ECS Mid-Atlantic, LLC

Geotechnical Engineering Report

Southampton Township Metal Building

200 Airport Road
Shippensburg, Pennsylvania

ECS Project Number 18:5866

March 3, 2023
Revised April 3, 2023

Revised April 3, 2023

Mr. Scott J. Mack
Southampton Township – Cumberland County
200 Airport Road
Southampton Township, PA 17257

ECS Project No. 18:5866

Reference: Geotechnical Engineering Report
Southampton Township Metal Building
Shippensburg, Pennsylvania

Dear Mr. Mack:

ECS Mid-Atlantic, LLC (ECS) has completed the subsurface exploration and geotechnical engineering analyses for the above-referenced project. Our services were performed in general accordance with our Proposal No. 18:9122-GP, dated January 25, 2023. This report presents our understanding of the geotechnical aspects of the project, results of the field exploration, laboratory testing, and our design and construction recommendations.

It has been our pleasure to be of service to Southampton Township during this phase of this project. We would appreciate the opportunity to remain involved during the continuation of the design phase and to provide our services during construction phase operations as well to verify the assumptions of subsurface conditions made for this report. Should you have any questions concerning the information contained in this report, or if we can be of further assistance to you, please contact us.

Respectfully submitted,

ECS Mid-Atlantic, LLC

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EXECUTIVE SUMMARY

The following summarizes the main findings of the exploration, particularly those that may have a cost impact on the planned development. Further, our principal foundation recommendations are summarized. Information gleaned from the Executive Summary should not be utilized in lieu of reading the entire geotechnical report.

- Provided subgrades and Structural Fills are prepared as discussed herein, the proposed addition can be supported by conventional shallow foundations consisting of column and continuous wall footings. Please note that historic undocumented fill that extends up to several feet below the proposed addition was identified by the test borings. ECS Recommends that if there exists no documentation relative to the previous compaction and subsequent field testing of this historic fill in lifts (which meets or exceeds the requirements of this report), then the superstructure (i.e., shallow footings) must bear on/in the natural soil materials or on new Structural Fill/lean concrete).

- Groundwater seepage into our borings was not observed during our exploration at the depths explored.

- Provided the exposed subgrade and overlying granular drainage layer are proofrolled and constructed per the recommendations discussed herein, the slab may be designed assuming a modulus of subgrade reaction, k_1, of 125 pci (lbs./cu. inch.).

- Up to approximately 6 feet of existing fill was noted within the proposed building footprint during the subsurface exploration. Due to the presence of fill on-site, select over-excavation of unsuitable fill material should be anticipated at some locations within the building pad where proofrolling reveals instability. The existing fill can be used for support of the slabs-on-grade provided the exposed subgrade passes a proof roll as described in **Section 5.2.2** of this report under the supervision of ECS

- Natural deposits of soils that meet the definition of Satisfactory Structural Fill do appear to be present on the site at possible excavation depths.

Refer to the text of the report for site specific design and construction recommendations.

1.0 INTRODUCTION

The purpose of this study was to provide geotechnical information for design and construction of a proposed metal building at the project site. The recommendations developed for this report are based on project information supplied by Southampton Township and Brehm-Lebo Engineering, Inc. including the *Overall Plan*, dated January 20, 2023.

Our services were provided in accordance with the Proposal No. 9122-GP, dated January 25, 2023, as authorized by Southampton Township, January 26, 2023, which includes our Terms and Conditions of Service.

This report contains the results of our subsurface exploration, site characterization, laboratory testing, engineering analyses, and recommendations for the design and construction of the proposed development.

This report includes the following:

- A review of area and site geologic conditions.
- A review of surface topographical features and site conditions.
- A brief review and description of our field procedures.
- A brief review and description of our field and laboratory test procedures and the results of testing conducted.
- A review of subsurface soil stratigraphy with pertinent available physical properties.
- Final copies of our boring, air probe, and test pit logs
- Discussion of site preparation including depth of removal of soil or rock and over-excavation, or applicable ground improvement methods.
- Discussion of groundwater concerns relative to the planned construction.
- Recommended allowable soil bearing pressure and recommendations for suitable shallow foundations and anticipated maximum settlement.
- Provide ground improvement or deep foundation recommendations.
- Recommended frost depth.
- Recommendations regarding specifications for Structural Fill.
- Recommended pavement sections for heavy and light duty pavement including a CBR value.
- Discussion of parameters for slab on grade construction and modulus of subgrade reaction.
- Recommendations for site seismic design coefficients based on the 2018 IBC parameters.
- Design and construction recommendations for below-grade or site retaining wall construction, including lateral earth pressures, sliding resistance coefficients and allowable bearing pressures, if applicable.
- A discussion of potential of karst geology features.

2.0 PROJECT INFORMATION

2.1 PROJECT LOCATION

The project site is located at the physical address of 200 Airport Road in Shippensburg, Pennsylvania. The site is located on the northwest corner of the intersection of Hershey Road and Airport Road and consists of three existing buildings and associated paved and gravel parking lots. At the time of exploration, the site was gradually sloping from west to east with a total topographic relief on the order of approximately 25 feet.

Refer to Figure 2.1.A and the Site Location Map in Appendix A for a detailed depiction of the project site location.

Figure 2.1.A – Site Location

2.2 PROPOSED CONSTRUCTION

Based on the "Overall Plan", by Brehm-Lebo Engineering, Inc., dated January 20, 2023, we understand that the proposed development consists of a single-story structure which we understand will be a metal fabrication structure. The following information explains our understanding of the structure and assumed loads:

DESIGN VALUES	
SUBJECT	**DESIGN INFORMATION / EXPECTATIONS**
Approximate Building Footprint	9,000 Square Feet
# of Stories	1 story above grade
Usage	Metal Building
Column Loads	62 Kips maximum
Wall Loads	Estimated - 2.5 kips/ft maximum
Lowest Finish Floor Elevation	+715.5 FT, MSL

3.0 FIELD EXPLORATION AND LABORATORY TESTING

Our exploration procedures are explained in greater detail in Appendix B including the insert titled Subsurface Exploration Procedure. Our scope of work included drilling a total of three (3) geotechnical borings. Our borings were located with a handheld GPS unit and their approximate locations are shown on the Exploration Location Plan in Appendix A.

3.1 SUBSURFACE CHARACTERIZATION

The following sections provide generalized characterizations of the soil strata. Please refer to both the Subsurface Cross-Section in Appendix A and the boring logs in Appendix B.

SUBSURFACE STRATIGRAPHY	
Stratum	**Description**
n/a	Surficial Material: Topsoil Thickness 3.0 to 6.0 inches Gravel Thickness 9.0 inches
I	FILL Materials, Stiff to Very Stiff Lean CLAY (CL), varying amounts of sand and gravel, moist, very loose SILT (ML), some medium dense SAND and some medium Dense Gravel with varying amounts of sand, silt, and gravel, Moist, contains asphalt and roots
II	Medium Dense to Very Dense SILT (ML) and SAND (SC) varying amounts of clay and gravel, moist
III	SANDSTONE, Highly weathered, hard, intensely fractured, orangish brown and white

3.2 SITE GEOLOGY

According to the Geologic Map of Pennsylvania (1980)[1], the site is underlain by the Zullinger Formation. Based on *Engineering Characteristics of the Rocks of Pennsylvania*[2], The Zullinger Formation consists of interbanded medium grey limestone and dolomite, interlaminated limestone and dolomite, thin dolomite, and local thin quartz-sand beds. Jointing and fracturing is well developed in a blocky manner, regularly spaced, and open and steeply dipping throughout the formation. It is moderately resistant to weathering and slightly to moderately weathered to a shallow depth. The interface between and soil is characterized by pinnacles, as prolonged exposure and weathering has formed a highly uneven and pinnacled soil-rock interface. It should be expected that the depth to bedrock and/or large cobbles and boulders will be variable. Limestone and Dolomite are carbonate based and therefore is prone to dissolution in water and karst processes including sinkhole formation.

[1] Berg, T. M., Edmunds, W. E., Geyer, A. R., and others, compilers, 1980, Geologic map of Pennsylvania (2nd ed.): Pennsylvania Geological Survey, 4th ser., Map 1, 3 sheets, scale 1:250,000
[2] Geyer, A. R., and Wilshusen, J. P., (1982), Engineering Characteristics of the Rocks of Pennsylvania. Bureau of Topographic and Geologic Survey.

3.3 SOIL SURVEY MAPPING

Based on our review of the Soil Survey (USDA - Natural Resources Conservation Service (websoilsurvey.ncrs.usda.gov), the site soils are mapped Monongahela silt loam, 0 to 3 percent slopes, Murrill channery loam, 3 to 8 percent slopes, and Penlaw silt loam. This soil type is described as having the following properties:

SOIL MAPPING SUMMARY						
Mapped Soil Unit	**Soil Unit Symbol**	**Origin/ Type**	**Depth to Restrictive Feature**	**Depth to Water Table**	**Hydrologic Soil Group**	**KSat (in/hr)**
Monongahela silt loam, 0 to 3 percent slopes	MnA	Old alluvium derived from sedimentary rock	18 to 30 inches to fragipan	About 18 to 30 inches	C/D	(0.06 – 0.60)
Murrill channery loam, 3 to 8 percent slopes	MuB	Weathered loamy colluvium derived from sandstone and siltstone over clayey residuum weathered from limestone	>80 inches	>80 inches	B	(0.20 – 2.00)
Penlaw silt loam	Pe	Colluvium derived from limestone, sandstone, and shale	15 to 30 inches to fragipan; 40 to 72 inches to lithic bedrock	About 6 to 18 inches	C/D	(0.06 – 0.20)

3.4 GROUNDWATER OBSERVATIONS

Groundwater seepage into our borings was not observed during our exploration at the depths explored. The boreholes were left open for a period of 3 hours to observe signs of seepage. Variations in both groundwater types (perched and groundwater table aquifer) can occur as a result of changes in precipitation, evaporation, surface water runoff, construction activities, and other factors.

3.5 LABORATORY TESTING

The laboratory testing consisted of selected tests performed on samples obtained during our field exploration operations. Classification and index property tests were performed on representative soil samples.

Each sample was visually classified on the basis of texture and plasticity in accordance with ASTM D2488 Standard Practice for Description and Identification of Soils (Visual-Manual Procedures) and including USCS classification symbols, and ASTM D2487 Standard Practice for Classification for Engineering Purposes (Unified Soil Classification System (USCS)). After classification, the samples were grouped in the major zones noted on the boring logs in Appendix B. The group symbols for each soil type are indicated in parentheses along with the soil descriptions. The stratification lines between strata on the logs are approximate; in situ, the transitions may be gradual.

4.0 DESIGN RECOMMENDATIONS

4.1 FOUNDATION DESIGN

Provided subgrades and Structural Fills are prepared as discussed herein, the proposed structures can be supported by conventional shallow foundations consisting of column and continuous wall footings. Please note that old undocumented fill (that extends up to several feet below the proposed addition) was identified by the test borings. ECS recommends that, if there exists no documentation relative to the previous compaction and subsequent testing of this old fill in lifts (which meets or exceeds the requirements of this report), then the superstructure (i.e., shallow footings) should bear on the natural soil materials or on new Structural Fill/lean concrete). However, due to the relatively light loading, it is our understanding that the overexcavtion of existing fill materials is undesirable to the Client. We have provided a lower bearing capacity should the overexcavation not be completed, **but it should be understood that due to the limited knowledge of the existing fill materials, anticipated total and/or differential settlement may not be within typical tolerance levels as fill can contain pockets of deleterious materials, unknown void spaces, and other potential causes of increased settlement**. The design of the foundations shall utilize the following parameters:

FOUNDATION DESIGN PARAMETERS WITHIN EXISTING FILL		
Design Parameter	**Column Footing**	**Wall Footing**
Net Allowable Bearing Pressure[1]	1,500 psf	1,500 psf
Acceptable Bearing Soil Material	Stratum I	Stratum I
Minimum Width	24 inches	18 inches
Minimum Footing Embedment Depth for Interior Foundations (below slab or finished grade)	24 inches	24 inches
Minimum Footing Embedment Depth for Exterior Foundations (below slab or finished grade)	36 inches	36 inches

Note[1]: Net allowable bearing pressure is the applied pressure in excess of the surrounding overburden soils above the base of the foundation.
Note[2]: Due to the nature of undocumented fill materials, ECS cannot provide anticipated settlement amounts if the new foundations are constructed to bear in Stratum I – existing fill materials.

