

REPORT

May 4, 2017
17-0278 S

Explorations and Geotechnical Engineering Services

Proposed Wastewater Treatment Facility Project
Hilldale Avenue
Haverhill, Massachusetts

PREPARED FOR:
J and S Development Corporation
Attn: Brian Farmer
58 S Kimball Street
Haverhill, MA 01835

PREPARED BY:
S. W. Cole Engineering, Inc.
10 Centre Road
Somersworth, NH 03878-2926
(603) 692-0088



- *Geotechnical Engineering*
- *Construction Materials Testing and Special Inspections*
- *GeoEnvironmental Services*
- *Test Boring Explorations*

www.swcole.com

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17-0278 S

May 4, 2017

J and S Development Corporation
Attention: Brian Farmer
58 S Kimball Street
Haverhill, MA 01835

Subject: Explorations and Geotechnical Engineering Services
Proposed Wastewater Treatment Facility Project
Hilldale Avenue
Haverhill, Massachusetts

Dear Brian:

In accordance with our Proposal dated April 6, 2017, we have performed subsurface explorations for the subject project. This report summarizes our findings and geotechnical recommendations, and its contents are subject to the limitations set forth in Appendix A.

1.0 INTRODUCTION

1.1 Scope and Purpose

The purpose of the work was to explore subsurface conditions at the site in order to provide geotechnical recommendations relative to foundations and earthwork associated with the proposed building construction. Our scope of services included observing test boring explorations, soils laboratory testing, a geotechnical evaluation of the findings relative to the proposed construction, and preparation of this report.

1.2 Existing Conditions and Proposed Construction

The site is located off the eastern side of Hilldale Avenue in Haverhill, Massachusetts. The site generally consists of wooded area in the southern portion of the site and a gravel access road in the northern portion of the site. The site is bordered to the north by an existing trucking company facility, to the west by Hilldale Avenue, and to the east by a railroad track. The site generally slopes downward west to east from approximate elevations 74 feet to 60 feet before dropping downward relatively quickly to elevations

varying from 52 feet to 64 feet.

Based on provided plans and discussions with you, we understand proposed construction will include a new Wastewater Treatment Facility with an approximate footprint of 120 feet by 200 feet in plan dimensions. The building will be located in the northwestern portion of the site and have associated parking areas and access way along the western, southern, and eastern sides of the building. We understand finish first floor elevation of the building will vary from approximate elevations 69.1 feet to 72.3 feet. We understand excavations will be on the order of 13 to 14 feet below finish floor elevation for below grade wastewater tank construction in the western portion of the building.

We understand a 1,500 gallon oil/grit separator is proposed on the south side of the building with a proposed depth of about 6 feet. Additionally, a 10,000 gallon below grade tank is proposed on the south side of the building. However, these items are not included in our scope of work.

We have included a "Site Location Map" in Appendix B. The proposed building location in relation to existing site features is shown on the "Exploration Location Plan," included in Appendix B.

2.0 EXPLORATION AND TESTING

2.1 Explorations

Six test borings (B-1 through B-6) and two probes (P-101 and P-102) were made at the site on April 21, 2017 by S.W.COLE Explorations, LLC. The test boring locations were selected and established in the field by S. W. Cole Engineering, Inc. (S.W.COLE) using a hand-held GPS unit with sub-meter accuracy. Ground surface elevations for each test boring were estimated based on contours shown on the "Environmental Site Plan of Land" plan prepared by R.A.M. Engineering and dated March 12, 2015. Test boring logs and a key to the notes and symbols used on the logs are included in Appendix C.

2.2 Laboratory Testing

Soil samples obtained from the explorations were returned to our laboratory for further classification and testing. Gradation and moisture contents were performed on two select soil samples. Moisture content test results are noted on the logs. Gradation test

results are included in Appendix D.

3.0 SUBSURFACE CONDITIONS

3.1 Soils

Test borings made at the site generally encountered a surficial layer of 3 to 8 inches of topsoil overlying fill consisting of loose to medium dense, light brown to brown silty sand and gravel to depths ranging from 1.0 to 2.5 feet below ground surface (bgs). Below the fill at B-1 and B-5, and below the topsoil at B-6, the test borings generally encountered loose to medium dense, brown to gray silt and fine sand to depths ranging from 5.0 to 11.5 feet bgs. Below the silt and fine sand layer at B-5 and B6, below topsoil at B-3, and below fill at B-2 and B-4, the test borings encountered loose to medium dense, brown to gray clayey silt with varying portions of sand to depths ranging from 5.0 to 12.5 feet bgs. Below the silt and fine sand and/or clayey silt layers, the test borings encountered glacial till generally consisting of medium dense to very dense, brown sand with varying portions of silt and gravel to depths ranging from 9.0 to 15.1 feet bgs. Refusal surfaces (probable boulder or bedrock) was encountered at each test boring and probe locations at depths ranging from 9.8 and 16.0 feet bgs.

For a more detailed descriptions of the subsurface findings, please refer to the attached logs included in Appendix C.

3.2 Groundwater

Saturated soils were encountered at the test boring locations at a depth of about 2 to 4 feet bgs. The poorly drained characteristics of the native soils did not allow for stabilized groundwater measurements during the short time the boreholes were open

Groundwater levels will fluctuate seasonally and in response to precipitation and snowmelt.

