIONAL VOCATIONAL TECHNICAL HIGH SCHOOL (NMRVHS)

CLIENT: LAHLAF GEOTECHNICAL CONSULTING, INC. (LGCI)

OWNER: NORTHEAST METROPOLITAN REGIONAL VOCATIONAL SCHOOL DISTRICT

NOTES:

1. Any measurements shown are approximate.
2. Figures not to scale unless indicated otherwise.
3. All photos taken by Scarptec, Inc. unless shown otherwise.

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FIG. 1A – SITE LOCUS MAP AND PROPOSED SLOPE LOCATION

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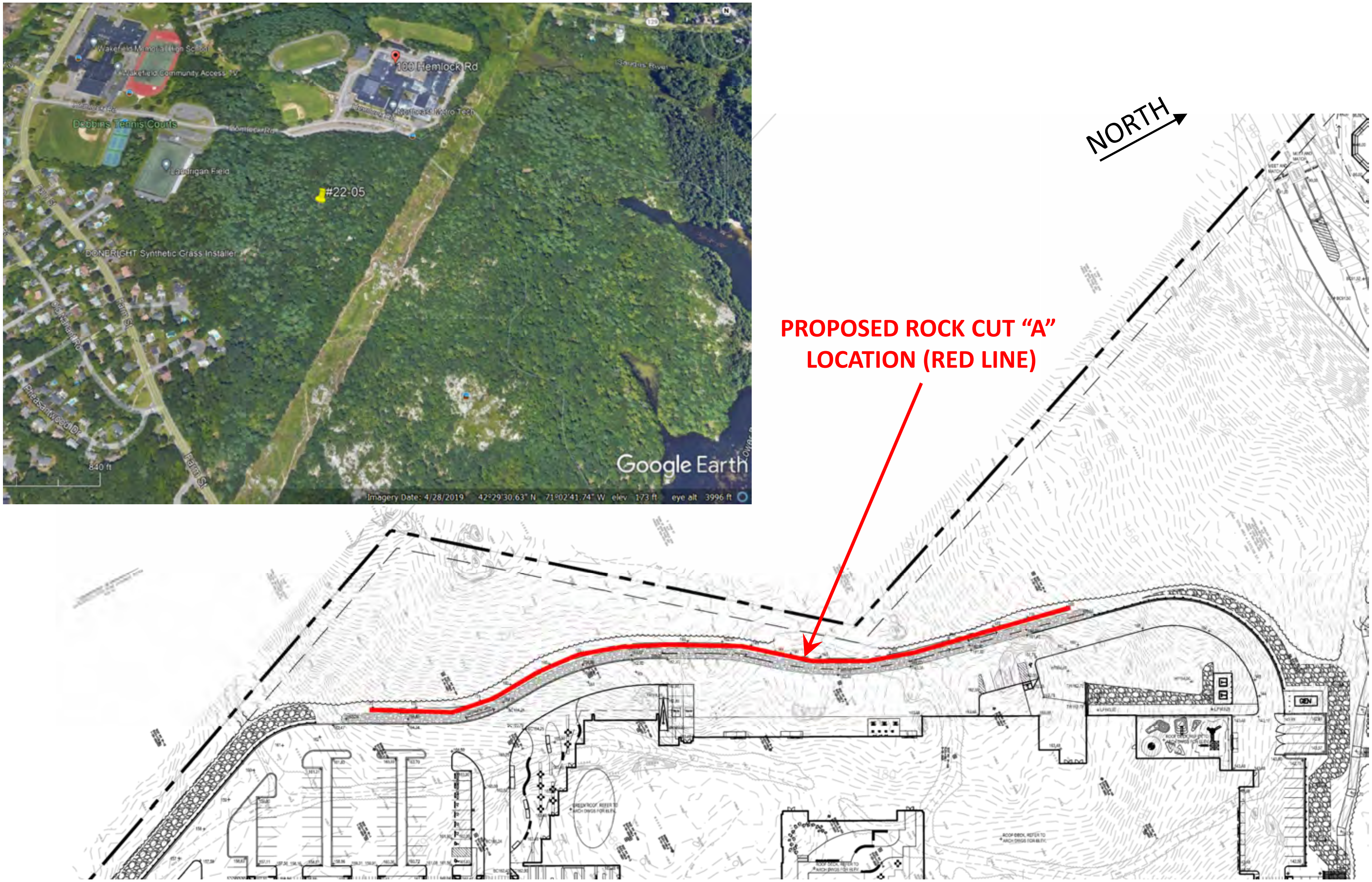

PROPOSED ROCK CUT "A" LOCATION (RED LINE)

NOTE: IMAGE ADAPTED FROM REF. 1 GRADING PLAN.

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25 JULY 2022

FIG. 1B – USGS BEDROCK GEOLOGIC MAP, BOSTON NORTH

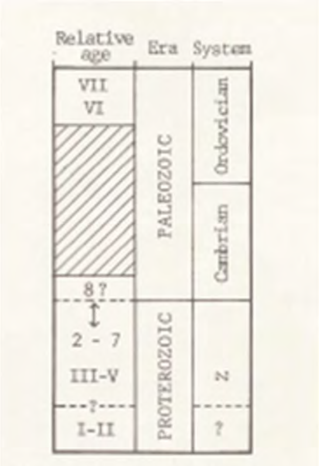
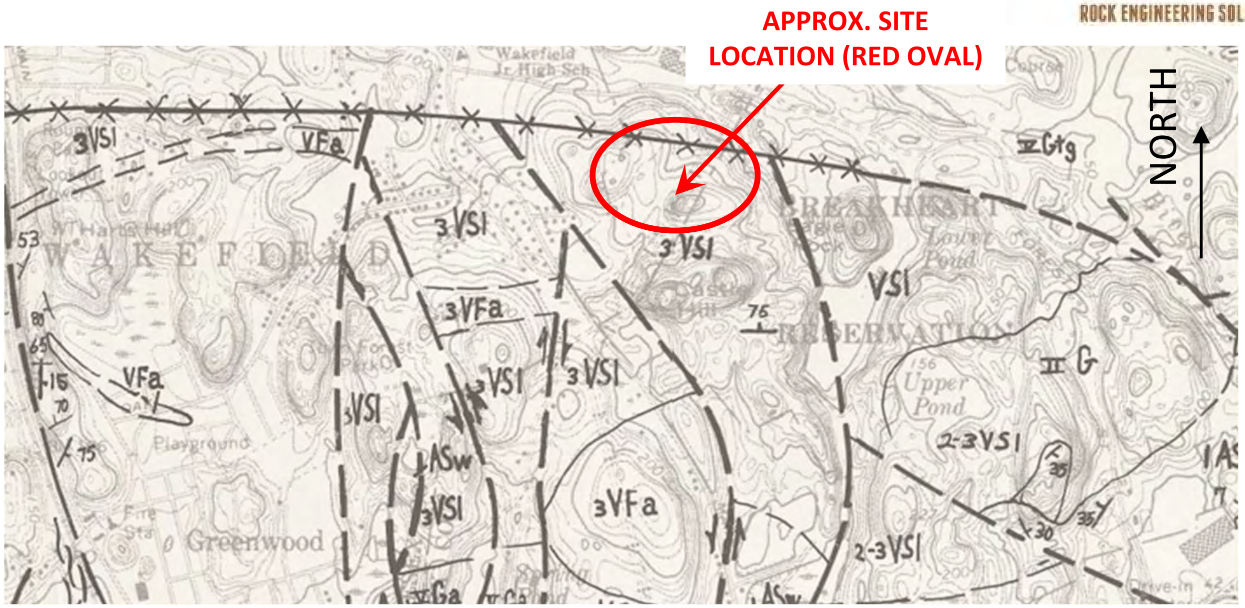


Figure 1.--Geologic ages.



APPROX. SITE LOCATION (RED OVAL)

VOLCANIC ROCKS (in part, hypabyssal feeder vents)

VS RHYOLITE AND RHYODACITE - Felsitic and porphyrofelsitic flows; welded-ash flows; vitric, lithic, and lapilli tuffs; flow breccias; breccia pipes; and extrusion domes. Textures are felsitic, porphyritic, trachytic, and pyroclastic. Generally microporphyritic in a slightly translucent groundmass. Rocks are black, red, white, cream, and shades of reddish- and greenish-gray. Generally massive but with fine flow-lamination in welded-ash flows. Stratification partings locally developed in ashy tuffs and in thin-layered flows

VSl North of Boston. Rhyolite and rhyodacite in about equal proportion. (Lynn Volcanic Complex - Clapp, 1921; LaForge, 1932)

BEDROCK GEOLOGIC MAPS OF THE BOSTON NORTH, BOSTON SOUTH, AND NEWTON QUADRANGLES, MASSACHUSETTS
By
Clifford A. Kaye
1980

2 1981

Gm Chilled contact facies of granodiorite-quartz monzonite (Gm). Fine-grained micrographic intergrowth of orthoclase and quartz with phenocrysts of zoned oligoclase. Toward margin of body micrographic mesh becomes increasingly fine-grained and more myrmekitic, and phenocrysts become smaller and sparser. (Lynn Volcanic Complex - LaForge, 1932)

Gtg Tonalite-granodiorite. Uniformly fine-grained; light- to dark-gray, pink in western part. Megascopically, femics in characteristically cuniform shapes. Microscopically, idiomorphic oligoclase in stubby zoned crystals, 25-55%; xenomorphic orthoclase or microcline, 0-15%; quartz in equigranular clusters, 30-60%; hornblende and biotite, about 15%. Feldspar largely to entirely altered to saussurite and fine sericite; quartz, badly strained; femics, largely to entirely altered to chlorite and epidote. Southern part of outcrop in Spot Pond area shows partial assimilation of older rocks. (Newburyport Quartz Diorite - Emerson, 1917; LaForge, 1932)

Gtg Chilled contact facies of tonalite-granodiorite (Gtg). Fine-grained, with pronounced micrographic texture; relict fragments of wall rock

≈≈≈≈≈≈ Fault zone—Wide zone of small displacements on many discontinuous fracture-surfaces

▲ ▲ ▲ ▲ ▲ ▲ ▲ Thrust-fault—Teeth on upper plate. Solid where known; dashed where approximately located

✕✕✕✕✕✕✕✕ Fault intruded by dike—Solid where known; dashed where approximately located

FIG. 1C – OUTCROP LOCATION OC-1

FIG. 1D – OUTCROP LOCATION OC-3

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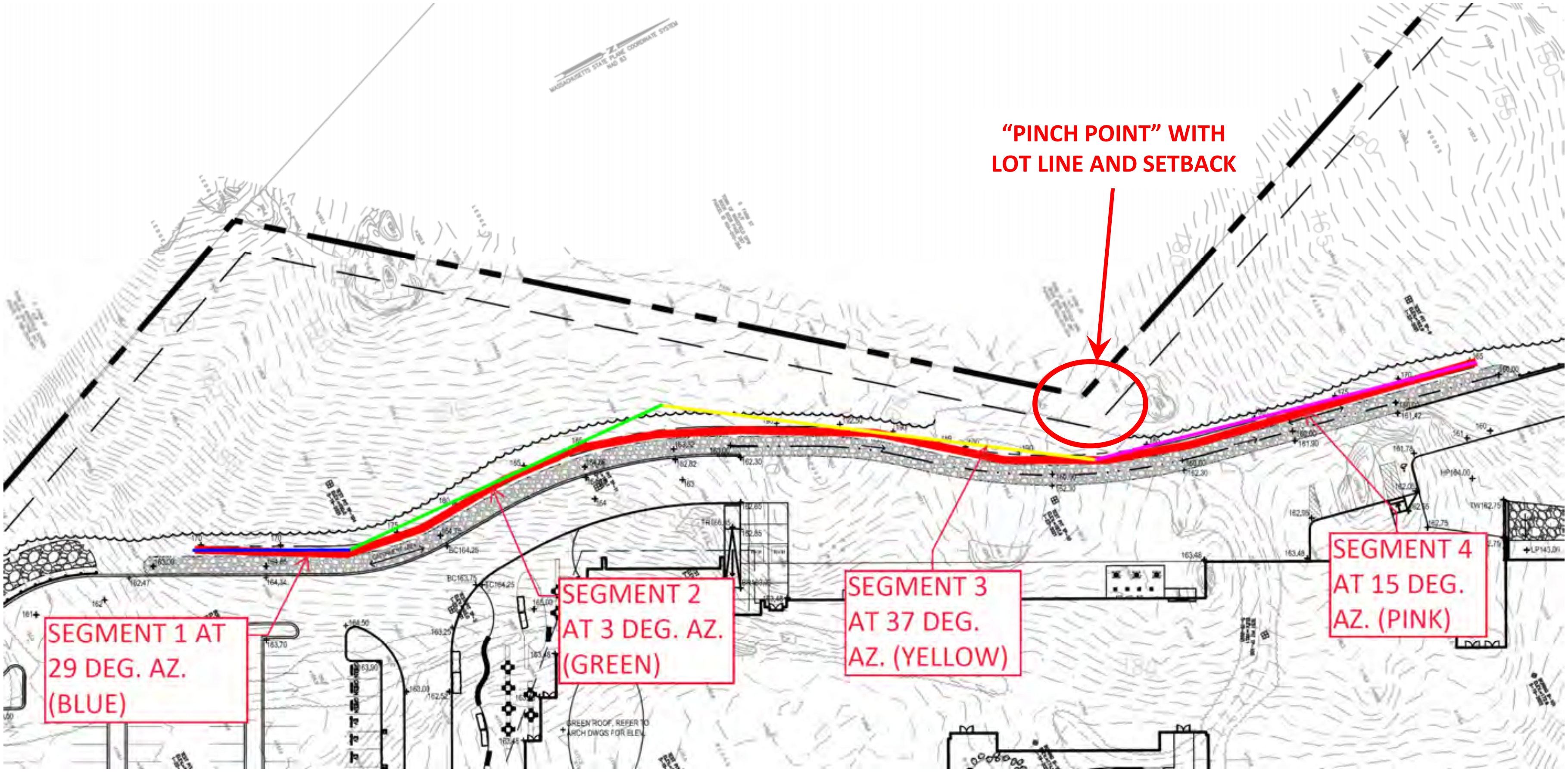
FIG. 1E – OUTCROP LOCATION OC-5 ALONG EXISTING PARKING AREA AT SCHOOL

FIG. 1F – OUTCROP LOCATION OC-5 ALONG EXISTING PARKING AREA AT SCHOOL

FIG. 1G – OUTCROP LOCATION OC-5 ALONG EXISTING PARKING AT SCHOOL. NOTE UPPER PORTION OF SLOPE IS BROKEN BACK

FIG. 1H – PROPOSED CUT SEGMENTS. SEGMENT ORIENTATIONS AND LENGTHS SHOWN ARE APPROXIMATE



NOTE: IMAGE ADAPTED FROM REF. 1 GRADING PLAN.