FOUNDATION DESIGN PARAMETERS WITHIN OVER-EXCAVATED FOUNDATION AREAS		
Design Parameter	**Column Footing**	**Wall Footing**
Net Allowable Bearing Pressure[1]	3,000 psf	3,000 psf
Acceptable Bearing Soil Material	Stratum II or Structural Fill	Stratum II or Structural Fill
Minimum Width	24 inches	18 inches
Minimum Footing Embedment Depth for Interior Foundations (below slab or finished grade)	24 inches	24 inches

FOUNDATION DESIGN PARAMETERS WITHIN OVER-EXCAVATED FOUNDATION AREAS		
Design Parameter	**Column Footing**	**Wall Footing**
Minimum Footing Embedment Depth for Exterior Foundations (below slab or finished grade)	36 inches	36 inches
Estimated Total Settlement (max.)	1 inch	1 inch
Estimated Differential Settlement	Less than ½ inch between columns	Less than ½ inch over 35 feet

Note[1]: Net allowable bearing pressure is the applied pressure in excess of the surrounding overburden soils above the base of the foundation.

It is imperative that the subgrade be evaluated by ECS prior to the placement of Structural Fill to determine the suitability of the subgrade. If soft soils or otherwise unsuitable soils are observed at the footing bearing elevations, the unsuitable soils should be undercut and removed.

Foundation undercut excavations should be widened 1 foot beyond the footing dimension on each side and then 1 foot for every 1 foot of over excavation (equivalent to a 1(H):1(V) slope for improved bearing area) where over-excavation exceeds 2 feet in depth. The undercut areas should be backfilled with Structural Fill (such as 2A aggregate) and compacted under engineering review until the designed bearing elevation has been reached. As an alternate, lean concrete (f'c=1,000 psi) may be used to backfill the undercut. If lean concrete is used, the excavation should be 6 inches larger than the footing on each side and no additional lateral over-excavation is necessary.

4.2 FLOOR SLABS

Provided subgrades and Structural Fills are prepared as discussed herein, the proposed floor slabs can be constructed as Ground Supported Slabs (or Slab-On-Grade). Based on a lowest finished floor elevation of EL. 715.50 feet, it appears that the slabs will bear on newly compacted Structural fill or *Stratum II – Silt and Sand* (SC or ML). Stratum I can be used for support of the slabs-on-grade provided the exposed subgrade passes a proof roll as described in **Section 5.2.2** of this report under the supervision of ECS. It should be noted that the long-term performance across the slab may be variable due to the presence of existing fill. The following graphic depicts our soil-supported slab recommendations:

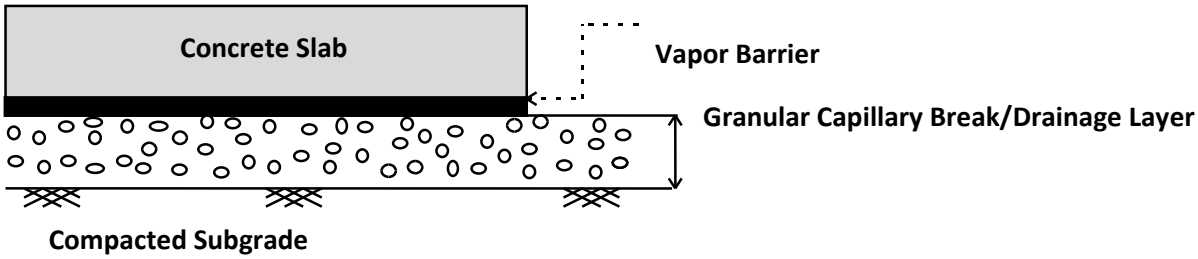


Figure 4.2.A

1. Drainage Layer Thickness: 6 inches minimum recommended
2. Drainage Layer Material: Coarse Graded Aggregate
3. Subgrade compacted to ***95%*** maximum dry density in Accordance with ASTM D698

Soft or yielding soils may be encountered in some areas. Those soils should be removed and replaced with compacted Structural Fill in accordance with the recommendations included in this report.

Subgrade Modulus: Provided the Structural Fill and Granular Drainage Layer are constructed in accordance with our recommendations, the slab may be designed assuming a modulus of subgrade reaction, k_1 of 125 pci (lbs./cu. inch). The modulus of subgrade reaction value is based on a 1 ft by 1 ft plate load test basis.

Vapor Barrier: Before the placement of concrete, a vapor barrier may be placed on top of the granular drainage layer to provide additional protection against moisture penetration through the floor slab. When a vapor barrier is used, special attention should be given to surface curing of the slab to reduce the potential for uneven drying, curling and/or cracking of the slab. Depending on proposed flooring material types, the structural engineer and/or the architect may choose to eliminate the vapor barrier.

Slab Isolation: Soil-supported slabs should be isolated from the foundations and foundation-supported elements of the structure so that differential movement between the foundations and slab will not induce excessive shear and bending stresses in the floor slab. Where the structural configuration prevents the use of a free-floating slab such as in a drop down footing/monolithic slab configuration, the slab should be designed with suitable reinforcement and load transfer devices to preclude overstressing of the slab.

4.3 SEISMIC DESIGN CHARACTERISTICS

The International Building Code (IBC) 2018 requires site classification for seismic design based on the upper 100 feet of a soil profile. At least two methods are utilized in classifying sites, namely the shear wave velocity (v_s) method and the Standard Penetration Resistance (N-value) method. The latter method (Standard Penetration Resistance) was used in classifying this site.

SEISMIC SITE CLASSIFICATION			
Site Class	**Soil Profile Name**	**Shear Wave Velocity, Vs, (ft./s)**	**N value (bpf)**
A	Hard Rock	Vs > 5,000 fps	N/A
B	Rock	2,500 < Vs ≤ 5,000 fps	N/A
C	Very dense soil and soft rock	1,200 < Vs ≤ 2,500 fps	>50
D	Stiff Soil Profile	600 ≤ Vs ≤ 1,200 fps	15 to 50
E	Soft Soil Profile	Vs < 600 fps	<15

Based upon our interpretation of the subsurface conditions, the appropriate Seismic Site Classification is "C" as shown in the preceding table.

Ground Motion Parameters: In addition to the seismic site classification noted above, ECS has determined the design spectral response acceleration parameters following the IBC 2018 methodology. The Mapped Reponses were estimated from the free seismic design maps available from *Structural Engineers Association of California (SEAOC) (http://seismicmaps.org*). The design responses for the short (0.2 sec, S_{DS}) and 1-second period (S_{D1}) are noted in bold at the far-right end of the following table.

GROUND MOTION PARAMETERS [IBC 2018 METHOD]								
Period (sec)	**Mapped Spectral Response Accelerations (g)**		**Values of Site Coefficient for Site Class**		**Maximum Spectral Response Acceleration Adjusted for Site Class (g)**		**Design Spectral Response Acceleration (g)**	
Reference	Figures 1613.2.1 (1) & (2)		Tables 1613.2.3 (1) & (2)		Eqs. 16-37 & 16-38		Eqs. 16-39 & 16-40	
0.2	S_S	0.123	F_a	1.3	$S_{MS}=F_aS_s$	0.160	$S_{DS}=2/3\ S_{MS}$	0.107
1.0	S_1	0.051	F_v	1.5	$S_{M1}=F_vS_1$	0.077	$S_{D1}=2/3\ S_{M1}$	0.051

The Site Class definition should not be confused with the Seismic Design Category designation which the Structural Engineer typically assesses. If a higher site classification is beneficial to the project, we can provide additional testing methods that may yield more favorable results.

5.0 SITE CONSTRUCTION RECOMMENDATIONS

5.1 KARST RELATED – GENERAL RISK

The Zullinger is composed of carbonate bedrock that is prone to karst activity. Karst activity can take the form of soft and loose soils above the bedrock, uneven bedrock surfaces, closed surficial depressions, and sinkholes. The Karst Features Map located in Appendix A depicts a scale of the level of karst activity in the vicinity of the site. The Karst Features Map shows nine (9) apparent sinkholes and 81 surface depressions within about 1/2 mile of the project site; however, the data is incomplete as there is not a requirement within the State to track and document the naturally developing karst activity. Based on our experience in the area and known karst features at nearby sites, the risk of sinkholes and related karst activity near this location is high.

Although sinkholes stem from geologic conditions within the underlying rock, they are often triggered by changes in the surface and subsurface drainage patterns. In order to reduce the potential for future sinkhole development which could impact foundation performance, positive surface drainage should be maintained both during and after construction. ECS recommends that the following preventative measures be followed to reduce the potential inducement of sinkhole formation in proposed development areas and to incorporate good construction practices. If subsidence features such as sinkholes, surface depressions, and exposed rock pinnacles are encountered, ECS should be consulted to provide a recommendation for repair on a case by case basis.

1. Earthwork operations should be graded to drain away from structures at all times. Upon completion of daily earthwork operations, the ground surface should be sealed by thorough rolling to reduce infiltration of precipitation and facilitate runoff.

2. Sediment control management facilities should be located outside of planned construction areas. Inlets associated with storm drain systems should not be utilized as temporary sediment control devices during construction.

3. During construction, care should be taken to reduce the ponding of surface water in and/or adjacent to the buildings. The foundations should be excavated and poured the same day, if possible, or the founding soils should be provided with a mud mat (lean concrete).

4. Visual observations during all earthwork operations should be carried out in order to detect previous unexposed or recently created collapse features. Such features should be called to ECS's attention for remedial improvement.

5. Final site grading should include sloping grades and piping of downspouts away from the building.

6. Storm piping should be designed such that joints and structure tie-ins remain watertight with allowance for some settlement. Leaking storm pipes promote subsurface seepage and can instigate sinkhole development in the form of surficial dropouts with little or no warning. It may be beneficial to use bentonite clay around all pipe joints to reduce the potential for long-term leaking.

Areas identified to be suspect during the initial earthwork phase should be further explored during construction to determine the extent, both vertically and horizontally, of possible solution activity. We recommend that all available geotechnical data be made available to ECS during earthwork operations.

5.2 SUBGRADE PREPARATION

5.2.1 Stripping and Grubbing

The subgrade preparation should consist of stripping all vegetation, rootmat, topsoil, unsuitable existing fill, asphalt, and other soft or unsuitable materials from the 10-foot expanded building and 5-foot expanded pavement limits, and 5 feet beyond the toe of Structural Fills. Borings performed in "undisturbed" areas of the site contained an observed 3 to 6 inches of topsoil. Deeper topsoil or organic laden soils may be present in wet, low-lying, and poorly drained areas. In wooded areas, the root balls may extend as deep as about 2 feet and will require additional localized stripping depth to completely remove the organics. ECS should be retained to verify that topsoil and unsuitable surficial materials have been removed prior to the placement of Structural Fill or construction of structures.

5.2.2 Proofrolling

Prior to fill placement or other construction on subgrades, the subgrades should be evaluated by an ECS field technician. The exposed subgrade should be thoroughly proofrolled with construction equipment having a minimum axle load of 10 tons [e.g. fully loaded tandem-axle dump truck]. Proofrolling should be traversed in two perpendicular directions with overlapping passes of the vehicle under the observation of an ECS technician. This procedure is intended to assist in identifying localized yielding materials.

Where proofrolling identifies areas that are unstable or "pumping" subgrade those areas should be repaired prior to the placement of subsequent Structural Fill or other construction materials. Methods of stabilization include undercutting, moisture conditioning, or chemical stabilization. The situation should be discussed with ECS to determine the appropriate procedure. Test pits may be excavated to explore the shallow subsurface materials to help in determining the cause of the observed unstable materials, and to assist in the evaluation of appropriate remedial actions to stabilize the subgrade.

