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MEMORANDUM

To: Mr. Jason Iacobucci (Robinson Green Beretta Corporation)

From: Anthony DiGiantomaso, P.E.^(RI), David R. Carchedi, Ph.D., P.E.^(RI)

Date: March 21, 2025

File No.: 03.0035492.00

Re: Geotechnical Design Memorandum
MEVA Facility Site Modifications
123 Railroad Avenue
Haverhill, MA 01835

GZA GeoEnvironmental, Inc. (GZA) is pleased to provide you with this geotechnical design memorandum for the subject project. This memorandum was prepared in accordance with our agreement dated December 6, 2024, and is subject to the Limitations in **Attachment A**.

BACKGROUND

The project consists of site modifications at the Merrimack Valley Regional Transit Authority (MEVA) facility located at 123 Railroad Avenue in Haverhill, Massachusetts. The project site is bound to the northwest by the Merrimack River, to the northeast by a residential development, to the southeast by Railroad Avenue and MBTA railroad lines, and to the southwest by undeveloped woodlands along the Merrimack River. An MBTA train station and rail lines are located east of the site. Refer to **Figure 1, Exploration Location Plan**, for the project location.

Our understanding of the proposed development is based on correspondence with the design team and the progress site civil drawings provided by PLACES Associates, Inc. (PLACES) on February 7, 2025 and March 6, 2025.

The proposed site modifications include re-grading the southern portion of the facility along Railroad Avenue, and the existing site access roadway. Re-grading is required in order to install an above-ground fuel storage tank and create additional parking space at the site. The project also includes the construction of an approximately 650-foot long retaining wall along the south side of the site to achieve the proposed grading. The maximum height of the retaining wall is anticipated to be approximately 13 feet above finish grade.

A future phase of development is planned at the site, which will involve an addition to the Bus Garage and Maintenance Facility. Excavations required for construction of that future development are anticipated to temporarily increase the maximum required height for the new site retaining wall to about 17.5 feet.



GEOLOGIC SETTING

Available United States Geological Survey (USGS) publications were reviewed in order to obtain an understanding of the area's geology. The following sections of this report describe these findings.

Surficial Geology

According to the 2018 Surficial Materials Map of the Haverhill Quadrangle, Massachusetts, the surficial soils in the vicinity of the project site are generally mapped as flood-plain alluvium. The flood-plain alluvium is described as stratified and well sorted to poorly sorted deposits of sand, gravel, silt, and some organic material, which were deposited beneath the flood plains of modern streams. The flood-plain alluvium is typically underlain by stratified glacial deposits. The surficial soils in the southern portion of the site are mapped as thin glacial till deposits overlying bedrock. The glacial till deposits are described as a non-sorted, non-stratified matrix of sand, some silt, and little clay, containing scattered pebbles, cobbles, and boulders. Large surface boulders are also common. The glacial till deposits are generally less than 10 to 15 feet thick.

Bedrock Geology

According to the 1983 Bedrock Geologic Map of Massachusetts, the bedrock in the vicinity of the site consists of the Berwick Formation. The Berwick formation is described as thin to thick bedded, metamorphosed, calcareous sandstone, siltstone, and muscovite schist.

SUBSURFACE EXPLORATIONS

Four test borings, designated GZ-101 through GZ-104, were drilled for this study. **Figure 1**, shows the locations of the test borings and logs of the explorations are in **Attachment B**. An engineer from GZA was present during the drilling to observe and log the explorations.

The test borings were drilled by New England Boring Contractors of Derry, New Hampshire between January 2 and January 3, 2025. The borings were advanced to depths ranging between 14.5 and 25 feet below the existing ground surface using a GTECH GT8 truck-mounted drill rig with drive and wash drilling methods. Split-spoon soil samples were obtained at 2- to 5-foot intervals in general accordance with ASTM D1586, the Standard Penetration Test (SPT). The SPT consists of driving a 1-3/8 inch inside diameter standard split spoon sampler at least 18 inches with a 140-pound hammer dropping from a height of 30 inches. The SPT blow count (N-value) is the number of blows required to drive the sample from 6 to 18 inches of penetration and is a commonly used indicator of soil density and consistency. The soil samples were classified according to the modified Burmister classification system. Bedrock core samples were obtained at borings GZ-101 through GZ-103 using rotary rock coring techniques with an NQ-size double tube core barrel.

The exploration locations were determined using a Global Navigation Satellite System (GNSS) unit with an accuracy of approximately 1-foot horizontally. Ground surface elevations of the explorations have been estimated by interpolating between contours on plans provided by PLACES. Elevations of the explorations are referenced to the North American Vertical Datum of 1988 (NAVD88) and should be considered approximate.

SUBSURFACE CONDITIONS

The generalized subsurface profile across the site consists of a surficial layer of asphalt or concrete pavement underlain by fill, glacial till, and bedrock. At boring GZ-102, buried subsoil was encountered above the fill, and a layer of sandy silt was encountered between the fill and glacial till deposits. The subsurface conditions are described in greater detail in the following paragraphs. Refer to the boring logs in **Attachment B** for more specific descriptions of the conditions encountered in each exploration.



Asphalt Pavement & Reclaimed Asphalt Surface

A 6-inch-thick layer of asphalt pavement was encountered at the ground surface at test boring GZ-103, and an 8-inch-thick layer of reclaimed asphalt was encountered at the ground surface at boring GZ-101.

Concrete

Boring GZ-102 was drilled on a concrete pad, which was approximately 6 inches thick.

Buried Subsoil

A layer of buried subsoil material was encountered below the concrete pad in boring GZ-102. The buried subsoil layer was 2 feet thick and consisted primarily of silt with up to 50 percent sand. The SPT N-value in the buried subsoil material was 4 blows per foot (bpf) indicating a relative density of “loose”.

Fill

Fill was encountered below the asphalt pavement/reclaimed asphalt in borings GZ-101 and GZ-103, and below the buried subsoil in boring GZ-102. Fill was encountered at the ground surface at boring GZ-104. The fill extended to depths ranging from 3.5 to 10 feet below the existing grade, which corresponds to elevations ranging from 14.5 to 33 feet. The fill material consisted primarily of sand with up to 50 percent silt and up to 35 percent gravel. Presumed pieces of cobbles and/or boulders were encountered in the fill in boring GZ-101. Portions of the fill in borings GZ-101 and GZ-102 contained up to 50 percent concrete pieces. SPT N-values in the fill material ranged from 8 to 85 bpf indicating relative densities of “very loose” to “very dense”. The higher blow counts may have been due to presence of concrete, cobbles, and/or boulders in the fill material and may not be indicative of the relative density of the soil.

Sandy Silt

A layer of silt with up to 50 percent sand was encountered below the fill in boring GZ-102. This layer extended from approximately 5 to 9.5 feet below grade, which corresponds to approximate elevations ranging from 10 feet to 16.5 feet. The SPT N-value in this layer was 16 bpf, which corresponds to a relative density of “medium dense”.

Glacial Till

The fill material in borings GZ-101, GZ-103, and GZ-104, and the sandy silt material in boring GZ-102, were underlain by glacial till deposits. The glacial till consisted of a heterogeneous mixture of sand, gravel, and silt. Portions of the gravel observed in the glacial till in boring GZ-103 were weathered. Inferred cobbles and/or boulders were encountered when drilling in the glacial till layer and are commonly found in the glacial till in this area. The top of the glacial till was encountered at depths ranging from 3.5 to 10 feet below the existing ground surface, which corresponds to approximate elevations ranging from 14.5 to 33 feet. The glacial till layer ranged from 1.5 to 6.5 feet thick. SPT N-values in the glacial till material ranged from 18 to greater than 100 blows per foot indicating relative densities of “medium dense” to “very dense”.

Weathered Bedrock

Weathered bedrock was encountered below the glacial till in boring GZ-101. The weathered bedrock was encountered from 5 to 14 feet below the existing grade, which corresponds to elevations ranging from 22.5 to 31.5 feet. The weathered bedrock was very severely weathered, where the fabric of the rock was discernible, but the strength of the rock was reduced to soil. The SPT N-



value in the weathered bedrock was greater than 100 bpf, indicating relative density to be “very dense”. The split spoon encountered refusal in the weathered bedrock, with less than 1-inch of advancement over 100 hammer blows.

Bedrock

Bedrock was encountered, and cored, below the weathered bedrock in boring GZ-101, and below the glacial till deposits in borings GZ-102 and GZ-103. The top of the bedrock was encountered at depths ranging from 11 to 16 feet below grade, which corresponds to approximate elevations ranging from 10 to 22.5 feet. Based on observed drilling resistance, possible bedrock was encountered in test boring GZ-104 at an approximate elevation of 12.8 feet, however a core sample was not obtained to confirm the presence of bedrock at this location.