4.0 EVALUATION AND RECOMMENDATIONS

4.1 General Findings

Based on the subsurface findings and our understanding of the proposed construction, the site is suitable to support the proposed building and wastewater tank structures. The principal geotechnical considerations for design and construction are as follows.

- All topsoil, soils containing organics, and uncontrolled fill must be completely removed from beneath the proposed building.
- We understand excavations will be on the order of 13 to 14 feet below finish floor elevation (around elevation 56 to 58 feet $\pm$) for wastewater tank construction. Given the shallow refusal depth at test boring B-6, we anticipate bedrock removal of approximately 3 feet may be required to achieve excavation depth in this area.
- The wastewater storage tanks will be installed well below the groundwater table. We recommend either installation of a foundation drainage system to keep groundwater levels below foundation footings or water proofing the wastewater storage tanks and accounting for buoyancy loading in foundation design.
- The design frost depth for the Haverhill, Massachusetts area is 4.0 feet. Footings that will be exposed to freezing temperatures (i.e., perimeter footings) should have at least 4.0 feet of soil cover to provide frost protection.
- The native soils, particularly the clay/silt/sand soils will be highly susceptible to disturbance under construction traffic. We recommend excavation to subgrades be made using a smooth-edged backhoe bucket to reduce disturbance of the bearing soils. If subgrades become disturbed, the soil must be overexcavated and replaced with ASTM No. 467 (1.5-inch minus) crushed stone.
- All footings and below grade slabs should be underlain by a minimum of 12 inches of ASTM No. 467 crushed stone wrapped in a non-woven geotextile fabric such as Mirafi 160N or equivalent.

4.2 Site Preparation

The soils that will be exposed will be subject to erosion. Site preparation should begin with construction of an erosion control system to protect drainage ways and areas outside the construction limits. All topsoil, soils containing organics, and uncontrolled fill must be completely removed from beneath the proposed building. The extent of removal should extend 1 foot laterally outward from the outside edge of perimeter footings for every 1 foot of excavation depth below the bottom of footing (1H:1V bearing splay). The over-excavated area should be backfilled with compacted Structural Fill.

4.3 Excavation and Dewatering

Excavations are anticipated to extend to depths on the order of 13 to 14 feet below finish floor elevation for wastewater tank construction. Excavation work will be below the groundwater table and will encounter soils that can undergo substantial strength loss when subjected to construction traffic and excavation activities, particularly during periods of precipitation. Care must be exercised during construction to reduce disturbance of the bearing soils. We recommend excavation to subgrades be made using a smooth-edged backhoe bucket to reduce disturbance. Should subgrades become yielding or difficult to work, disturbed areas should be excavated and backfilled with compacted Structural Fill.

Given the shallow refusal depth at test boring B-6, we anticipate bedrock removal of approximately 3 feet may be required to achieve excavation depth in this area. If blasting is performed, the depth of over-blast should be limited to 12 inches below footings and slabs. All over-blast should be removed and replaced with compacted Crushed Stone.

Given the close proximity of the new building to the northern property line, open excavation slope inclination may be steeper than OSHA trenching regulations of 1.5H:1V for the given soil type.

The Contractor should anticipate the need for dewatering excavations. Controlling the water levels to at least one foot below planned excavation depths will help stabilize subgrades during construction.

Excavations must be properly shored and/or sloped in accordance with OSHA trenching regulations to prevent sloughing and caving of the sidewalls during construction and protect from undermining the property line. The contractor is responsible for selection, design, and implementation of the excavation and dewatering program.

4.4 Fill Materials and Compaction

We recommend that foundations be backfilled with a clean, free-draining sand and gravel material. We can provide recommendations for gradation specification upon request.

The excavated soils are expected to high silt content and high water content. It is our

opinion that the soils will not be suitable for re-use on the site after excavation.

New fill supporting foundations and slabs should be placed in horizontal lifts and be compacted. Lift thickness should range between 6 to 12 inches depending upon the size and type of equipment such that the desired density is achieved throughout the lift thickness with 3 to 5 passes of the compaction equipment. We recommend that fill placed below the building areas be compacted to at least 95 percent of its maximum dry density as determined by ASTM D-1557. Foundation backfill should be compacted to at least 95 percent of ASTM D-1557. Crushed Stone should be compacted with 3 to 5 passes of a vibratory plate compactor having a static weight of at least 500 pounds.

4.5 Foundation Design

We recommend the following geotechnical parameters for design consideration:

GEOTECHNICAL FOUNDATION DESIGN PARAMETERS	
Design Frost Depth	4.0 feet
Net Allowable Foundation Bearing Pressure	1.0 ksf
Net Allowable Wastewater Tank Bearing Pressure	2.0 ksf
Seismic Soil Site Class (IBC 2009)	D
Estimated Post-Construction Settlement of Foundations on Properly Prepared Subgrades	1/2-inch or less

Strip and column footings should be at least 24 inches in width, regardless of the bearing pressure.

4.6 Foundation Drainage Considerations

Wastewater storage tanks will be installed well below the groundwater table. We recommend either installation of a foundation drainage system to keep groundwater levels below tank foundations, or water proofing the wastewater tanks designing to account for buoyancy loading effects. A groundwater table near the ground surface should be considered.

4.7 Weather Considerations

Construction activity should be limited during wet and freezing weather and the site soils may require drying before construction activities may continue. The Contractor should anticipate the need for water to temper fills in order to facilitate compaction during dry

weather. If construction takes place during cold weather, subgrades, foundations and floor slabs must be protected during freezing conditions. Concrete and fill must not be placed on frozen soil; and once placed, the concrete and soil beneath the structure must be protected from freezing.