5.3 EARTHWORK OPERATIONS

5.3.1 Existing Man-Placed Fill

Fill Content: Up to approximately 6 feet of existing fill was noted within the proposed building footprint during the subsurface exploration. Due to the presence of fill on-site, select over-excavation of unsuitable fill material should be anticipated at some locations within the building pad where proofrolling reveals instability.

5.3.2 Structural Fill Materials

Prior to placement of Structural Fill, representative bulk samples (about 50 pounds) of on-site and/or off-site borrow should be submitted to ECS for laboratory testing, which will typically include Atterberg limits, natural moisture content, grain-size distribution, and moisture-density relationships (i.e., Proctors) for compaction. Import materials should be tested prior to being hauled to the site to determine if they meet project specifications.

Satisfactory Structural Fill Materials: Materials satisfactory for use as Structural Fill should consist of inorganic soils with the following engineering properties and compaction requirements.

STRUCTURAL FILL INDEX PROPERTIES	
Subject	**Property**
Building and Pavement Areas	LL < 40, PI <20
Max. Particle Size	4 inches
Minimum Dry Density	105 pcf

STRUCTURAL FILL COMPACTION REQUIREMENTS	
Subject	**Requirement**
Compaction Standard	Standard Proctor, ASTM D698
Required Compaction	95% of Max. Dry Density
Moisture Content	±2 % points of the soil's optimum value
Loose Thickness	8 inches prior to compaction

On-Site Borrow Suitability: Natural deposits of soils that meet the definition of Satisfactory Structural Fill do appear to be present on the site at possible excavation depths.

Fill Placement: Fill materials should not be placed on frozen soils, on frost-heaved soils, and/or on excessively wet soils. Borrow fill materials should not contain frozen materials at the time of placement, and all frozen or frost-heaved soils should be removed prior to placement of Structural Fill or other fill soils and aggregates. Excessively wet soils or aggregates should be scarified, aerated, and moisture conditioned.

5.3.3 Proposed Fill Slopes

Slopes comprised of Structural Fill may be constructed at a slope of 3(H):1(V) or flatter. Slopes steeper than 3(H):1(V) should be evaluated by ECS. All slopes should be properly vegetated to reduce the likelihood of surficial erosion and sloughing.

5.4 FOUNDATION AND SLAB OBSERVATIONS

Protection of Foundation Excavations: Exposure to the environment may weaken the soils at the footing bearing level if the foundation excavations remain open for too long a time. Therefore, foundation concrete should be placed the same day that excavations are made. If the bearing soils are softened by surface water intrusion or exposure, the softened soils must be removed from the foundation excavation bottom immediately prior to placement of concrete. If the excavation must remain open overnight, or if rainfall becomes imminent while the bearing soils are exposed, a 1 to 3-inch thick "mud mat" of "lean" concrete should be placed on the bearing soils before the placement of reinforcing steel.

Footing Subgrade Observations: Most of the soils at the foundation bearing elevation are anticipated to be suitable for support of the proposed structure. It is important to have ECS observe the foundation subgrade prior to placing foundation concrete, to confirm the bearing soils are what was anticipated.

Slab Subgrade Verification: Prior to placement of a drainage layer, the subgrade should be prepared in accordance with the recommendations found in **Section 5.2.2 Proofrolling**.

5.5 UTILITY INSTALLATIONS

Utility Subgrades: The soils encountered in our exploration are expected to be generally suitable for support of utility pipes. The pipe subgrades should be observed and probed for stability by ECS. Loose or unsuitable materials encountered should be removed and replaced with suitable compacted Structural Fill, or pipe stone bedding material.

Utility Backfilling: The granular bedding material (often AASHTO #57 stone) should be at least 4 inches thick, but not less than that specified by the civil engineer's project drawings and specifications. We recommend that the bedding materials be placed up to the springline of the pipe. Fill placed for support of the utilities, as well as backfill over the utilities, should satisfy the requirements for Structural Fill and Fill Placement.

Utility Excavation Dewatering: It is possible that perched water may be encountered by utility excavations which extend below existing grades. It is expected that removal of perched water which seeps into excavations could be accomplished by pumping from sumps excavated in the trench bottom and which are backfilled with AASHTO No. 57 Stone or open graded bedding material. Should water conditions beyond the capability of sump pumping be encountered, the contractor should submit a Dewatering Plan in accordance with project specifications.

Excavation Safety: All excavations and slopes should be constructed and maintained in accordance with OSHA excavation safety standards. The contractor is solely responsible for designing, constructing, and maintaining stable temporary excavations and slopes. The contractor's responsible person, as defined in 29 CFR Part 1926, should evaluate the soil exposed in the excavations as part of the contractor's safety procedures. In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulations. ECS is providing this information solely as a service to our client. ECS is not assuming responsibility for construction site safety or the contractor's activities; such responsibility is not being implied and should not be inferred.

6.0 CLOSING

ECS has prepared this report to guide the geotechnical-related design and construction aspects of the project. We performed these services in accordance with the standard of care expected of professionals in the industry performing similar services on projects of like size and complexity at this time in the region. No other representation, expressed or implied, and no warranty or guarantee is included or intended in this report.

The description of the proposed project is based on information provided to ECS by Southampton Township and Brehm-Lebo Engineering, Inc. If any of this information is inaccurate, either due to our interpretation of the documents provided or if the site's design changed, ECS should be contacted immediately to review the report in light of the changes and provide additional or alternate recommendations as required to reflect the proposed construction.

We recommend that ECS review the project plans and specifications so we can confirm that those plans/specifications are in accordance with the recommendations of this geotechnical report.

Field observations, and quality assurance testing during earthwork and foundation installation are an extension of, and integral to, the geotechnical design. We recommend that ECS be retained to apply our expertise throughout the geotechnical phases of construction, and to provide consultation and recommendation should issues arise.

ECS is not responsible for the conclusions, opinions, or recommendations of others based on the data in this report.

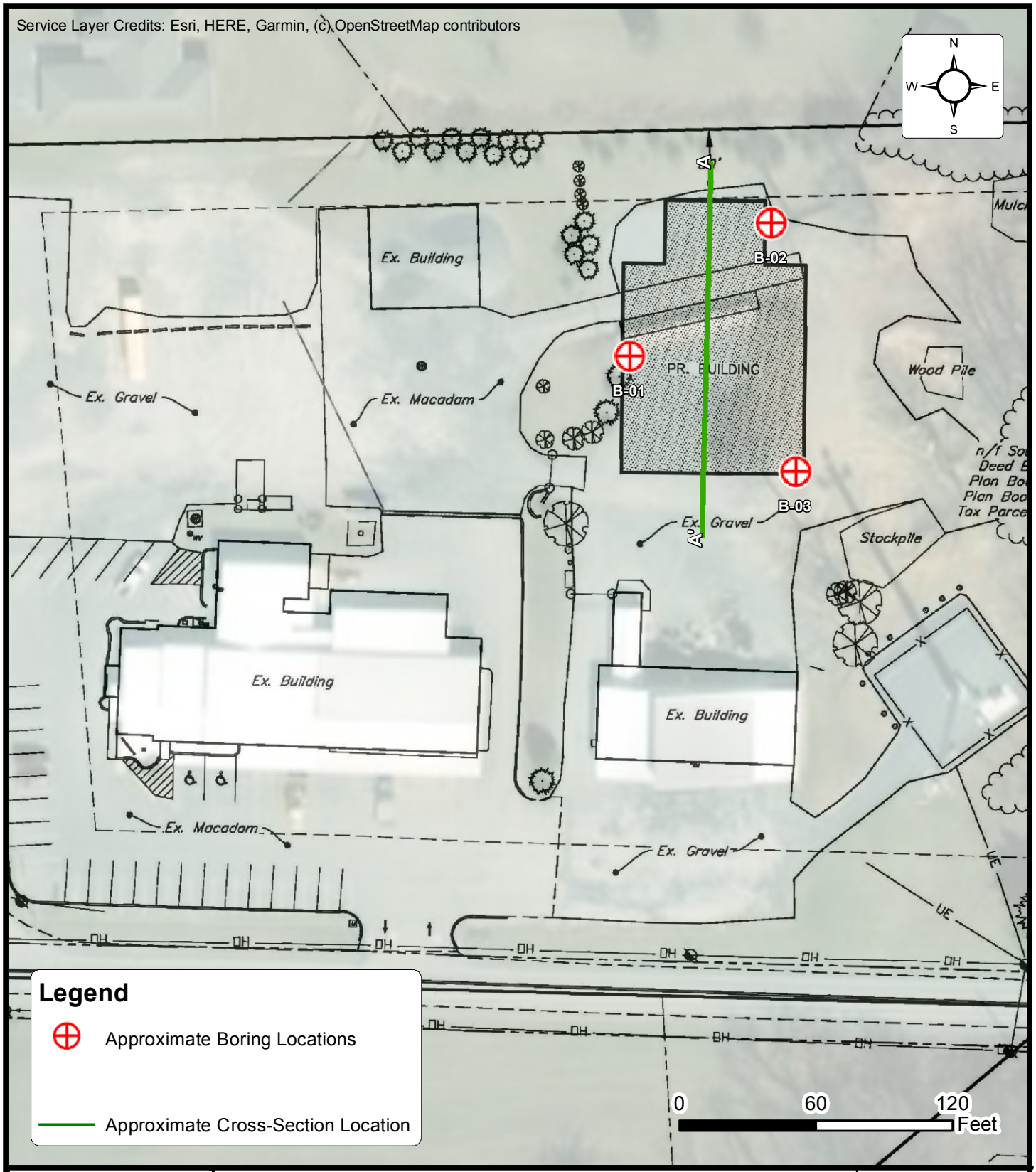
APPENDIX A – Drawings & Reports

Site Location Diagram
Exploration Location Diagram
Subsurface Cross-Section A-A’
Geologic Map
Soil Survey Map
Karst Features Map

