July 27, 2015

Mr. Todd M. Costa
Kaestle Boos Associates, Inc.
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Re: **Geotechnical Letter Report**
Proposed Police Station
Middleborough, Massachusetts
LGCI Project No. 1525

Dear Mr. Costa:

Lahlaf Geotechnical Consulting, Inc. (LGCI) has completed a geotechnical study for the proposed police station in Middleborough, Massachusetts. This letter report presents the results of our study.

We performed our services in general accordance with our proposal No. 15074 dated July 1, 2015. Mr. Michael McKeon of Kaestle Boos Associates, Inc. (KBA) authorized our services by signing our proposal on July 20, 2015.

1. PROJECT INFORMATION

1.1 Purpose and Scope of Services

The purpose of this study was to obtain preliminary subsurface information at the site and to provide preliminary foundation design and construction recommendations for the police station. LGCI performed the following services:

- Provided a geotechnical engineer to observe test pits excavated by the Town of Middleborough DPW, describe the soil samples, and prepare field logs.
- Submitted two (2) soil samples for grain-size analyses.
- Prepared this geotechnical letter report containing the results of our subsurface explorations, and our preliminary foundation design and construction recommendations.

We understand that LGCI will be engaged to perform additional explorations, including soil borings and test pits, during the design phase. At that time, LGCI will revise the recommendations contained in this preliminary geotechnical report, if needed.

LGCI did not perform environmental services for this project. LGCI did not perform an assessment to evaluate the presence or absence of hazardous or toxic materials above or below the ground surface at or around the site. Any statement about the color, odor, or the presence of suspicious materials included in our test pit logs or report were made by LGCI for information only and to support our geotechnical services. No environmental recommendations and/or opinions are included in this report.

Our scope did not include preparing specifications, attending meetings, performing contract document review, or providing construction services. LGCI would be pleased to perform these services, when needed, under a separate agreement. Recommendations for stormwater management, erosion control, pavement design, and detailed cost or quantity estimates are not included in our scope of work.

1.2 Site Description

The site is located on the western side of Wood Street just south of the intersection with East Main Street in Middleborough, Massachusetts as shown in Figure 1.

Our understanding of the site is based on our field observations and on the following drawings:

> "Wood Street North – Site #2, Middleborough Police Study," (Site Plan) prepared by KBA and dated June 25, 2015.

The site is mostly vacant and wooded and is accessible from Wood Street. The eastern side of the site near Wood Street is currently used by the Town of Middleborough as a material storage yard. A large stockpile of crushed asphalt is located near the entrance to the site.

Survey data about the site is not available at this time; however, based on the Site Plan, the ground surface at the site rises in a southerly direction to a plateau near the southern edge of the site. What appears to be wetlands are located at low elevations on the northern side of the site.

1.3 Project Description

We understand that the Town of Middleborough plans to build a new Police Facility at the site. We understand that the proposed facility will have a footprint of between 12,000 and 15,000 square feet. Based on our discussions with KBA, we understand that the proposed facility will likely be located on the plateau on the southern side of the site. We understand that the proposed facility will not have a basement. No other details about the proposed facility are available at this time.

2. SITE AND SUBSURFACE CONDITIONS

2.1 Surficial Geology

LGCI reviewed the following map:

> "Surficial geologic map of the Norton-Manomet-Westport-Sconticut Neck 23-quadrangle area in southeast Massachusetts" prepared by Stone, B.D., Stone, J.R., DiGiacomo-Cohen, M.L., and Kincare, K.A, for U.S. Geological Survey, Open-File Report 2006–1260–F, 2011.

Based on the map, the natural surficial materials at the site consist of coarse glacial stratified deposits. These deposits are comprised of gravel deposits and sand deposits, and may contain very fine sand, silt, and clay.

The surficial geologic map is shown in Figure 2.

2.2 Test Pits

The Town of Middleborough DPW provided equipment and an operator to excavate six (6) test pits (TP-1 to TP-6) using a CAT 315CL rubber-tire backhoe on July 15, 2015. The test pits extended to depths ranging between 6.5 and 17.3 feet beneath the ground surface. Upon completion, the test pits were backfilled with the excavated material that was placed and compacted in 12-inch lifts.

The test pit locations are shown in Figure 3, and the test pit logs are included as attachment A.

2.3 Subsurface Conditions

The subsurface descriptions in this report are based on a limited number of test pits and are intended to highlight the major soil strata encountered during our test pits. The subsurface conditions are known only at the actual test pit locations. Variations may occur and should be expected between test pit locations. The test pit logs represent conditions that we observed at the time of our explorations 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 logs are based on our interpretations and the actual transition may be gradual. Graphic soil symbols are for illustration only.

The soil strata encountered in the test pits were as follows, starting at the ground surface:

<u>Topsoil/Forest Mat and Subsoil</u> – A layer of 2 to 24 inches of topsoil/forest mat and subsoil was encountered at the ground surface in the test pits. This layer was thin in the test pits excavated in preciously disturbed areas.

Fill – Fill was encountered beneath the topsoil/forest mat and subsoil in test pits TP-4 to TP-6. This extended to depths ranging between 1.5 and 6 feet beneath the ground surface. The fill consisted mostly of silty sand with up to 20 percent fines. In test pit TP-5, the fill consisted of well graded sand with silt. The fill contained up to 15 percent gravel. It also contained asphalt, organic soil, root, and bricks.

About one foot of buried topsoil and about 1.2 feet of peat were encountered beneath the fill in test pits TP-4 and TP-6, respectively. Based on the site topography and the results of the test pits, peat and/or buried topsoil is likely to be present in the low lying areas.

