GEOTECHNICAL EVALUATION REPORT

350 SOUTH FIFTH AVENUE REDEVELOPMENT
ANN ARBOR, MICHIGAN

SME Project 084868.01
November 3, 2023

SME

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November 3, 2023

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RE: Geotechnical Evaluation Report
350 South Fifth Avenue Redevelopment
Ann Arbor, Michigan
SME Project No. 084868.01

Dear Jennifer:

We have completed our geotechnical evaluation for the proposed redevelopment of the 350 South Fifth Avenue property in Ann Arbor, Michigan. This report presents the results of our observations and analyses, along with our geotechnical recommendations and general construction considerations based on the information disclosed by the borings.

We appreciate the opportunity to be of service. If you have questions or require additional information, please contact me.

Very truly yours,

SME

Alex Kuisell, PE
Senior Project Engineer

Enclosure: SME Geotechnical Evaluation Report; Dated November 3, 2023

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IMPORTANT INFORMATION ABOUT THIS GEOTECHNICAL-ENGINEERING REPORT
GENERAL COMMENTS

1. INTRODUCTION

This report presents the results of our geotechnical evaluation for the subject project. Per the request of DMC Real Estate Services and SmithGroup, we have incorporated additional recommendations for the alternate building concept that was considered by the project team after we transmitted our initial (draft) report dated February 6, 2023. We prepared this report based on your authorization of SME Proposal P04165.22 dated December 29, 2022.

1.1 SITE CONDITIONS AND PROJECT BACKGROUND

The site is located at 350 South Fifth Avenue, on the north side of East William Street, and between Fourth Avenue and Fifth Avenue in Ann Arbor, Michigan. The project site consists of a surface (paved) parking lot. The existing ground surface gradually slopes downward from east to west. Based on aerial imagery from Google Earth, existing ground surface elevations range from about elevations 850 to 855 feet.

Previous development on this site consisted of a multi-story YMCA residential building. The previous building had a basement level, and a pool near the west end of the building (refer to the Boring Location Diagram – Figure 1, attached to this report). During the demolition of the building, we understand the existing basement (or at least a portion of the basement/pool) was left in place.

SME has previously completed geotechnical evaluations within and/or near this site for previously considered site redevelopments. The boring logs from those evaluations (SME projects 051735.00 and 073815.00) are included in Appendix A for reference. Approximate locations of the previous borings are depicted on the Boring Location Diagram (Figure 1) included in Appendix A.

1.2 PROJECT DESCRIPTION

Two options are being considered for the project, herein referred to as the “primary” and “alternate” concepts.

1.2.1 PRIMARY CONCEPT

The proposed development consists of a new residential tower and circulation for transit vehicles. The tower is anticipated to be a minimum of 19 stories tall, plus a small penthouse, and will have a one-story basement level. The tower will be located along the southern portion of the site along Williams Street. The bus lanes for the transit center will be on the northern portion of the site. We understand this is the primary option for development being considered by the project team. See Image 1 below.