SITE LOCATION DIAGRAM
SOUTHAMPTON TOWNSHIP METAL BUILDING

200 AIRPORT ROAD, SHIPPENSBURG, PA
SOUTHAMPTON TOWNSHIP

ENGINEER	JMC2
SCALE	AS NOTED
PROJECT NO.	18:5866
FIGURE	1 OF 1
DATE	2/3/2023

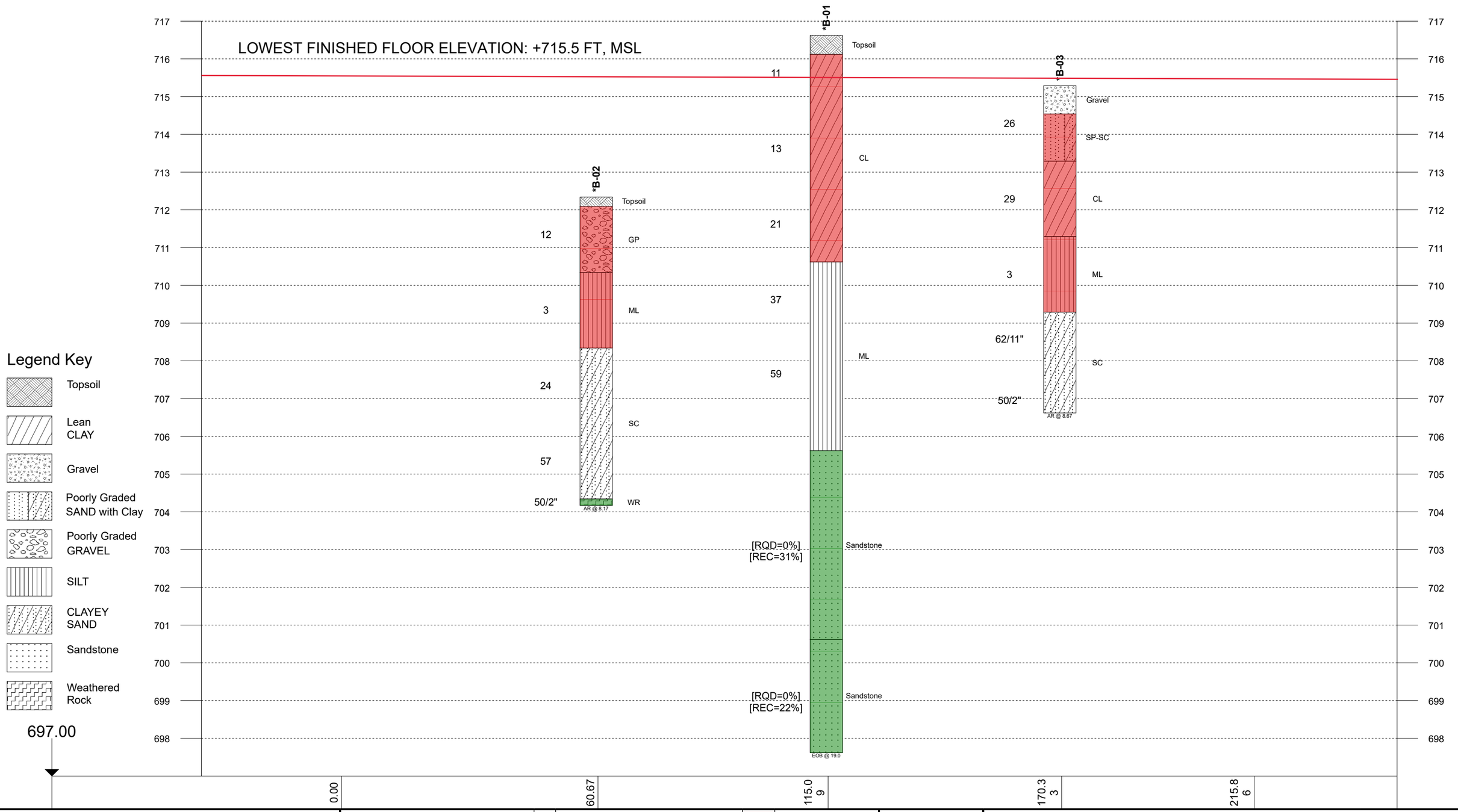


EXPLORATION LOCATION DIAGRAM
SOUTHAMPTON TOWNSHIP METAL

200 AIRPORT ROAD, SHIPPENSBURG, PA

SOUTHAMPTON TOWNSHIP

ENGINEER	JMC2
SCALE	AS NOTED
PROJECT NO.	18:5866
FIGURE	1 OF 1
DATE	2/28/2023



Legend Key

- Topsoil
- Lean CLAY
- Gravel
- Poorly Graded SAND with Clay
- Poorly Graded GRAVEL
- SILT
- CLAYEY SAND
- Sandstone
- Weathered Rock

697.00

Notes:

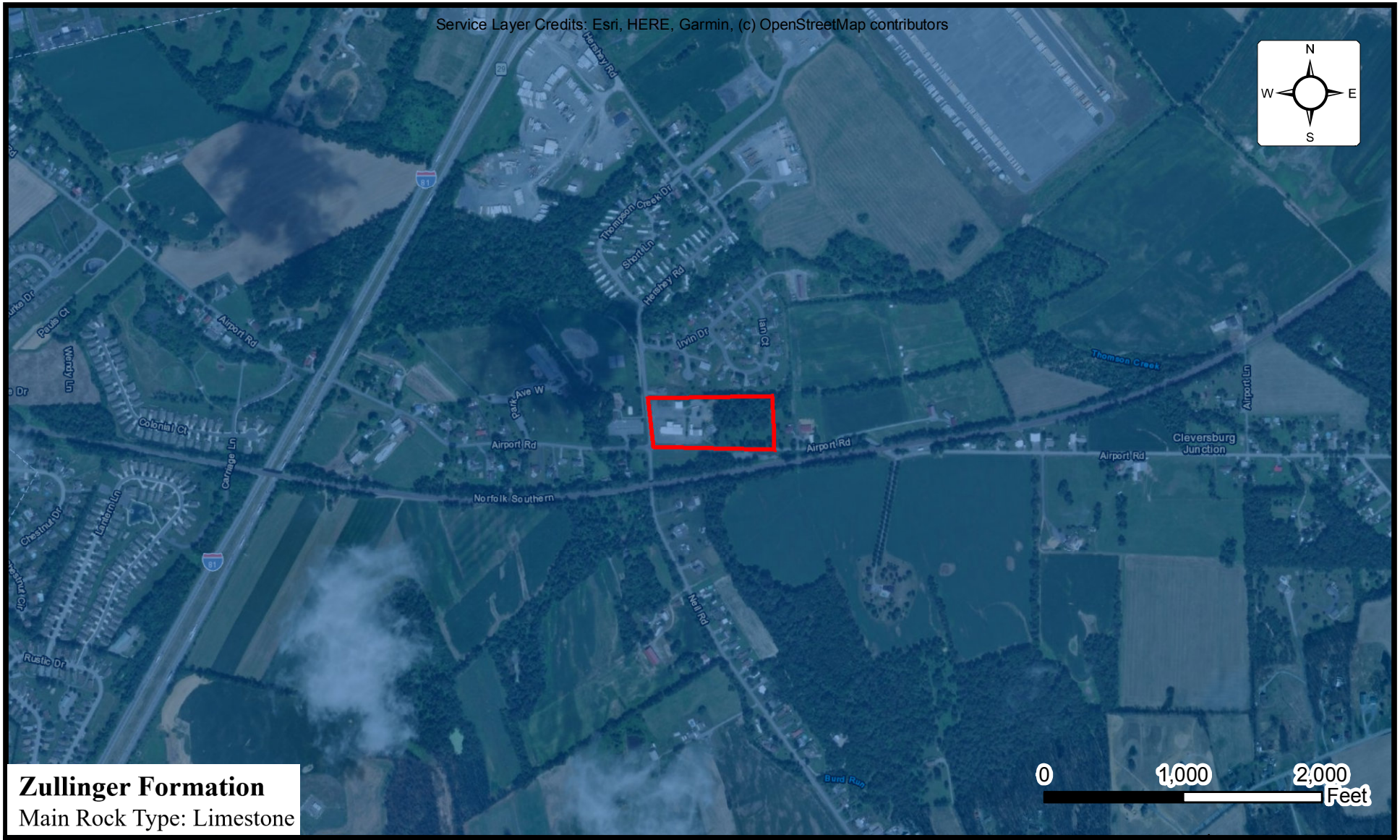
1- EOB: END OF BORING AR: AUGER REFUSAL SR: SAMPLER REFUSAL.
2- THE NUMBER BELOW THE STRIPS IS THE DISTANCE ALONG THE BASELINE.
3- SEE INDIVIDUAL BORING LOG AND GEOTECHNICAL INFORMATION.
4- STANDARD PENETRATION TEST RESISTANCE (LEFT OF BORING) IN BLOWS PER FOOT (ASTM D1586).

Plastic Limit Water Content Liquid Limit X—●—△	WL (First Encountered)	Fill
[FINES CONTENT %]	WL (Completion)	Possible Fill
BOTTOM OF CASING	WL (Estimated Seasonal High Water)	Probable Fill
100% LOSS OF CIRCULATION	WL (Stabilized)	Rock

GENERALIZED SUBSURFACE SOIL PROFILE A-A'

Southampton Township Metal Building
Southampton Township
200 Airport Road, Shippensburg, Pennsylvania, 17257