Sand – Sand was encountered beneath the fill or topsoil/forest mat and subsoil. The gradation of this layer ranged from Silty sand with up to 20 percent fines to well graded sand with to 15 percent fines and up to 30 percent fine gravel. This layer contained more gravel in test pit TP-6 and was classified as well graded gravel with sand. This layer extended to the test pit termination depths.

2.4 Groundwater

Groundwater was encountered in test pits TP-3 to TP-6. These test pits were excavated in the lower areas of the site. The groundwater levels ranged between 5 and 11 feet beneath the ground surface.

The groundwater levels were measured during our test pits and therefore may not represent the actual groundwater levels, as additional time may be required for the groundwater levels to stabilize. The groundwater levels reported herein only represent the conditions encountered at the time and locations of our test pits. Seasonal variation should be expected.

2.5 Laboratory Test Results

LGCI submitted two (2) soil samples obtained from the test pits for grain-size analysis. The laboratory data sheets are included in Attachment B and the results are summarized below.

Test Pit No.	Sample Depth (ft.)	Soil Layer	Percent Gravel	Percent Sand	Percent Fines
TP-1	2 – 15	Nat. Sand	.6	80.4	19
TP-2	2 – 12	Nat. Sand	27.1	71.6	1.3

EVALUATION AND RECOMMENDATIONS

3.1 General

The subsurface conditions encountered in the test pits are suitable to support the proposed police station after the subgrade of the proposed foundations is prepared in accordance with the recommendations in this report.

The topsoil/forest mat/subsoil layer and the existing fill are not suitable to support the proposed building. If the proposed building is located on the plateau where test pits TP-1 and TP-2 were excavated, little to no fill is anticipated within the proposed building footprint. If the building is located near the low lying areas, excavation to remove the topsoil/forest mat and subsoil, the existing fill, and the buried topsoil and peat should be anticipated and will extend to depths of up to 6 feet. The fill may be deeper at locations not explored by LGCI.

The proposed building footings and slab should be supported on Structural Fill placed directly on top of the natural sand. Where the fill does not overlay peat, the existing fill could be improved under paved areas. Our recommendations for preliminary allowable net bearing resistance and for slab support are presented in Sections 3.2aned 3.4. Our recommendations for preparing the subgrade and improving the existing fill are presented in Section 4.1.

We believe that the major consideration during construction will be the delineation of the peat and buried subsoil layer. We recommend engaging LGCI to perform additional explorations after the proposed building layout is established.

3.2 Allowable Bearing Pressure

- Footings should be founded on Structural Fill placed directly on top of the natural sand. The subgrade of footings should be prepared in accordance with the recommendations in Section 4.1. A representative of LGCI should observe the subgrade during construction to confirm that it is consistent with the materials encountered in our explorations.

- For footing design, we recommend using a net preliminary allowable bearing pressure of 4,000 pounds per square foot (psf).

- All foundations should be designed in accordance with *The Commonwealth of Massachusetts State Building Code 780 CMR, Eighth Edition* (MSBC 8th Edition).

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

- We recommend that wall footings have a minimum width of 2 feet, and that column footings have a minimum width of 3 feet. For foundations with a least lateral dimension smaller than 3 feet, the allowable bearing pressure should be reduced to 1/3 of the recommended allowable bearing pressure times the least dimension in feet.

- 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.

3.3 Settlement

We estimate that the total settlement, using the net allowable bearing pressure recommended in this report, will be 1 inch or less, and that the differential settlement will be ¾-inch or less over a distance of 25 feet. Total and differential settlements of these magnitudes are usually considered tolerable for the anticipated construction. However, the tolerance of the proposed structure to the predicted total and differential settlements should be assessed by the Structural Engineer.

3.4 Concrete Slab Considerations

- We recommend supporting the proposed slab on a minimum of 12 inches of Structural Fill placed directly over the natural sand after the forest mat/topsoil/subsoil, the existing fill, and the peat are removed from under the proposed building footprint. The subgrade of the proposed slab should be prepared in accordance with the recommendations in Section 4.1.

- A vapor retarder membrane with a minimum thickness of 15 mils could be used beneath the slab. The need for such a membrane should be evaluated by the architect. The membrane should be protected from puncture during placement of the steel mesh and 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 85 tons per cubic foot (tcf) (100 pci). 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:

$$Modulus\ of\ Subgrade\ \mathrm{Re}action\ (k_s) = k_{s1} * \left(\frac{B+1}{2B}\right)^2$$

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 and exterior utility trenches should be properly compacted as recommended in Section 3.6.

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

3.5 Seismic Design Criteria

In accordance with AASHTO-6, Section 3.10, the seismic criteria are as follows:

- Site Class: D
- Spectral Response Acceleration at short period (S_s): 0.24g
- Spectral Response Acceleration at 1 sec. (S_1): 0.061g
- Site Coefficient F_a (Table 9.4.1.2.4a): 1.6
- Site Coefficient F_v (Table 9.4.1.2.4b): 2.4
- Adjusted spectral response S_{ms}: 0.384g
- Adjusted spectral responses S_{m1}: 0.146g

Soil borings are needed to assess the liquefaction potential of the natural sand. LGCI will provide this recommendation after borings are performed at the site.

3.6 Site Utilities

Utilities should be placed on suitable bedding material in accordance with the manufacturer's recommendations. "Cushion" material should be placed, by hand, above the utility pipe in maximum 6-inch lifts. The lift should be compacted by hand to avoid damage to the utility. Where the bedding/cushion material consists of crushed stone, it should be wrapped in a geotextile fabric.