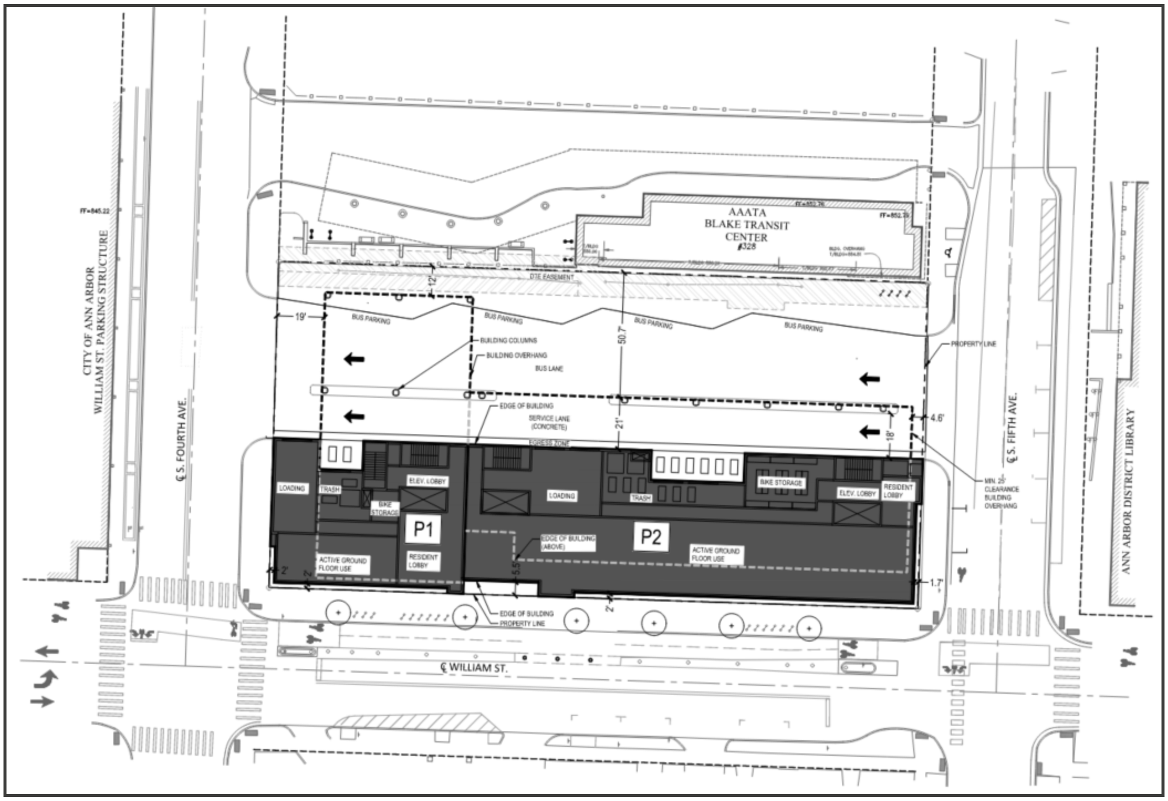


IMAGE NO. 1: Site Concept Provided by SmithGroup (Sheet SB-1 Dated November 9, 2021)

The project is in the early stages of design and a foundation plan is not available. However, the project structural engineer (SmithGroup) provided SME with preliminary information for preparing this report. Both concrete and structural steel framing systems are being considered for the design of the superstructure, which will impact the maximum column loads. The basement will be constructed of cast-in-place reinforced concrete and used for mechanical and electrical equipment, substation equipment, and storage. Refer to the image below.

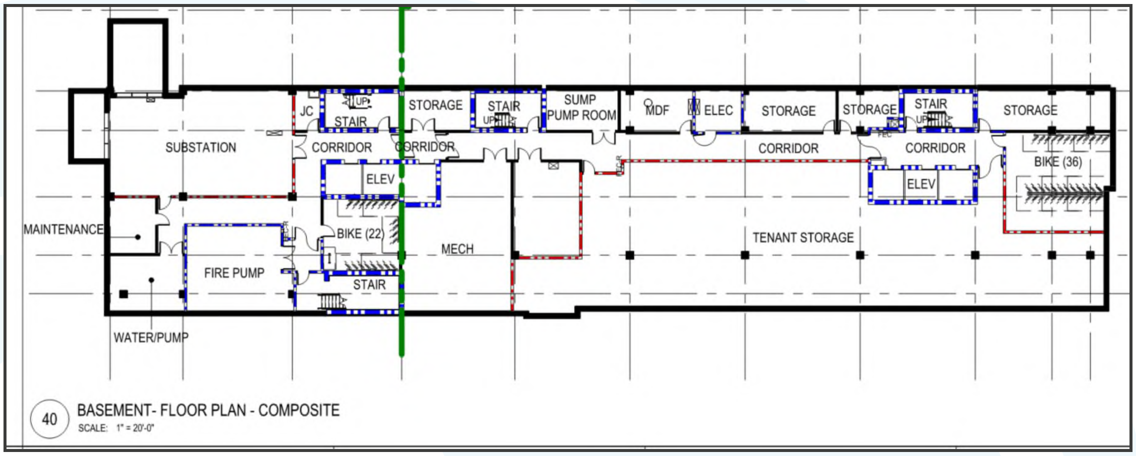


IMAGE NO. 2: Basement Floor Plan Provided by SmithGroup via email on February 19, 2023.

Column bays will be approximately 30 ft x 30 ft. Column loads are expected to range from 450 to 3,000 kips. However, we understand the distribution of loads will be relatively uniform across the building's footprint.