The bedrock observed in the rock core samples consisted of siltstone. The bedrock core samples were moderately hard, moderately to slightly weathered, and extremely to slightly fractured. Borings GZ-102 and GZ-103 were advanced approximately 4 feet into the bedrock layer prior to obtaining core samples. It should be noted that the upper portion of the bedrock material may be softer and more weathered/fractured than what was observed in the core samples. The Rock Quality Designation (RQD) is the percentage of recovered rock that is greater than 4 inches long, relative to the total penetration, and is a rough measure of the overall quality of the bedrock. The RQD for the bedrock generally ranged from 0% to 25%, indicating a “poor” rock quality. Photographs of the rock core samples are included in **Attachment C**. Refer to the boring logs in **Attachment B** for additional information on rock core run recovery, RQD, and rock core sample descriptions.

Groundwater

Stabilized groundwater readings were not obtained in the borings at the time of drilling due to the addition of drilling fluids to the boreholes. Based on soil sample moisture, groundwater was inferred at approximately 4 to 5 feet below grade in borings GZ-102 through GZ-104, which corresponds to an approximate elevation of 21 feet.

It is anticipated that groundwater levels will vary due to variations in rainfall and other factors different than those prevailing at the time the explorations were performed, and the measurements were made. Seasonal groundwater elevation changes of 10 feet or more are possible in glacial till and bedrock. It should be noted that the seasonally lowest groundwater levels typically occur during the late summer and early fall months, and the highest levels typically occur during the spring months. Refer to the boring logs in **Attachment B** for additional details on groundwater observations.

GEOTECHNICAL LABORATORY TESTING

Four soil samples were submitted for laboratory grain size analysis in general accordance with ASTM D6913. A summary of the laboratory test results is included in the table below, and the laboratory data sheets are included in **Attachment D**.

Boring	Sample	Depth (ft)	Material	Fines Content (%)	Burmister Classification
GZ-101	S-2A	2-4	Fill	40.5	Brown, fine to coarse SAND and Clayey SILT, little fine to coarse Sand
GZ-101	S-3	5-6.2	Glacial Till	18.6	Brown, fine GRAVEL and fine to coarse SAND, little Silt
GZ-102	S-3	5-7	Sandy Silt	54.4	Light brown, SILT and fine SAND
GZ-103	S-1	1-3	Fill	34.3	Brown, fine to coarse SAND, some Clayey Silt, little fine Gravel



IMPLICATIONS OF SUBSURFACE CONDITIONS

Undisturbed natural deposits of sandy silt, glacial till, weathered bedrock, and bedrock are considered competent bearing materials for support of foundations for the proposed tank pad and site retaining wall. These deposits were encountered below asphalt, concrete, buried subsoil, and existing fill material, which are not considered competent bearing materials for support of shallow foundations. These unsuitable materials will need to be removed from foundation bearing areas prior to foundation construction.

A site retaining wall with a maximum retained height of 17.5 feet is proposed along the southeast side of the parcel. Given the close proximity of the proposed wall alignment to the property line, the project team has selected a drilled soldier pile wall with temporary timber lagging wall and a permanent cast-in-place concrete face. The soldier piles will be cantilevered with toe resistance developed in bedrock. Other wall systems that were considered include a gravity wall (cast-in-place or precast block), a soil nail wall, and mechanically stabilized earth (MSE) walls. Construction of these systems would require excavation beyond the property line, temporary earth support, relocation or temporary support of existing utilities along Railroad Avenue, and/or an easement for wall components that extend off the property. Given these constraints, a soldier pile wall system was selected for this project. At the south end of the wall alignment, where the wall returns into the site and the height decreases, the soldier pile wall will transition to a cast-in-place concrete gravity retaining wall.

Overhead wires in the southern portion of the site and along Railroad Avenue will need to be relocated in order to install the soldier piles. In addition, existing gas and water lines that extend through the proposed wall alignment will need to be relocated prior to construction of the wall.

The excavated existing fill, glacial till, and weathered bedrock can be selectively reused as structural fill provided that the material is placed in lifts and properly compacted. The site soils are silty (silt contents above 10 percent) and may be difficult to work with if the material becomes saturated during construction. It is critical that the earthwork contractor manage the soils to be reused by protecting stockpiles and loose lifts from precipitation and maintaining positive drainage during earthwork operations to avoid ponding of stormwater runoff.

Inferred cobbles and boulders were encountered in the existing fill material and glacial till layer. In addition, portions of the fill contained miscellaneous debris such as concrete. Boulders and other larger debris will need to be culled from excavated materials prior to reuse. The earthwork specifications for the project should reflect the need to cull and/or process cobbles, boulders, or other large debris if the site soils are to be reused. In areas where large voids result from boulder excavation, compacted structural fill will be required to fill the voids and provide an even bearing surface. In addition, it is anticipated that boulders and other debris will be encountered during the drilling of soldier piles for the site retaining wall.

Excavation of weathered bedrock and bedrock will be required for the proposed construction. It should be noted that the bedrock surface may be highly irregular and could be encountered at higher elevations than reported on the exploration logs. The weathered bedrock material encountered in the borings was very severely weathered so it may be possible to excavate the weathered bedrock material by ripping with a dozer or with the bucket of a hydraulic excavator. Excavation into the more competent bedrock material is anticipated and additional means of rock removal such as hammering may be required in order to facilitate bedrock excavation. Hammering may also be required for weathered bedrock if difficulty is encountered during excavation. If hammering is required, the Contractor's Earthwork Plan should include identification of potential offsite impacts and measures to mitigate impacts of construction vibrations and noise. Bedrock cuts will be required along the property line in order to reach the proposed grades. Line drilling may be required during bedrock removal along the southeast edge of the property in order to maintain the site retaining wall alignment and limit rock excavation from extending off the property.



CONCLUSIONS AND RECOMMENDATIONS

The following sections present geotechnical design and related earthwork recommendations for the proposed development. The recommendations have been developed based on the results of the subsurface explorations and design information provided by Robinson Green Beretta Corporation (RGB). If the design is modified, GZA should be provided the opportunity to revise our recommendations as/if needed.

Foundation Recommendations

Undisturbed naturally deposited sandy silt, glacial till, weathered bedrock, and bedrock are considered competent bearing material for support of the tank pad and site retaining wall foundations. These deposits were encountered below buried subsoil and existing fill materials, which are not considered competent bearing materials for the support of foundations. These unsuitable materials will need to be removed from the foundation bearing areas prior to crushed stone placement and foundation construction.

Over-excavation of unsuitable materials should extend to the limit defined by a 1-horizontal to 1-vertical slope extending downward and outward from two feet outside the edges of the foundations. Unsuitable materials should be removed to firm, undisturbed, naturally deposited sandy silt, glacial till, weathered bedrock, or bedrock. The over-excavation at the tank foundation should extend to 4 feet below proposed finished grade for frost protection or to the bottom of the unsuitable soils, whichever is deeper.

Following the over-excavation of unsuitable material(s), and prior to the placement of fill or foundation construction, soil subgrades should be surface compacted with a minimum of six passes of a walk behind double drum vibratory roller such as a Bomag DMP 8500 (or equivalent). It is anticipated that subgrade soils will be silty (silt contents above 10 percent). Care must be taken during proof-compaction if the soils are wet so as not to cause weaving and softening of the subgrade. If subgrade soils are saturated, static rolling may be more appropriate.

If saturated soils resulting from precipitation or groundwater are encountered at subgrade elevations and cannot be proof-compacted, the subgrade could either be left to dry to a workable moisture content and be re-compacted or be replaced. If the subgrade soils are to be replaced due to disturbance or saturation during construction, they should be over-excavated by 6 to 12 inches and replaced by "3/4-Inch Crushed Stone" placed over a layer of non-woven filter fabric (Mirafi 180N or equivalent). Boulders encountered during excavation for foundations should be removed to a depth of at least 12 inches below the bottom of foundations and replaced with "3/4-inch Crushed Stone".

Following over-excavation at the tank pad, "3/4-Inch Crushed Stone" should be placed to the proposed bottom of foundation elevation. The "3/4-Inch Crushed Stone" should be enveloped in non-woven filter fabric (Mirafi 180N or equivalent). Placement of crushed stone should be performed in horizontal lifts and compacted with vibratory compaction equipment until a non-yielding surface is observed.

The site retaining wall foundation (bottom of wall) should extend at least 4 feet below final exterior grade for frost protection. If freezing weather occurs during construction, measures should be taken to protect exposed footings.

Following over-excavation at the site retaining wall foundation, structural fill consisting of "Granular Fill" and/or "Sand-Gravel Fill" should then be placed to the proposed bottom of footing elevation. Structural fill and backfill should be placed and compacted in horizontal lifts. The maximum loose lift thickness should be 12 inches for vibratory rollers and 6 inches for plate compactors. Structural fill in foundation bearing zones, within the 1H:1V slope defined above, should be compacted to 95% of the maximum dry density as determined by the modified Proctor test (ASTM D1557). Fill placed outside the bearing zone, beyond the 1H:1V slope defined above, should consist of "Granular Fill" compacted to 92% of the maximum dry density. Soils



placed within 3 feet of paved surfaces as either the subbase or base course for pavement or as structural backfill for retaining walls or other structures should be compacted to 95% of the maximum dry density as determined by the modified Proctor test.