4.8 Design Review and Construction Testing

S.W.COLE should be retained to review the final design and specifications to determine that our earthwork and foundation recommendations have been properly interpreted and implemented.

A soils and concrete testing program should be implemented during construction to observe compliance with the design concepts, plans, and specifications. S.W.COLE should be on-site to observe foundation and slab subgrade preparation. S.W.COLE is available to provide testing services for soils, concrete, asphalt, steel and spray-applied fireproofing construction materials.

5.0 CLOSURE

It has been a pleasure to be of assistance to you with this phase of your project. If you have any questions or we may be of further assistance, please do not hesitate to contact us.

Sincerely,

S. W. Cole Engineering, Inc.

Tyler S. Demers, E.I.
Geotechnical Engineer



Chad B. Michaud, P.E.
Senior Geotechnical Engineer

TSD:cbm

APPENDIX A

Limitations

This report has been prepared for the exclusive use of J and S Development Corporation for specific application to the proposed Wastewater Treatment Facility Project on Hilldale Avenue in Haverhill, Massachusetts. S.W.COLE has endeavored to conduct the work in accordance with generally accepted soil and foundation engineering practices. No warranty, expressed or implied, is made.

The soil profiles described in the report are intended to convey general trends in subsurface conditions. The boundaries between strata are approximate and are based upon interpretation of exploration data and samples.

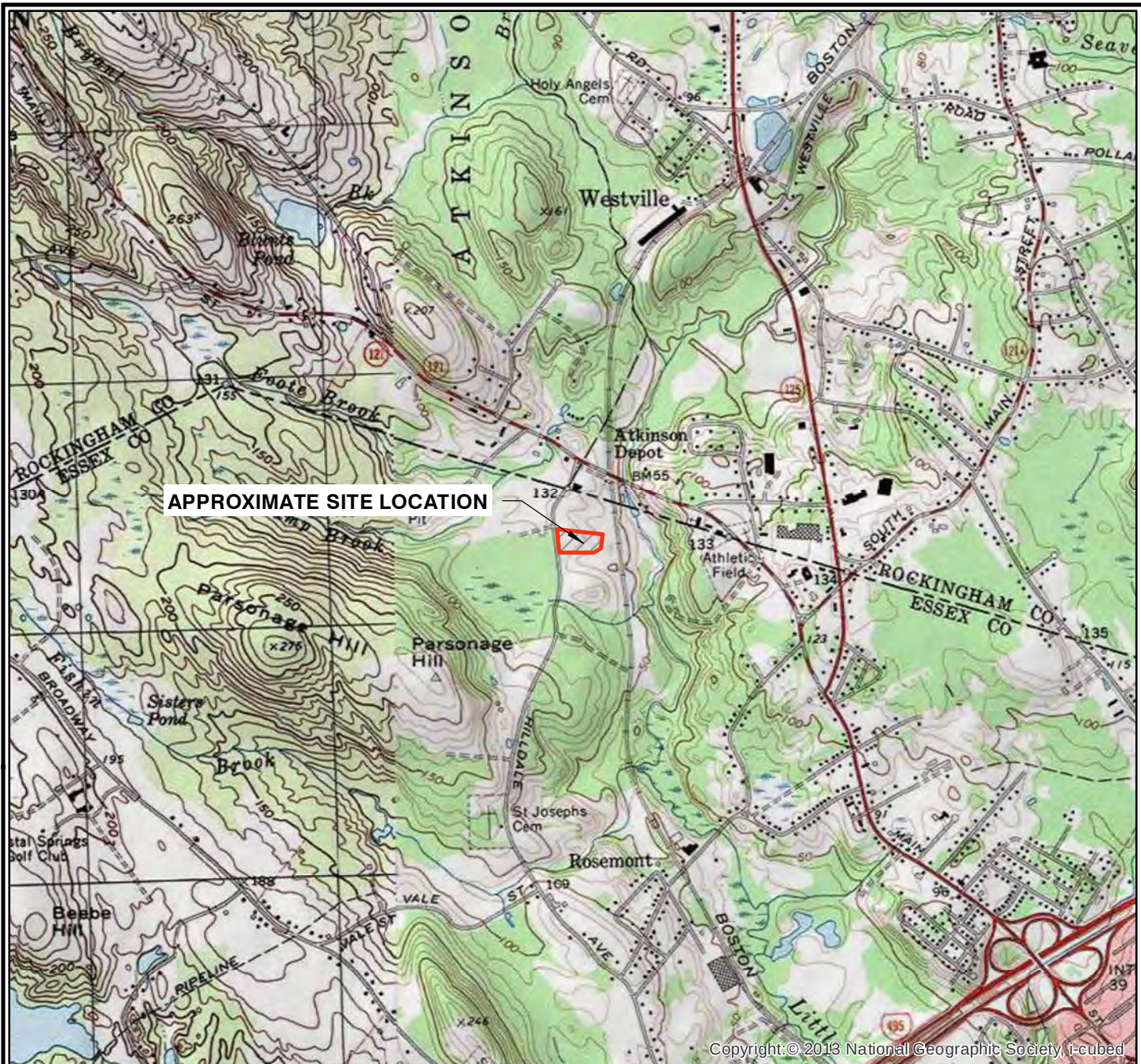
The analyses performed during this assessment and recommendations presented in this report are based in part upon the data obtained from subsurface explorations made at the site. Variations in subsurface conditions may occur between explorations and may not become evident until construction. If variations in subsurface conditions become evident after submission of this report, it will be necessary to evaluate their nature and to review the recommendations of this report.