The finished first floor elevation has tentatively been set at approximately 848 feet on the west portion of the building and 851 feet on the eastern portion. The basement finished floor elevation has tentatively been set at 833 feet, with elevator pits extending approximately 5 to 7 feet lower. We estimate the basement excavation will extend about 20 feet below the existing ground surface (bgs). We understand a partial (shallower) basement level will be located near the northwest corner of the building, although the depth (from existing grade) is unknown at this time. Based on similar projects, we estimate exterior wall loads on basement wall foundations may vary from 1 kip per linear foot (klf) to 10 klf.

Canopy foundations will be located outside of the main building footprint (to the north) near the bus lanes. We assume column loads of 300 kips or less for the canopy.

1.2.2 ALTERNATE CONCEPT

SmithGroup contacted SME in July 2023 for assistance with evaluating the feasibility of a smaller building concept (as an alternate option). This concept consists of a 7-story, slab-on-grade, residential structure with the building footprint extending slightly further north than the primary concept. We were not provided with additional information for this concept. Based on similar projects we anticipate maximum column loads of 700 kips and wall loads up to 5 klf.

At this time, we are providing design development considerations for this concept to help the project team consider associated cost, feasibility, and schedule implications. Refer to Section 5 of this report. If requested, we can provide more detailed recommendations for this concept if it is selected later as the new primary option.

2. EVALUATION PROCEDURES

2.1 FIELD EXPLORATION

SME mobilized a truck-mounted drill rig to the site and completed fourteen soil borings (B1A, B1B, B2, B3A, B3B, B4 – B11, and IT1) between January 4, 2023 and January 12, 2023. Note proposed borings B1 and B3 were drilled twice due to encountering unknown obstructions at 16 feet and 8 feet bgs at borings B1A and B3A, respectively. The borings were advanced using hollow-stem augers and extended about 8 feet to 90 feet bgs. The boring locations are shown approximately on Figure 1 included in Appendix A. Recovered Standard Penetration Test (SPT) split-barrel samples were sealed in glass jars. Groundwater level measurements (or lack thereof) were recorded during and immediately after completion of each boring. Then, the borings were backfilled with excess auger cuttings and capped with asphalt cold patch. Therefore, long-term groundwater information is not available from the borings. Soil samples recovered from the field exploration were returned to the SME laboratory for further observation and testing.

We also completed in-situ pressuremeter testing at the site between January 5, 2023 and January 7, 2023. We performed the pressuremeter testing in the natural sands during the drilling of borings B6, B7, and B9. The tests were performed to obtain limit pressures and soil moduli of the tested soils, to more accurately evaluate the soil bearing capacity that can be achieved for shallow foundations and estimate the associated settlement due to imposed building loads. Pressuremeter testing was performed at various depths between about 20 to 35 feet bgs, within the anticipated primary stress influence zone for the building’s foundation support system. Refer to Section 4.2.1 for more information.

2.2 LABORATORY TESTING

The laboratory testing program consisted of visual soil classification on recovered samples along with moisture content and hand penetrometer shear tests on portions of cohesive samples obtained. The Laboratory Testing Procedures in Appendix B provide general descriptions of the laboratory tests mentioned above.

Upon completion of the laboratory testing, we prepared boring logs including materials encountered, penetration resistances, pertinent field observations made during the drilling operations, and the results of certain laboratory tests. The current boring logs are included in Appendix A. We developed the soil descriptions included on the boring logs from both visual classification and the results of laboratory tests, where applicable.

Soil samples, retained over a long time, even sealed in jars, are subject to moisture loss and are no longer representative of the conditions initially encountered in the field. Therefore, we normally retain soil samples in our laboratory for 60 days and then dispose of them, unless instructed otherwise.

3. SUBSURFACE CONDITIONS

3.1 SOIL CONDITIONS

The soil conditions encountered at the borings consist of surficial pavement overlying existing fill, which is underlain by natural sands to the explored depths. We provide a summary of the materials encountered at the boring locations, beginning at the existing ground surface and proceeding downward, below.

Stratum 1: Surficial Pavement. The existing pavement at the site appears to consist of a cemented gravel, possibly used as a permeable pavement for stormwater management. The pavement thickness varied from about 3 to 10 inches at the borings.