FIG. 1I – EXAMPLE ROCK RAIL FOR CATCHMENT DITCHES

NOTE: IMAGES ADAPTED COURTESY OF NEW YORK STATE THRUWAY AUTHORITY

ATTACHMENT NOS. 2 & 3

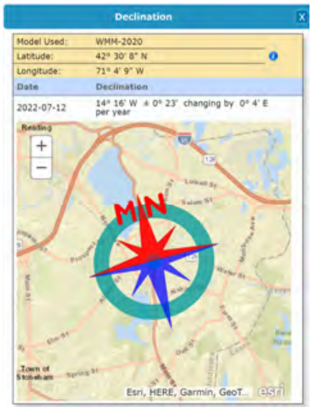
TABLES OF STRUCTURAL GEOLOGIC DATA

Int. Proj. No. 22-05
LGCI
Prop. NE Metro Regional Voc. Tech. High School
Rock Slope Stability Analyses
Discontinuity Field Mapping Data
TABLE I

	Staff	Date
Des. By:	DJS	7/12/2022
Chk. By:	PCI	7/13/2022

	PROPOSED SLOPE ORIENTATION (DEG.) [1]				
	Strike (Raw)	Strike (Corr.)	Dip Direc. (Raw)	Dip Direc. (Corr.)	Dip Angle
MIN	0	0	90	90	71
MAX	40	40	130	130	71

	No.	DISC. ORIENTATION (DEG.) [2]			Notes
		Dip Direction (Raw)	Dip Direction (Corr.)	Dip Angle	
OC-1	1	317	303	69	25 feet NW of B-101
	2	19	5	75	
	3	139	125	23	
	4	345	331	10	
	5	170	156	31	
	6	172	158	72	
	7	225	211	62	
OC-2	8	140	126	63	100 feet East of B208
	9	143	129	66	
	10	93	79	79	
OC-3	11	312	298	64	110 feet NW of B208
	12	32	18	70	
	13	270	256	87	
	14	259	245	54	
	15	175	161	41	
OC-4	16	213	199	71	Near B-1 Observation Well
	17	175	161	58	
OC-5	18	63	49	33	Parking Lot [3]
	19	35	21	78	
	20	356	342	89	
	21	233	219	80	
	22	24	10	56	
	23	102	88	87	
	24	110	96	85	
	25	234	220	85	
	26	160	146	20	
	27	297	283	78	
	28	235	221	88	
	29	1	347	15	
	30	347	333	54	
	31	210	196	74	
	32	168	154	89	
	33	225	211	88	
	34	25	11	17	
	35	358	344	64	



Model Used:	WMM-2020
Latitude:	42° 30' 8" N
Longitude:	71° 4' 9" W
Date	Declination
2022-07-12	14° 16' W ± 0° 23' changing by 0° 4' E per year

NOTES:

1. Slope orientation estimated from proposed site plan titled: Grading Plan", prepared by DRA and Warner Lawson, dated 15 February 2022. Plan dimensions based on Mass. State Plane Coordinate System.
2. Magnetic declination per NOAA/NCEI is approx. -14 deg. west declination
3. At OC-5, one half cast was observed at approx. 86 degree inclination, with backbrake at approx. 50-60 degrees apparent.

Int. Proj. No. 22-05
LGCI
Prop. NE Metro Regional Voc. Tech. High School
Rock Slope Stability Analyses
Discontinuity A/O TV Data (External Source)
TABLE II

	Staff	Date
Des. By:	DJS	7/12/2022
Chk. By:	PCI	7/13/2022

B-206

No.	Depth (ft.)	DISC. ORIENTATION (DEG.)<2>		Rank
		Dip Direction	Dip Angle	
1	2.3	96	37	Fracture Rank 1
2	2.5	256	77	Fracture Rank 2
3	2.9	328	78	Fracture Rank 1
4	3.0	352	21	Fracture Rank 4
5	3.2	209	50	Fracture Rank 1
6	3.6	225	26	Fracture Rank 1
7	3.8	231	60	Fracture Rank 1
8	3.9	245	69	Fracture Rank 4
9	3.9	250	79	Fracture Rank 2
10	4.4	250	62	Fracture Rank 1
11	5.2	7	51	Foliation / Vein
12	6.1	357	32	Fracture Rank 2
13	6.2	305	73	Foliation / Vein
14	6.6	335	40	Foliation / Vein
15	6.9	38	8	Fracture Rank 3
16	7.1	60	1	Fracture Rank 4
17	8.3	155	11	Fracture Rank 1
18	8.6	282	72	Foliation / Vein
19	9.2	345	6	Fracture Rank 1
20	9.6	332	15	Fracture Rank 2
21	10.5	338	50	Foliation / Vein
22	10.8	10	52	Foliation / Vein
23	11.0	46	52	Foliation / Vein
24	11.9	337	51	Foliation / Vein
25	14.7	338	10	Fracture Rank 2
26	14.9	67	43	Foliation / Vein
27	16.0	338	9	Fracture Rank 3
28	16.3	24	14	Fracture Rank 4
29	17.1	190	14	Fracture Rank 2
30	17.2	306	17	Fracture Rank 2
31	18.4	266	32	Fracture Rank 2
32	19.1	96	36	Foliation / Vein
33	19.7	356	17	Fracture Rank 1

B-208

No.	Depth (ft.)	DISC. ORIENTATION (DEG.)<2>		Rank
		Dip Direction	Dip Angle	
1	3.3	338	13	Fracture Rank 1
2	3.6	146	73	Fracture Rank 1
3	4.0	281	22	Fracture Rank 2
4	4.1	136	67	Fracture Rank 1
5	4.5	333	17	Fracture Rank 2
6	4.6	311	71	Fracture Rank 1
7	5.1	332	46	Foliation / Vein
8	7.1	341	56	Foliation / Vein
9	7.9	353	35	Foliation / Vein
10	8.2	152	73	Fracture Rank 1
11	9.0	102	59	Foliation / Vein
12	9.4	282	39	Foliation / Vein
13	9.7	260	46	Foliation / Vein
14	10.8	293	3	Fracture Rank 3
15	10.9	274	25	Fracture Rank 3
16	11.1	335	42	Foliation / Vein
17	11.6	271	34	Foliation / Vein
18	12.4	254	68	Fracture Rank 2
19	12.6	279	35	Fracture Rank 3
20	12.8	260	24	Foliation / Vein
21	13.8	203	80	Fracture Rank 2
22	13.9	0	41	Foliation / Vein
23	15.3	49	6	Fracture Rank 2
24	15.5	321	38	Foliation / Vein
25	15.6	3	15	Fracture Rank 2
26	16.1	8	9	Fracture Rank 4
27	16.4	331	36	Foliation / Vein
28	16.9	351	29	Fracture Rank 2
29	17.7	302	55	Foliation / Vein
30	19.4	343	45	Foliation / Vein
31	19.6	337	46	Foliation / Vein
32	19.9	334	42	Foliation / Vein
33	20.1	337	45	Foliation / Vein
34	20.5	69	43	Foliation / Vein
35	21.2	338	61	Foliation / Vein
36	21.8	359	27	Fracture Rank 2
37	22.0	286	69	Fracture Rank 2
38	22.3	359	33	Foliation / Vein
39	23.1	61	16	Fracture Rank 2
40	23.6	335	46	Fracture Rank 1
41	23.7	114	41	Fracture Rank 2
42	23.9	3	27	Foliation / Vein
43	24.2	95	57	Foliation / Vein
44	24.5	83	60	Foliation / Vein
45	24.6	356	36	Fracture Rank 1
46	24.7	10	29	Fracture Rank 2
47	24.8	358	45	Fracture Rank 2
48	25.4	21	56	Foliation / Vein
49	25.7	98	16	Fracture Rank 2
50	25.8	338	11	Fracture Rank 1
51	26.0	188	59	Fracture Rank 1
52	26.0	11	11	Fracture Rank 1
53	26.8	325	4	Fracture Rank 1
54	26.9	358	4	Fracture Rank 4
55	27.0	347	6	Fracture Rank 2
56	27.1	7	19	Foliation / Vein
57	27.2	356	9	Fracture Rank 1
58	28.1	161	23	Fracture Rank 2
59	28.2	161	29	Fracture Rank 2
60	28.5	355	12	Fracture Rank 1
61	28.5	47	40	Foliation / Vein
62	28.9	28	55	Fracture Rank 2
63	29.1	35	29	Fracture Rank 1
64	29.1	87	66	Fracture Rank 1
65	29.2	67	11	Fracture Rank 4
66	29.2	354	61	Foliation / Vein
67	29.6	348	63	Foliation / Vein
68	29.8	340	72	Fracture Rank 1
69	29.9	34	4	Fracture Rank 2
70	29.9	339	71	Fracture Rank 1
71	29.9	69	21	Fracture Rank 4
72	30.4	348	33	Foliation / Vein
73	30.5	356	31	Foliation / Vein
74	31.6	352	20	Fracture Rank 2
75	32.2	357	47	Foliation / Vein
76	32.7	348	19	Fracture Rank 3
77	32.8	113	53	Fracture Rank 1
78	33.2	34	22	Fracture Rank 2
79	33.4	47	29	Fracture Rank 3
80	33.5	74	41	Fracture Rank 1
81	33.6	34	32	Foliation / Vein
82	33.9	349	36	Foliation / Vein
83	34.1	3	40	Foliation / Vein
84	34.4	355	40	Foliation / Vein
85	34.6	357	57	Foliation / Vein

NOTES:

1. Magnetic declination per NOAA/NCEI is approx. -14 deg. west declination
2. Magnetic declination of approx. -14 deg. west declination has been accounted for in Hager-Richter's data report.

ATTACHMENT NO. 4

STEREOGRAPHIC PROJECTIONS & KINEMATIC ANALYSES

25 JULY 2022

INT. PROJ. NO. 22-05

PROJECT: PROP. NORTHEAST METRO. REGIONAL VOCATIONAL TECHNICAL HIGH SCHOOL (NMRVHS)

CLIENT: LAHLAF GEOTECHNICAL CONSULTING, INC. (LGCI)

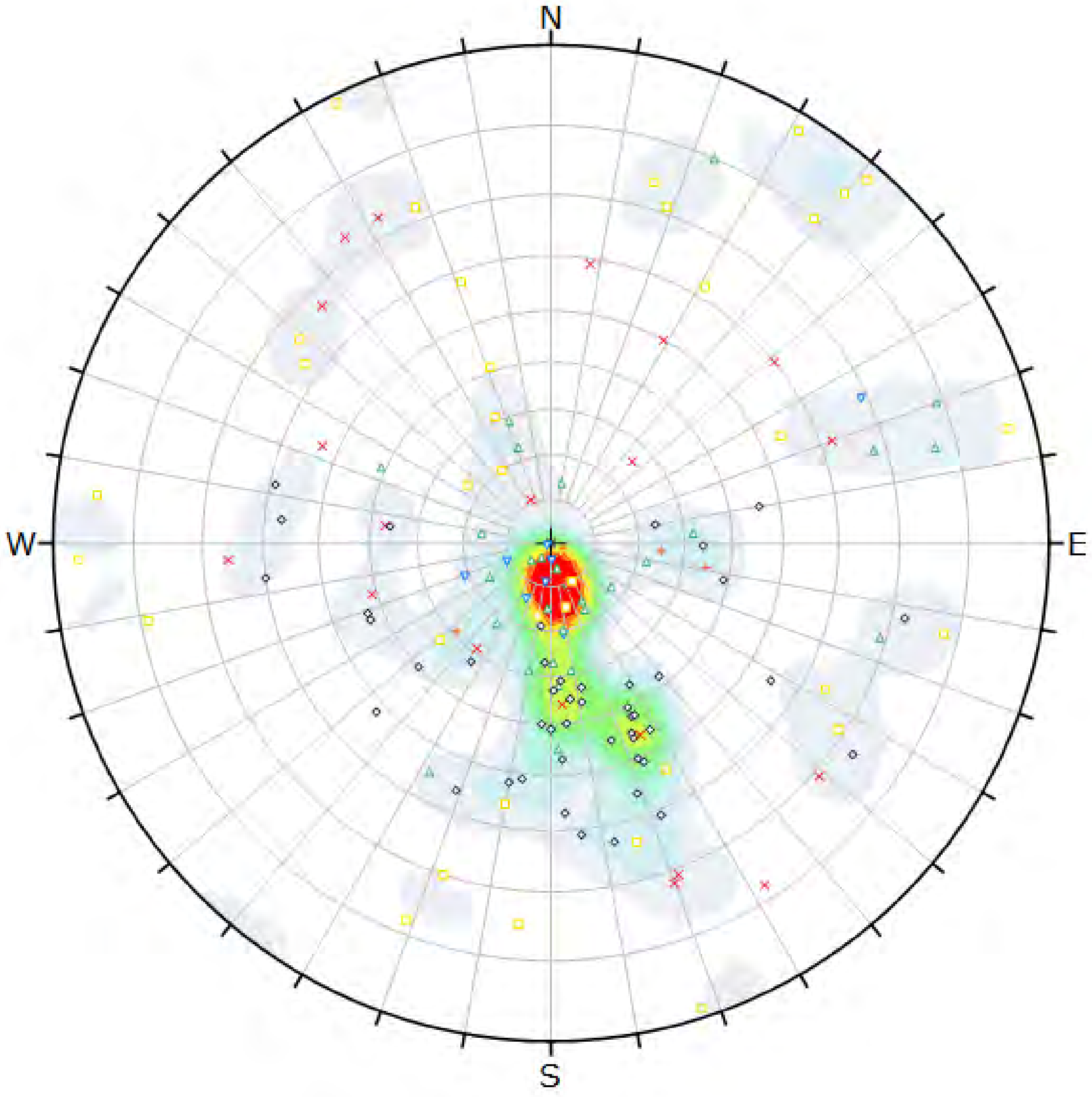
OWNER: NORTHEAST METROPOLITAN REGIONAL VOCATIONAL SCHOOL DISTRICT

NOTES:

1. Any measurements shown are approximate.

PROP. NMRVHS
INT. PROJ. NO. 22-05
LGCI
25 JULY 2022

FIG. 4A – STEREONET OUTPUT GRAPHICS: ALL DATA COMBINED (POLES)



Symbol	RANK	Quantity
◇	Foliation / Vein	46
×	Fracture Rank 1	28
△	Fracture Rank 2	29
+	Fracture Rank 3	7
▽	Fracture Rank 4	8
□	[no data]	35

Color	Density Concentrations
⬜	0.00 - 1.00
⬜	1.00 - 2.00
⬜	2.00 - 3.00
🟦	3.00 - 4.00
🟩	4.00 - 5.00
🟩	5.00 - 6.00
🟨	6.00 - 7.00
🟨	7.00 - 8.00
🟧	8.00 - 9.00
🟥	9.00 <

Contour Data	Pole Vectors
Maximum Density	12.63%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Plot Mode	Pole Vectors
Vector Count	153 (153 Entries)
Hemisphere	Lower
Projection	Equal Angle

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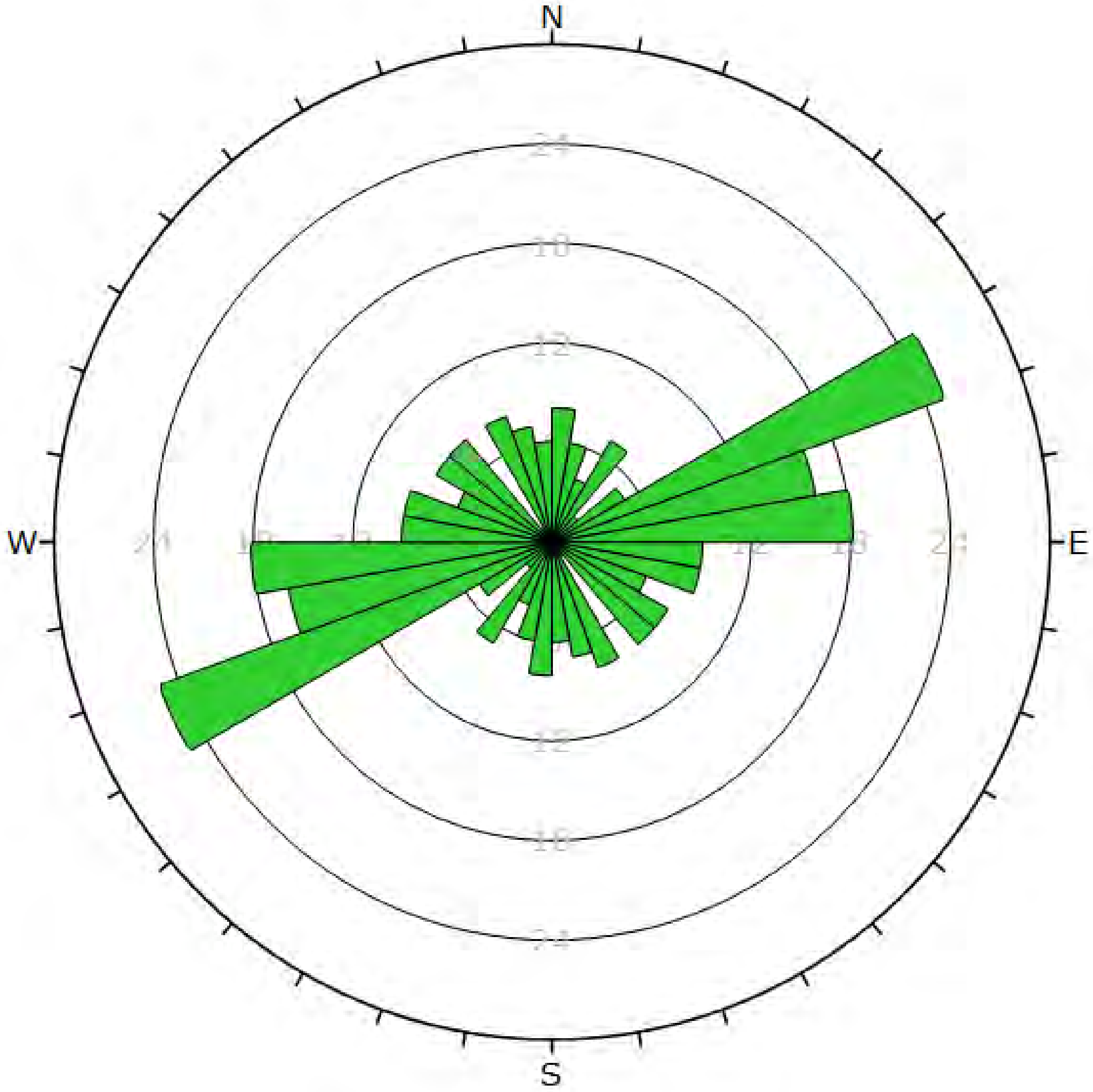
INT. PROJ. NO. 22-05
LGCI
25 JULY 2022

FIG. 4B – STEREONET OUTPUT GRAPHICS: ALL DATA COMBINED (STRIKE ROSETTE)

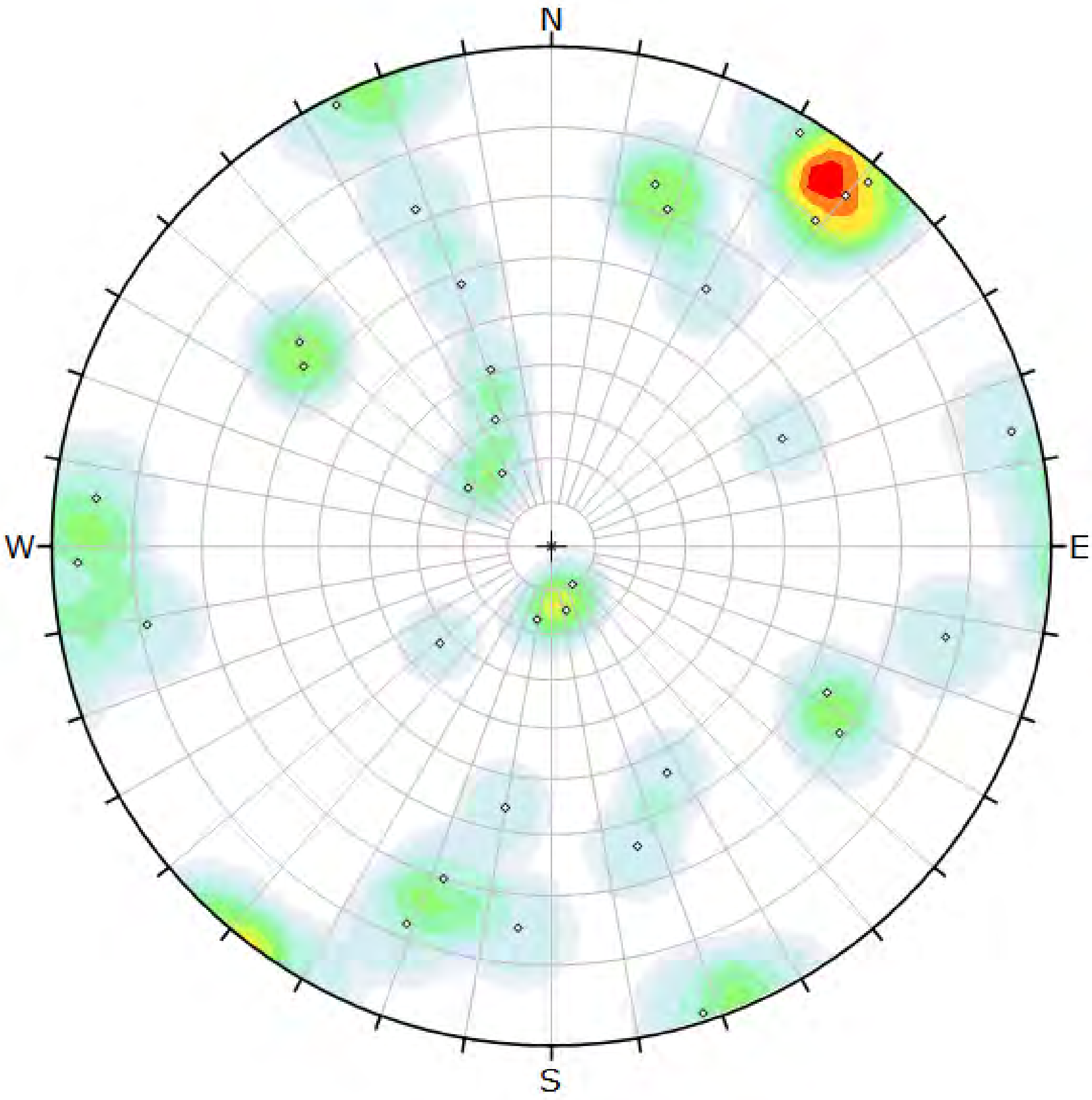


Plot Mode	Rosette
Plot Data	Apparent Strike
Face Normal Trend	0.0
Face Normal Plunge	90.0
Bin Size	10°
Outer Circle	30 planes per arc
Planes Plotted	153
Minimum Angle To Plot	0.0°
Maximum Angle To Plot	90.0°

PROP. NMRVHS
INT. PROJ. NO. 22-05
LGCI
25 JULY 2022

FIG. 4C – STEREONET OUTPUT GRAPHICS: FIELD SURFACE OUTCROP MAPPING DATA (POLES)

SCARP TEC INC.
ROCK ENGINEERING SOLUTIONS



Symbol	Feature
◇	Pole Vectors

Color	Density Concentrations
⬜	0.00 - 1.00
⬜	1.00 - 2.00
⬜	2.00 - 3.00
🟦	3.00 - 4.00
🟩	4.00 - 5.00
🟩	5.00 - 6.00
🟨	6.00 - 7.00
🟨	7.00 - 8.00
🟧	8.00 - 9.00
🟥	9.00 - 10.00

Contour Data	Pole Vectors
Maximum Density	9.65%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Plot Mode	Pole Vectors
Vector Count	35 (35 Entries)
Hemisphere	Lower
Projection	Equal Angle

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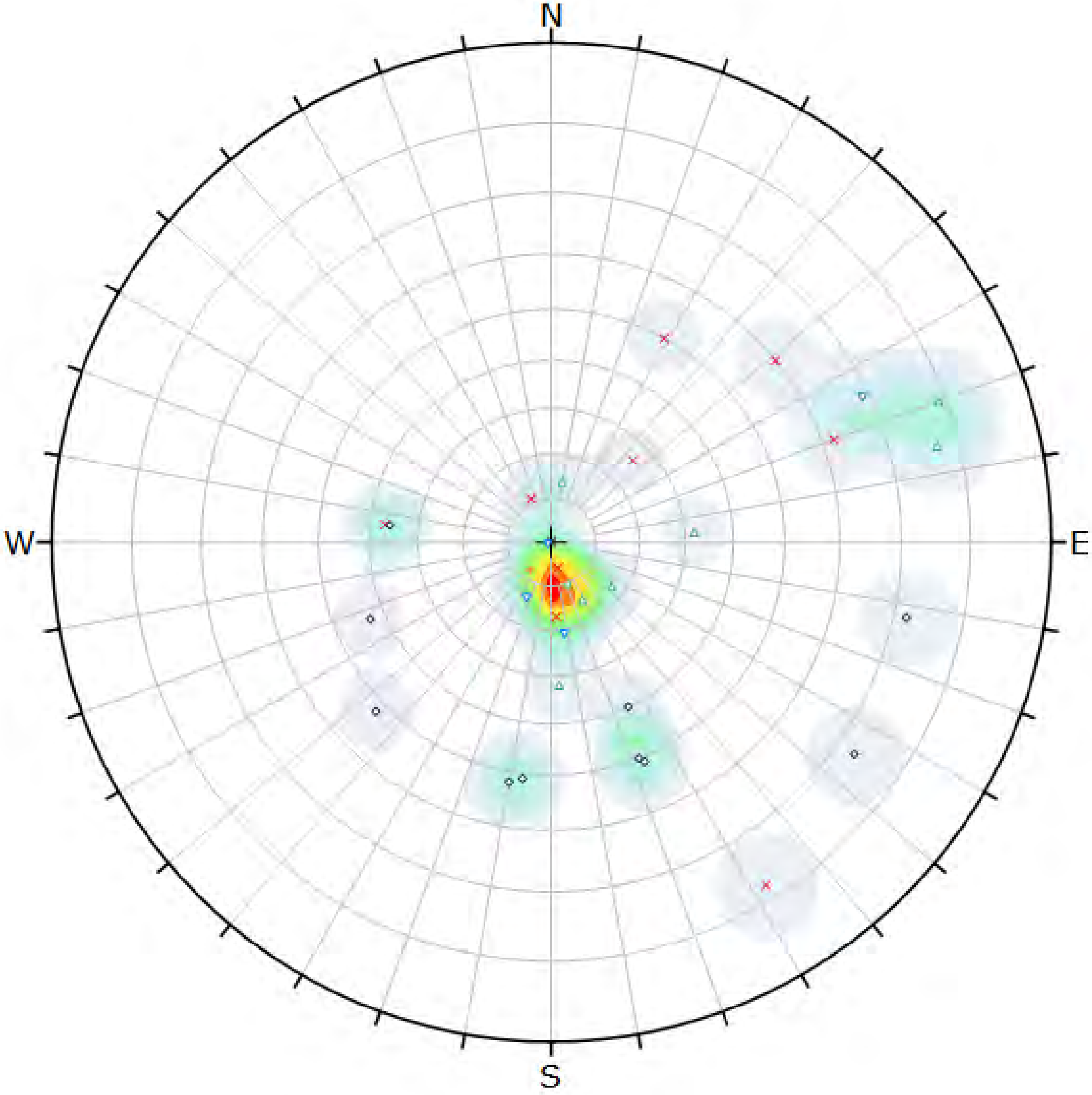
FIG. 4D – STEREONET OUTPUT GRAPHICS: DATA FROM TV LOG B-206, SYMBOLIC POLE PLOT