Observations have been made during exploration work to assess site groundwater levels. Fluctuations in water levels will occur due to variations in rainfall, temperature, and other factors.

S.W.COLE's scope of work has not included the investigation, detection, or prevention of any Biological Pollutants at the project site or in any existing or proposed structure at the site. The term "Biological Pollutants" includes, but is not limited to, molds, fungi, spores, bacteria, and viruses, and the byproducts of any such biological organisms.

Recommendations contained in this report are based substantially upon information provided by others regarding the proposed project. In the event that any changes are made in the design, nature, or location of the proposed project, S.W.COLE should review such changes as they relate to analyses associated with this report. Recommendations contained in this report shall not be considered valid unless the changes are reviewed by S.W.COLE.

APPENDIX B



2,000 0 2,000 4,000
Scale in Feet



J AND S DEVELOPMENT CORPORATION

SITE LOCATION MAP

PROPOSED WASTEWATER TREATMENT FACILITY PROJECT
HILDALE AVENUE
HAVERHILL, MASSACHUSETTS

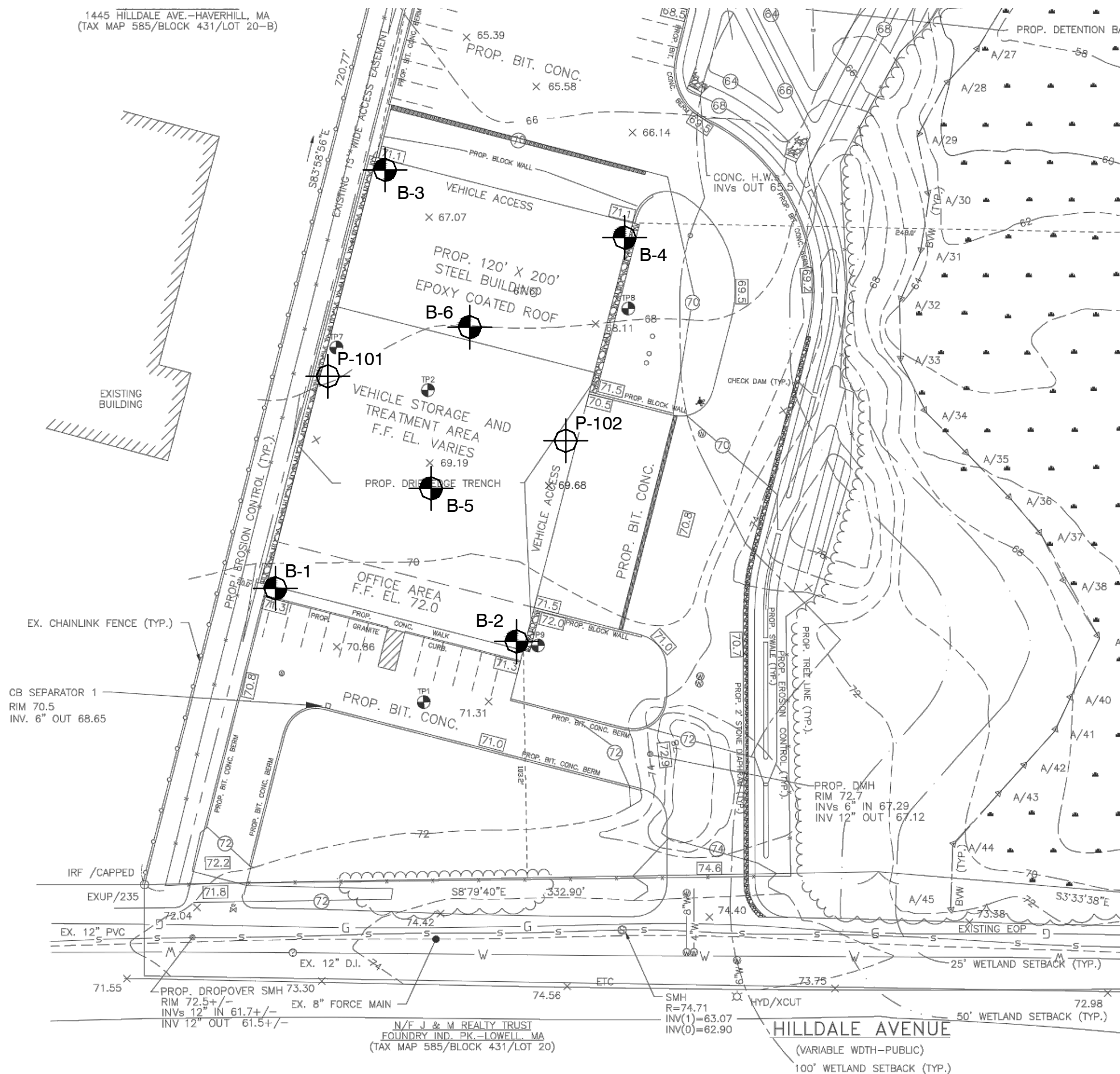
NOTE:

SITE LOCATION MAP PREPARED FROM
ESRI ArcGIS ONLINE AND DATA PARTNERS
INCLUDING USGS AND © 2007 NATIONAL
GEOGRAPHIC SOCIETY.