Stratum 2: Existing Fill. We encountered existing, undocumented fill below the surficial pavement, similar to previous borings performed by SME at the site. The fill extended to the refusal depths at borings B1A and B3A (8 to 16 feet) and about 9 to 17 feet bgs at the other borings. The fill extended about 16 to 22 feet bgs at previous borings B101 and B102.

The upper zone of the fill (about 3 feet) appeared to consist of a mixture of sand/gravel soil and concrete debris. Below this zone, we encountered varying amounts of debris (e.g. brick, concrete, metal, and glass fragments) mixed in with the sand fill. The debris appears to consist of construction materials, possibly remnants of the demolished YMCA building structure. We also drilled through zones of concrete debris (about 1 to 1.5 feet thick) within the fill at borings B5, B10, and B11, and encountered obstructions (resulting in drill rig auger refusal) during drilling at borings B1A and B3A. We understand the pool slab within the former YMCA building may have been left in place, as shown approximately on Figure 1 in Appendix A.

Standard Penetration Test (SPT) resistances (N_{60}-values) ranged from 8 to greater than 100 blows per foot (bpf) in the fill. Some of the blow counts appear elevated due to the presence of debris within the fill. The sand fill appears to be in a loose to dense condition.

Stratum 3: Natural Sands. Natural sands, ranging in grain size and varying in silt, clay, and gravel content, were encountered beneath the fill, and extended to the explored depths of the borings. N_{60} values ranging from 19 to 104 blows per foot (bpf) indicate the sands are in a medium dense to extremely dense condition.

We encountered cobble zones within the natural sands at the current and previous borings at this site, as noted by the driller during drilling. The frequency and depths of the cobble zones vary, but were generally encountered between 20 and 75 feet bgs.

The soil profile described above and included on the appended boring logs are generalized descriptions of the conditions encountered. We intend the stratification depths described above and shown on the boring logs to indicate a zone of transition from one soil type to another. They do not show exact depths of change from one soil type to another. We base the soil descriptions on visual classification of the soils encountered. Soil conditions may vary between or away from the boring locations. Please refer to the boring logs for the soil conditions at the specific boring locations.

Consider thickness measurements of the surficial materials reported on the boring logs (e.g. pavement) approximate as mixing of these materials can occur in small diameter boreholes. If accurate thickness measurements are required for inclusion in bid documents or for purposes of design, we recommend performing additional evaluations such as pavement cores.

It is sometimes difficult to distinguish between fill and natural soils based on samples and cuttings from small-diameter boreholes, especially when portions of the fill do not contain man-made materials, debris, topsoil or organic layers, and when the fill appears similar in composition to the local natural soils. Therefore, consider the delineation of fill described above and on the appended boring logs approximate only. Review former site topography plans, aerial photographs, demolition plans, environmental reports, and other historic site records and/or excavate test pits if a more comprehensive evaluation of the extent and composition of suspect fill is required.

3.2 GROUNDWATER CONDITIONS

We encountered groundwater during drilling at about 42 to 48 feet bgs, which is generally consistent with previous SME borings drilled on the site and longer-term groundwater levels encountered in the site vicinity. The depths where groundwater was encountered correspond to about elevations 799.5 to 805.5 feet. The depths where groundwater was measured shortly after drilling correspond to about elevations 801.5 to 807.5 feet. Based on our previous experience, the long-term groundwater elevations tend to vary from roughly elevations 800 to 810 feet in the southern end of the downtown Ann Arbor area.

In addition, some groundwater may be encountered at higher levels when it is entrapped (or perched) above seams/layers of less permeable soils (e.g. silts and clays) or existing fill. In general, we expect such perched groundwater (if any) would occur in isolated areas of the site. Typically, the perched groundwater originates in area(s) where surface runoff accumulates (e.g. near downspout outlets, below-grade utilities, utility corridors, low-lying areas relative to the surrounding ground surface, etc.) and cannot easily drain into the underlying well-draining granular soils. Perched water volumes could also be present around the buried debris within the existing fill (e.g. former YMCA pool slab possible left in-place). Seepages from perched groundwater source(s) (if any) that may be encountered in excavations can be relatively significant once initially encountered but tend to dissipate over time as the source(s) drain into the excavation.