Project No: 18:5866 Date: 03/01/2023

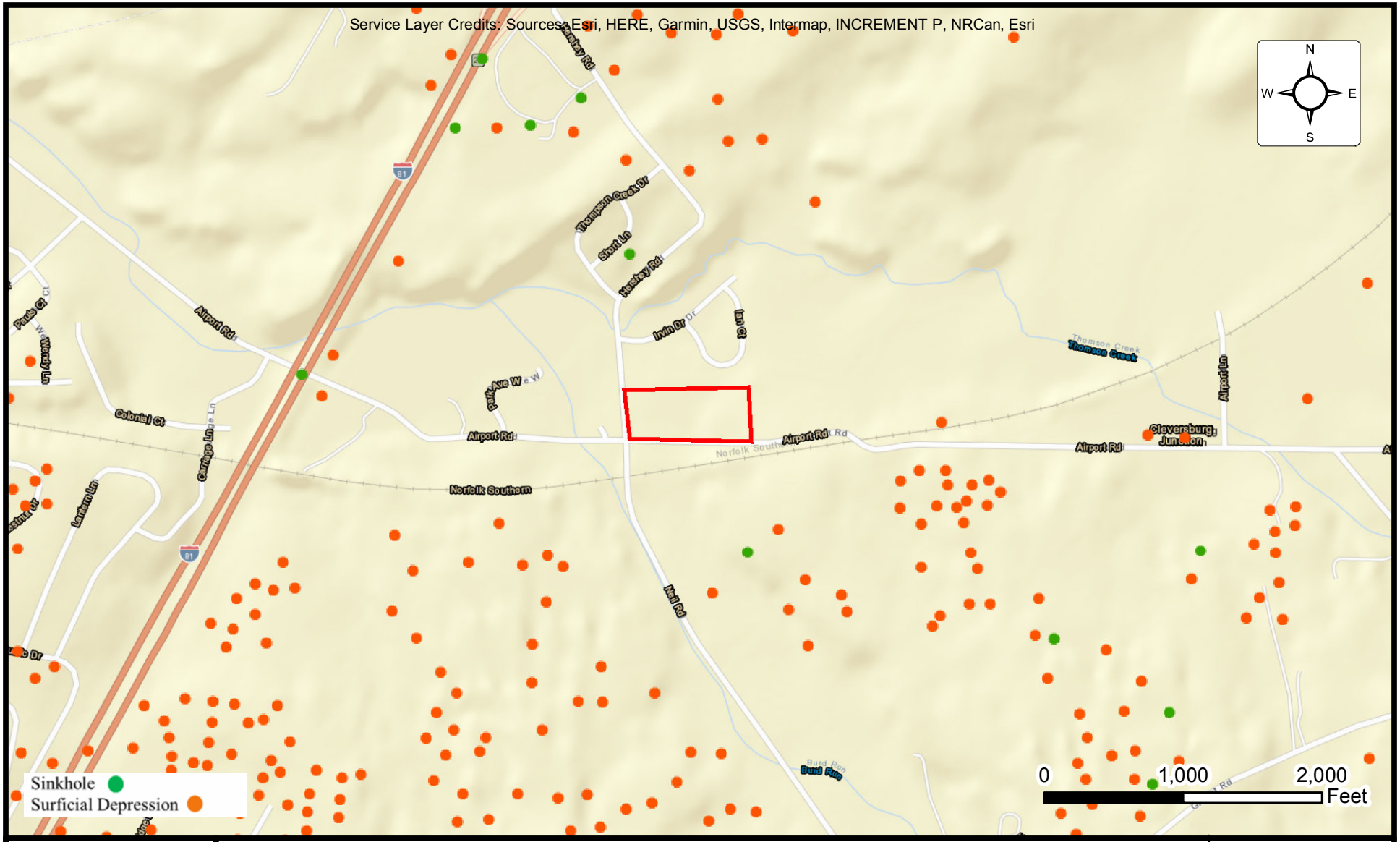


Zullinger Formation
Main Rock Type: Limestone

GEOLOGIC MAP
SOUTHAMPTON TOWNSHIP METAL BUILDING

200 AIRPORT ROAD, SHIPPENSBURG, PA
SOUTHAMPTON TOWNSHIP

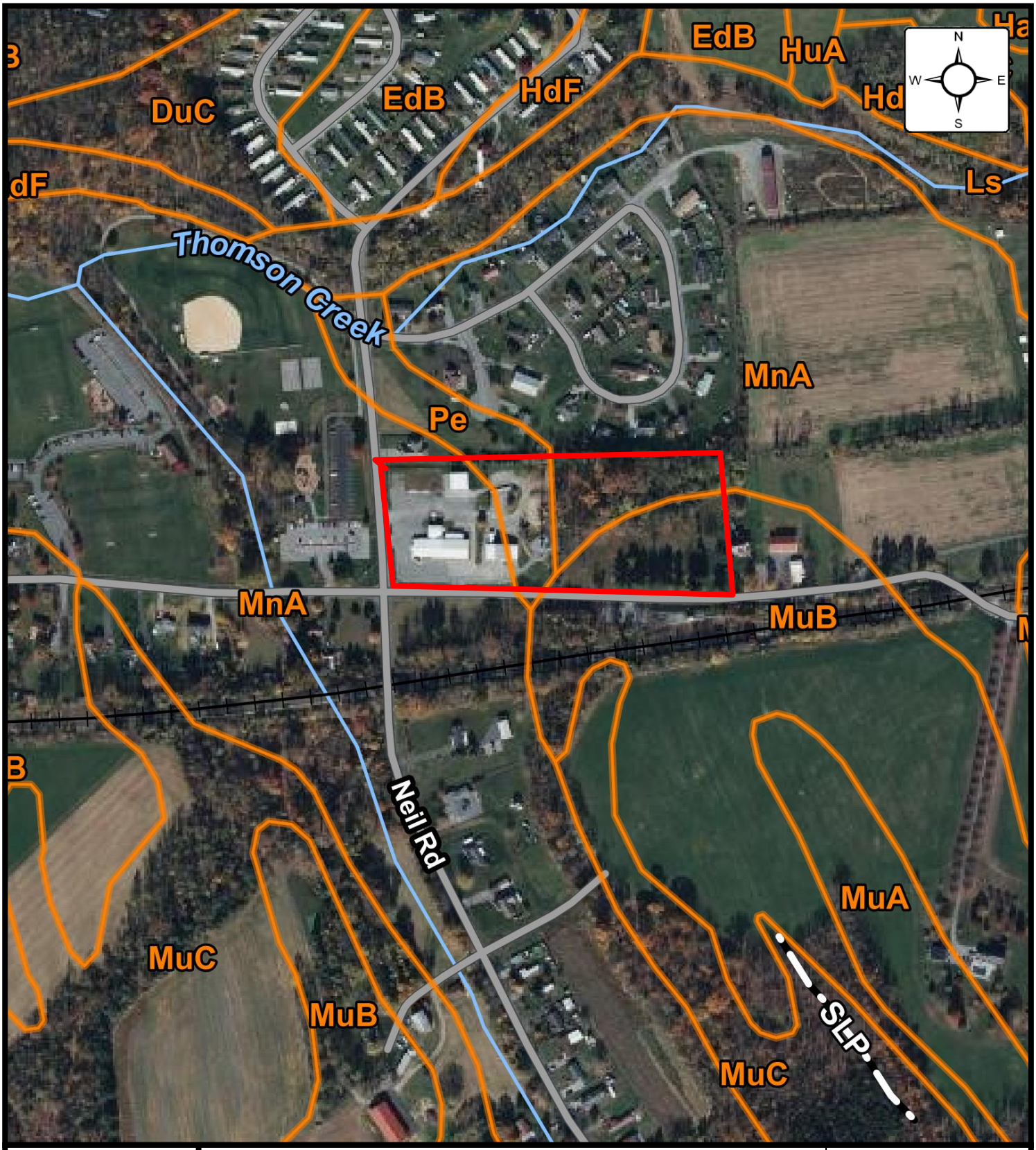
ENGINEER	JMC2
SCALE	AS NOTED
PROJECT NO.	18:5866
FIGURE	1 OF 1
DATE	2/3/2023



KARST FEATURES MAP
SOUTHAMPTON TOWNSHIP METAL BUILDING

200 AIRPORT ROAD, SHIPPENSBURG, PA
SOUTHAMPTON TOWNSHIP

ENGINEER	JMC2
SCALE	AS NOTED
PROJECT NO.	18:5866
FIGURE	1 OF 1
DATE	2/28/2023



SOIL SURVEY MAP
SOUTHAMPTON TOWNSHIP
METAL BUILDING

200 AIRPORT ROAD, SHIPPENSBURG, PA
SOUTHAMPTON TOWNSHIP

DRAFTER	SCA
SCALE	NTS
PROJECT NO.	18:5866
DATE	2/3/2023
SOURCE	Web Soil Survey https://websoilsurvey.nrcs.usda.gov

APPENDIX B – Field Operations

Subsurface Exploration Procedure: Standard Penetration Test (SPT)
Reference Notes for Boring Logs
Reference Notes for Rock Cores
Borings B-01 through B-03
Rock Core Photographs

SUBSURFACE EXPLORATION PROCEDURE: STANDARD PENETRATION TESTING (SPT) ASTM D 1586 Split-Barrel Sampling

Standard Penetration Testing, or **SPT**, is the most frequently used subsurface exploration test performed worldwide. This test provides samples for identification purposes, as well as a measure of penetration resistance, or N-value. The N-Value, or blow counts, when corrected and correlated, can approximate engineering properties of soils used for geotechnical design and engineering purposes.

SPT Procedure:

- Involves driving a hollow tube (split-spoon) into the ground by dropping a 140-lb hammer a height of 30-inches at desired depth
- Recording the number of hammer blows required to drive split-spoon a distance of 18-24 inches (in 3 or 4 Increments of 6 inches each)

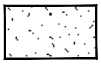
- Auger is advanced* and an additional SPT is performed
- One SPT typically performed for every two to five feet. An approximate 1.5 inch diameter soil sample is recovered.

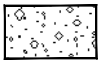
**Drilling Methods May Vary*— The predominant drilling methods used for SPT are open hole fluid rotary drilling and hollow-stem auger drilling.

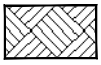
REFERENCE NOTES FOR BORING LOGS

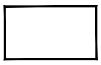
MATERIAL[1,2]

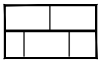

ASPHALT


CONCRETE


GRAVEL

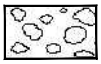

TOPSOIL

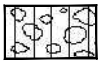

VOID


BRICK

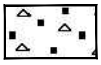

AGGREGATE BASE COURSE

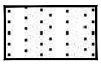

GW **WELL-GRADED GRAVEL**
gravel-sand mixtures, little or no fines

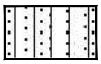

GP **POORLY-GRADED GRAVEL**
gravel-sand mixtures, little or no fines


GM **SILTY GRAVEL**
gravel-sand-silt mixtures

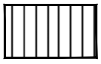

GC **CLAYEY GRAVEL**
gravel-sand-clay mixtures

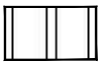

SW **WELL-GRADED SAND**
gravelly sand, little or no fines

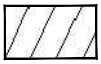

SP **POORLY-GRADED SAND**
gravelly sand, little or no fines


SM **SILTY SAND**
sand-silt mixtures

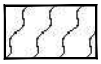

SC **CLAYEY SAND**
sand-clay mixtures

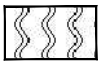

ML **SILT**
non-plastic to medium plasticity

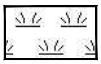

MH **ELASTIC SILT**
high plasticity


CL **LEAN CLAY**
low to medium plasticity


CH **FAT CLAY**
high plasticity


OL **ORGANIC SILT or CLAY**
non-plastic to low plasticity


OH **ORGANIC SILT or CLAY**
high plasticity


PT **PEAT**
highly organic soils

DRILLING SAMPLING SYMBOLS & ABBREVIATIONS

SS	Split Spoon Sampler	PM	Pressuremeter Test
ST	Shelby Tube Sampler	RD	Rock Bit Drilling
WS	Wash Sample	RC	Rock Core, NX, BX, AX
BS	Bulk Sample of Cuttings	REC	Rock Sample Recovery %
PA	Power Auger (no sample)	RQD	Rock Quality Designation %
HSA	Hollow Stem Auger		

PARTICLE SIZE IDENTIFICATION

DESIGNATION		PARTICLE SIZES
Boulders		12 inches (300 mm) or larger
Cobbles		3 inches to 12 inches (75 mm to 300 mm)
Gravel:	Coarse	¾ inch to 3 inches (19 mm to 75 mm)
	Fine	4.75 mm to 19 mm (No. 4 sieve to ¾ inch)
Sand:	Coarse	2.00 mm to 4.75 mm (No. 10 to No. 4 sieve)
	Medium	0.425 mm to 2.00 mm (No. 40 to No. 10 sieve)
	Fine	0.074 mm to 0.425 mm (No. 200 to No. 40 sieve)
Silt & Clay ("Fines")		<0.074 mm (smaller than a No. 200 sieve)

COHESIVE SILTS & CLAYS

UNCONFINED COMPRESSIVE STRENGTH, Q_P[4]	SPT[5] (BPF)	CONSISTENCY[7] (COHESIVE)
<0.25	<2	Very Soft
0.25 - <0.50	2 - 4	Soft
0.50 - <1.00	5 - 8	Firm
1.00 - <2.00	9 - 15	Stiff
2.00 - <4.00	16 - 30	Very Stiff
4.00 - 8.00	31 - 50	Hard
>8.00	>50	Very Hard

GRAVELS, SANDS & NON-COHESIVE SILTS

SPT[5]	DENSITY
<5	Very Loose
5 - 10	Loose
11 - 30	Medium Dense
31 - 50	Dense
>50	Very Dense

RELATIVE AMOUNT[7]	COARSE GRAINED (%)[8]	FINE GRAINED (%)[8]
Trace	≤5	≤5
With	10 - 20	10 - 25
Adjective *(ex: "Silty")*	25 - 45	30 - 45

WATER LEVELS[6]

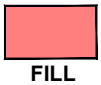

WL (First Encountered)


WL (Completion)


WL (Seasonal High Water)


WL (Stabilized)

FILL AND ROCK


FILL


POSSIBLE FILL


PROBABLE FILL


ROCK

[1]Classifications and symbols per ASTM D 2488-17 (Visual-Manual Procedure) unless noted otherwise.

[2]To be consistent with general practice, "POORLY GRADED" has been removed from GP, GP-GM, GP-GC, SP, SP-SM, SP-SC soil types on the boring logs.

[3]Non-ASTM designations are included in soil descriptions and symbols along with ASTM symbol [Ex: (SM-FILL)].

[4]Typically estimated via pocket penetrometer or Torvane shear test and expressed in tons per square foot (tsf).

[5]Standard Penetration Test (SPT) refers to the number of hammer blows (blow count) of a 140 lb. hammer falling 30 inches on a 2 inch OD split spoon sampler required to drive the sampler 12 inches (ASTM D 1586). "N-value" is another term for "blow count" and is expressed in blows per foot (bpf). SPT correlations per 7.4.2 Method B and need to be corrected if using an auto hammer.

[6]The water levels are those levels actually measured in the borehole at the times indicated by the symbol. The measurements are relatively reliable when augering, without adding fluids, in granular soils. In clay and cohesive silts, the determination of water levels may require several days for the water level to stabilize. In such cases, additional methods of measurement are generally employed.

[7]Minor deviation from ASTM D 2488-17 Note 14.

[8]Percentages are estimated to the nearest 5% per ASTM D 2488-17.

REFERENCE NOTES FOR ROCK CORES

ROCK CLASSIFICATION TYPES		
Igneous	**Sedimentary**	**Metamorphic**
Coarse Grained	**Clastic (sediment)**	**Foliated**
DIABASE	SHALE	GNEISS
DIORITE	SILTSTONE	PHYLLITE
GABBRO	SANDSTONE	SCHIST
GRANITE	CONGLOMERATE	SLATE
PEGMATITE	LIMESTONE, OOLITIC	**Non-Foliated**
PERIDOTITE	**Chemically Formed**	AMPHIBOLITE
SYENITE	DOLOSTONE	HORNFELS
Fine Grained	GYPSUM	MARBLE
ANDESITE	HALITE	QUARTZITE
BASALT	LIMESTONE	
RHYOLITE	**Organic Remains**	
TRACHYTE	CHALK	
Pyroclastic	COAL	
OBSIDIAN	COQUINA	
PUMICE		
TUFF		

HARDNESS	
Very Soft	Deformed by hand
Soft	Scratched with a fingernail
Moderately Hard	Scratched easily with a knife
Hard	Scratched with difficulty with a knife
Very Hard	Cannot be scratched with a knife

JOINT/FRACTURE SPACING	
Fractured/Jointed	**Spacing**
Very Widely	> 10 feet
Slightly	3 - 10 feet
Moderately	1 - 3 feet
Highly	2 inches - 1 foot
Intensely	< 2 inches

BEDDING	
Thinly	≤ 0.3 ft.
Medium	>0.3 ft. ≤ 1 ft.
Thickly	>1 ft. ≤ 3 ft.
Massive	>3 ft.