Job No. 17-0278
Date: 05/03/2017

Scale 1:24000
Sheet 1

1445 HILDALE AVE.-HAVERHILL, MA
(TAX MAP 585/BLOCK 431/LOT 20-B)



LEGEND:



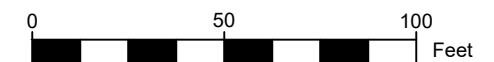
APPROXIMATE BORING LOCATION



APPROXIMATE PROBE LOCATION

NOTES:

1. EXPLORATION LOCATION PLAN WAS PREPARED FROM A 1"=40' SCALE PLAN OF THE SITE ENTITLED "SITE GRADING PLAN," PREPARED BY R.A.M. ENGINEERING, DATED 3/12/2015, REVISED 2/20/2017 AND PROVIDED AS A PORTABLE DOCUMENT FORMAT (PDF) FILE.
2. THE BORINGS WERE LOCATED IN THE FIELD BY GPS SURVEY BY S. W. COLE ENGINEERING, INC. USING A MAPPING GRADE TRIMBLE GPS RECEIVER, HORIZONTAL DATUM ESTABLISHED USING EXISTING SITE FEATURES AS CONTROL.
3. THIS PLAN SHOULD BE USED IN CONJUNCTION WITH THE ASSOCIATED S. W. COLE ENGINEERING, INC. GEOTECHNICAL REPORT.
4. THE PURPOSE OF THIS PLAN IS ONLY TO DEPICT THE LOCATION OF THE EXPLORATIONS IN RELATION TO THE EXISTING CONDITIONS AND PROPOSED CONSTRUCTION AND IS NOT TO BE USED FOR CONSTRUCTION.



J AND S DEVELOPMENT CORPORATION
EXPLORATION LOCATION PLAN
PROPOSED WASTEWATER TREATMENT FACILITY PROJECT
HILDALE AVENUE
HAVERHILL, MASSACHUSETTS

Job No.: 17-0278 Scale: 1" = 50'
Date: 05/03/2017 Sheet: 2

APPENDIX C

BORING NO.: B-1



BORING LOG

CLIENT: J and S Development Corporation
PROJECT: Proposed Wastewater Treatment Facility Project
LOCATION: Hilldale Ave, Haverhill, Massachusetts

BORING NO.: B-2
SHEET: 1 of 1
PROJECT NO. 17-0278
DATE START: 4/21/2017
DATE FINISH: 4/21/2017

Drilling Information

LOCATION: See Exploration Location Plan ELEVATION (FT): 70' +/- TOTAL DEPTH (FT): 12.5 LOGGED BY: Tyler Demers
DRILLING CO.: S. W. Cole Explorations, LLC DRILLER: Jeff Lee DRILLING METHOD: Hollow Stem Auger
RIG TYPE: Track Mounted CME 850 AUGER ID/OD: 2 1/4 in / 5 5/8 in SAMPLER: Standard Split-Spoon
HAMMER TYPE: Automatic HAMMER WEIGHT (lbs): 140 CASING ID/OD: N/A /N/A CORE BARREL:
HAMMER EFFICIENCY FACTOR: HAMMER DROP (inch): 30
WATER LEVEL DEPTHS (ft): 4 Soils saturated below 4 feet

GENERAL NOTES:

KEY TO NOTES AND SYMBOLS: Water Level
At time of Drilling
At Completion of Drilling
After Drilling
D = Split Spoon Sample
U = Undisturbed Tube Sample
R = Rock Core Sample
V = Field Vane Shear
Pen. = Penetration Length
Rec. = Recovery Length
bpf = Blows per Foot
mpf = Minute per Foot
WOR = Weight of Rods
WOH = Weight of Hammer
RQD = Rock Quality Designation
PID = Photoionization Detector
S_v = Field Vane Shear Strength, kips/sq.ft.
q_u = Unconfined Compressive Strength, kips/sq.ft.
N/A = Not Applicable

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION					Graphic Log	Sample Description & Classification	H ₂ O Depth	Remarks
			Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD				
			1D		0-2	24/2	4-7-5-5		4" Topsoil Medium dense, brown Silty GRAVEL and SAND (Fill)		
			2D		2-4	24/24	6-4-6-7	w = 26.1 %	Loose, brown-gray clayey SILT trace fine SAND		
65	5		3D		5-7	24/16	8-7-12- 17		Medium dense, brown-gray Silty fine SAND		
60	10		4D		10-11	12/6	15-50		Very dense, brown Silty SAND and GRAVEL (Glacial Till)		
									Refusal at 12.5 feet (Probable boulder or bedrock)		

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

BORING NO.: B-2



BORING LOG

CLIENT: J and S Development Corporation
PROJECT: Proposed Wastewater Treatment Facility Project
LOCATION: Hilldale Ave, Haverhill, Massachusetts

BORING NO.: B-5
SHEET: 1 of 1
PROJECT NO. 17-0278
DATE START: 4/21/2017
DATE FINISH: 4/21/2017

Drilling Information

LOCATION: See Exploration Location Plan ELEVATION (FT): 69' +/- TOTAL DEPTH (FT): 15.9 LOGGED BY: Tyler Demers
DRILLING CO.: S. W. Cole Explorations, LLC DRILLER: Jeff Lee DRILLING METHOD: Hollow Stem Auger
RIG TYPE: Track Mounted CME 850 AUGER ID/OD: 2 1/4 in / 5 5/8 in SAMPLER: Standard Split-Spoon
HAMMER TYPE: Automatic HAMMER WEIGHT (lbs): 140 CASING ID/OD: N/A / N/A CORE BARREL:
HAMMER EFFICIENCY FACTOR: HAMMER DROP (inch): 30
WATER LEVEL DEPTHS (ft): 4 Soils saturated below 4 feet