A net allowable bearing pressure of 4,000 pounds per square foot (psf) should be used for design of footings on naturally deposited sandy silt, glacial till deposits, or on fill placed and compacted in accordance with the recommendations of this memorandum. A net allowable bearing pressure of 6,000 psf should be used for design of footings on weathered bedrock and a net allowable bearing pressure of 10,000 pounds per square foot (psf) is recommended for foundations bearing on sound bedrock. For footings less than three feet wide, the allowable bearing pressure should be reduced proportionately, and in no case should continuous footings be less than 18 inches wide, with the exception of the soldier pile wall face or the bottom of haunched footings, nor isolated footings be less than 24 inches wide.

Total settlement of foundations bearing on natural undisturbed sandy silt deposits, glacial till deposits, weathered bedrock/bedrock, or properly placed and compacted fill are anticipated to be less than 1-inch and may be expected to occur during construction.

Bedrock may be encountered during foundation construction. Continuous footings on competent bedrock should not be less than 12 inches wide, nor should isolated footings be less than 24 inches wide. Isolated footings that are partially on competent bedrock should be over-excavated and placed completely on competent bedrock. Fill may be required below footing levels to provide a smooth surface for footing construction. Strip footings should not be placed partially on competent bedrock and partially on soil unless special provisions are made. These special provisions may include the following:

1. Excavation of rock 6 inches below the bottom of the footing and replacement with compacted "Granular Fill".
2. A transition zone of at least 20 feet in length. Excavate competent bedrock to 18 inches below the footing at the change in bearing material. Taper this rock excavation to 6 inches below the footing at 20 feet from the change and backfill with compacted "Granular Fill".

It is expected that differential settlements will not exceed ½-inch between the footings constructed on undisturbed natural material or compacted structural fill and the adjacent footings bearing on weathered/competent bedrock. Because the actual location of the transition of footings bearing on competent bedrock to soil will have to be determined during construction, and the difficulty associated with excavating competent bedrock to an exact grade, it may be prudent from a design standpoint to specify that competent bedrock be over-excavated by at least 12 inches below the footing elevation and be replaced to footing grade with "1½-Inch Crushed Stone". In this case the need to evaluate field conditions and the requirements of the special transition zones or construction joints described above will be eliminated, thereby simplifying the design and construction process.

Retaining Walls

The proposed retaining wall along the southeast side of the site is a permanent pre-drilled soldier pile and lagging wall with a cast-in-place concrete face. A pre-drilled soldier pile and lagging wall is constructed by pre-drilling a hole, setting a steel H- or W-section soldier pile into the hole, and then backfilling the hole with low strength concrete. The excavation then proceeds from top to bottom in stages as the lagging is installed behind the flanges of adjacent soldier piles to retain the soil. The cast-in-place wall face will be on the outside face of the soldier pile wall. The wall face will be connected to the soldier piles using shear studs located on the pile's flanges. Drainage board should be located between the cast-in-place face and timber lagging to prevent buildup of hydrostatic pressures behind the wall. The drainage board should connect to a collector pipe at the bottom of the wall face, which drains by gravity to convey water away from the wall.

Soldier pile spacing typically ranges from 6 to 10 feet on-center. It is our understanding that an easement for tieback installation is not available, therefore the soldier piles will be cantilevered. The soldier piles will develop toe resistance through



a socket drilled into the bedrock. It is anticipated that cobbles and boulders will be encountered during drilling of the soldier piles.

Existing overhead wires located in the vicinity of the proposed site retaining wall will need to be relocated in order to allow for wall construction. In addition, water and gas lines that run through the proposed wall alignment will need to be relocated.

At the south end, where the wall returns in towards the site, it will transition to a cast-in-place gravity wall. It is recommended that retaining wall be supported by a subgrade prepared in accordance with the above foundation recommendations. It is also recommended that the wall be backfilled with free draining "Granular Fill" compacted to at least 95% of the maximum dry density (ASTM D1557) (93 % maximum within 5 feet of the wall stem). For wall design, a moist unit weight of 135 pcf and an internal angle of friction of 32 degrees are recommended for granular backfill. A drainage system should be provided to prevent the buildup of hydrostatic pressures behind the wall. The wall should be designed for any surcharge loads that may occur, including construction traffic.

For walls that are unrestrained at the top, an active soil pressure coefficient (K_a) of 0.3 is recommended. For foundation and retaining walls that are restrained at the top, an at-rest soil pressure coefficient (K_o) of 0.5 is recommended. For foundations and walls designed to resist lateral forces, a passive pressure coefficient (K_p) of 1.6 is recommended (factor of safety of 2 included due to strain considerations), provided that all backfill is compacted to a minimum of 95% of ASTM D1557 on both sides of the wall.

Excavations

Excavations for the project should be sloped back in accordance with the Occupational Safety Health Administration (OSHA) Construction Industry Standards. In areas where sloping is not possible, excavation support should be designed in accordance with OSHA 29 CFR Part 1926 Occupational Safety Health Standards – Excavations, latest edition.

Bedrock Removal

Excavation of weathered bedrock and bedrock will be required to reach the proposed site grades and bottom of wall elevation for the proposed site retaining wall. It should be noted that the bedrock surface may be highly irregular and could be encountered at higher elevations than reported on the exploration logs. Bedrock should be removed to a minimum depth of 12" below footing elevations and 24" below roadways and parking areas. Bedrock excavation should be carefully controlled to avoid fracturing and loosening of rock below the proposed subgrade levels. Loosened rock should be removed, and remaining voids should be filled with compacted Granular Fill or "3/4-Inch Crushed Stone".

The weathered bedrock material encountered in boring GZ-101 was very severely weathered so it may be possible to excavate the material by ripping with a dozer or with the bucket of a hydraulic excavator. If difficulty is encountered during bedrock excavation, an alternate bedrock excavation technique is using an excavator in conjunction with the use of a hydraulic hammer (hoe ram). Monitoring of vibration levels will likely be required during hoe ramming. This type of bedrock excavation may pose difficulties in areas that do not have an "open face" for which to hoe-ram the bedrock from. In addition, this alternative may not be efficient for deeper bedrock cuts, or where the bedrock excavation will extend over long linear distances.

Given the close proximity of the proposed rock excavation to the property line, blasting will not be feasible for bedrock removal. Alternative bedrock excavation techniques that may be considered are line drilling and chemical splitting. Line drilling and/or chemical splitting, if used, should not extend below the proposed maximum cut elevation in order to avoid weakening the bedrock formation around the toe of the soldier piles. These techniques are described in greater detail below:



1. Excavation by Line Drilling - Using a Hydraulic Excavator, and Hydraulic Hammer – Given the close proximity of the proposed excavation to the property line, line drilling may be required to maintain the excavation face to the lines and grades shown on the plans and to help facilitate the hammering of the bedrock material. Following line drilling, bedrock excavation may consist of the use of a hydraulic hammer and excavator. Typically the fractures caused by excavation using the hydraulic hammer and excavator will extend from each drill hole to the nearby drill hole, therefore maintaining the face. In addition, closely spaced drill holes help to reduce the strength of the rock mass and improve hammering efficiency.

2. Excavation by Drilling and Chemical Splitting – Chemical splitting consists of first drilling a pattern of holes to the dimensions and depth required for the excavation. This type of excavation does not require a specialty contractor; however, the specific chemical agent used should be recommended by the manufacturer based on the rock type. The dry splitting agent is then mixed with water and placed into the drill holes. The water activates a chemical reaction that produces heat and causes the splitting agent to expand within the drill holes. The expansion results in fracturing of the bedrock, typically with the fractures traversing from each drill hole to a nearby drill hole. The splitting agent typically produces fractures within 24 hours and can continue to expand and produce further fracturing for about 48 hours. Following this expansion and fracturing of the bedrock, the bedrock can be excavated with a hydraulic excavator. In some cases, a hydraulic hammer may still be needed to dislodge fracture rock pieces or to assist in the excavation.

Construction Vibrations and Pre-Construction Survey

Hammering activities for bedrock removal will result in construction vibrations. Since there are a number of existing utilities and structures adjacent to the site, it is recommended that a preconstruction survey of structures and properties located within 100 feet of any earthwork activities be completed prior to construction. It is also recommended that vibration monitoring be performed during periods of vibration-intensive activities. Project specifications should include permissible vibration thresholds in accordance with the U.S. Bureau of Mines criteria.