Symbol	RANK	Quantity
⋄	Foliation / Vein	10
×	Fracture Rank 1	9
△	Fracture Rank 2	8
+	Fracture Rank 3	2
▽	Fracture Rank 4	4

Color	Density Concentrations
⬜	0.00 - 1.80
⬜	1.80 - 3.60
🟦	3.60 - 5.40
🟦	5.40 - 7.20
🟩	7.20 - 9.00
🟩	9.00 - 10.80
🟩	10.80 - 12.60
🟨	12.60 - 14.40
🟧	14.40 - 16.20
🟥	16.20 - 18.00

Contour Data	Pole Vectors
Maximum Density	17.32%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Plot Mode	Pole Vectors
Vector Count	33 (33 Entries)
Hemisphere	Lower
Projection	Equal Angle

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FIG. 4E – STEREONET OUTPUT GRAPHICS: DATA FROM TV LOG B-208, SYMBOLIC POLE PLOT

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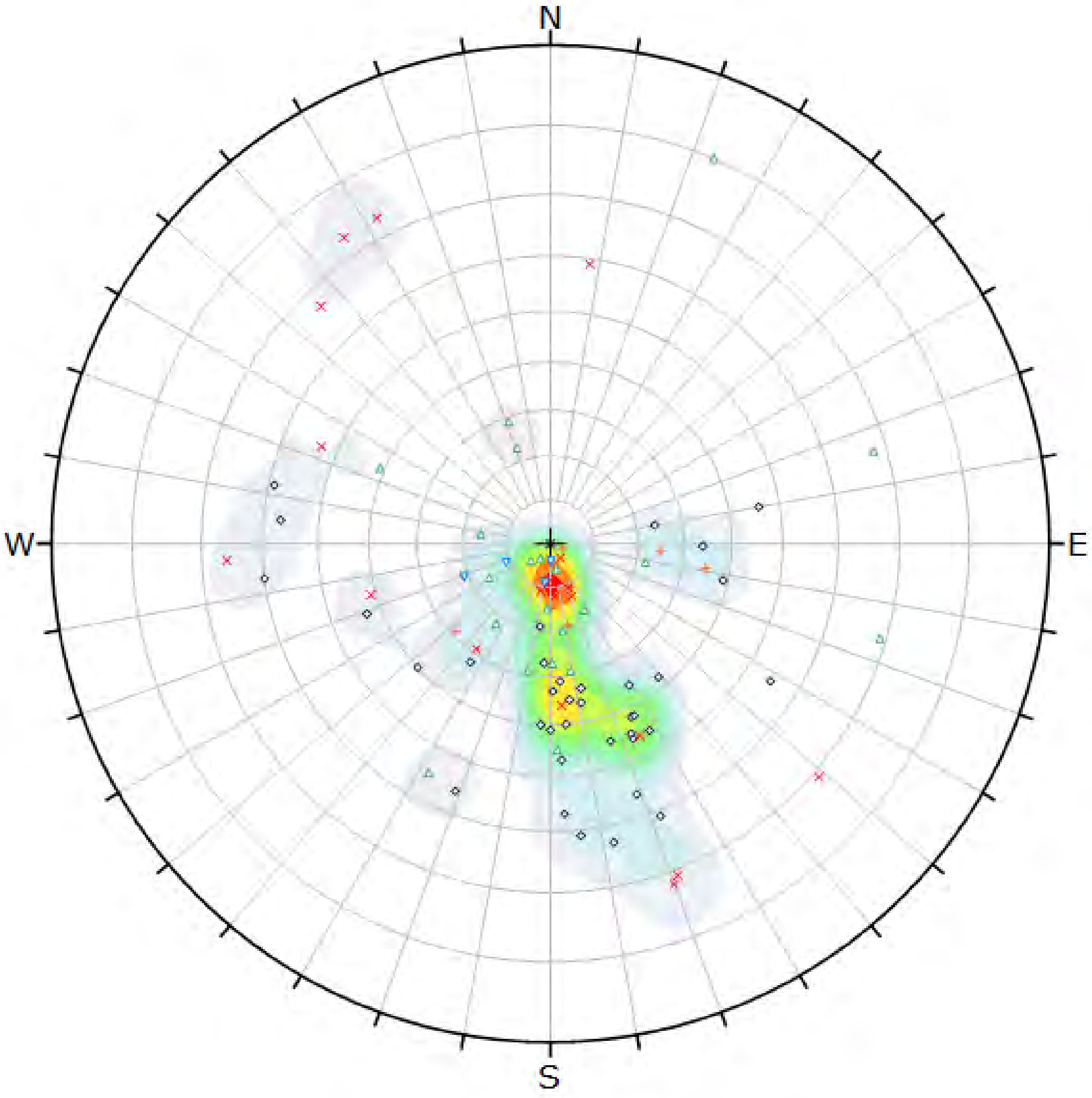

Symbol	RANK	Quantity
◇	Foliation / Vein	36
×	Fracture Rank 1	19
△	Fracture Rank 2	21
+	Fracture Rank 3	5
▽	Fracture Rank 4	4

Color	Density Concentrations
⬜	0.00 - 1.40
⬜	1.40 - 2.80
🟦	2.80 - 4.20
🟦	4.20 - 5.60
🟩	5.60 - 7.00
🟩	7.00 - 8.40
🟨	8.40 - 9.80
🟨	9.80 - 11.20
🟧	11.20 - 12.60
🟥	12.60 - 14.00

Contour Data	Pole Vectors
Maximum Density	13.57%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Plot Mode	Pole Vectors
Vector Count	85 (85 Entries)
Hemisphere	Lower
Projection	Equal Angle

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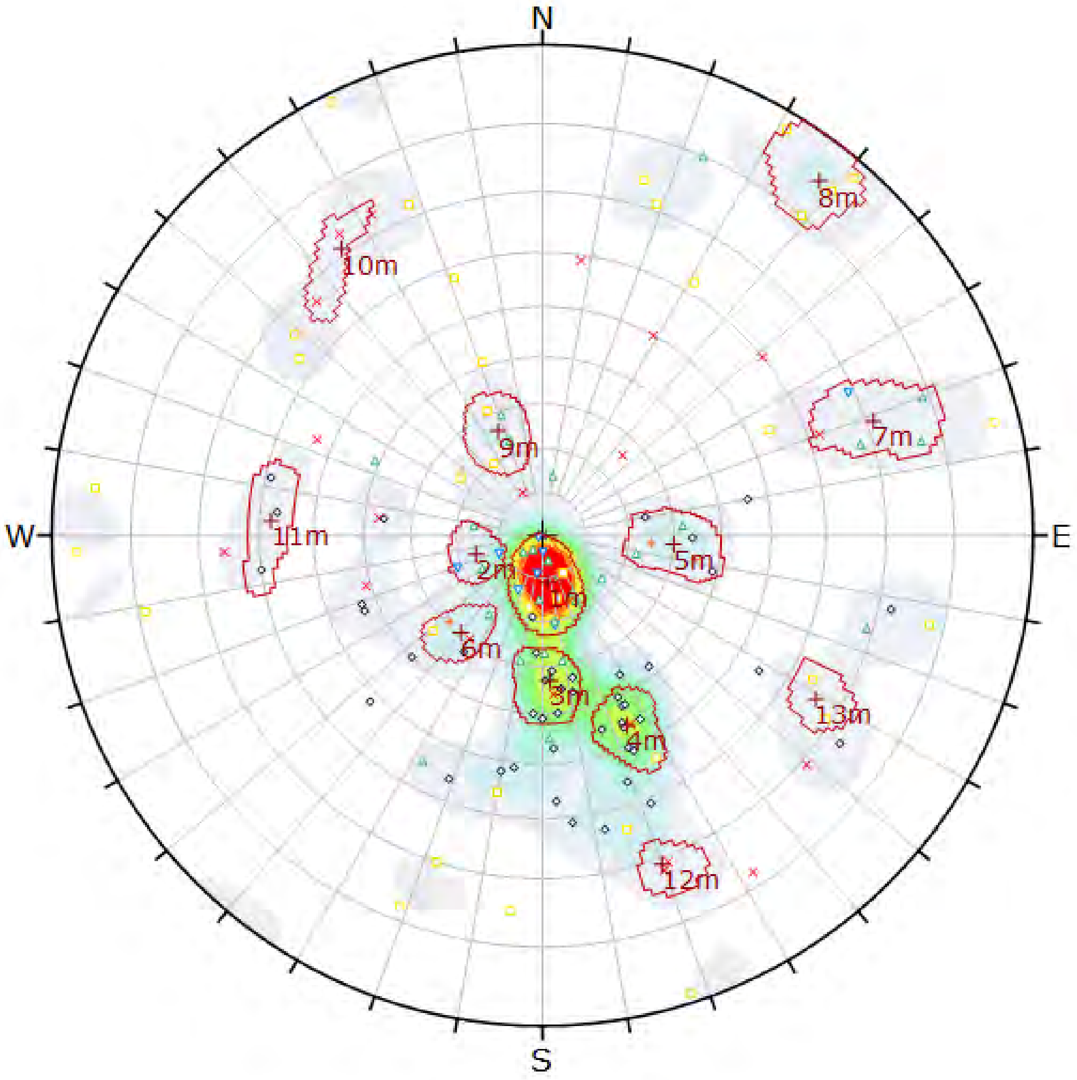
FIG. 4F – STEREONET OUTPUT GRAPHICS: POSSIBLE SETS, NO CIRCLES



Symbol	RANK	Quantity
◇	Foliation / Vein	46
×	Fracture Rank 1	28
△	Fracture Rank 2	29
+	Fracture Rank 3	7
▽	Fracture Rank 4	8
□	[no data]	35

Color	Density Concentrations
⬜	0.00 - 1.00
🟦	1.00 - 2.00
🟦	2.00 - 3.00
🟩	3.00 - 4.00
🟩	4.00 - 5.00
🟩	5.00 - 6.00
🟨	6.00 - 7.00
🟨	7.00 - 8.00
🟧	8.00 - 9.00
🟥	9.00 <

Contour Data	Pole Vectors
Maximum Density	12.63%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Plot Mode	Pole Vectors
Vector Count	153 (153 Entries)
Hemisphere	Lower
Projection	Equal Angle

PROP. NMRVHS
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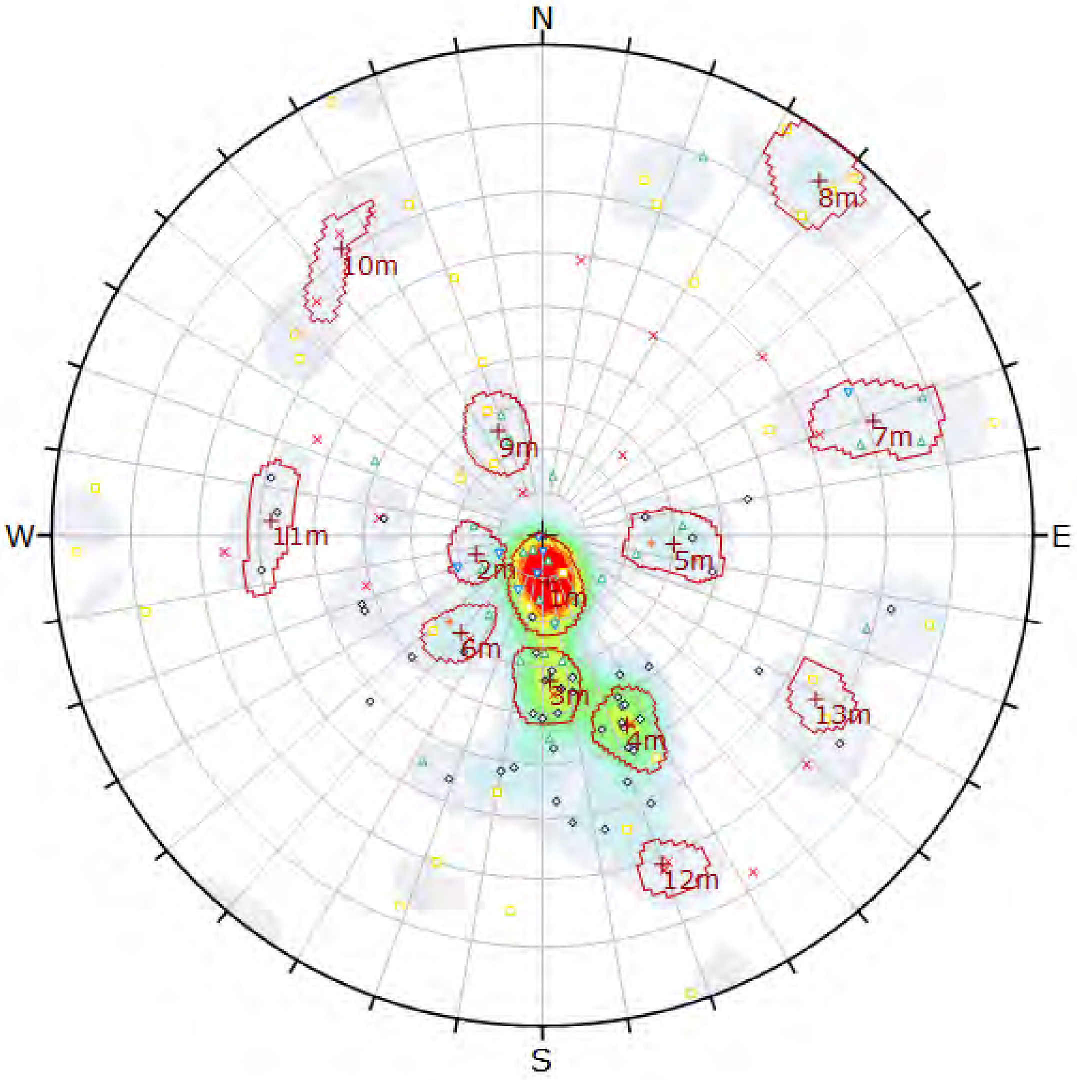
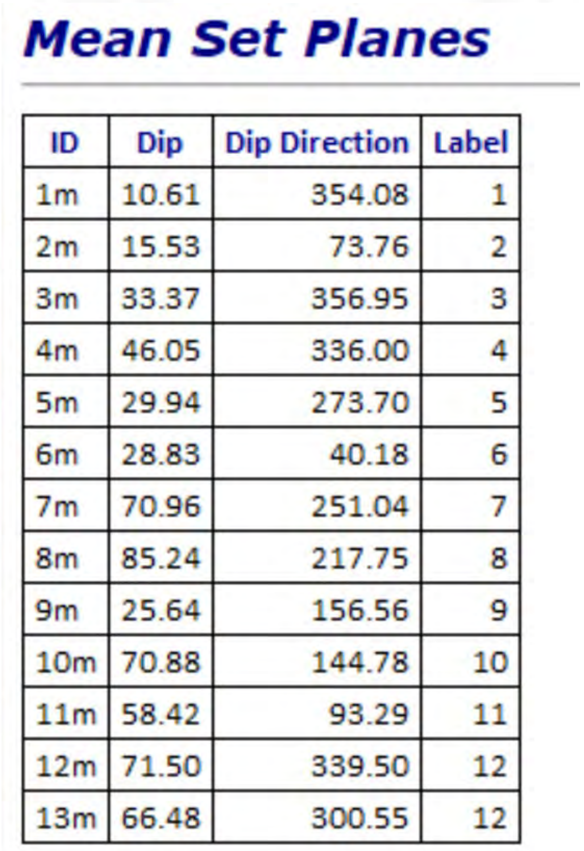
FIG. 4G – STEREONET OUTPUT GRAPHICS: POSSIBLE SETS, NO CIRCLES