GENERAL NOTES:

KEY TO NOTES AND SYMBOLS: Water Level
▽ At time of Drilling
▽ At Completion of Drilling
▽ After Drilling
D = Split Spoon Sample
U = Undisturbed Tube Sample
R = Rock Core Sample
V = Field Vane Shear
Pen. = Penetration Length
Rec. = Recovery Length
bpf = Blows per Foot
mpf = Minute per Foot
WOR = Weight of Rods
WOH = Weight of Hammer
RQD = Rock Quality Designation
PID = Photoionization Detector
S_v = Field Vane Shear Strength, kips/sq.ft.
q_u = Unconfined Compressive Strength, kips/sq.ft.
N/A = Not Applicable

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION					Graphic Log	Sample Description & Classification	H ₂ O Depth	Remarks
			Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD				
			1D		0-2	24/4	4-3-2-4		0.3 3" Topsoil Loose, brown Silty SAND and GRAVEL (Fill)		
			2D		2-4	24/20	4-2-4-5		2.5 Loose, brown-gray fine sandy clayey SILT		
65	5		3D		5-7	24/22	3-3-3-5		5.0 Loose, gray-brown clayey SILT some sand	▽	
60	10		4D		10-12	24/24	2-1-2-4				
55	15		5D		15-15.8	9/6	11-50/3"		12.5 Probable glacial till		
									15.0 Very dense, brown Silty SAND and GRAVEL (Probable weathered bedrock)		
									15.9 Refusal at 15.9 feet (Probable boulder or bedrock)		

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

BORING NO.: B-5



BORING LOG

CLIENT: J and S Development Corporation
PROJECT: Proposed Wastewater Treatment Facility Project
LOCATION: Hilldale Ave, Haverhill, Massachusetts

BORING NO.: B-6
SHEET: 1 of 1
PROJECT NO.: 17-0278
DATE START: 4/21/2017
DATE FINISH: 4/21/2017

Drilling Information

LOCATION: See Exploration Location Plan ELEVATION (FT): 68' +/- TOTAL DEPTH (FT): 9.8 LOGGED BY: Tyler Demers
DRILLING CO.: S. W. Cole Explorations, LLC DRILLER: Jeff Lee DRILLING METHOD: Hollow Stem Auger
RIG TYPE: Track Mounted CME 850 AUGER ID/OD: 2 1/4 in / 5 5/8 in SAMPLER: Standard Split-Spoon
HAMMER TYPE: Automatic HAMMER WEIGHT (lbs): 140 CASING ID/OD: N/A /N/A CORE BARREL:
HAMMER EFFICIENCY FACTOR: HAMMER DROP (inch): 30
WATER LEVEL DEPTHS (ft): 3 Soils saturated below 3 feet

GENERAL NOTES:

KEY TO NOTES: Water Level
AND SYMBOLS: At time of Drilling
At Completion of Drilling
After Drilling
D = Split Spoon Sample
U = Undisturbed Tube Sample
R = Rock Core Sample
V = Field Vane Shear
Pen. = Penetration Length
Rec. = Recovery Length
bpf = Blows per Foot
mpf = Minute per Foot
WOR = Weight of Rods
WOH = Weight of Hammer
RQD = Rock Quality Designation
PID = Photoionization Detector
S_v = Field Vane Shear Strength, kips/sq.ft.
q_u = Unconfined Compressive Strength, kips/sq.ft.
N/A = Not Applicable

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION					Graphic Log	Sample Description & Classification	H ₂ O Depth	Remarks
			Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD				
			1D		0-2	24/20	1-1-3-2		Very loose, brown-gray SILT and fine SAND some clay		
			2D		2-4	24/22	2-3-2-3		Loose to medium dense, brown-gray Clayey SILT some fine SAND		
			3D		5-7	24/18	3-8-7-9		Medium dense, brown Gravelly Silty SAND (Glacial Till)		
									Possible weathered bedrock		
									Refusal at 9.8 feet (Probable boulder or bedrock)		

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

BORING NO.: B-6



BORING LOG

CLIENT: J and S Development Corporation
PROJECT: Proposed Wastewater Treatment Facility Project
LOCATION: Hilldale Ave, Haverhill, Massachusetts

BORING NO.: P-101
SHEET: 1 of 1
PROJECT NO. 17-0278
DATE START: 4/21/2017
DATE FINISH: 4/21/2017

Drilling Information

LOCATION: See Exploration Location Plan ELEVATION (FT): 68' +/- TOTAL DEPTH (FT): 13.6 LOGGED BY: Tyler Demers
DRILLING CO.: S. W. Cole Explorations, LLC DRILLER: Jeff Lee DRILLING METHOD: Solid Stem Auger
RIG TYPE: Track Mounted CME 850 AUGER ID/OD: N/A / 4 1/2 in SAMPLER:
HAMMER TYPE: N/A HAMMER WEIGHT (lbs): N/A CASING ID/OD: N/A /N/A CORE BARREL:
HAMMER EFFICIENCY FACTOR: HAMMER DROP (inch): N/A
WATER LEVEL DEPTHS (ft):
GENERAL NOTES:

KEY TO NOTES AND SYMBOLS: Water Level
▽ At time of Drilling D = Split Spoon Sample Pen. = Penetration Length WOR = Weight of Rods
▽ At Completion of Drilling U = Undisturbed Tube Sample Rec. = Recovery Length WOH = Weight of Hammer S_v = Field Vane Shear Strength, kips/sq.ft.
▽ After Drilling R = Rock Core Sample bpf = Blows per Foot RQD = Rock Quality Designation q_u = Unconfined Compressive Strength, kips/sq.ft.
V = Field Vane Shear mpf = Minute per Foot PID = Photoionization Detector N/A = Not Applicable

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION					Graphic Log	Sample Description & Classification	H ₂ O Depth	Remarks
			Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD				
65	5								Probe		
60											
55	10										

Refusal at 13.6 feet
(Probable boulder or bedrock)

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

BORING NO.: P-101



BORING LOG

BORING NO.: **P-102**
SHEET: 1 of 1
PROJECT NO. 17-0278
DATE START: 4/21/2017
DATE FINISH: 4/21/2017

CLIENT: J and S Development Corporation
PROJECT: Proposed Wastewater Treatment Facility Project
LOCATION: Hilldale Ave, Haverhill, Massachusetts

Drilling Information

LOCATION: See Exploration Location Plan ELEVATION (FT): 69' +/- TOTAL DEPTH (FT): 16.0 LOGGED BY: Tyler Demers
DRILLING CO.: S. W. Cole Explorations, LLC DRILLER: Jeff Lee DRILLING METHOD: Solid Stem Auger
RIG TYPE: Track Mounted CME 850 AUGER ID/OD: N/A / 4 1/2 in SAMPLER:
HAMMER TYPE: N/A HAMMER WEIGHT (lbs): N/A CASING ID/OD: N/A /N/A CORE BARREL:
HAMMER EFFICIENCY FACTOR: HAMMER DROP (inch): N/A
WATER LEVEL DEPTHS (ft):
GENERAL NOTES:

KEY TO NOTES AND SYMBOLS: Water Level
✓ At time of Drilling D = Split Spoon Sample Pen. = Penetration Length WOR = Weight of Rods
✓ At Completion of Drilling U = Undisturbed Tube Sample Rec. = Recovery Length WOH = Weight of Hammer S_v = Field Vane Shear Strength, kips/sq.ft.
✓ After Drilling R = Rock Core Sample bpf = Blows per Foot RQD = Rock Quality Designation q_u = Unconfined Compressive Strength, kips/sq.ft.
V = Field Vane Shear mpf = Minute per Foot PID = Photoionization Detector N/A = Not Applicable

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION					Graphic Log	Sample Description & Classification	H ₂ O Depth	Remarks
			Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD				
65	5								Probe		
60	10										
55	15										
Refusal at 16.0 feet (Probable boulder or bedrock)											