Seismic Design Considerations

The following seismic design guidelines are based on information collected during the subsurface exploration program as well as current design information provided to GZA. Site soils are not considered susceptible to seismic liquefaction. Should conditions vary from those stated in this report, the following should be verified to maintain compliance with the applicable guidelines and codes. In accordance with the International Building Code 2021 with Massachusetts State Building Code (CMR 780) 10th Edition amendments, the following seismic design parameters should be used at the site:

<u>Definition</u>	<u>Value</u>
Site Class	D
Design Spectral Response Acceleration for 0.2-second Period ($S_{D0.2}$)	0.39 g
Design Spectral Response Acceleration for 1-second Period (S_{D1})	0.13 g

Drainage & Dewatering

Based on the inferred depths to groundwater in the test borings and the anticipated seasonal fluctuations in groundwater levels, dewatering may be required during construction. Should excavations extend only marginally (1 to 3 feet) below groundwater, dewatering can likely be accomplished using sumps and open pumping techniques. During construction, run-off from precipitation should be diverted away from excavations. Sumping of ponded rainfall within excavations may be required.



Fill Materials and Soil-Reuse

All fill should be free from ice, snow, roots, sod, rubbish, rubble, and other deleterious or organic matter. Gradation requirements for the fill materials should meet the requirements tabulated below.

Sieve Size	Percent Finer by Weight			
	Sand-Gravel Fill	Granular Fill	¾-Inch Crushed Stone	1½-Inch Crushed Stone
*	100	100	-	-
1½-inch	-	-	-	100
1¼-inch	-	-	-	85-100
¾-inch	-	-	90-100	10-40
½-inch	50-85	-	10-50	0-8
No. 4	40-75	-	0-5	-
No. 10	30-60	30-95	-	-
No. 40	10-35	10-70	-	-
No. 100	5-20**	-	-	-
No. 200	0-8	0-10	-	<1

* The maximum recommended stone size is 4 inches where used as a base course below slabs and pavement; elsewhere, maximum stone sizes should be 2/3 of the loose lift thickness.

** The amount passing the No. 100 sieve should be between forty percent (40%) and seventy percent (70%) of that amount passing the No. 40 sieve.

The onsite soils are relatively silty and likely will not meet the above-referenced gradation specifications. These materials may still be reused at the discretion of the Geotechnical Engineer provided they are culled of boulders and deleterious material and that proper placement and compaction techniques are followed to achieve adequate compaction. These materials may be particularly difficult to work with if they become saturated during construction. It is critical that the earthwork contractor manage the soils to be reused by protecting stockpiles and loose lifts from precipitation and maintaining positive drainage during earthwork operations to avoid ponding of stormwater runoff. Special measures such as discing or harrowing may be required to facilitate drying of wet soils prior to compaction, which may result in construction delays. Additionally, saturated or wet silty soils may not support wheeled vehicle traffic. It is not recommended that the silty materials be used where free-draining materials are desired, such as retaining wall backfill and pavement base and subbase layers.

Additional Explorations

Additional explorations are recommended to further identify variations in the bedrock surface along the proposed wall alignment. The explorations may consist of a series of test borings and/or test pits along the wall alignment and other proposed cut areas of the site. This data can be used to help quantify the volume of bedrock excavation that will be required to reach the proposed site grades and the pile lengths needed to reach the required embedment in bedrock. A better-defined bedrock elevation could also lead to a more efficient and cost-effective design of the proposed soldier piles.

Construction Monitoring

It is recommended that GZA be retained for construction observation and special Inspection services during the earthwork and foundation construction phases of the project. Services may include observation of removal of unsuitable materials, soldier pile installation, placement of fill, performance of field density tests, vibration monitoring, and general



observation of compliance with recommendations in this report and the contract documents. Given the potentially difficult subsurface conditions, construction oversight is considered an important part of obtaining quality site improvements.

We trust that this geotechnical engineering design memorandum meets the present project requirements. Should you have any questions, require clarification on any of the recommendations, or need additional information, please contact Anthony DiGiantommaso at (401) 248-3949 or anthony.digiantommaso@gza.com.

- Attachments: Figure 1 - Exploration Location Plan
Attachment A – Limitations
Attachment B – Boring Logs
Attachment C – Rock Core Photo Log
Attachment D – Geotechnical Laboratory Results

Reviewed By: James J. Marsland, P.E.^(MA)



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FIGURE 1

Exploration Location Plan

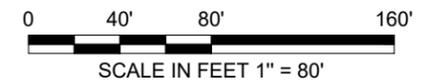
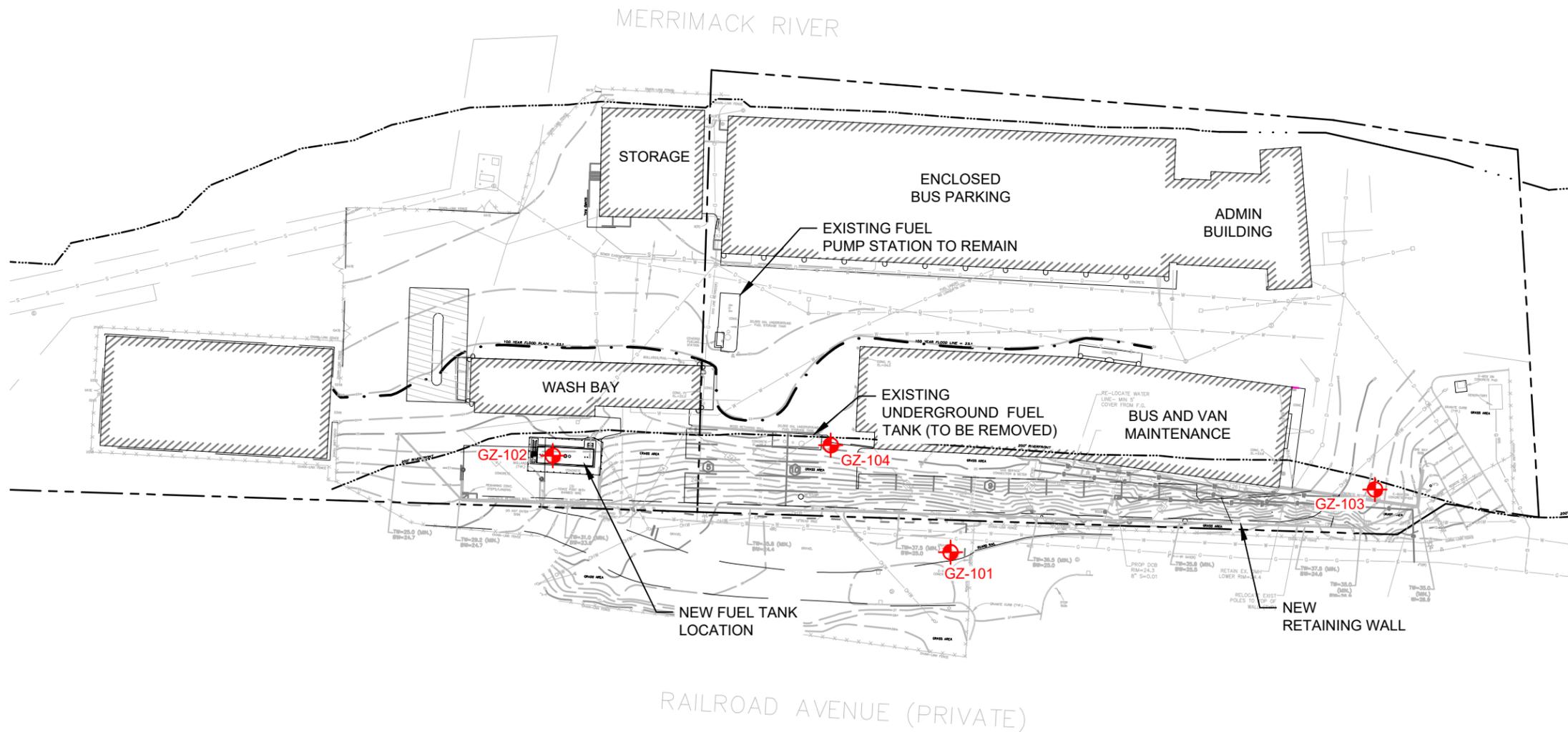
© 2025 - GZA GeoEnvironmental, Inc.
 GZA - J:\GEO\35492.ADG\FIGURES\CAD\35492.00 EXP.DWG FIG. 2 SITE MARCH 13, 2025 ANTHONY DIGIANTOMMASO

GENERAL NOTES:

1. SITE BASE PLAN DEVELOPED FROM ELECTRONIC DRAWING FILES TITLED "5689 - SURVEY BASE-CLEAN 1-24-25.DWG" AND "5689 DESIGN 2025-CLEAN 2-7-25.DWG" WHICH WERE PREPARED BY PLACES ASSOCIATES, INC. AND TRANSMITTED TO GZA.
2. BORING LOCATIONS WERE DETERMINED USING A GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS) UNIT WITH AN ACCURACY OF APPROXIMATELY 1-FOOT HORIZONTALLY. EXPLORATION LOCATIONS SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.