3.7 Paved Areas

We recommend removing at least 12 inches of the existing fill in paved areas and restoring the grades with Ordinary Fill before placing the subbase layer. The extent of the removal may be deeper depending on the results of a proof-rolling test as described in Sections 4.1 and in areas where zones of roots and organic soil are encountered. In areas where the fill is underlain by peat, the peat should be removed from under the paved areas.

3.8 Sidewalks

- Sidewalks 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 sidewalk, the sidewalk concrete sections should be sealed with a waterproof compound. The sidewalks 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 sidewalk surfaces.

3.9 Typical Pavement Sections

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)

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).

Areas to receive relatively highly concentrated, sustained loads such as dumpsters, loading areas, and storage bins are typically installed over a rigid pavement section to distribute concentrated loads and reduce the possibility of high stress concentrations on the subgrade. Typical rigid pavement sections consist of 6 inches of concrete placed over a minimum of 12 inches of subbase material.

4 CONSTRUCTION CONSIDERATIONS

4.1 Subgrade Preparation

- The surficial organic soil should be entirely removed from under the construction area, including the proposed building footprint and paved areas.

- The contractor should perform test pits at the start of construction to delineate the limits of the peat and organic soil beneath the existing fill.

- The forest mat/topsoil/subsoil layer, the fill layer, and the peat should be removed from under the proposed building footprint. The removal should extend beyond the limits of the proposed building a distance equal to the height of the removed material beneath the proposed footings or 5 feet, whichever is greater. After the forest mat/topsoil/subsoil layer, the fill layer, and the peat are removed, the exposed subgrade should be compacted with a vibratory compactor imparting a minimum of 40 kips of force to the subgrade.

- The base of the footing excavations 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 concrete.

- Due to the silty nature of the natural silty sand and to reduce the potential for disturbance, we recommend placing a minimum of 6 inches of Structural Fill or crushed stone at the bottom of the footing excavations during construction to serve as a working pad.

- Boulders at the bottom of the excavation for footings and slabs should be removed, and the resulting excavation should be backfilled with compacted Structural Fill.

- 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 below the subbase material of the proposed paved areas and sidewalks, should meet the gradation and compaction requirements of Ordinary Fill shown in Section 4.3.2.

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

- After the top 12 inches of fill are removed beneath the subbase layer of the proposed paved areas, the exposed fill surface should be compacted with a vibratory roller compactor imparting a minimum dynamic effort of 40 kips. The compacted surface should be proof-rolled with a loaded dump truck. The proof-rolling should be observed by a representative of LGCI. Where ruts are formed, the fill should be removed. Please note that compaction and handling of the existing fill will be difficult when the fill is wet.

4.2 Subgrade Protection

The onsite fill and natural sand are anticipated to be 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. The proposed wall foundation excavations should be backfilled as soon as possible after construction. Soil used as backfill should be free of frozen material, as should be the ground on which it is placed. Fill placement should be halted during freezing weather.

The onsite soils will likely be sensitive to moisture content variations. The contractor should keep exposed subgrades properly drained and free of ponded water. This may be achieved by sloping the site topography adjacent to the construction to direct the water away from the excavation, by trenching and berming to collect the excess run-off, or by other means. If the subgrade soils are wet, machine or foot traffic should be reduced or eliminated to lessen disturbance of the subgrade.

4.3 Compacted Fill

Fill placed within the footprint of the proposed buildings and under sidewalks should meet the gradation and compaction requirements of Structural Fill. Fill placed outside the building footprint beneath any pavement subbase should meet the gradation and compaction requirements of Ordinary Fill. Structural Fill and Ordinary Fill should consist of inert, hard, durable sand and gravel, free from organic matter, clay, surface coatings and deleterious materials.

4.3.1 Structural Fill

Structural Fill should have a plasticity index of less than 6, should be well graded, 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 percent of optimum moisture content.

Sieve Size	Percent Passing by Weight
3 inches	100
1.5 inches	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

4.3.2 Ordinary Fill

Ordinary Fill should have a plasticity index of less than 6, should be well graded, 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 of Existing Soils

Based on the grain-size analyses, the natural sand may be used as Ordinary Fill and may also be used as Structural Fill if improved by blending with other material.

During earthwork operations, the contractor should avoid mixing the reusable soils with fine-grained and/or organic soils. The soils to be reused should be excavated and stockpiled separately.

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

4.5 Temporary Earth Support System and Excavation Safety

Excavations must 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 be shored.

If space does not allow for open excavations, a temporary earth support system will be needed. 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. The earth support system should be designed by a professional engineer registered in the Commonwealth of Massachusetts and engaged by the contractor.

4.6 Groundwater Control Procedures

Based on the groundwater levels encountered in our test pits, we anticipate that groundwater control procedures will be needed during the removal of the existing fill. We expect that filtered sump pumps installed in pits located at least three feet below the bottom of the excavation may be sufficient to handle the groundwater or surface runoff that may enter the excavation.

The contractor should be permitted to employ whatever commonly accepted means and practices are 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.

5 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 structure 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 contaminates in or around the site.

We cannot accept responsibility for designs based on recommendations in this report unless we are engaged to 1) perform additional explorations, 2) make site visits during construction to check that the subsurface conditions exposed during construction are in general conformance with our design assumptions and 3) 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 Kaestle Boos Associates, Inc. for the specific application to the proposed police station in Middleborough,, Massachusetts as conceived at this time.

Very truly yours,

Lahlaf Geotechnical Consulting, Inc.