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

BORING NO.: **P-102**

APPENDIX D

Report of Gradation

ASTM C-117 & C-136

Project Name HAVERHILL MA - PROPOSED WASTEWATER PROJECT -
 GEOTECHNICAL ENGINEERING SERVICES

Client J AND S DEVELOPMENT CORPORATION

Project Number 17-0278

Lab ID 15961S

Date Received 4/28/2017

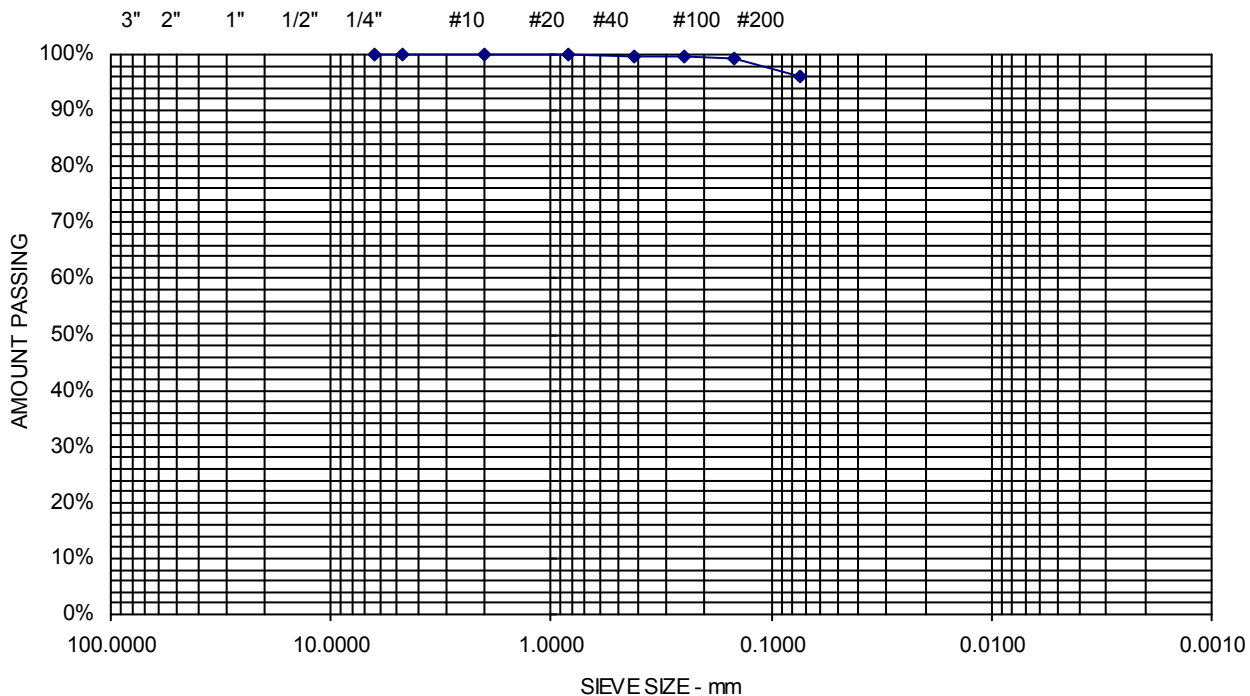
Date Completed 5/4/2017

Tested By BRADLEY GERSCHWILER

Material Source **B-2, 3D, 5.0'-7.0'**

<u>STANDARD DESIGNATION (mm/μm)</u>	<u>SIEVE SIZE</u>	<u>AMOUNT PASSING (%)</u>	
6.3 mm	1/4"	100	
4.75 mm	No. 4	100	0% Gravel
2.00 mm	No. 10	100	
850 μm	No. 20	100	
425 μm	No. 40	100	3.9% Sand
250 μm	No. 60	100	
150 μm	No. 100	99	
75 μm	No. 200	96.1	96.1% Fines

CLAYEY SILT TRACE FIEN SAND



Comments: Moisture Content = 26.1%

Sheet

Report of Gradation

ASTM C-117 & C-136

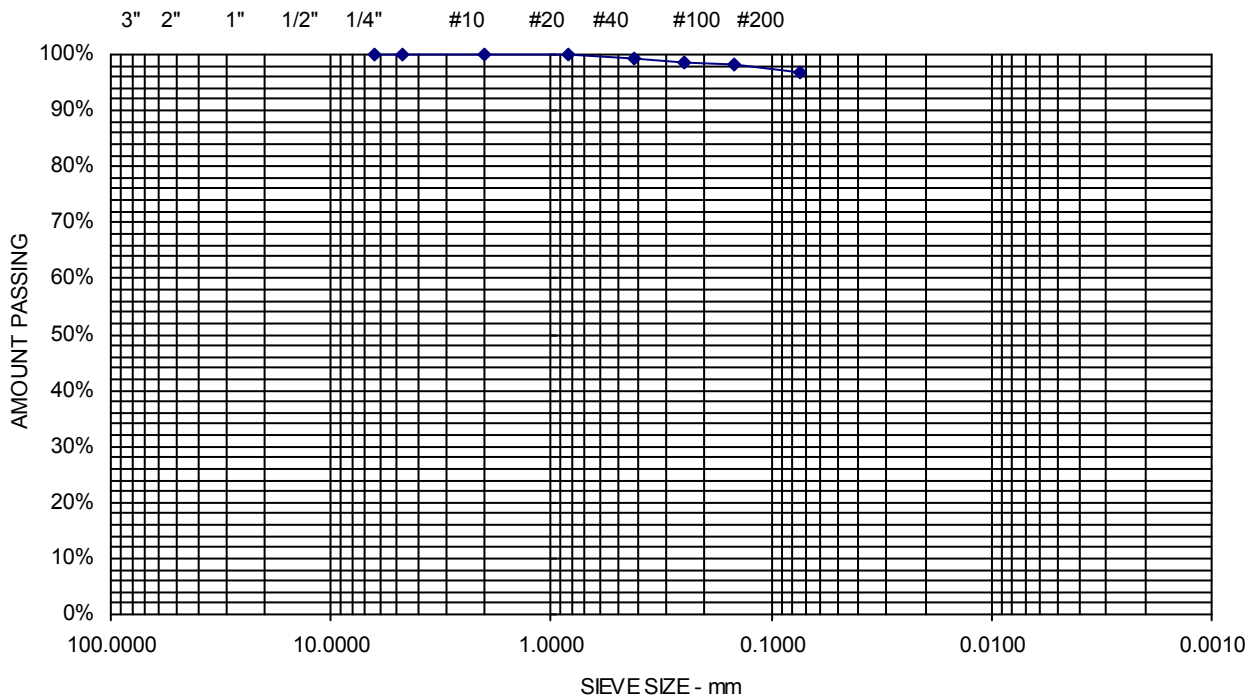
Project Name HAVERHILL MA - PROPOSED WASTEWATER PROJECT -
 GEOTECHNICAL ENGINEERING SERVICES
 Client J AND S DEVELOPMENT CORPORATION

Project Number 17-0278
 Lab ID 15962S
 Date Received 4/28/2017
 Date Completed 5/4/2017
 Tested By BRADLEY GERSCHWILER

Material Source **B-4, 2D, 2.0'-4.0'**

<u>STANDARD DESIGNATION (mm/μm)</u>	<u>SIEVE SIZE</u>	<u>AMOUNT PASSING (%)</u>	
6.3 mm	1/4"	100	
4.75 mm	No. 4	100	0% Gravel
2.00 mm	No. 10	100	
850 μm	No. 20	100	
425 μm	No. 40	99	3.1% Sand
250 μm	No. 60	99	
150 μm	No. 100	98	
75 μm	No. 200	96.9	96.9% Fines

CLAYEY SILT TRACE FINE SAND



Comments: Moisture Content = 23.4%

Sheet