LEGEND:

- INDICATES SITE PROPERTY BOUNDARIES
-  INDICATES APPROXIMATE LOCATION OF BORINGS DRILLED BY NEW ENGLAND BORING CONTRACTORS BETWEEN JANUARY 2 AND 3, 2025 AND OBSERVED BY GZA PERSONNEL.



UNLESS SPECIFICALLY STATED BY WRITTEN AGREEMENT, THIS DRAWING IS THE SOLE PROPERTY OF GZA GEOENVIRONMENTAL, INC. (GZA). THE INFORMATION SHOWN ON THE DRAWING IS SOLELY FOR USE BY GZA'S CLIENT OR THE CLIENT'S DESIGNATED REPRESENTATIVE FOR THE SPECIFIC PROJECT AND LOCATION IDENTIFIED ON THE DRAWING. THE DRAWING SHALL NOT BE TRANSFERRED, REUSED, COPIED, OR ALTERED IN ANY MANNER FOR USE AT ANY OTHER LOCATION OR FOR ANY OTHER PURPOSE WITHOUT THE PRIOR WRITTEN CONSENT OF GZA. ANY TRANSFER, REUSE, OR MODIFICATION TO THE DRAWING BY THE CLIENT OR OTHERS WITHOUT THE PRIOR WRITTEN EXPRESS CONSENT OF GZA, WILL BE AT THE USER'S SOLE RISK AND WITHOUT ANY RISK OR LIABILITY TO GZA.

MEVA FACILITY SITE MODIFICATIONS
 123 RAILROAD AVE
 HAVERHILL, MA 01835

EXPLORATION LOCATION PLAN

PREPARED BY:  GZA GeoEnvironmental, Inc. www.gza.com		PREPARED FOR: ROBINSON GREEN BERETTA CORPORATION	
PROJ MGR: AGD	REVIEWED BY: DRC	CHECKED BY: JJM	FIGURE
DESIGNED BY: AGD	DRAWN BY: TRM	SCALE: AS NOTED	1
DATE: MARCH 2025	PROJECT NO. 35492.00	REVISION NO.	
			SHEET NO. 1 OF 1



ATTACHMENT A

Limitations



USE OF REPORT

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

STANDARD OF CARE

2. GZA's findings and conclusions are based on the work conducted as part of the Scope of Services set forth in Proposal for Services and/or Report, and reflect our professional judgment. These findings and conclusions must be considered not as scientific or engineering certainties, but rather as our professional opinions concerning the limited data gathered during the course of our work. If conditions other than those described in this report are found at the subject location(s), or the design has been altered in any way, GZA shall be so notified and afforded the opportunity to revise the report, as appropriate, to reflect the unanticipated changed conditions .
3. GZA's services were performed using the degree of skill and care ordinarily exercised by qualified professionals performing the same type of services, at the same time, under similar conditions, at the same or a similar property. No warranty, expressed or implied, is made.
4. In conducting our work, GZA relied upon certain information made available by public agencies, Client and/or others. GZA did not attempt to independently verify the accuracy or completeness of that information. Inconsistencies in this information which we have noted, if any, are discussed in the Report.

SUBSURFACE CONDITIONS

5. The generalized soil profile(s) provided in our Report are based on widely-spaced subsurface explorations and are intended only to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized, and were based on our assessment of subsurface conditions. The composition of strata, and the transitions between strata, may be more variable and more complex than indicated. For more specific information on soil conditions at a specific location refer to the exploration logs. The nature and extent of variations between these explorations may not become evident until further exploration or construction. If variations or other latent conditions then become evident, it will be necessary to reevaluate the conclusions and recommendations of this report.
6. In preparing this report, GZA relied on certain information provided by the Client, state and local officials, and other parties referenced therein which were made available to GZA at the time of our evaluation. GZA did not attempt to independently verify the accuracy or completeness of all information reviewed or received during the course of this evaluation.
7. Water level readings have been made in test holes (as described in this Report) and monitoring wells at the specified times and under the stated conditions. These data have been reviewed and interpretations have been made in this Report. Fluctuations in the level of the groundwater however occur due to temporal or spatial variations in areal recharge rates, soil heterogeneities, the presence of subsurface utilities, and/or natural or artificially induced perturbations. The water table encountered in the course of the work may differ from that indicated in the Report.
8. GZA's services did not include an assessment of the presence of oil or hazardous materials at the property. Consequently, we did not consider the potential impacts (if any) that contaminants in soil or groundwater may have on construction activities, or the use of structures on the property.



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

COMPLIANCE WITH CODES AND REGULATIONS

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

COST ESTIMATES

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

ADDITIONAL SERVICES

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



ATTACHMENT B

Boring Logs

TEST BORING LOG



GZA
GeoEnvironmental, Inc.
Engineers and Scientists

Robinson Green Beretta Corporation
MEVA Facility
123 Railroad Ave, Haverhill, MA

EXPLORATION NO.: GZ-101
SHEET: 1 of 1
PROJECT NO: 35492.00
REVIEWED BY: AGD

Logged By: N.Westkott
Drilling Co.: NEBC
Foreman: Mark D'Ambrosia

Type of Rig: Truck Mount
Rig Model: GTECH GT8
Drilling Method:
Drive & Wash

Boring Location: See Plan
Ground Surface Elev. (ft.): 36.5
Final Boring Depth (ft.): 23.7
Date Start - Finish: 1/2/2025 - 1/2/2025

H. Datum:
V. Datum: NAVD88

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

Sampler Type: SS
Sampler O.D. (in.): 2.0
Sampler Length (in.): 24
Rock Core Size: NQ

Groundwater Depth (ft.)

Date	Time	Stab. Time	Water	Casing
Not Measured				

GZA TEMPLATE TEST BORING - GZA GINT DATA TEMPLATE 10-27-20.GDT - 3/20/25 16:55 - J:\GINT PROJECT DATABASES\35492.00_MEVA MAINTENANCE FACILITY.GPJ

Depth (ft)	Casing Blows/ (Core Rate)	Sample						SPT Value	Sample Description (Modified Burmister Classification)	Remark	Depth (ft.)	Stratum Description	Elev. (ft.)
		No.	Depth (ft.)	Pen. (in)	Rec. (in)	Blows (per 6 in.)							
		S-1	0.0-2.0	24	14	12 10 11 13	21	S-1: Top 8": Black, fine to coarse SAND and ASPHALT PIECES, little Silt, dry		0.67	Reclaimed Asphalt	35.8	
		S-2	2.0-4.0	24	22	17 22 63 65	85	Middle 4": Brown/grey, fine to coarse SAND and MISCELLANEOUS DEBRIS (Concrete), trace Silt, dry			Fill		
		S-2						Bottom 4": Brown, fine to coarse SAND and SILT, dry	1	3.5		33.0	
5		S-3	4.0-5.2	14	14	47 79 100 /2"	R	S-2: Top 13": Brown fine to coarse SAND and Clayey SILT, little fine to coarse Gravel, dry	2	5	Glacial Till with Boulders	31.5	
								Middle 6": Grey, fine to coarse GRAVEL					
								Bottom 3": Brown, fine to coarse SAND, little Silt, dry					
								S-3: Very dense, brown/grey, fine GRAVEL and fine to coarse SAND, little Silt, dry	3				
10		S-4	10.0-10.1	1	1	100 /1"	R	S-4: Very dense, grey, WEATHERED BEDROCK	4		Weathered Bedrock		
	(3:27)	C-1	14.0-15.3	16	16			C-1: Moderately hard, slightly weathered, gray SILTSTONE, extremely fractured (RQD = 0%).		14		22.5	
	(1:50)	C-2	15.3-19.1	46	46			C-2: Moderately hard, slightly weathered, gray SILTSTONE, extremely to slightly fractured (RQD = 17%).					
	(2:02)												
	(2:14)												
	(2:09)												
	(2:16)												
	(2:00)	C-3	19.0-23.7	56	56			C-3: Moderately hard, slightly weathered, gray SILTSTONE, extremely to slightly fractured (RQD = 18%).			Bedrock		
20	(1:57)												
	(2:12)												
	(3:50)												
	(4:00)												
25								End of exploration at 23.7 feet		23.8		12.7	
30													

REMARKS

- 1 - Gravel in middle of sample S-2 appeared to have been broken by the split spoon and may have been pieces of cobbles and/or boulders.
- 2 - Inferred boulder encountered between 4' & 5' below grade based on drilling resistance.
- 3 - Drilling resistance increased at 8.5' below grade.
- 4 - Drill wash water and cuttings between 8.5' to 10' below grade were iron-stained. Below 10' below grade, limited iron-staining observed in wash water and spoils.