Mean Set Planes

ID	Dip	Dip Direction	Label
1m	10.61	354.08	1
2m	15.53	73.76	2
3m	33.37	356.95	3
4m	46.05	336.00	4
5m	29.94	273.70	5
6m	28.83	40.18	6
7m	70.96	251.04	7
8m	85.24	217.75	8
9m	25.64	156.56	9
10m	70.88	144.78	10
11m	58.42	93.29	11
12m	71.50	339.50	12
13m	66.48	300.55	12

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FIG. 4H – STEREONET OUTPUT GRAPHICS: PLANAR SLIDING AT STRIKE 20 DEG. AZ.

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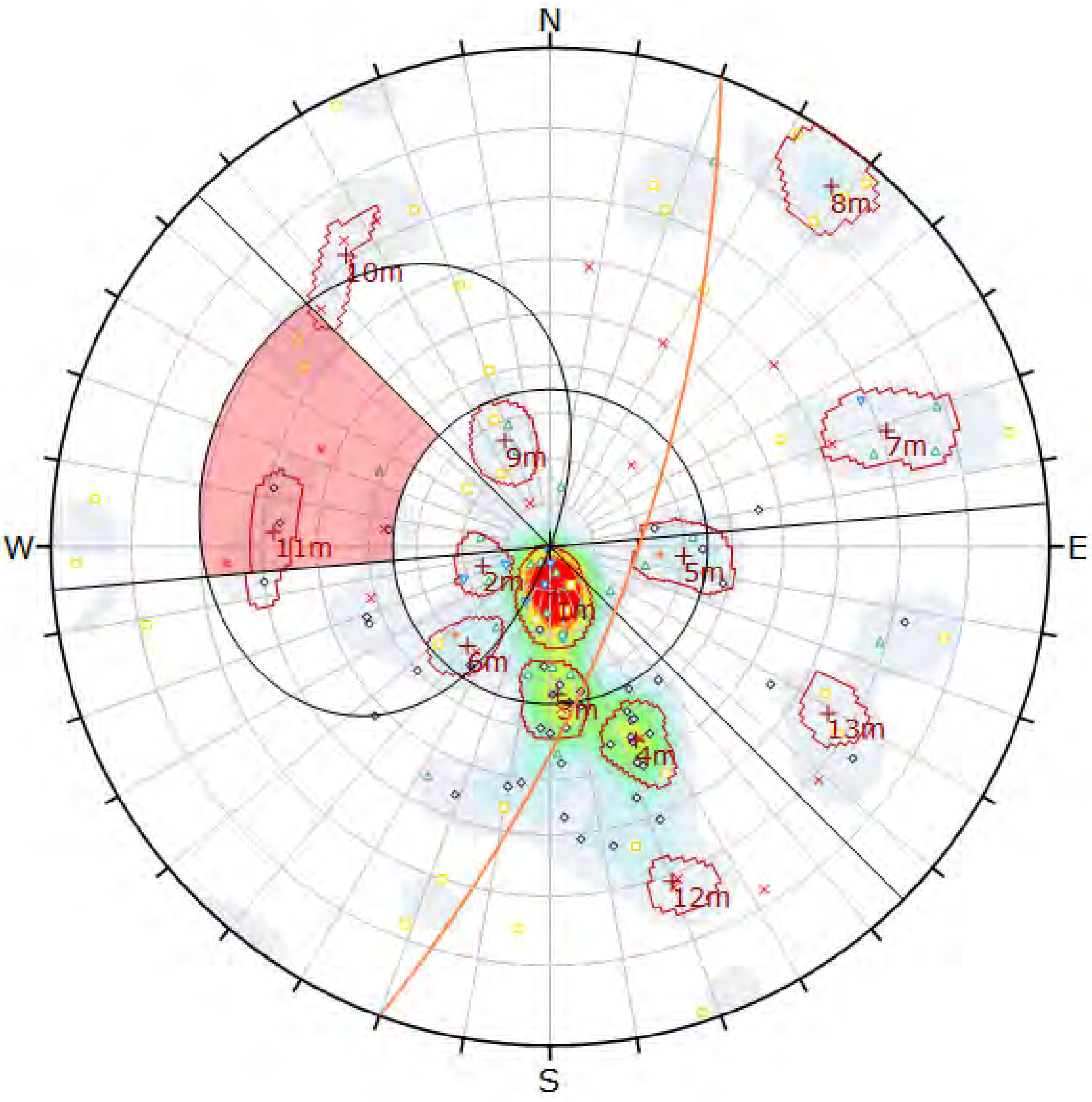


Symbol	RANK	Quantity
◇	Foliation / Vein	46
×	Fracture Rank 1	28
△	Fracture Rank 2	29
+	Fracture Rank 3	7
▽	Fracture Rank 4	8
□	[no data]	35

Color	Density Concentrations		
⬜	0.00		1.00
⬜	1.00		2.00
🟦	2.00		3.00
🟦	3.00		4.00
🟩	4.00		5.00
🟩	5.00		6.00
🟩	6.00		7.00
🟨	7.00		8.00
🟧	8.00	-	9.00
🟥	9.00	<	

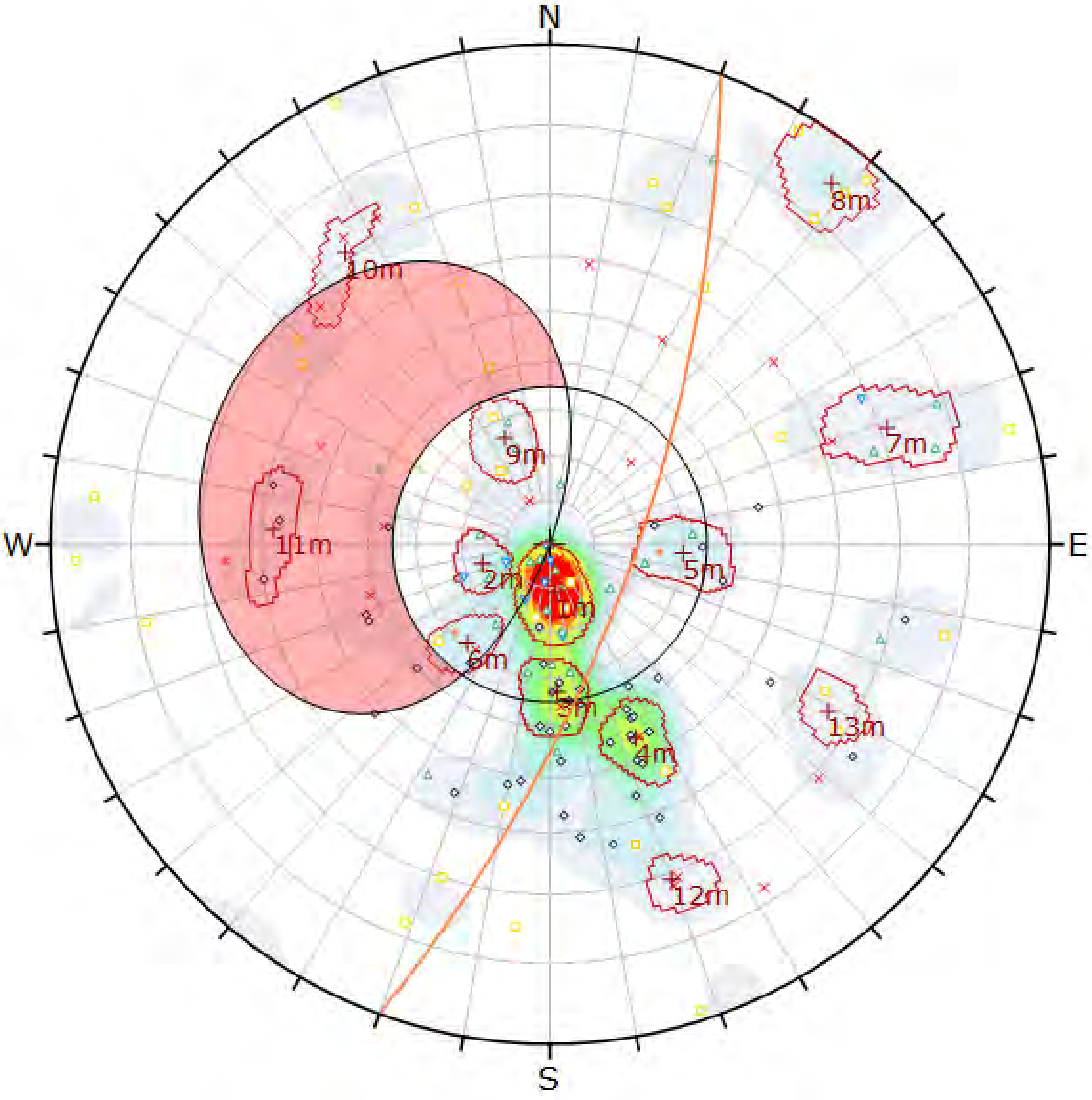
Contour Data	Pole Vectors
Maximum Density	12.63%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Planar Sliding
Slope Dip	71
Slope Dip Direction	110
Friction Angle	35°
Lateral Limits	25°

	Critical	**Total**	**%**
Planar Sliding (All)	9	153	5.88%
Planar Sliding (Set 11: 11)	2	3	66.67%

Plot Mode	Pole Vectors
Vector Count	153 (153 Entries)
Hemisphere	Lower
Projection	Equal Angle

FIG. 4I – STEREONET OUTPUT GRAPHICS: PLANAR SLIDING AT STRIKE 20 DEG. AZ. (NO LIMITS)



Symbol	RANK	Quantity
◇	Foliation / Vein	46
×	Fracture Rank 1	28
△	Fracture Rank 2	29
+	Fracture Rank 3	7
▽	Fracture Rank 4	8
□	[no data]	35

Color	Density Concentrations
⬜	0.00 - 1.00
⬜	1.00 - 2.00
🟦	2.00 - 3.00
🟦	3.00 - 4.00
🟩	4.00 - 5.00
🟩	5.00 - 6.00
🟩	6.00 - 7.00
🟨	7.00 - 8.00
🟧	8.00 - 9.00
🟥	9.00 <

Contour Data	Pole Vectors
Maximum Density	12.63%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Planar Sliding
Slope Dip	71
Slope Dip Direction	110
Friction Angle	35°

	Critical	Total	%
Planar Sliding (All)	17	153	11.11%
Planar Sliding (Set 10: 10)	1	3	33.33%
Planar Sliding (Set 11: 11)	3	3	100.00%

Plot Mode	Pole Vectors
Vector Count	153 (153 Entries)
Hemisphere	Lower
Projection	Equal Angle

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FIG. 4J – STEREONET OUTPUT GRAPHICS: DIRECT/OBLIQUE TOPPLING AT CUT STRIKE AZIMUTH 20 DEG.