JOINT OR FRACTURE CONTINUITY

It shall be noted whether the joints or fractures are continuous or discontinuous. If continuity of joints is not discernable at the scale of the rock core, continuous joints or fractures shall be assumed.

JOINT/FRACTURE ORIENTATION

The range or average orientation of each joint set or fracture trend shall be measured in degrees from a horizontal plane where possible. If no measurement is possible, the qualitative terms High, Moderate or Low-angle shall be used. Record whether the joints are present in Conjugate sets (i.e. having an opposite sense of dip)

High	61-90 degree
Moderate	31-60 degree
Low-angle	0-30 degree
Dip-angle	(1-90) ____ degrees (if measured)

Recovery (REC(%))

$$\frac{\text{Total rock recovered from run}}{\text{Total Run Length}}$$

Rock Quality Designation (RQD(%))*

$$\frac{\text{Sum of core pieces} \geq 4 \text{ inches long}}{\text{Total Run Length}}$$

RQD%	Description of Rock Quality
0-25%	Very Poor
>25%-50%	Poor
>50%-75%	Fair
>75%-90%	Good
>90%	Excellent

WEATHERING	
Unweathered	No evidence of any chemical or mechanical alteration.
Slightly Weathered	Slight discoloration on surface, slight alteration along discontinuities, less than 10 percent of the rock volume altered.
Moderately Weathered	Discoloring evident, surface pitted and altered with alteration penetrating well below rock surfaces, weathering 'halos' evident. 10 to 50 percent of the rock altered.
Highly Weathered	Entire mass discolored, alteration pervading nearly all of the rock, with some pockets of slightly weathered rock noticeable, some minerals leached away.
Decomposed	Rock reduced to a soil with relict rock structure remaining (i.e. saprolite). Generally molded and crumbled by hand (friable).

JOINT/FRACTURE SURFACE CONDITION

The following qualitative terms shall be used to describe surface condition of joints and fractures. Multiple terms can be used.

Very rough	Slightly rough	Slickensided	Gouge

WALL ROCK CONDITION

The qualitative terms 'hard wall rock' or 'soft wall rock' shall be used to describe the condition of the parent rock on either side of the joint or fracture.

Description Sequence	Example Rock Classification Description
ROCK TYPE, [REC=_%,RQD=_%], Weathering, Hardness, Bedding, Joint/Fracture Spacing, Joint/Fracture Surface Condition, Wall Rock Condition, Joint or Fracture Continuity, Joint/Fracture Orientation, Color, Additional Features	LIMESTONE, [REC=95%,RQD=60%], Highly Weathered, Hard, Thinly Bedded, Slightly Fractured/Jointed, Slightly Rough, Hard Wall Rock, Continuous, Moderate-angle Dip, Gray White

*ASTM D6032-17: RQD is performed on cores using BQ to PQ sized bits (1.433 to 3.345 inch diameter cores, respectively)

CLIENT:	PROJECT NO.:	BORING NO.:	SHEET:
Southampton Township	**18:5866**	**B-01**	**1 of 1**

PROJECT NAME:	DRILLER/CONTRACTOR:
Southampton Township Metal Building	**Eichelbergers, Inc.**

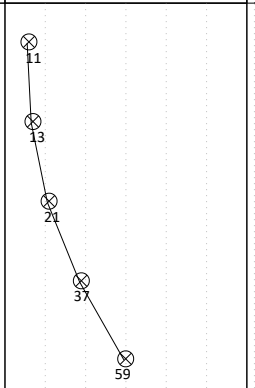
SITE LOCATION: **200 Airport Road, Shippensburg, Pennsylvania, 17257**

LOSS OF CIRCULATION

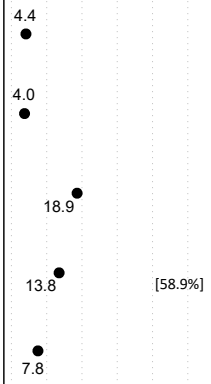
NORTHING:	EASTING:	STATION:	SURFACE ELEVATION:	BOTTOM OF CASING
			716.62	

DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	SS	24	18	Topsoil Thickness[6.00"] (CL FILL) FILL, GRAVELLY LEAN CLAY, contains asphalt, dark brown and dark gray, moist, stiff to very stiff			3-5-6-7 (11)
	S-2	SS	24	10				9-8-5-4 (13)
5	S-3	SS	24	24			712	5-10-11-15 (21)
	S-4	SS	24	19	(ML) SANDY SILT, orangish brown to white, moist, dense to very dense			23-23-14-14 (37)
	S-5	SS	23	22				8-25-34-50/5" (59)
10							707	
	R-1	RC	60	19	SANDSTONE, [REC=31%,RQD=0%], Highly Weathered, Hard, Thinly Bedded, Intensely Fractured/Jointed, Moderate-angle Dip, Orangish Brown and White			
15							702	
	R-2	RC	36	8	SANDSTONE, [REC=22%,RQD=0%], Highly Weathered, Hard, Thinly Bedded, Intensely Fractured/Jointed, Moderate-angle Dip, Orangish Brown and White			
20					**END OF BORING AT 19.0 FT**		697	
25							692	
30							687	

STANDARD PENETRATION BLOWS/FT (20 40 60 80 100)
ROCK QUALITY DESIGNATION & RECOVERY
RQD
REC



LIQUID LIMIT
PLASTIC LIMIT
CALIBRATED PENETROMETER TSF (1 2 3 4 5)
WATER CONTENT %
[FINES CONTENT] %
(10 20 30 40 50)



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL

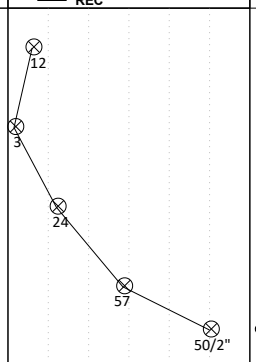
WL (First Encountered)	**N/E**
WL (Completion)	**N/E**
WL (Seasonal High Water)	**N/E**
WL (Stabilized)	

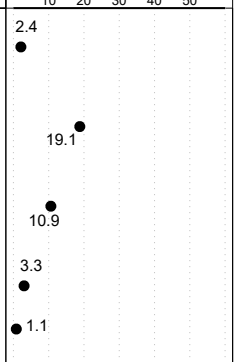
BORING STARTED:	**Feb 15 2023**	CAVE IN DEPTH:	**8.00**
BORING COMPLETED:	**Feb 15 2023**	HAMMER TYPE:	**Auto**
EQUIPMENT: **Diedrich D-50**	LOGGED BY: **SA8**	DRILLING METHOD:	**3.25" HSA**

GEOTECHNICAL BOREHOLE LOG

CLIENT:	PROJECT NO.:	BORING NO.:	SHEET:
Southampton Township	**18:5866**	**B-02**	**1 of 1**
PROJECT NAME:	DRILLER/CONTRACTOR:		
Southampton Township Metal Building	**Eichelbergers, Inc.**		
SITE LOCATION: **200 Airport Road, Shippensburg, Pennsylvania, 17257**			LOSS OF CIRCULATION
NORTHING:	EASTING:	STATION:	SURFACE ELEVATION: **712.34**

DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	ELEVATION (FT)	BLOWS/6"
0	S-1	SS	24	14	Topsoil Thickness[3.00"] (GP FILL) FILL, GRAVEL WITH SAND, gray, moist, medium dense		5-7-5-3 (12)
	S-2	SS	24	17	(ML FILL) FILL, SILT WITH SAND, contains roots, light brown, moist, very loose		4-1-2-2 (3)
5	S-3	SS	24	13	(SC) CLAYEY SAND WITH GRAVEL, orangish brown and white, moist, medium dense to very dense	708	2-7-17-20 (24)
	S-4	SS	24	21			25-29-28-37 (57)
	S-5	SS	2	2			50/2" (50/2")
10					(WR) WEATHERED SANDSTONE SAMPLED AS GRAVEL WITH SAND, white, moist [Weathered SANDSTONE]	703	
					AUGER REFUSAL AT 8.17 FT		
15						698	
20						693	
25						688	
30						683	





THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL

WL (First Encountered)	**N/E**	BORING STARTED:	**Feb 15 2023**	CAVE IN DEPTH:	**6.50**
WL (Completion)	**N/E**	BORING COMPLETED:	**Feb 15 2023**	HAMMER TYPE:	**Auto**
WL (Seasonal High Water)	**N/E**	EQUIPMENT: **Diedrich D-50**	LOGGED BY: **SA8**	DRILLING METHOD:	**3.25" HSA**
WL (Stabilized)					

GEOTECHNICAL BOREHOLE LOG

CLIENT:	PROJECT NO.:	BORING NO.:	SHEET:
Southampton Township	**18:5866**	**B-03**	**1 of 1**
PROJECT NAME:	DRILLER/CONTRACTOR:		
Southampton Township Metal Building	**Eichelbergers, Inc.**		
SITE LOCATION: **200 Airport Road, Shippensburg, Pennsylvania, 17257**			LOSS OF CIRCULATION
NORTHING:	EASTING:	STATION:	SURFACE ELEVATION: **715.29** / BOTTOM OF CASING

DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	SS	24	16	Gravel Thickness[9.00"] (SP-SC FILL) FILL, SAND WITH CLAY AND GRAVEL, dark gray and orangish brown, moist, medium dense		715	11-19-7-15 (26)
	S-2	SS	24	21	(CL FILL) FILL, SANDY LEAN CLAY WITH GRAVEL, contains asphalt, dark gray and black, moist, very stiff			19-17-12-8 (29)
5	S-3	SS	24	20	(ML FILL) FILL, SANDY SILT WITH GRAVEL, contains roots, light gray, moist, very loose		711	2-1-2-4 (3)
	S-4	SS	17	17	(SC) CLAYEY SAND WITH GRAVEL, orangish brown, moist, very dense			7-12-50/5" (62/11")
	S-5	SS	8	7	**AUGER REFUSAL AT 8.67 FT**		706	33-50/2" (50/2")
10								
15							701	
20							696	
25							691	
30							686	

STANDARD PENETRATION BLOWS/FT: 20 40 60 80 100
ROCK QUALITY DESIGNATION & RECOVERY — RQD — REC
Standard penetration values: 26, 29, 3, 62/11", 50/2"

LIQUID LIMIT
PLASTIC LIMIT
CALIBRATED PENETROMETER TSF: 1 2 3 4 5
WATER CONTENT % [FINES CONTENT] %: 10 20 30 40 50
Water content values: 22.2, 10.8, 21.7, 15.1, 22.2

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL

WL (First Encountered)	**N/E**	BORING STARTED:	**Feb 15 2023**	CAVE IN DEPTH:	**6.50**
WL (Completion)	**N/E**	BORING COMPLETED:	**Feb 15 2023**	HAMMER TYPE:	**Auto**
WL (Seasonal High Water)	**N/E**	EQUIPMENT:	LOGGED BY:	DRILLING METHOD:	**3.25" HSA**
WL (Stabilized)		**Diedrich D-50**	**SA8**		