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

Exploration No.:
GZ-101

TEST BORING LOG



GZA
GeoEnvironmental, Inc.
Engineers and Scientists

Robinson Green Beretta Corporation
MEVA Facility
123 Railroad Ave, Haverhill, MA

EXPLORATION NO.: GZ-102
SHEET: 1 of 1
PROJECT NO: 35492.00
REVIEWED BY: AGD

Logged By: N. Westkott
Drilling Co.: NEBC
Foreman: Mark D'Ambrosia

Type of Rig: Truck
Rig Model: GTECH GT8
Drilling Method:
Drive & Wash

Boring Location: See Plan
Ground Surface Elev. (ft.): 26
Final Boring Depth (ft.): 25
Date Start - Finish: 1/2/2025 - 1/2/2025

H. Datum:
V. Datum: NAVD88

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

Sampler Type: SS
Sampler O.D. (in.): 2.0
Sampler Length (in.): 24
Rock Core Size: NQ

Groundwater Depth (ft.)

Date	Time	Stab. Time	Water	Casing
Not Measured				

Depth (ft)	Casing Blows/ (Core Rate)	Sample						Sample Description (Modified Burmister Classification)	Remark	Depth (ft.)	Stratum Description	Elev. (ft.)
		No.	Depth (ft.)	Pen. (in)	Rec. (in)	Blows (per 6 in.)	SPT Value					
										0.5	Concrete	25.5
		S-1	1.0-3.0	24	14	2 2 2 2	4	S-1: Top 9": Brown, SILT and fine to medium SAND, moist Bottom 5": Tan, SILT and fine to medium SAND, dry				
		S-2	3.0-5.0	24	5	4 4 4 6	8	S-2: Loose, olive, fine to medium SAND and SILT, some Miscellaneous Debris (Concrete), dry		3	Buried Subsoil	23.0
5		S-3	5.0-7.0	24	10	5 7 9 19	16	S-3: Top 8": Brown, SILT and fine SAND, moist Bottom 2": Gray, coarse GRAVEL		5	Fill	21.0
		S-4	10.0-12.0	24	13	32 31 25 23	56	S-4: Very dense, olive-brown, fine to medium SAND, some Silt, some fine to coarse Gravel, moist	1	9.5	Sandy Silt	16.5
10		S-5	15.0-16.0	12	12	18 100/6"	R	S-5: Very dense, olive-brown, SILT, some fine to medium Sand, little to coarse Gravel, moist		16	Glacial Till with Boulders	10.0
20	(3:02) (2:55) (2:50/6") (1:58/6") (2:53) (3:03)	C-1	20.0-22.5	30	24			C-1: Moderately hard, slightly weathered, gray SILTSTONE, extremely to slightly fractured (RQD=23%)			Bedrock	
		C-2	22.5-25.0	30	30			C-2: Moderately hard, slightly weathered, gray SILTSTONE, extremely to slightly fractured (RQD = 13%)				
25								End of exploration at 25 feet		25		1.0
30												

REMARKS
1 - Drill chatter when advancing rollerbit at 9.5' below grade.

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

Exploration No.:
GZ-102

GZA TEMPLATE TEST BORING - GZA GINT DATA TEMPLATE 10-27-20.GDT - 3/20/25 16:55 - J:\GINT PROJECT DATABASES\35492.00_MEVA MAINTENANCE FACILITY.GPJ

TEST BORING LOG



GZA
GeoEnvironmental, Inc.
Engineers and Scientists

Robinson Green Beretta Corporation
MEVA Facility
123 Railroad Ave, Haverhill, MA

EXPLORATION NO.: GZ-103
SHEET: 1 of 1
PROJECT NO: 35492.00
REVIEWED BY: AGD

Logged By: N. Westkott
Drilling Co.: NEBC
Foreman: Mark D'Ambrosia

Type of Rig: Truck
Rig Model: GTECH GT8
Drilling Method:
 Drive & Wash

Boring Location: See Plan
Ground Surface Elev. (ft.): 26.5
Final Boring Depth (ft.): 20.1
Date Start - Finish: 1/3/2025 - 1/3/2025

H. Datum:
V. Datum: NAVD88

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

Sampler Type: SS
Sampler O.D. (in.): 2.0
Sampler Length (in.): 24
Rock Core Size: NQ

Groundwater Depth (ft.)				
Date	Time	Stab. Time	Water	Casing
Not Measured				

Depth (ft)	Casing Blows/ (Core Rate)	Sample						Sample Description (Modified Burmister Classification)	Remark	Depth (ft.)	Stratum Description	Elev. (ft.)
		No.	Depth (ft.)	Pen. (in)	Rec. (in)	Blows (per 6 in.)	SPT Value					
									0.5	Asphalt	26.0	
		S-1	1.0-3.0	24	15	15 22 18 15	40	S-1: Dense, brown fine to coarse SAND, some Clayey Silt, little fine Gravel, dry.				
		S-2	3.0-5.0	24	6	14 12 14 14	26	S-2: Medium dense, brown fine to coarse SAND, little Silt, little fine to coarse Gravel, dry.				
5		S-3	5.0-7.0	24	10	14 6 8 10	14	S-3: Medium dense, brown fine to coarse SAND and SILT, little fine to coarse Gravel, moist				
		S-4	10.0-10.8	10	10	37 100 /4"	R	S-4: Very dense, olive-brown fine to coarse SAND and fine and coarse GRAVEL, some Silt, moist	1	8.5	18.0	
		S-5	15.0-15.0	0	0	50 /0"	R	S-5: No Recovery	2	11	15.5	
	(2:46)	C-1	15.1-20.1	60	60			C-1: Moderately hard, moderately to slightly weathered, gray with orange SILTSTONE, extremely to slightly fractured, 5" quartz layer at bottom of core sample (RQD = 25%)				
15	(3:03)											
	(2:36)											
	(3:19)											
	(5:13)											
20										20.1	6.4	
								End of exploration at 20.1 feet				
25												
30												

REMARKS
 1 - Drilling resistance increased at 8.5' below grade.
 2 - Portions of the gravel in sample S-4 were weathered.

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

Exploration No.:
GZ-103

GZA TEMPLATE TEST BORING - GZA GINT DATA TEMPLATE 10-27-20.GDT - 3/20/25 16:55 - J:\GINT PROJECT DATABASES\35492.00_MEVA MAINTENANCE FACILITY.GPJ

TEST BORING LOG



GZA
GeoEnvironmental, Inc.
Engineers and Scientists

Robinson Green Beretta Corporation
MEVA Facility
123 Railroad Ave, Haverhill, MA

EXPLORATION NO.: GZ-104
SHEET: 1 of 1
PROJECT NO: 35492.00
REVIEWED BY: AGD

Logged By: N. Westkott
Drilling Co.: NEBC
Foreman: Mark D'Abrosia

Type of Rig: Truck
Rig Model: GTECH GT8
Drilling Method:
Drive & Wash

Boring Location: See Plan
Ground Surface Elev. (ft.): 24.5
Final Boring Depth (ft.): 14.5
Date Start - Finish: 1/3/2025 - 1/3/2025

H. Datum:
V. Datum: NAVD88

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

Sampler Type: SS
Sampler O.D. (in.): 2.0
Sampler Length (in.): 24
Rock Core Size: N/A

Groundwater Depth (ft.)

Date	Time	Stab. Time	Water	Casing
Not Measured				

Depth (ft)	Casing Blows/ (Core Rate)	Sample						Sample Description (Modified Burmister Classification)	Remark	Depth (ft.)	Stratum Description	Elev. (ft.)
		No.	Depth (ft.)	Pen. (in)	Rec. (in)	Blows (per 6 in.)	SPT Value					
5		S-1	0.0-2.0	24	14	5 7 9 8	16	S-1: Top 7": Black fine to coarse SAND, some fine to coarse Gravel, little Silt, dry Bottom 7": Brown fine to coarse SAND, trace Silt, dry		Fill		
		S-2	2.0-4.0	24	6	14 8 5 4	13	S-2: Medium dense, brown fine to coarse SAND, some Silt, little fine to coarse Gravel, moist				
		S-3	4.0-6.0	24	0	3 3 2 2	5	S-3: No recovery				
10		S-4	10.0-11.8	21	3	1 2 15 100/3"	17	S-4: Medium dense, brown/grey, fine to coarse GRAVEL and fine to coarse SAND, trace Silt, wet	1	10 ----- 14.5 Glacial Till with Boulders 11.75 ----- 12.8		
15		S-5	14.5-14.5	0	0	50 /0"	R	S-5: No Recovery	2 3	Inferred Bedrock or Boulder 14.5 ----- 10.0		
								End of exploration at 14.5 feet	4			

REMARKS

- 1 - Dilling wash return lost when washing out casing at 10' below grade.
- 2 - Drilling resistance between 11.75' and 14.5' indicated boulder or bedrock. Wash return was white when rollerbitting over this depth.
- 3 - Drilling wash returned when rollerbitting at 12' after seating casing at 12'.
- 4 - Drilling wash return was lost at 14.5'.