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

Attachments: Figure 1 – Site Location Map
Figure 2 – Surficial Geologic Map
Figure 3 – Test Pit Location Plan
Attachment A – Test Pit Logs
Attachment B – Laboratory Test Results

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0 0.5 Mi

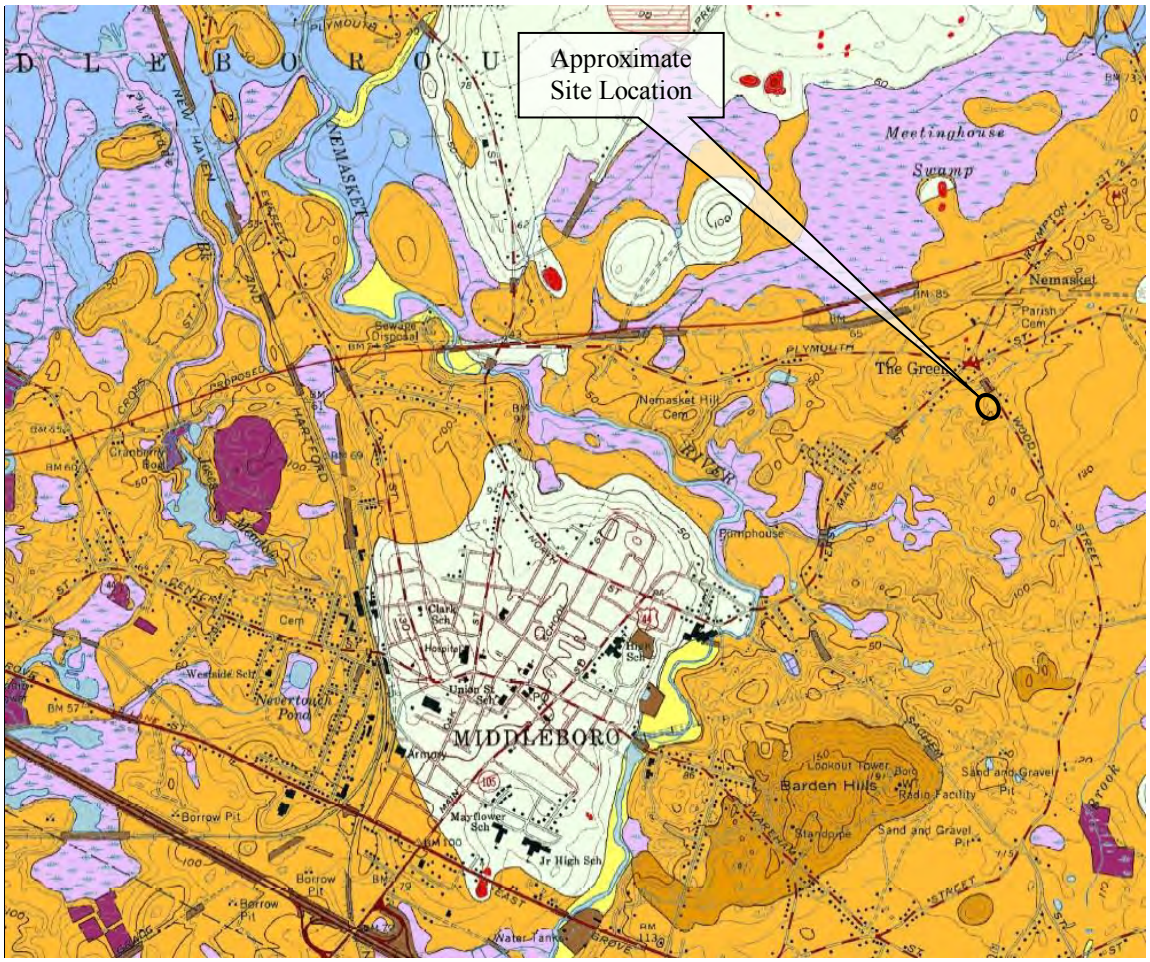
0 3000 Ft

Map provided by MyTopo.com

Contour intervals: 10 feet

Note: Figure based on USGS topographic map of Middleborough, MA from http://www.mytopo.com/maps

Client:	Project:	**Figure 1** **Site Location Map**	
Kaestle Boos Associates, Inc.	Proposed Police Station		
LGCI Lahlaf Geotechnical Consulting, Inc.	Project Location: Middleborough, MA	LGCI Project No.: 1525	Date: July 2015



Glacial Stratified Deposits

Sorted and stratified sediments composed of gravel, sand, silt, and clay (as defined in particle-size diagram, fig. 3) deposited in layers by glacial meltwater. These sediments occur as four basic textural units—gravel deposits, sand and gravel deposits, sand deposits, and fine deposits. On this interim surficial geologic map layer, gravel, sand and gravel, and sand deposits are not differentiated and are shown as *Coarse deposits* where they occur at land surface. *Stagnant-ice deposits* are surface coarse sediments bounded by ice-contact slopes, present on tops of till hills or extending >30 ft above the altitudes of adjacent meltwater morphosequences in lowlands. These stagnant-ice deposits are aligned in belts parallel to the retreating ice margin. *Fine deposits* also are shown where they occur at land surface. Textural changes occur both areally and vertically (fig. 2); however, subsurface textural variations are not shown on this map.