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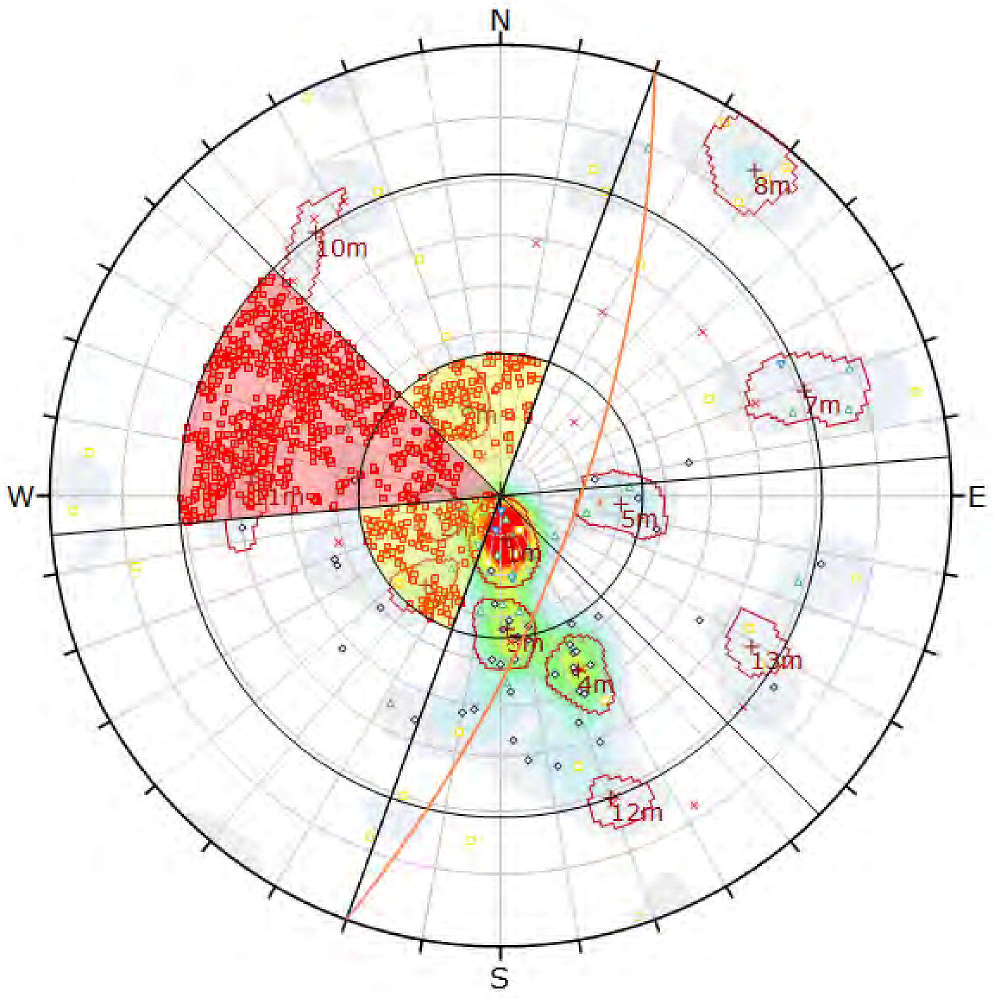

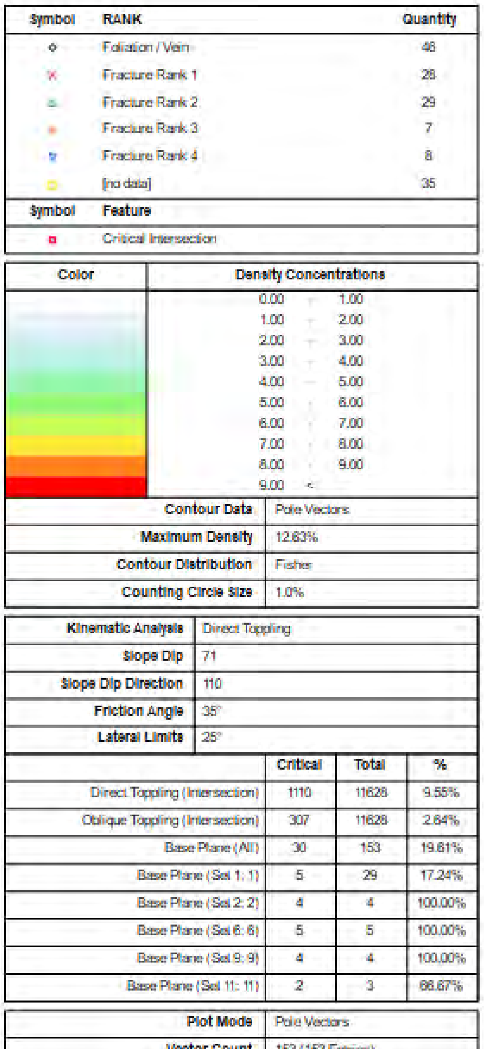

Symbol	RANK	Quantity
◇	Foliation / Vein	46
×	Fracture Rank 1	28
△	Fracture Rank 2	29
●	Fracture Rank 3	7
▽	Fracture Rank 4	8
□	[no data]	35
Symbol	**Feature**	
□	Critical Intersection	

Color	Density Concentrations
	0.00 - 1.00
	1.00 - 2.00
	2.00 - 3.00
	3.00 - 4.00
	4.00 - 5.00
🟩	5.00 - 6.00
	6.00 - 7.00
🟨	7.00 - 8.00
🟧	8.00 - 9.00
🟥	9.00 <

Contour Data	Pole Vectors
Maximum Density	12.63%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Direct Toppling
Slope Dip	71
Slope Dip Direction	110
Friction Angle	35°
Lateral Limits	25°

	Critical	Total	%
Direct Toppling (Intersection)	1110	11628	9.55%
Oblique Toppling (Intersection)	307	11628	2.64%
Base Plane (All)	30	153	19.61%
Base Plane (Set 1: 1)	5	29	17.24%
Base Plane (Set 2: 2)	4	4	100.00%
Base Plane (Set 6: 6)	5	5	100.00%
Base Plane (Set 9: 9)	4	4	100.00%
Base Plane (Set 11: 11)	2	3	66.67%

Plot Mode	Pole Vectors
Vector Count	153 (153 Entries)

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FIG. 4K – STEREONET OUTPUT GRAPHICS: FLEXURAL TOPPLING AT CUT STRIKE AZIMUTH 20 DEG.

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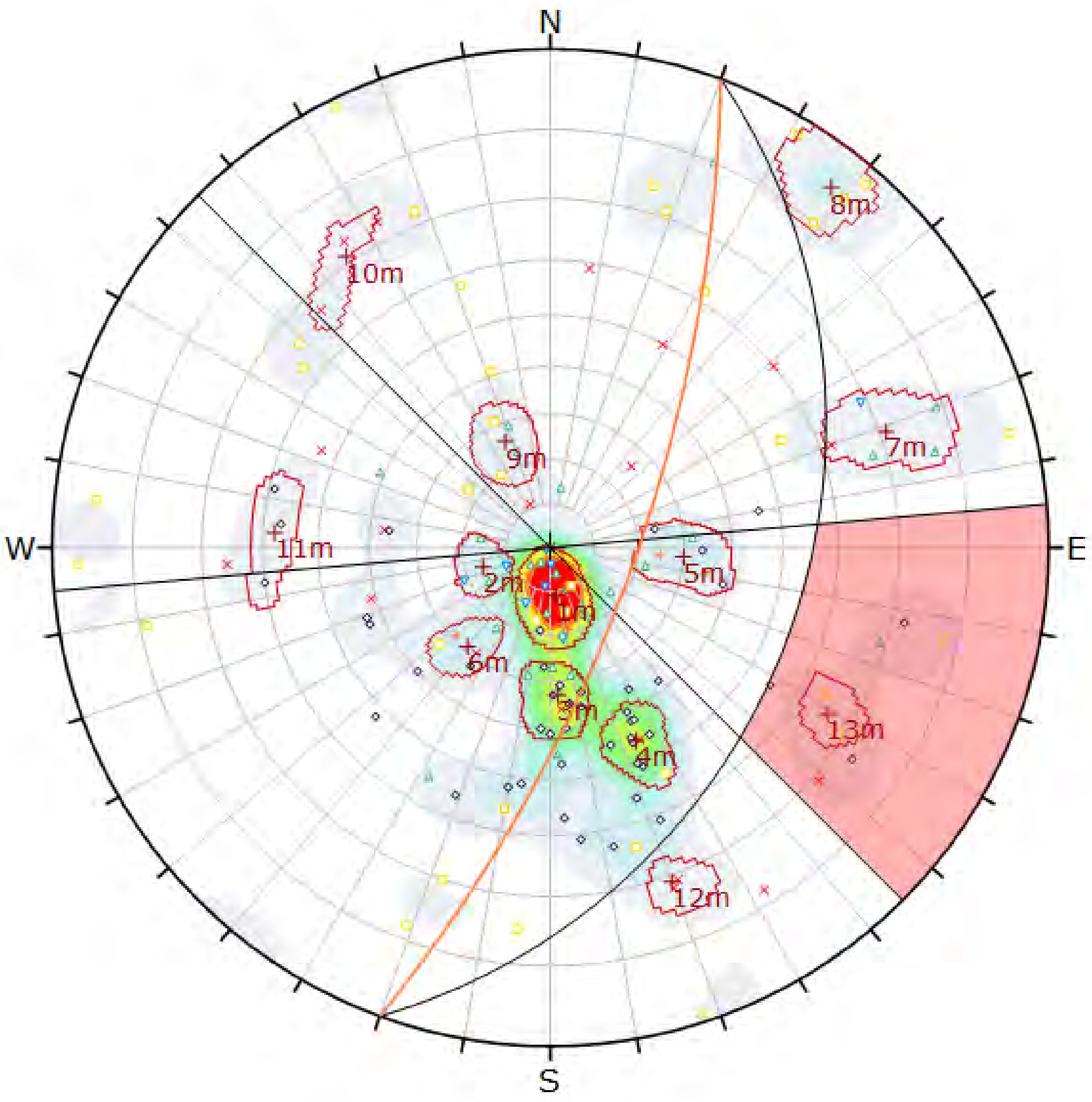
ROCK ENGINEERING SOLUTIONS



Symbol	RANK	Quantity
○	Foliation / Vein	46
×	Fracture Rank 1	28
△	Fracture Rank 2	29
+	Fracture Rank 3	7
▽	Fracture Rank 4	8
□	[no data]	35

Color	Density Concentrations
⬜	0.00 - 1.00
⬜	1.00 - 2.00
🟦	2.00 - 3.00
🟩	3.00 - 4.00
🟩	4.00 - 5.00
🟩	5.00 - 6.00
🟨	6.00 - 7.00
🟨	7.00 - 8.00
🟧	8.00 - 9.00
🟥	9.00 <

Contour Data	Pole Vectors
Maximum Density	12.63%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Flexural Toppling
Slope Dip	71
Slope Dip Direction	110
Friction Angle	35°
Lateral Limits	25°

	Critical	Total	%
Flexural Toppling (All)	8	153	5.23%
Flexural Toppling (Set 13: 12)	2	2	100.00%

Plot Mode	Pole Vectors
Vector Count	153 (153 Entries)
Hemisphere	Lower
Projection	Equal Angle

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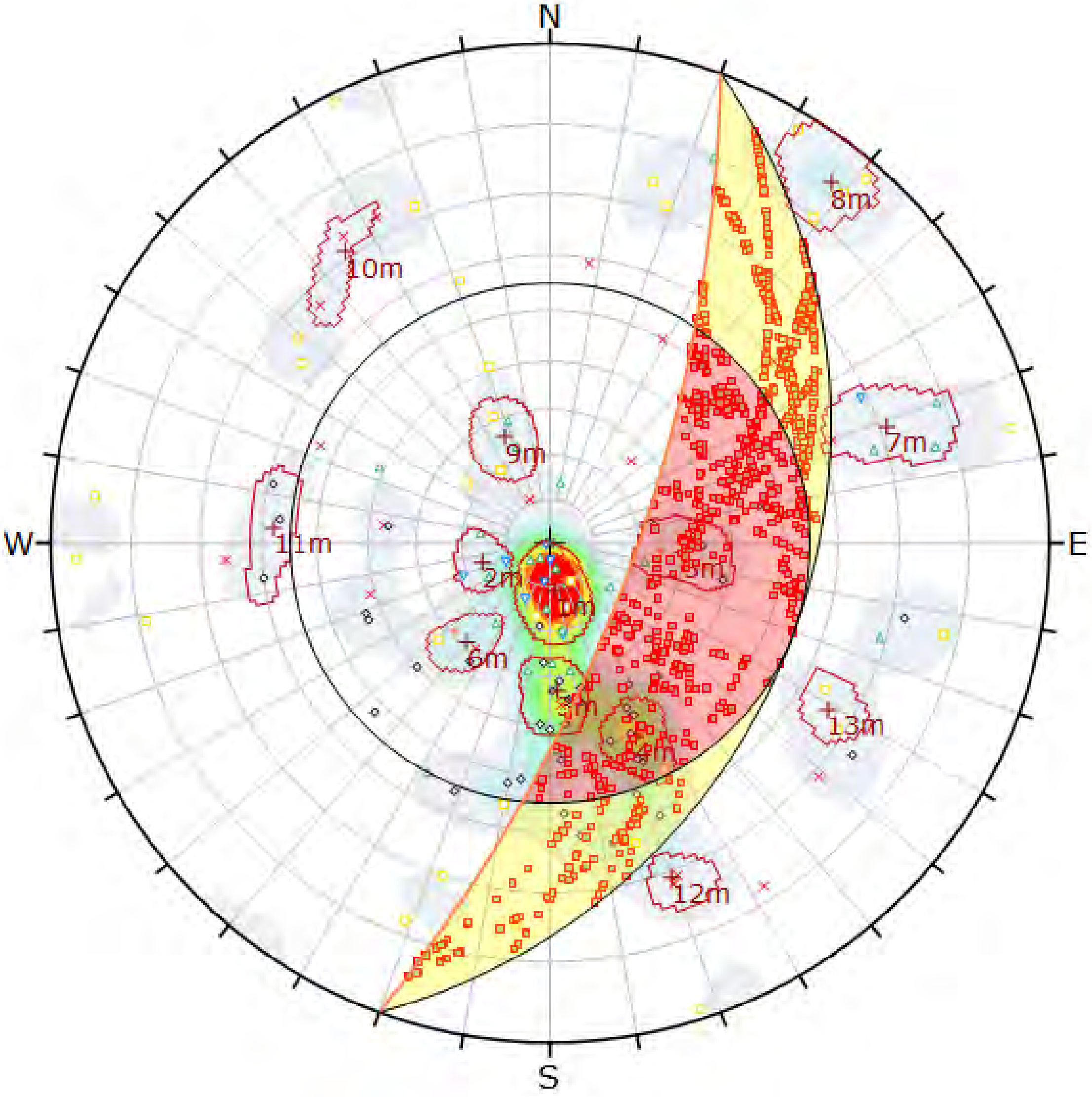
25 JULY 2022

FIG. 4L – STEREONET OUTPUT GRAPHICS:
WEDGE INTERSECTIONS AT CUT STRIKE AZ. 20 DEG.