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

Exploration No.:
GZ-104

GZA TEMPLATE TEST BORING - GZA GINT DATA TEMPLATE 10-27-20.GDT - 3/20/25 16:56 - J:\GINT PROJECT DATABASES\35492.00_MEVA MAINTENANCE FACILITY.GPJ



ATTACHMENT C

Rock Core Photo Log



Photographic Log

Client Name: Robinson Green Beretta Corporation	Site Location: 123 Railroad Avenue, Haverhill, MA 01835	Project No.: 03.0035492.00
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Photo 1



Description: View of rock core samples from borings GZ-101 and GZ-102.

Photo 2



Description: View of rock core sample from boring GZ-103.



ATTACHMENT D

Geotechnical Laboratory Results



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

Client Information:
GZA GeoEnvironmental
 Providence, RI
 (401) 421-4140
 Project Contact: Anthony DiGiantommaso
 Collected By: Client

Project Information:
MEVA Maintenance Facility
 85 Railroad Ave, Haverhill, MA
 Project Number: 03.0035492.00
 Summary Page: 1 of 1
 Report Date: 1/17/2025

LABORATORY TESTING DATA SHEET, Report No.: 7425-A-162

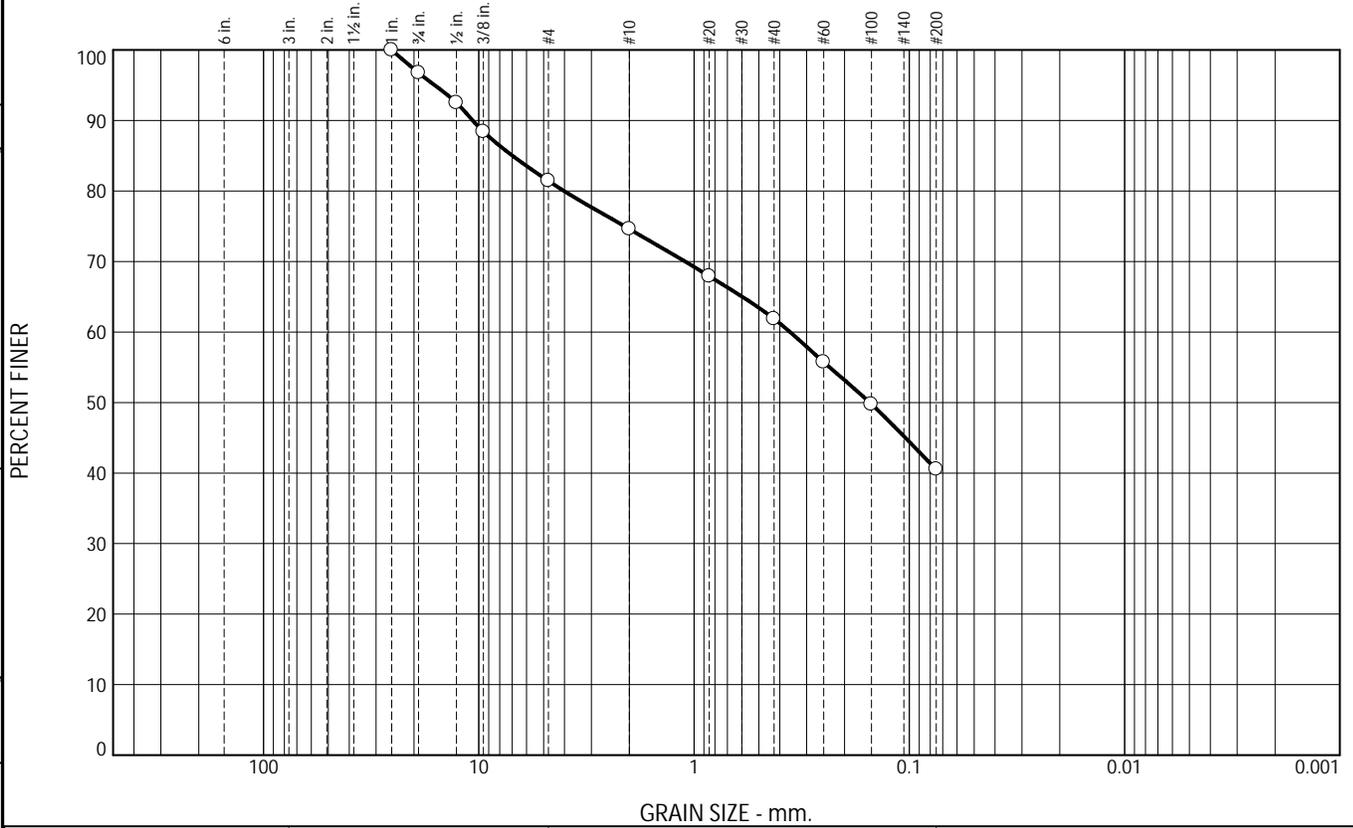
Material Source	Sample ID	Depth (ft)	Laboratory No.	Identification Tests										Proctor / CBR / Permeability Tests							Laboratory Log and Soil Description	
				As Rcvd Moisture Content %	LL %	PL %	OD LL	Gravel %	Sand %	Fines %	Org. %	pH	9 _d MAX (pcf) W _{opt} (%)	9 _d MAX (pcf) W _{opt} (Corr.)	Dry unit wt. (pcf)	Test Moisture Content %	Target Test Setup as % of Proctor	CBR @ 0.1"	CBR @ 0.2"	Permeability cm/sec		
				D2216	D4318			D6913			D2974	D4792	D1557									
GZ-101	S-2A	2-4	25-S-180					18.6	40.9	40.5											Brown f-c SAND and CLAYEY SILT, little f-c Gravel	
GZ-101	S-3	5-6.2	25-S-181					41.5	39.9	18.6											Brown fine GRAVEL and f-c SAND, little Silt	
GZ-102	S-3A	5-7	25-S-182					0.0	45.6	54.4											Light Brown SILT and fine SAND	
GZ-103	S-1	1-3	25-S-183					15.7	50.0	34.3											Brown f-c SAND, some Clayey Silt, little fine Gravel	

Date Received: 1/13/2025 Reviewed By:  Date Reviewed: 1/17/2025

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These results are for the exclusive use of the client for whom they were obtained. This report only relates to items inspected and/or tested. No warranty, expressed or implied, is made.

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	3.3	15.3	6.8	12.7	21.4	40.5	

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1"	100.0		
3/4"	96.7		
1/2"	92.5		
3/8"	88.4		
#4	81.4		
#10	74.6		
#20	67.9		
#40	61.9		
#60	55.7		
#100	49.8		
#200	40.5		

* (no specification provided)

Soil Description

Brown f-c SAND and CLAYEY SILT, little f-c Gravel

Atterberg Limits
 PL= NP LL= NV PI= NP

Coefficients
 D₉₀= 10.6685 D₈₅= 6.9693 D₆₀= 0.3580
 D₅₀= 0.1529 D₃₀= D₁₅=
 D₁₀= C_u= C_c=

Classification
 USCS= SM AASHTO= A-4(0)