Coarse deposits include gravel deposits composed of at least 50 percent gravel-size clasts; cobbles and boulders predominate; minor amounts of sand occur within gravel beds, and sand comprises 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 from 25 to 50 percent gravel particles and from 50 to 75 percent sand particles. Layers are well 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

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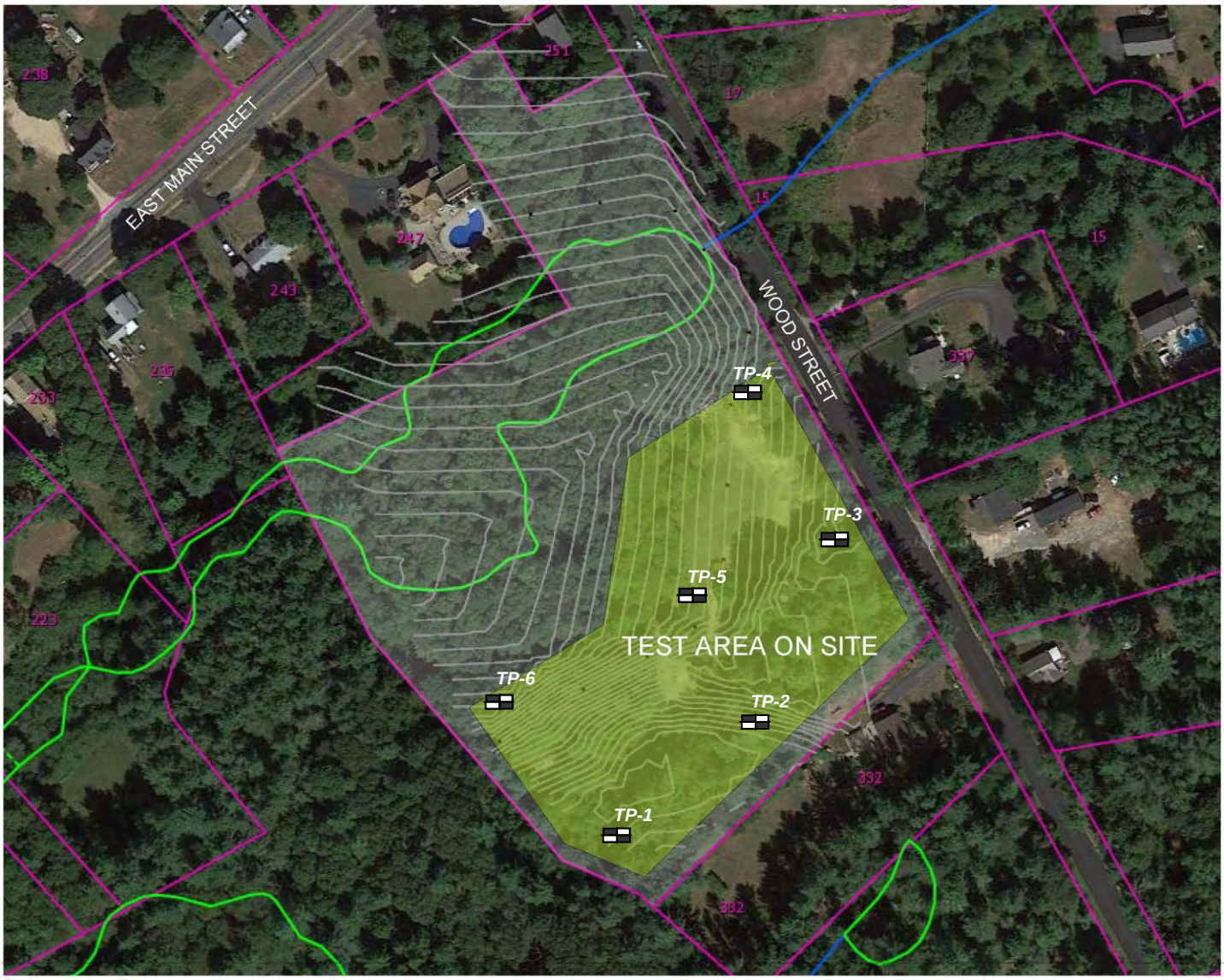
Note: Figure based on map titled:, "Surficial geologic map of the Norton-Manomet-Westport-Sconticut Neck 23-quadrangle area in southeast Massachusetts" prepared by Stone, B.D., Stone, J.R., DiGiacomo-Cohen, M.L., and Kincare, K.A, for U.S. Geological Survey, Open-File Report 2006–1260–F, 2011.

Client:	Project:	Figure 2 - Surficial Geologic Map	
Kaestle Boos Associates, Inc.	Proposed Police Station		
LGCI Lahlaf Geotechnical Consulting, Inc.	Project Location: Middleborough, MA	LGCI Project No.: 1525	Date: July 2015



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Legend

Test pit excavated by the Town of Middleborough DPW on July 15, 2015 and observed by Lahlaf Geotechnical Consulting, Inc. (LGCI).

Note: Figure based on Plan titled "Wood Street North – Site #2, Middleborough Police Study," prepared by Kaestle Boos Associates, Inc. and dated June 25, 2015.

Client:	Project:	**Figure 3 – Test Pit Location Plan**	
Kaestle Boos Associates, Inc.	Proposed Police Station		
LGCI Lahlaf Geotechnical Consulting, Inc.	Project Location: Middleborough, MA	LGCI Project No.: 1525	Date: July 2015

Attachment A – Test Pit Logs

LGCI
Lahlaf Geotechnical Consulting, Inc.

Project:	**Proposed Police Station, Middleborough, MA**		
Client:	**Kaestle Boos Associates, Inc.**		LGCI Project No.: 1525
Excavation Subcontractor:	Middleborough DPW	Date Started:	07/15/15
Excavation Foreman :	Jeff Jenness	Date Completed:	07/15/15
LGCI Engineer:	A. M. Lahlaf	Location:	SW corner of site
Ground Surface El:	N/A	Total Depth:	17.3 feet
Groundwater Depth:	Not encountered	Excavator Type:	CAT 315CL
		Test Pit Dimension	8' x 15'

Depth Scale	Exc. Effort	Remark	Strata	Soil Description
	E		Topsoil/ Subsoil ~24"	8": Topsoil 8" - 24": Silty SAND (SM), fine, ~15% fines, traces of organic soil, roots, orange brown, subsoil
	M			
	M		Sand	24" - 15': Silty SAND (SM), fine, 15-20% fines, tan, moist
	M			
5 ft	M			
	M			
	M			
	M			
	M			
10 ft	M			
	M			
	M			
	M			
15 ft	M			
	M	1		15' - 17.3': Poorly Graded SAND with Silt (SP-SM), fine, 10-15% fines in thin layers, tan brown to olive gray, moist
	M			
				End of test pit at 17.3'. Backfilled with excavated material.
20 ft				

Remarks: E = Easy, M = Moderate, D = Difficult, V = Very Difficult

1- No water seeping on sides of TP. Moisture increased at ~15'.