Symbol	RANK	Quantity
◇	Foliation / Vein	46
×	Fracture Rank 1	28
△	Fracture Rank 2	29
+	Fracture Rank 3	7
▽	Fracture Rank 4	8
△	[no data]	35

Symbol	Feature
◻	Critical Intersection

Color	Density Concentrations
⬜	0.00 - 1.00
⬜	1.00 - 2.00
🟦	2.00 - 3.00
🟦	3.00 - 4.00
🟦	4.00 - 5.00
🟩	5.00 - 6.00
🟩	6.00 - 7.00
🟨	7.00 - 8.00
🟧	8.00 - 9.00
🟥	9.00 <

Contour Data	Pole Vectors
Maximum Density	12.63%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Wedge Sliding
Slope Dip	71
Slope Dip Direction	110
Friction Angle	35°

	Critical	Total	%
Wedge Sliding	1019	11628	8.76%

Plot Mode	Pole Vectors
Vector Count	153 (153 Entries)
Intersection Mode	Grid Data Planes
Intersections Count	11628
Hemisphere	Lower
Projection	Equal Angle

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25 JULY 2022

FIG. 4M – STEREONET OUTPUT GRAPHICS:
WEDGE INTERSECTIONS & PLANES AT CUT STRIKE AZ. 20 DEG.

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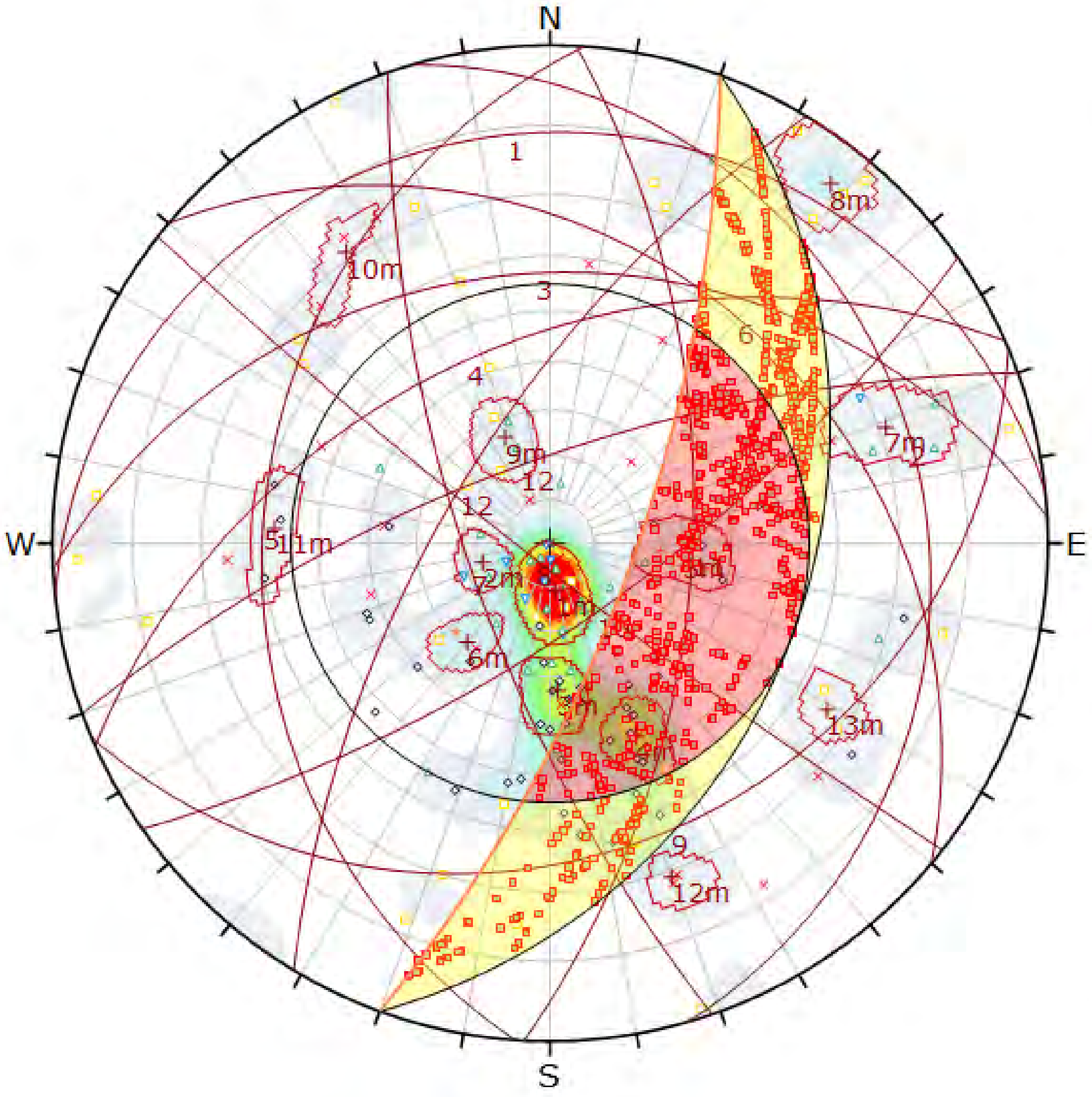


Symbol	RANK	Quantity
◇	Foliation / Vein	46
×	Fracture Rank 1	28
△	Fracture Rank 2	29
●	Fracture Rank 3	7
▽	Fracture Rank 4	8
▭	[no data]	35

Symbol	Feature
▫	Critical Intersection

Color	Density Concentrations
⬜	0.00 - 1.00
⬜	1.00 - 2.00
🟦	2.00 - 3.00
🟦	3.00 - 4.00
🟩	4.00 - 5.00
🟩	5.00 - 6.00
🟨	6.00 - 7.00
🟨	7.00 - 8.00
🟧	8.00 - 9.00
🟥	9.00 <

Contour Data	Pole Vectors
Maximum Density	12.63%
Contour Distribution	Fisher
Counting Circle Size	1.0%

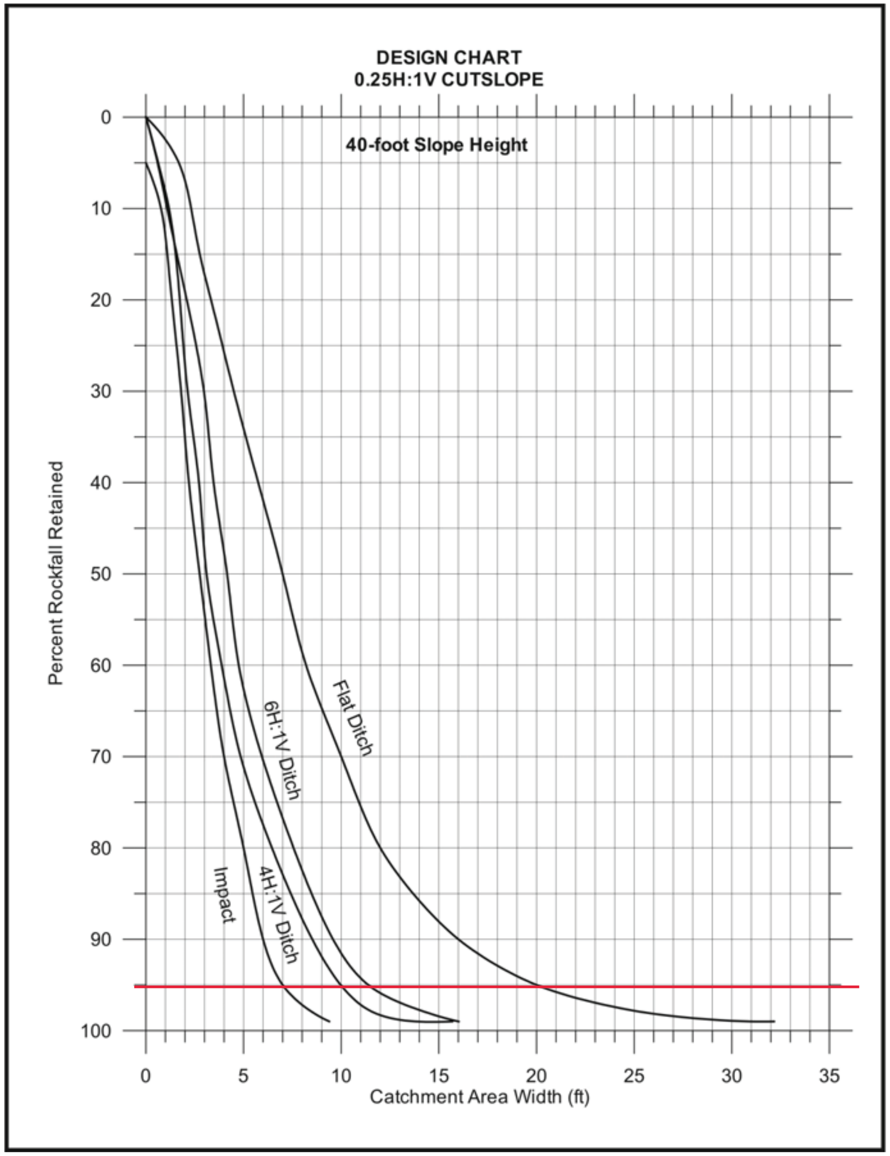
Kinematic Analysis	Wedge Sliding
Slope Dip	71
Slope Dip Direction	110
Friction Angle	35°

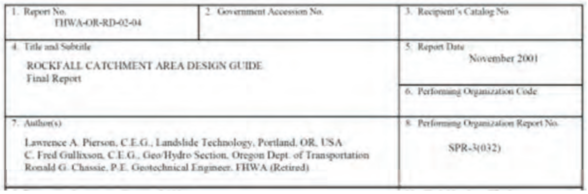
	Critical	Total	%
Wedge Sliding	1019	11628	8.76%

Plot Mode	Pole Vectors
Vector Count	153 (153 Entries)
Intersection Mode	Grid Data Planes
Intersections Count	11628
Hemisphere	Lower
Projection	Equal Angle

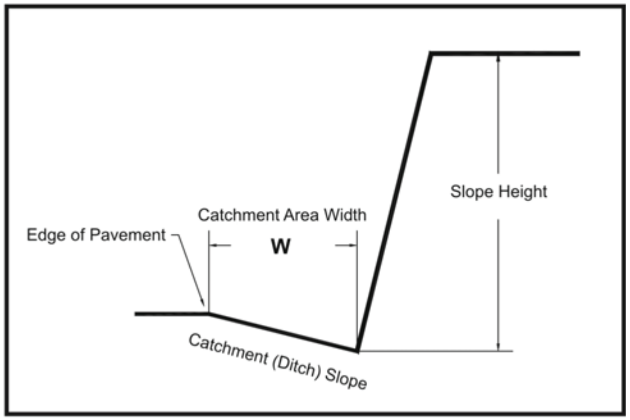
ATTACHMENT NO. 5

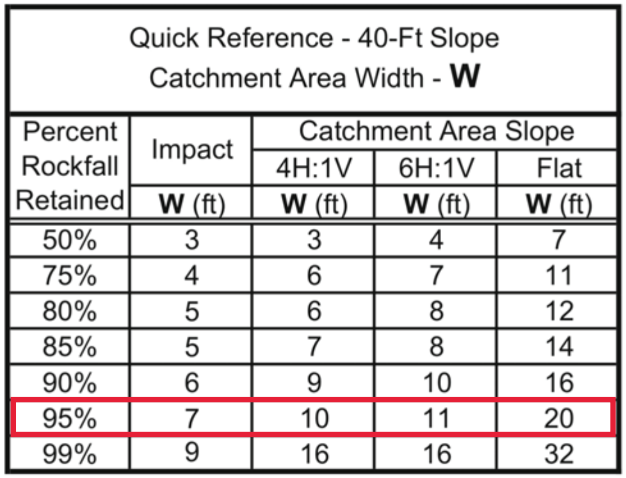
ODOT/FHWA CATCHMENT GUIDE DESIGN CHARTS





1. Report No. FHWA-OR-RD-02-04	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle ROCKFALL CATCHMENT AREA DESIGN GUIDE Final Report		5. Report Date November 2001
		6. Performing Organization Code
7. Author(s) Lawrence A. Pierson, C.E.G., Landslide Technology, Portland, OR, USA C. Fred Gullixson, C.E.G., Geo/Hydro Section, Oregon Dept. of Transportation Ronald G. Chassie, P.E. Geotechnical Engineer, FHWA (Retired)		8. Performing Organization Report No. SPR-3(032)