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

Source of Sample: Boring Depth: 2-4'
 Sample Number: GZ-101 / S-2A

Date: 1/16/25

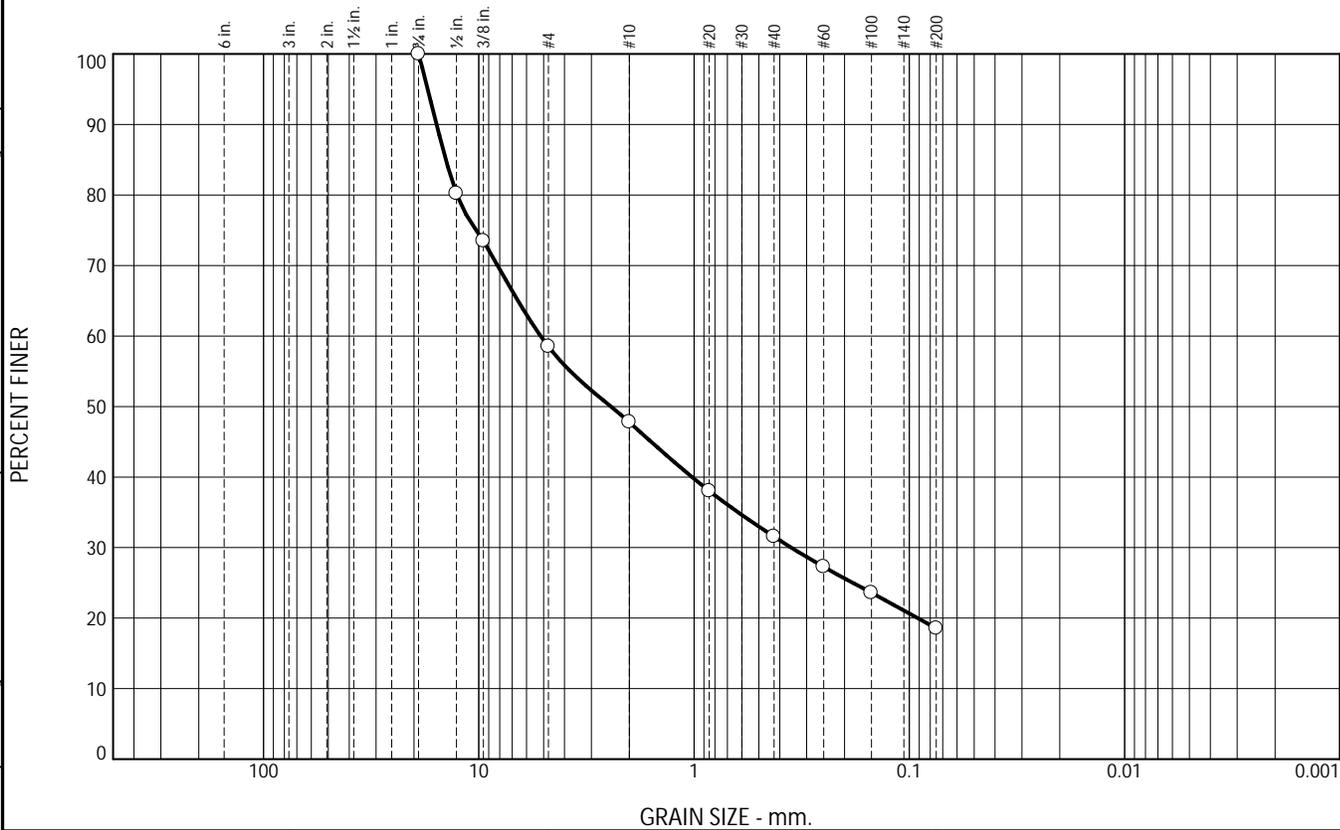
Thielsch Engineering Inc. Cranston, RI	Client: GZA GeoEnvironmental Project: MEVA Maintenance Facility Haverhill, MA Project No: 03.0035492.00
Fig. 25-S-180	

Tested By: RKO/SBR

Checked By: Rebecca Roth

These results are for the exclusive use of the client for whom they were obtained. This report only relates to items inspected and/or tested. No warranty, expressed or implied, is made.

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	41.5	10.7	16.2	13.0	18.6	

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100.0		
1/2"	80.2		
3/8"	73.5		
#4	58.5		
#10	47.8		
#20	38.0		
#40	31.6		
#60	27.3		
#100	23.6		
#200	18.6		

Soil Description

Brown fine GRAVEL and f-c SAND, little Silt

Atterberg Limits
 PL= NP LL= NV PI= NP

Coefficients
 D₉₀= 15.7135 D₈₅= 14.2224 D₆₀= 5.1611
 D₅₀= 2.4341 D₃₀= 0.3538 D₁₅=
 D₁₀= C_u= C_c=

Classification
 USCS= GM AASHTO= A-1-b

Remarks

* (no specification provided)

Source of Sample: Boring Depth: 5-6.2'
 Sample Number: GZ-101 / S-3

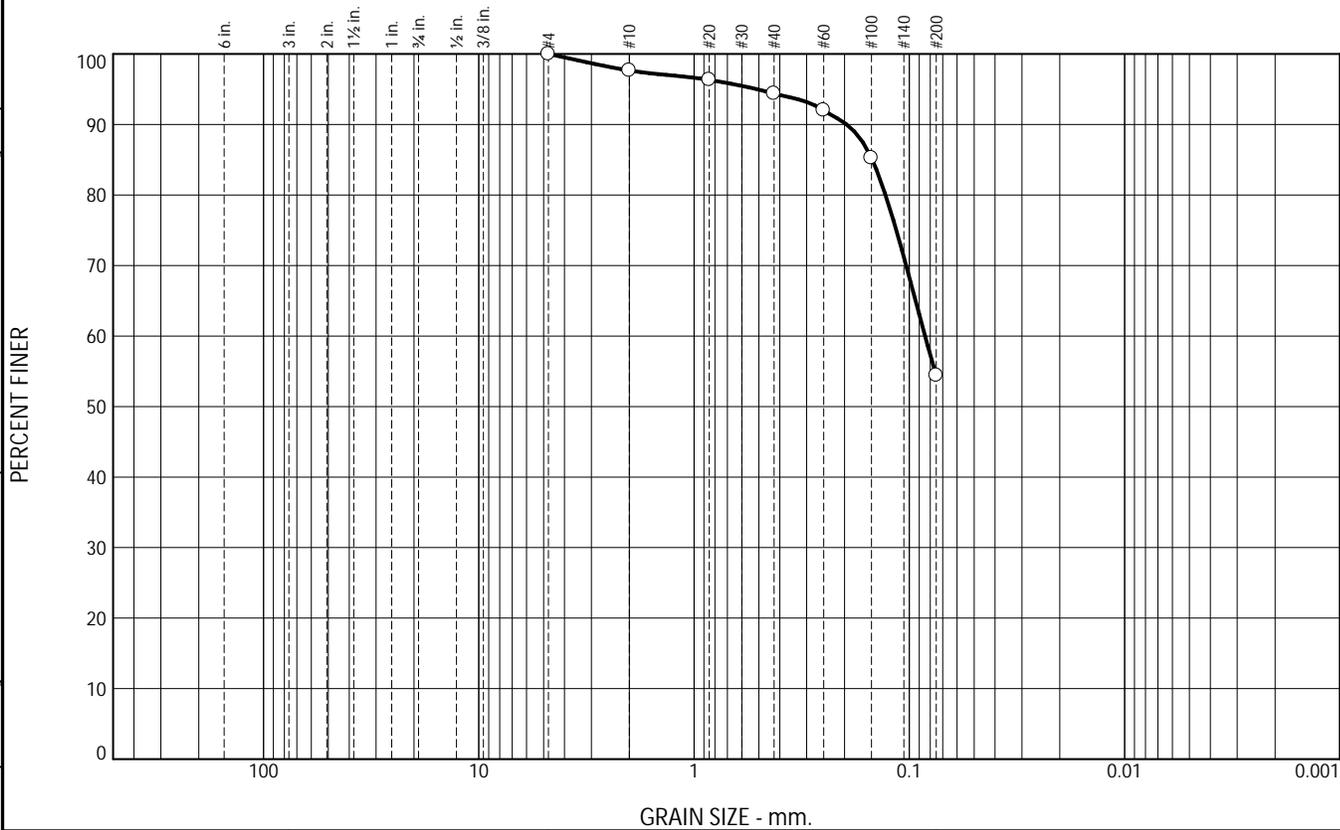
Date: 1/16/25

Thielsch Engineering Inc. Cranston, RI	Client: GZA GeoEnvironmental Project: MEVA Maintenance Facility Haverhill, MA Project No: 03.0035492.00
Fig. 25-S-181	

Tested By: RKO/SBR Checked By: Rebecca Roth

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Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	2.3	3.3	40.0	54.4	

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	97.7		
#20	96.3		
#40	94.4		
#60	92.0		
#100	85.3		
#200	54.4		

Soil Description

Light Brown SILT and fine SAND

Atterberg Limits
 PL= NP LL= NV PI= NP

Coefficients
 D₉₀= 0.1955 D₈₅= 0.1487 D₆₀= 0.0845
 D₅₀= D₃₀= D₁₅=
 D₁₀= C_u= C_c=

Classification
 USCS= ML AASHTO= A-4(0)

Remarks
 Sample visually classified as non-plastic. Sample could not be rolled to 1/4".

* (no specification provided)

Source of Sample: Boring Depth: 5-7'
 Sample Number: GZ-102 / S-3A

Date: 1/16/25

Thielsch Engineering Inc. Cranston, RI	Client: GZA GeoEnvironmental Project: MEVA Maintenance Facility Haverhill, MA Project No: 03.0035492.00
Fig. 25-S-182	

Tested By: RKO/SBR Checked By: Rebecca Roth

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Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	15.7	6.3	18.0	25.7	34.3	

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100.0		
1/2"	93.8		
3/8"	90.7		
#4	84.3		
#10	78.0		
#20	69.6		
#40	60.0		
#60	53.3		
#100	46.0		
#200	34.3		

Soil Description

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

Atterberg Limits
 PL= NP LL= NV PI= NP

Coefficients
 D₉₀= 8.9141 D₈₅= 5.1690 D₆₀= 0.4265
 D₅₀= 0.1970 D₃₀= D₁₅=
 D₁₀= C_u= C_c=

Classification
 USCS= SM AASHTO= A-2-4(0)

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

* (no specification provided)

Source of Sample: Boring Depth: 1-3'
 Sample Number: GZ-103 / S-1

Date: 1/16/25

Thielsch Engineering Inc. Cranston, RI	Client: GZA GeoEnvironmental Project: MEVA Maintenance Facility Haverhill, MA Project No: 03.0035492.00 Fig. 25-S-183
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Tested By: RKO/AB/SBR Checked By: Rebecca Roth