LGCI
Lahlaf Geotechnical Consulting, Inc.

Project:	**Proposed Police Station, Middleborough, MA**		
Client:	**Kaestle Boos Associates, Inc.**		LGCI Project No.: 1525
Excavation Subcontractor:	Middleborough DPW	Date Started:	07/15/15
Excavation Foreman :	Jeff Jenness	Date Completed:	07/15/15
LGCI Engineer:	A. M. Lahlaf	Location:	Southern side of site
Ground Surface El:	N/A	Total Depth:	12 feet
Groundwater Depth:	Not encountered	Excavator Type:	CAT 315CL
		Test Pit Dimension	15' x 15'

Depth Scale	Exc. Effort	Remark	Strata	Soil Description
	E		Topsoil/ Subsoil	0 - 12": Forest mat/ subsoil
	E		Sand	12" - 12': Well Graded SAND with Gravel (SW), medium to coarse, 25-30% fine gravel, brown, moist
	M			
	M			
5 ft	M			
	M			
	M			
	M			
	M			
10 ft	M			
	M			
	M			
				End of test pit at 12'. Backfilled with excavated material.
15 ft				
20 ft				

Remarks: E = Easy, M = Moderate, D = Difficult, V = Very Difficult

LGCI
Lahlaf Geotechnical Consulting, Inc.

Project:	**Proposed Police Station, Middleborough, MA**		
Client:	**Kaestle Boos Associates, Inc.**		LGCI Project No.: 1525
Excavation Subcontractor:	Middleborough DPW	Date Started:	07/15/15
Excavation Foreman :	Jeff Jenness	Date Completed:	07/15/15
LGCI Engineer:	A. M. Lahlaf	Location:	Eastern side of site
Ground Surface El:	N/A	Total Depth:	14 feet
Groundwater Depth:	9 feet (seeping)	Excavator Type:	CAT 315CL
		Test Pit Dimension	8' x 15'

Depth Scale	Exc. Effort	Remark	Strata	Soil Description
	E		Topsoil/	~4": Topsoil
			Fill ~18"	4" - 18": Silty SAND (SM), fine to medium, ~15-20% fines, ~10% fine gravel, traces of organic soil (fill)
	M			18" - 3.5': Well Graded SAND with Gravel (SW), medium to coarse, trace fine, ~15% fine gravel, brown, moist
	M			
	M			
5 ft	M			3.5' - 14': Poorly Graded SAND with Silt (SP-SM), fine, ~10-15% fines, tan to brown, moist, wet below 9' (eastern side of test pit material consistent with 18"-3.5')
	M			
	M			
	M			
	M			
10 ft	M			
	M		Sand	
	M			
	M			
	M			
15 ft				End of test pit at 14'. Backfilled with excavated material.
20 ft				

Remarks: E = Easy, M = Moderate, D = Difficult, V = Very Difficult

LGCI
Lahlaf Geotechnical Consulting, Inc.

Project:	**Proposed Police Station, Middleborough, MA**		
Client:	**Kaestle Boos Associates, Inc.**		LGCI Project No.: 1525
Excavation Subcontractor:	Middleborough DPW	Date Started:	07/15/15
Excavation Foreman :	Jeff Jenness	Date Completed:	07/15/15
LGCI Engineer:	A. M. Lahlaf	Location:	NE corner of site
Ground Surface El:	N/A	Total Depth:	14 feet
Groundwater Depth:	11 feet (seeping)	Excavator Type:	CAT 315CL
		Test Pit Dimension	10' x 15'

Depth Scale	Exc. Effort	Remark	Strata	Soil Description
	E		Topsoil/ Subsoil	10": Forest mat
	E		Fill ~6'	10" - 12": Asphalt (on southern side of test pit) 12" - 6': Reworked Silty SAND (SM) and Well Graded SAND (SW), with up to 20% fines, traces of organic soil, roots, bricks, orange brown, moist (fill)
	E			
	E			
5 ft	E			
	M			
	M		Buried Subsoil	6' - 7': Buried subsoil (SM), fine to medium, ~20% fines, roots, orange brown
	M		Sand	7' - 14': Well Graded SAND (SW), fine to medium, trace coarse, tan, moist, wet below 11 feet
	M			
10 ft	M			
	M			
	M			
	M			
	M			
15 ft				End of test pit at 14'. Backfilled with excavated material.
20 ft				

Remarks: E = Easy, M = Moderate, D = Difficult, V = Very Difficult

LGCI
Lahlaf Geotechnical Consulting, Inc.