GEOTECHNICAL BOREHOLE LOG

R-1

R-2

RUN	DEPTH	RECOVERY	RQD
R-1	11.0’-16.0'	31%	0%
R-2	16.0’-19.0’	22%	0%

ROCK CORE PHOTOGRAPHS

Southampton Township Metal Building

200 Airport Road, Southampton Township, PA

Project Number: 18:5866
Boring Number: B-01
Boring Completed: February 2023

APPENDIX C – Laboratory Testing

Laboratory Test Results Summary
Plasticity Chart
Grain Size Analysis

Laboratory Testing Summary

Sample Location	Sample Number	Depth (feet)	^MC (%)	Soil Type	Atterberg Limits			**Percent Passing No. 200 Sieve	Moisture - Density		CBR (%)		#Organic Content (%)
					LL	PL	PI		<Maximum Density (pcf)	<Optimum Moisture (%)	0.1 in.	0.2 in.	
B-01	S-1	0-2	4.4										
B-01	S-2	2-4	4.0										
B-01	S-3	4-6	18.9										
B-01	S-4	6-8	13.8	ML	NP	NP	NP	58.9					
B-01	S-5	8-9.92	7.8										
B-02	S-1	0-2	2.4										
B-02	S-2	2-4	19.1										
B-02	S-3	4-6	10.9										
B-02	S-4	6-8	3.3										
B-02	S-5	8-8.17	1.1										

Notes: See test reports for test method, ^ASTM D2216-19, *ASTM D2488, **ASTM D1140-17, #ASTM D2974-20e1 < See test report for D4718 corrected values

Definitions: MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, CBR: California Bearing Ratio, OC: Organic Content

Project: Southampton Township Metal Building
Client: Southampton Township

Project No.: 18:5866
Date Reported: 2/21/2023

Office / Lab	Address	Office Number / Fax
ECS Mid-Atlantic LLC - York	52-6 Grumbacher Road York, PA 17406	(717)767-4788 (717)767-5658

Tested by	Checked by	Approved by	Date Received
JGates		agolihew	

Laboratory Testing Summary

Sample Location	Sample Number	Depth (feet)	^MC (%)	Soil Type	Atterberg Limits			**Percent Passing No. 200 Sieve	Moisture - Density		CBR (%)		#Organic Content (%)
					LL	PL	PI		<Maximum Density (pcf)	<Optimum Moisture (%)	0.1 in.	0.2 in.	
B-03	S-1	0-2	22.2										
B-03	S-2	2-4	10.8										
B-03	S-3	4-6	21.7										
B-03	S-4	6-7.42	15.1										
B-03	S-5	8-8.67	22.2										

Notes: See test reports for test method, ^ASTM D2216-19, *ASTM D2488, **ASTM D1140-17, #ASTM D2974-20e1 < See test report for D4718 corrected values

Definitions: MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, CBR: California Bearing Ratio, OC: Organic Content

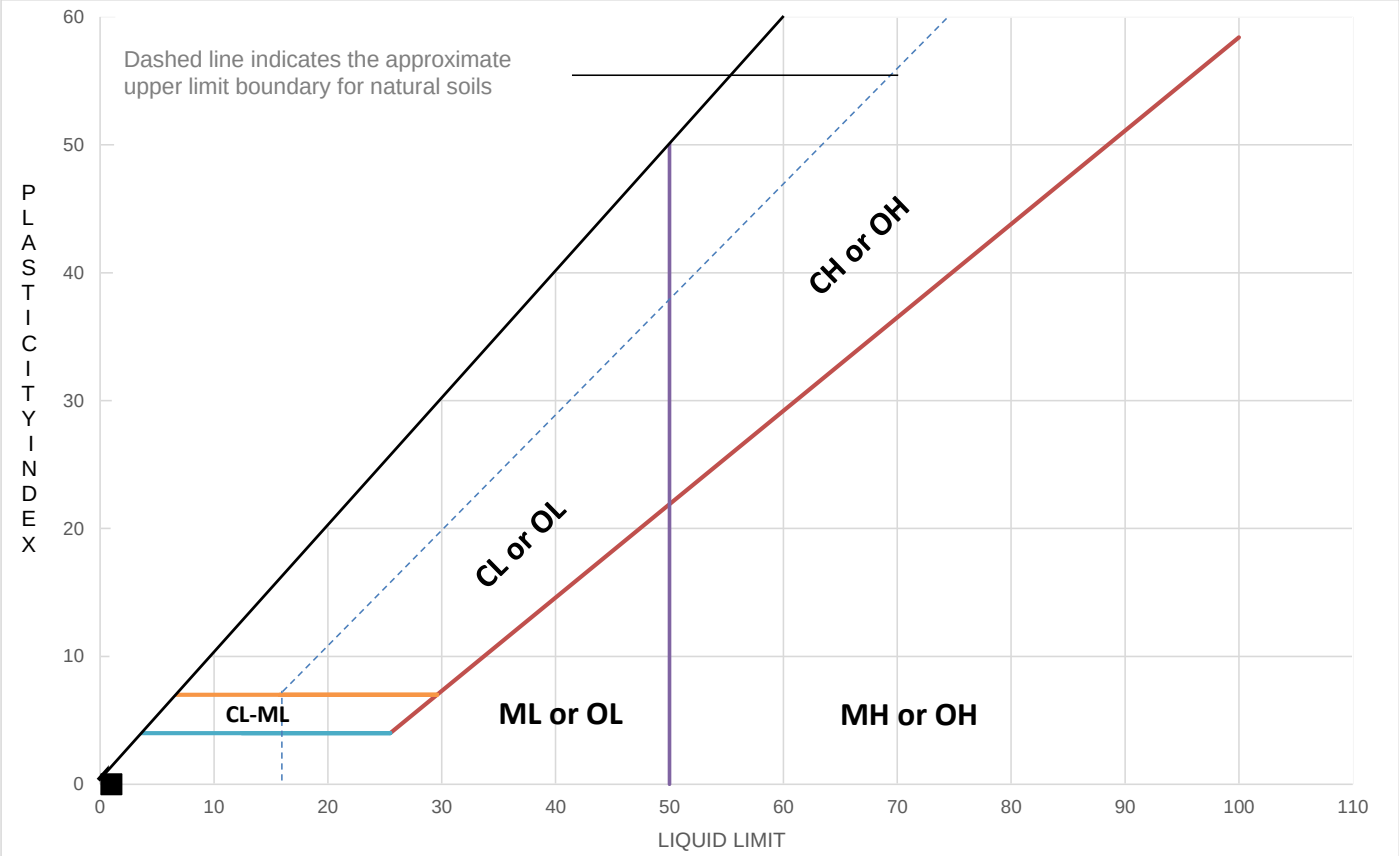
Project: Southampton Township Metal Building
Client: Southampton Township

Project No.: 18:5866
Date Reported: 2/21/2023

Office / Lab	Address	Office Number / Fax
ECS Mid-Atlantic LLC - York	52-6 Grumbacher Road York, PA 17406	(717)767-4788 (717)767-5658

Tested by	Checked by	Approved by	Date Received
JGates		agolihew	

LIQUID AND PLASTIC LIMITS TEST REPORT



TEST RESULTS (ASTM D4318-10 (MULTIPOINT TEST))

	Sample Location	Sample Number	Sample Depth (ft)	LL	PL	PI	%<#40	%<#200	AASHTO	USCS	Material Description
■	B-01	S-4	6-8	NP	NP	NP	88.5	58.9	A-4	ML	Sandy Silt

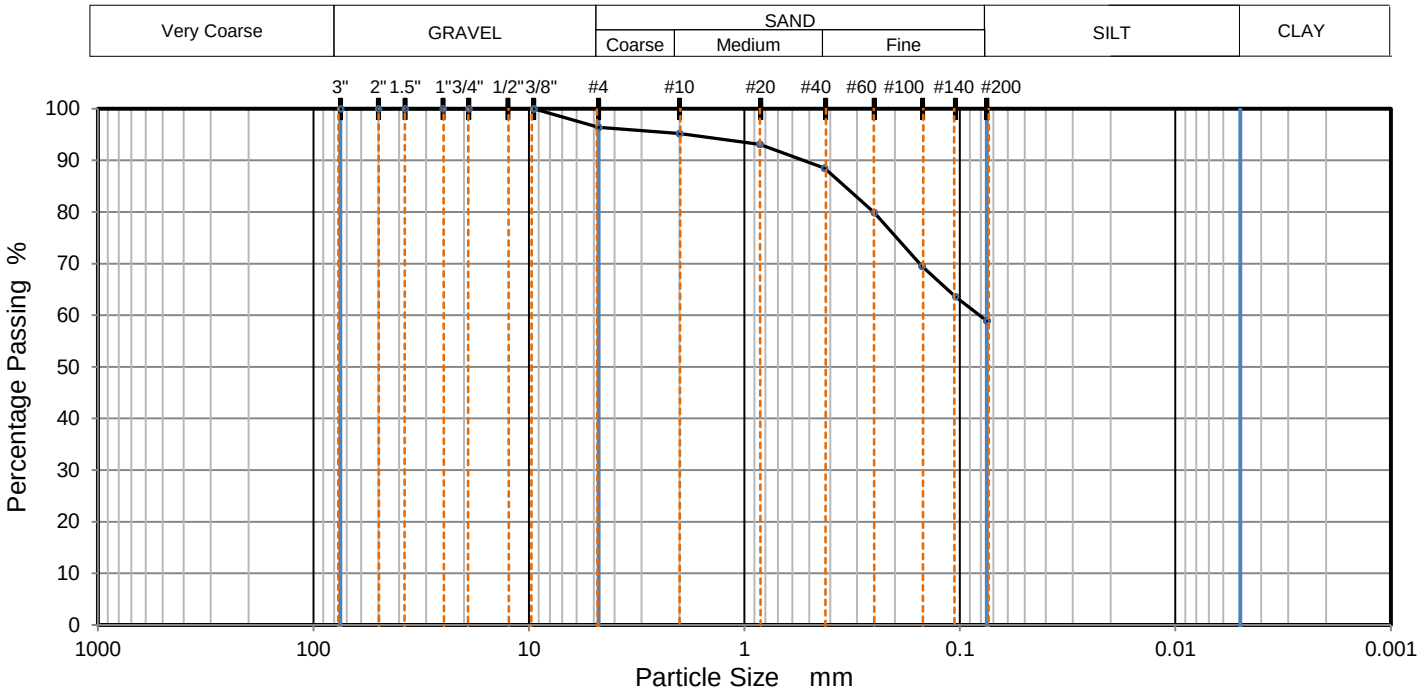
Project: Southampton Township Metal Building
Client: Southampton Township

Project No.: 18:5866
Date Reported: 2/21/2023

Office / Lab	Address	Office Number / Fax
ECS Mid-Atlantic LLC - York	52-6 Grumbacher Road York, PA 17406	(717)767-4788 (717)767-5658

Tested by	Checked by	Approved by	Date Received
JGates		agolihew	

PARTICLE SIZE DISTRIBUTION



TEST RESULTS (ASTM D6913M-17-METHOD A)

Sieving		Hydrometer Sedimentation	
Particle Size	% Passing	Particle Size mm	% Passing
3"	100		
2"	100		
1 1/2"	100		
1"	100		
3/4"	100		
3/8"	100		
#4	96		
#10	95		
#20	93		
#40	89		
#60	80		
#100	70		
#140	64		
#200	59		

Dry Mass of sample, g	55.8

Sample Proportions	% dry mass
Very coarse, >3" sieve	0
Gravel, 3" to # 4 sieve	4
Coarse Sand, #4 to #10 sieve	1
Medium Sand, #10 to #40	7
Fine Sand, #40 to #200	30
Fines <#200	59

USCS	ML	Liquid Limit	NP	D90	0.533	D50		D10	
AASHTO	A-4	Plastic Limit	NP	D85	0.343	D30		Cu	
USCS Group Name	Sandy silt	Plasticity Index	NP	D60	0.081	D15		Cc	

Project: Southampton Township Metal Building
Client: Southampton Township
Sample Description: Sandy Silt
Sample Source: B-01