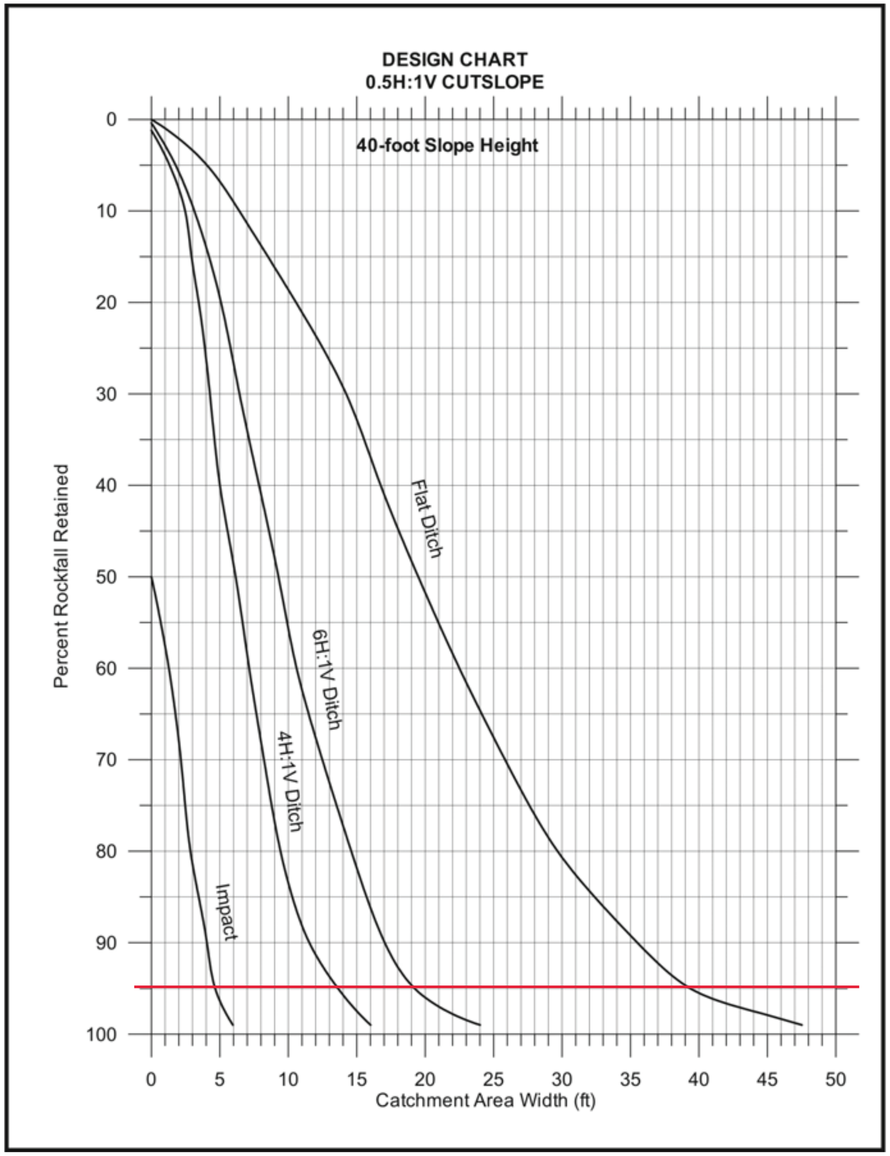


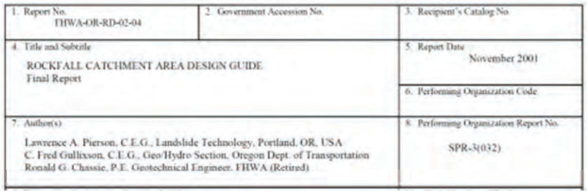


Quick Reference - 40-Ft Slope
Catchment Area Width - **W**

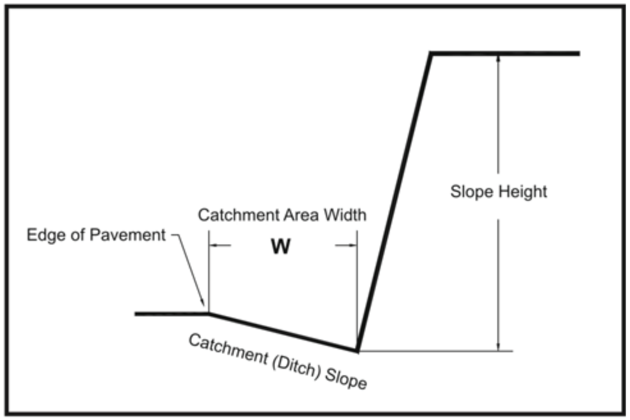
Percent Rockfall Retained	Impact	Catchment Area Slope		
		4H:1V	6H:1V	Flat
	W (ft)	**W** (ft)	**W** (ft)	**W** (ft)
50%	3	3	4	7
75%	4	6	7	11
80%	5	6	8	12
85%	5	7	8	14
90%	6	9	10	16
95%	7	10	11	20
99%	9	16	16	32

Figure 5.6: Design chart for 40-foot high 0.25H:1V cutslopes





1. Report No. FHWA-OR-RD-02-04	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle ROCKFALL CATCHMENT AREA DESIGN GUIDE Final Report		5. Report Date November 2001 6. Performing Organization Code
7. Author(s) Lawrence A. Pierson, C.E.G., Landslide Technology, Portland, OR, USA C. Fred Gullixson, C.E.G., Geo/Hydro Section, Oregon Dept. of Transportation Ronald G. Chassie, P.E. Geotechnical Engineer, FHWA (Retired)		8. Performing Organization Report No. SPR-3(032)



Quick Reference - 40-Ft Slope
Catchment Area Width - **W**

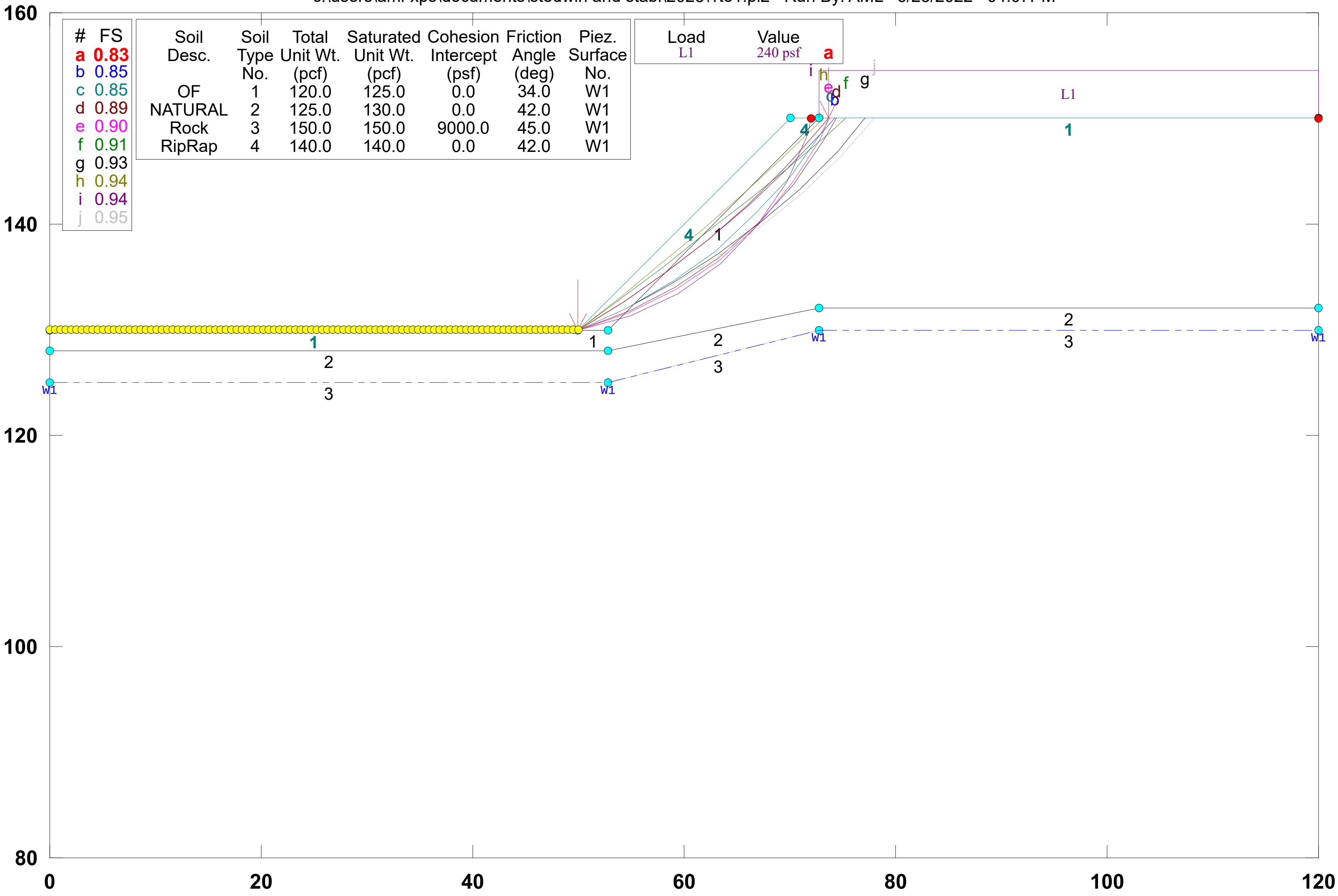
Percent Rockfall Retained	Impact	Catchment Area Slope		
		4H:1V	6H:1V	Flat
	W (ft)	**W** (ft)	**W** (ft)	**W** (ft)
50%	0	6	9	19
75%	2	9	14	28
80%	3	9	15	30
85%	3	10	16	32
90%	4	11	17	35
95%	5	14	19	39
99%	6	16	24	48

Figure 5.11: Design chart for 40-foot high 0.5H:1V cutslopes

Appendix K – Results of Slope Stability Analyses

Fill Slope on Eastern Side of Site Rip-rapped at 1H:1V

c:\users\aml-xps\documents\stedwin and stabl\2025\1to1.pl2   Run By: AML   6/23/2022   04:07PM



#	FS
a	0.83
b	0.85
c	0.85
d	0.89
e	0.90
f	0.91
g	0.93
h	0.94
i	0.94
j	0.95

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
OF	1	120.0	125.0	0.0	34.0	W1
NATURAL	2	125.0	130.0	0.0	42.0	W1
Rock	3	150.0	150.0	9000.0	45.0	W1
RipRap	4	140.0	140.0	0.0	42.0	W1

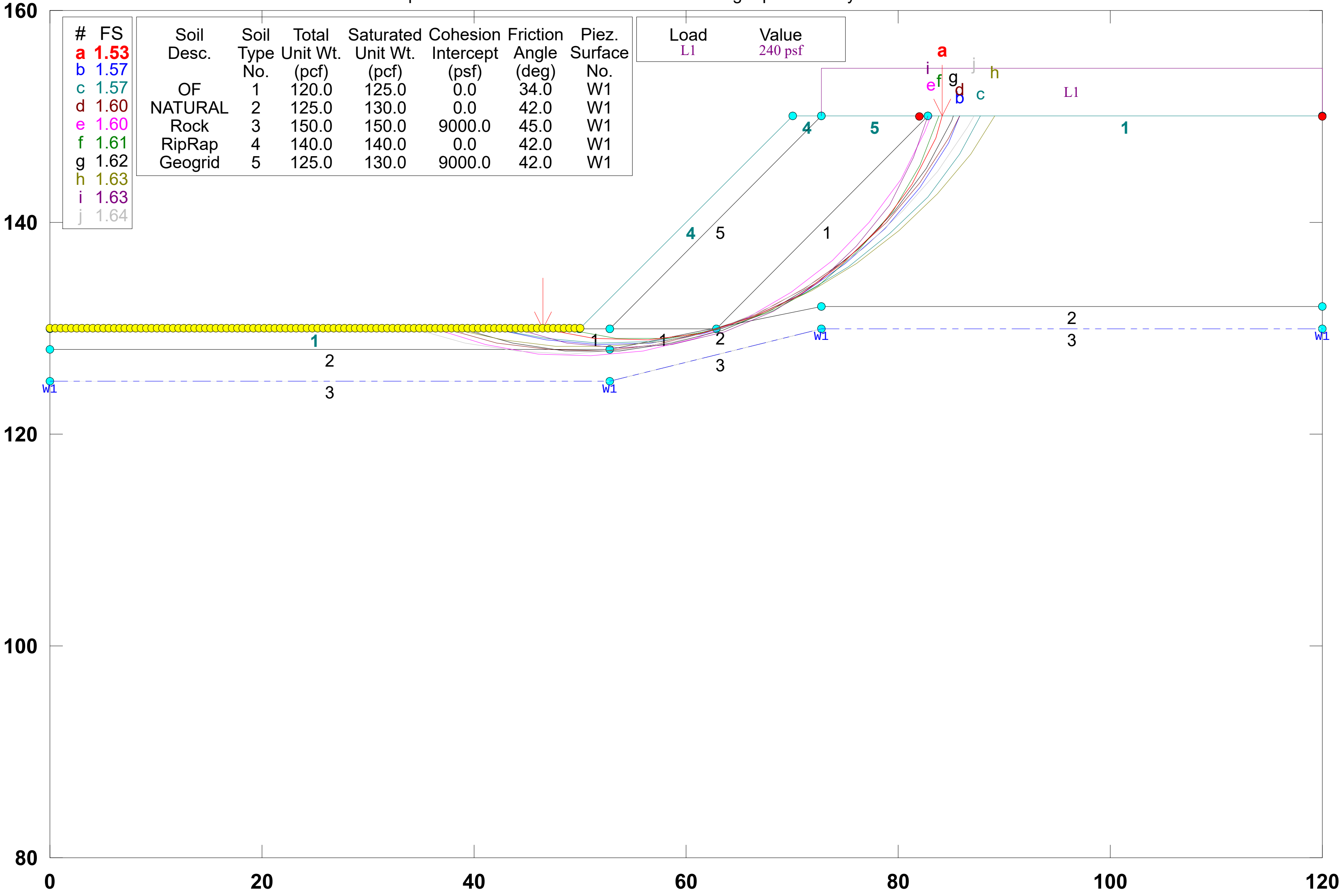
Load	Value
L1	240 psf

PCSTABL5M/si FSmin=0.83

Safety Factors Are Calculated By The Modified Bishop Method

Fill Slope on Eastern Side of Site Rip-rapped at 1H:1V with Geogrid

c:\users\aml-xps\documents\stedwin and stabl\2025\1to1grd.pl2 Run By: AML 6/23/2022 04:11PM



#	FS
a	1.53
b	1.57
c	1.57
d	1.60
e	1.60
f	1.61
g	1.62
h	1.63
i	1.63
j	1.64

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
OF	1	120.0	125.0	0.0	34.0	W1
NATURAL	2	125.0	130.0	0.0	42.0	W1
Rock	3	150.0	150.0	9000.0	45.0	W1
RipRap	4	140.0	140.0	0.0	42.0	W1
Geogrid	5	125.0	130.0	9000.0	42.0	W1

Load	Value
L1	240 psf

PCSTABL5M/si FSmin=1.53

Safety Factors Are Calculated By The Modified Bishop Method