Project:	**Proposed Police Station, Middleborough, MA**		
Client:	**Kaestle Boos Associates, Inc.**		LGCI Project No.: 1525
Excavation Subcontractor:	Middleborough DPW	Date Started:	07/15/15
Excavation Foreman :	Jeff Jenness	Date Completed:	07/15/15
LGCI Engineer:	A. M. Lahlaf	Location:	West of asphalt stockpile
Ground Surface El:	N/A	Total Depth:	11 feet
Groundwater Depth:	10 feet	Excavator Type:	CAT 315CL
		Test Pit Dimension	9' x 12'

Depth Scale	Exc. Effort	Remark	Strata	Soil Description
	E		Topsoil/	~4": Topsoil
	E			4" - 5': Well Graded SAND with Silt and Gravel (SW-SM), fine to medium, trace coarse, 10-15% fines, ~15% fine gravel, traces of organic soil in top 18", brown, moist (fill)
	E		Fill	
	E			
5 ft	E		~5'	
	M			5' - 11': Well Graded SAND with Gravel (SW), fine to medium, trace coarse, ~15% fine gravel, tan to brown, moist
	M		Sand	
	M			
	M			
10 ft	M			
	M			
				End of test pit at 11'. Backfilled with excavated material.
15 ft				
20 ft				

Remarks: E = Easy, M = Moderate, D = Difficult, V = Very Difficult

LGCI
Lahlaf Geotechnical Consulting, Inc.

Project:	**Proposed Police Station, Middleborough, MA**		
Client:	**Kaestle Boos Associates, Inc.**		LGCI Project No.: 1525
Excavation Subcontractor:	Middleborough DPW	Date Started:	07/15/15
Excavation Foreman :	Jeff Jenness	Date Completed:	07/15/15
LGCI Engineer:	A. M. Lahlaf	Location:	Bottom of hill on western side of site
Ground Surface El:	N/A	Total Depth:	6.5 feet
Groundwater Depth:	5 feet seeping	Excavator Type:	CAT 315CL
		Test Pit Dimension	7' x 12'

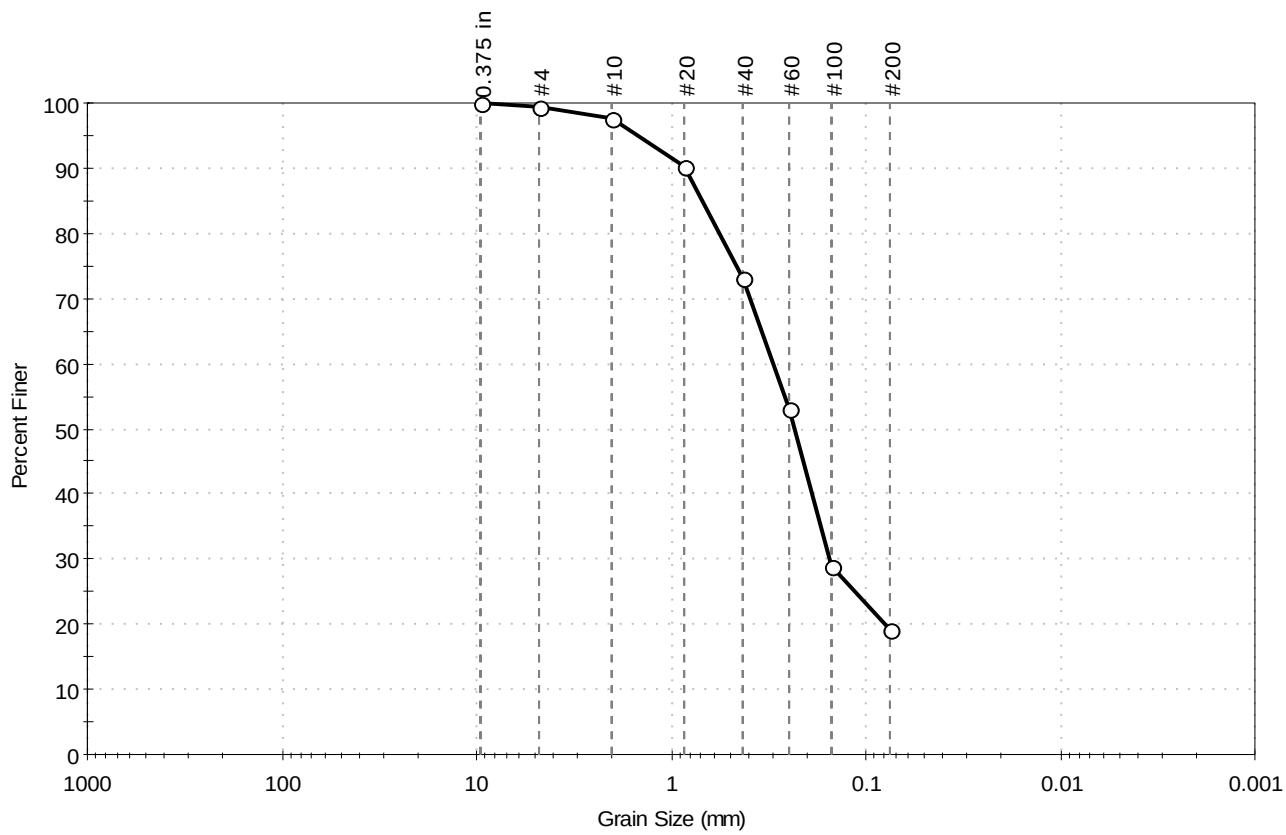
Depth Scale	Exc. Effort	Remark	Strata	Soil Description
	E		Topsoil	2": Topsoil
	E		Fill ~3.5'	2" - 3.5': Silty SAND (SM), fine to medium, trace coarse, ~15% fines, (appears reworked), brown, moist (fill)
	E			
	E		Organic Soil ~4.7'	3.5' - 4.7': Peat
5 ft	E		Sand	4.7' - 6.5': Well Graded GRAVEL with Sand (GW), fine to coarse, ~40% medium to coarse sand, gray, wet
	M			
	M			End of boring at 6.5'. Backfilled with excavated material.
10 ft				
15 ft				
20 ft				