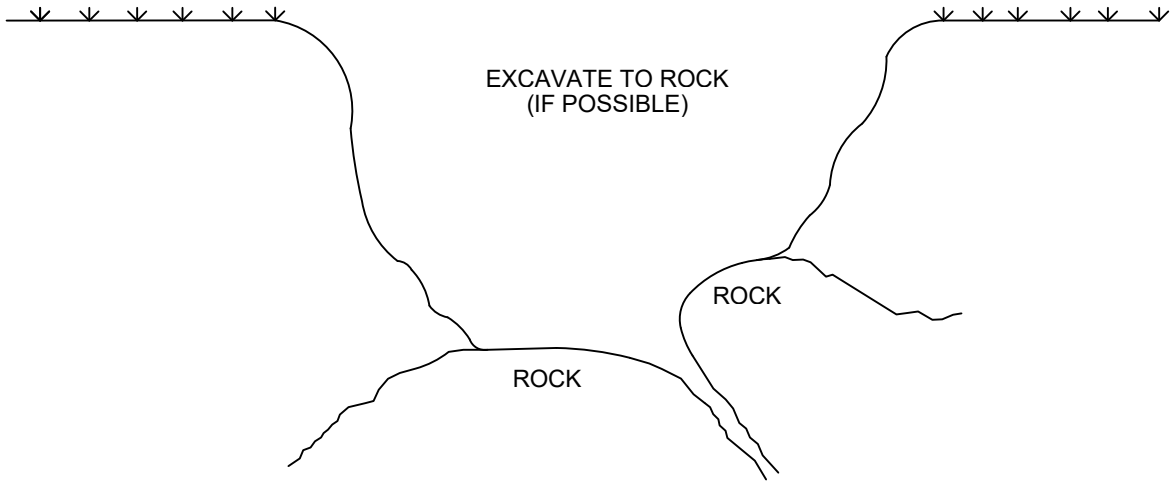
Project No.: 18:5866
Depth (ft): 6 - 8
Sample No.: S-4
Date Reported: 2/21/2023

Office / Lab	Address	Office Number / Fax
ECS Mid-Atlantic LLC - York	52-6 Grumbacher Road York, PA 17406	(717)767-4788 (717)767-5658

Tested by	Checked by	Approved by	Date Received	Remarks
JGates		agolihew		

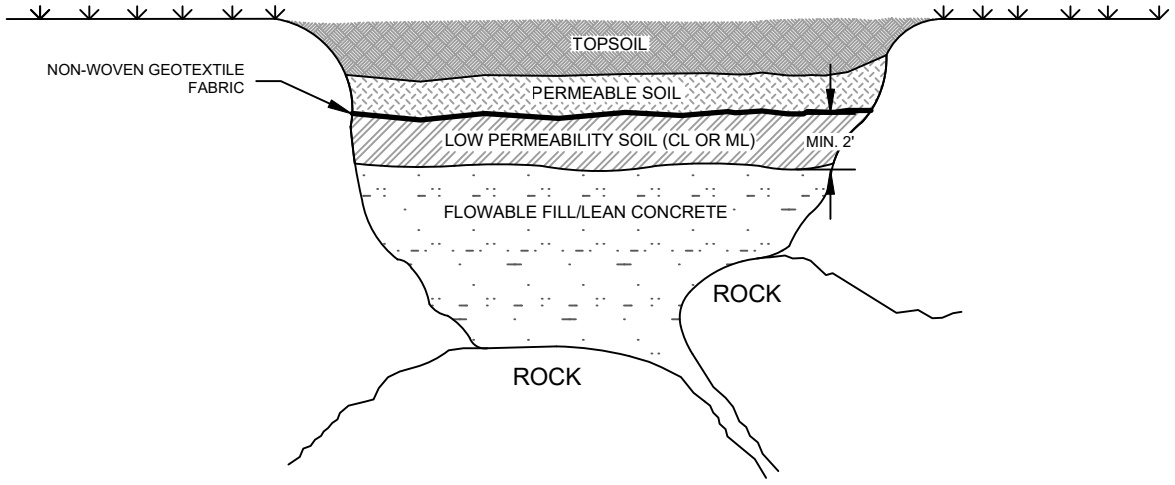
APPENDIX D – Supplemental Report Documents

Sinkhole Repair Details



STEP 1: EXCAVATE THE SINKHOLE DOWN TO ROCK, IF POSSIBLE.

STEP 2: CLEAN OUT ALL LOOSE SOIL AND EXPOSE THROAT, IF POSSIBLE.



STEP 3: PLACE APPROXIMATELY 2 TO 3 FEET (OR AS NEEDED) OF FLOWABLE FILL/LEAN CONCRETE.

STEP 4: COMPACT LOW PERMEABILITY SOIL (CL OR ML MATERIALS) OVER FLOWABLE FILL/LEAN CONCRETE TO A MINIMUM THICKNESS OF 2 FEET.

STEP 5: COVER THE SOIL WITH NON-WOVEN GEOTEXTILE FABRIC.

STEP 6: COVER GEOTEXTILE WITH PERMEABLE SOIL, COMPATIBLE WITH THE ON-SITE SOILS. COMPACT TO A MINIMUM OF 95% OF THE MAXIMUM DRY DENSITY (MDD) AS OBTAINED BY ASTM D698 (OR 92% OF THE MDD AS OBTAINED BY ASTM D1557.)

STEP 7: FILL THE REMAINDER OF THE HOLE WITH SOIL TO MATCH GRADE. THIS CAN BE LAYERED TO MATCH THE EXISTING SOIL PROFILE.

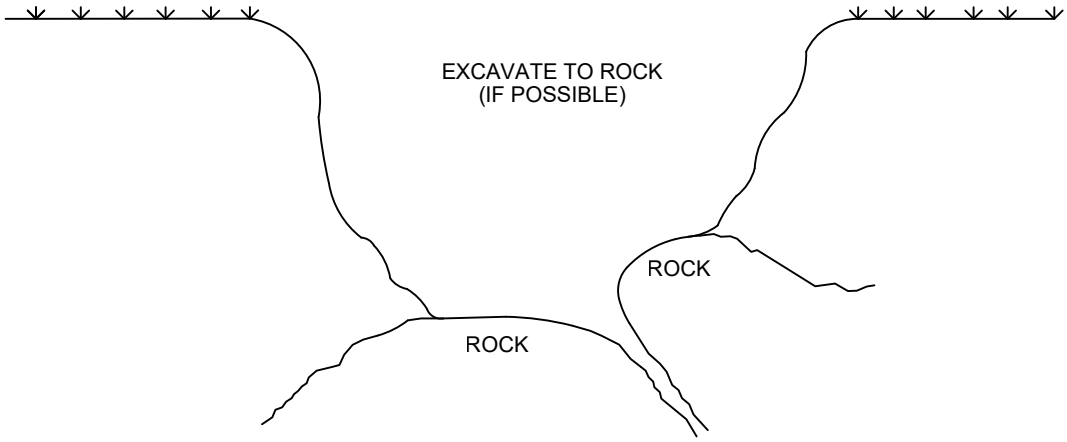
NOTE: ALL SINKHOLE REPAIRS SHOULD BE PERFORMED UNDER THE SUPERVISION OF A GEOTECHNICAL ENGINEER EXPERIENCED WITH CARBONATE GEOLOGY AND SINKHOLE REPAIR PROCEDURES. DETAILS CAN BE MODIFIED AT THE DESCRETION OF THE GEOTECHNICAL ENGINEER BASED ON THE ENCOUNTERED CONDITIONS.POSITIVE DRAINAGE AWAY FROM THE OPEN EXCAVATION SHOULD BE MAINTAINED.

ECS MID-ATLANTIC, LLC
52-6 GRUMBACHER ROAD
YORK, PA 17406
(717)-767-4788

TYPICAL SINKHOLE REPAIR DETAIL

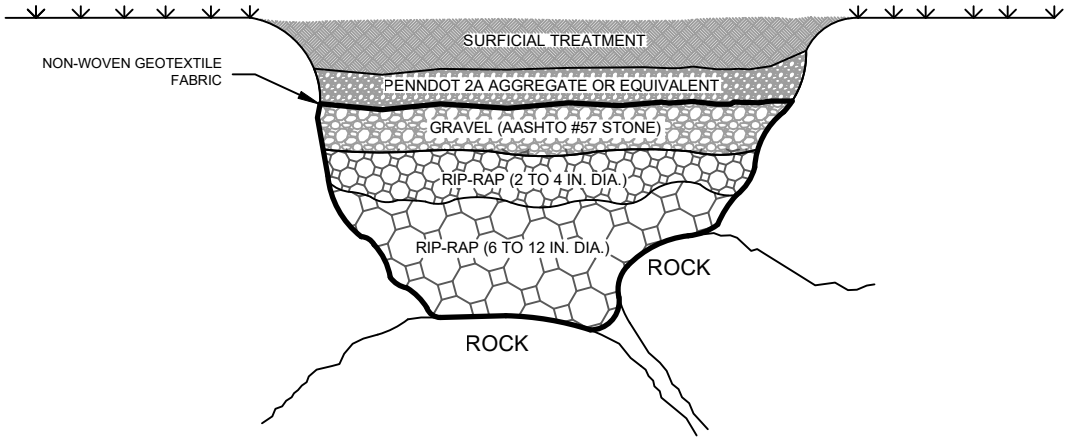
GROUTED REPAIR

NOT TO SCALE



STEP 1: EXCAVATE THE SINKHOLE DOWN TO ROCK, IF POSSIBLE.

STEP 2: CLEAN OUT ALL LOOSE SOIL AND EXPOSE THROAT, IF POSSIBLE.



STEP 3: LINE THE EXCAVATION WITH NON-WOVEN GEOTEXTILE FABRIC (MIRAFI 140N OR EQUIVALENT.

STEP 4: PLACE A LAYER OF LARGE STONE IN THE EXCAVATION. STONE SHOULD BE APPROXIMATELY 6 TO 12 INCHES IN DIAMETER.

STEP 5: PLACE A LAYER OF SMALLER STONE ON TOP. THIS LAYER SHOULD CONSIST OF STONES APPROXIMATELY 2 TO 4 INCHES IN DIAMETER.

STEP 6: PLACE A LAYER OF GRAVEL ON TOP OF THE SMALLER STONES. THE GRAVEL SHOULD BE AASHTO #57 STONE OR EQUIVALENT.

STEP 7: COVER THE GRAVEL WITH THE GEOTEXTILE FABRIC. THIS WILL PREVENT THE FINES FROM THE NEXT LAYER FROM BEING LOST IN THE VOID SPACE OF THE GRAVEL/STONE.

STEP 8: PLACE A LAYER OF PENNDOT 2A AGGREGATE OR EQUIVALENT ON TOP OF THE GEOTEXTILE FABRIC. COMPACT TO A MINIMUM OF 95% OF THE MAXIMUM DRY DENSITY (MDD) AS OBTAINED BY ASTM D698 (OR 92% OF THE MDD AS OBTAINED BY ASTM D1557.)

STEP 9: FILL THE REMAINDER OF THE HOLE WITH SOIL TO MATCH GRADE. THIS CAN BE LAYERED TO MATCH THE EXISTING SOIL PROFILE.

NOTE: IDEALLY EACH LAYER IS APPROXIMATELY 6 INCHES TO 2 FEET THICK; HOWEVER, THICKER LAYERS ARE SOMETIMES WARRANTED DEPENDING ON THE DEPTH OF THE FEATURE.ALL SINKHOLE REPAIRS SHOULD BE PERFORMED UNDER THE SUPERVISION OF A GEOTECHNICAL ENGINEER EXPERIENCED WITH CARBONATE GEOLOGY AND SINKHOLE REPAIR PROCEDURES. DETAILS CAN BE MODIFIED AT THE DESCRETION OF THE GEOTECHNICAL ENGINEER BASED ON THE ENCOUNTERED CONDITIONS. POSITIVE DRAINAGE AWAY FROM THE OPEN EXCVATION SHOULD BE MAINTAINED.

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TYPICAL SINKHOLE REPAIR DETAIL

STONE TYPE REPAIR

NOT TO SCALE