Remarks: E = Easy, M = Moderate, D = Difficult, V = Very Difficult

Attachment B – Laboratory Test Results

Client:	Lahlaf Geotechnical Consulting				
Project:	Proposed Police Station				
Location:	Middleboro, MA			Project No:	GTX-303469
Boring ID:	TP-1	Sample Type:	bucket	Tested By:	jbr
Sample ID:	Grab	Test Date:	07/21/15	Checked By:	jsc
Depth :	2-15 ft	Test Id:	339205		
Test Comment:	---				
Sample Description:	Moist, yellowish brown silty sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.6	80.4	19.0

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100.0		
#4	4.75	99.0		
#10	2.00	98.0		
#20	0.85	90.0		
#40	0.42	73.0		
#60	0.25	53.0		
#100	0.15	29.0		
#200	0.075	19.0		

Coefficients

D_{85} = 0.6892 mm D_{30} = 0.1534 mm
D_{60} = 0.3007 mm D_{15} = N/A
D_{50} = 0.2345 mm D_{10} = N/A
C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample / Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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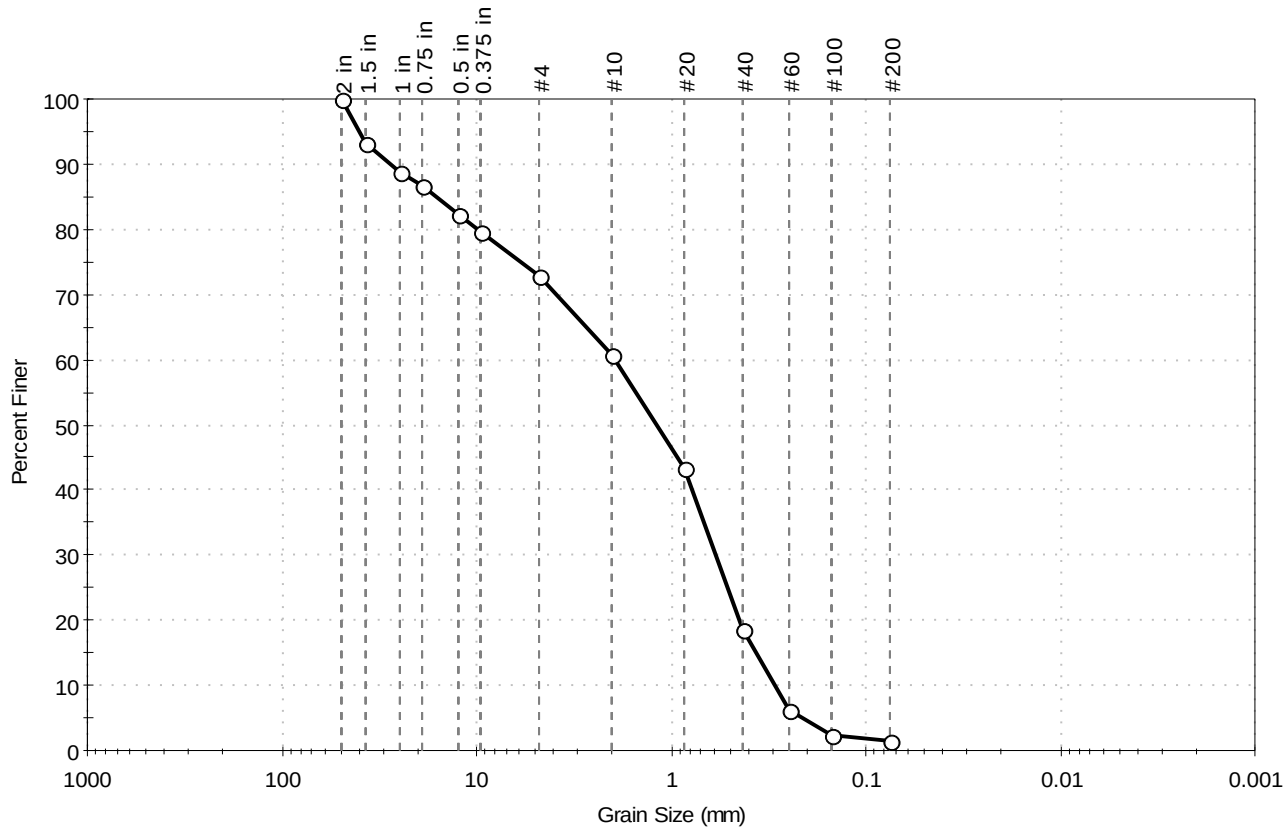
Client:	Lahlaf Geotechnical Consulting				
Project:	Proposed Police Station				
Location:	Middleboro, MA			Project No:	GTX-303469
Boring ID:	TP-2	Sample Type:	bucket	Tested By:	jbr
Sample ID:	Grab	Test Date:	07/21/15	Checked By:	jsc
Depth :	2-12 ft	Test Id:	339206		
Test Comment:	---				
Sample Description:	Moist, brown sand with gravel				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	27.1	71.6	1.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
2 in	50.00	100		
1.5 in	37.50	93		
1 in	25.00	89		
0.75 in	19.00	87		
0.5 in	12.50	82		
0.375 in	9.50	80		
#4	4.75	73		
#10	2.00	61.0		
#20	0.85	43.0		
#40	0.42	19.0		
#60	0.25	6.0		
#100	0.15	2.0		
#200	0.075	1.3		

Coefficients

D_{85} = 16.0377 mm	D_{30} = 0.5842 mm
D_{60} = 1.9158 mm	D_{15} = 0.3635 mm
D_{50} = 1.1741 mm	D_{10} = 0.2932 mm
C_u = 6.534	C_c = 0.608

Classification

ASTM Poorly graded sand with gravel (SP)

AASHTO Stone Fragments, Gravel and Sand (A-1-b (1))

Sample / Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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