We expect hydrostatic groundwater levels and the potential rate of infiltration into excavations to fluctuate throughout the year, based on variations in precipitation, evaporation, surface run-off, and other factors. The groundwater levels (or lack thereof) indicated by the borings and presented in this section represent conditions at the time the readings were taken. The actual groundwater levels at the time of construction may vary. If more information regarding groundwater levels at this site is required, then we recommend additional subsurface assessment(s).

4. ANALYSIS AND RECOMMENDATIONS – PRIMARY CONCEPT

4.1 SITE PREPARATION AND EARTHWORK

4.1.1 EXISTING FILL CONSIDERATIONS

We have encountered a relatively deep profile of existing fill at this site, extending up to 22 feet bgs. Based on the borings and site history, we expect the existing fill soils (and debris within the existing fill profile) are widespread on the site. The deepest portions of the fill appear to be located within the footprint of the former YMCA building – refer to the appended Figure 1. Presumably, the deeper fills are a result of backfill placed to fill the basement of the former YMCA building. It is difficult to discern the relative density of the existing sand fill due to the presence of debris elevating some of the SPT blow counts. However, portions of the fill at the current borings, and at previous borings performed around the perimeter of the site (refer to previous boring logs from SME Project 051735.00), appear to be poorly compacted based on the SPT blow counts. Overall, since the origin of the existing fill is not known and we are not aware of records that document the fill placement and any compaction operations during placement, and because of the variable density of the fill, we consider the fill to be undocumented or uncontrolled.

Based on our current understanding of the project, we anticipate a mass excavation extending about 20 feet bgs will be required for below-grade construction. Therefore, we expect most of the existing fill will be removed within the proposed building footprint, which covers the southern half (approximately) of the project site. The remainder of the site (to the north) will consist of at-grade pavements for the service and bus lanes. Based on the borings, about 8 to 22 feet of existing fill is located within the proposed pavement areas – refer to current borings B1A – B6, B11, and IT1 and previous borings B101, B102, B4, and B8.

We anticipate a mass removal of the existing fill in the proposed pavement areas would be impractical due to associated costs, schedule concerns, and proximity to neighboring properties/right-of-way areas. Therefore, after removal of the existing pavements, utilities and other structures, we recommend a thorough field evaluation of the remaining existing fill. We anticipate the existing fill will require partial removal (and replacement with engineered fill) in some areas and/or improvement (where practical) to achieve a suitable subgrade for grade slab and pavement construction. A suitable subgrade is required for support of new slabs and pavements, particularly where the pavements will be subjected to traffic loading (e.g., emergency fire lane, bus lanes, etc.). Even if the existing fill is improved, construction of new slabs/pavements over the fill requires the Owner’s acceptance of an elevated risk of poor slab/pavement performance, due to the variable nature of the fill.

The recommendations presented above consider management of the existing fill to achieve an adequate subgrade for support of grade slabs and pavements. The project team may also need to consider the environmental implications of leaving the existing fill in place or transporting it offsite. Refer to the project environmental report(s) for additional information regarding special handling/disposal requirements for the onsite soils and groundwater.

Regarding new foundations, we recommend the foundations extend through the existing fill soils and bear directly on/within suitable natural soils. For additional information regarding foundation construction, refer to Section 4.2 of this report.

Any existing fill to remain below new slabs, pavements, sidewalks, etc. will need to be verified by SME as adequate for structural support. We recommend these further evaluation(s) occur on a case-by-case basis to address the specific needs of each situation where existing fill is to remain in-place below any proposed improvements. Based on the available borings, most of the existing fill is considered adequate for pavement support. However, portions of the existing fill are in an overly loose condition and therefore, there is a heightened risk for poor performance of structures supported on the fill. Proper subgrade preparation can reduce (but not eliminate) this risk. If even a low risk for poor performance is not acceptable then the existing fill would need to be completely removed and replaced with engineered fill. SME can provide additional recommendations if a complete removal/replacement of the existing fill is desirable. Due to the significant depths of existing fill, we anticipate a complete removal would require the use of an earth retention system (ERS) installed along the site perimeter.

Proper subgrade preparation includes removing unsuitable fill, uniformly compacting the existing fill with relatively large compaction equipment, performing proofroll tests, undercutting overly soft/loose (and/or debris/organic-laden) subgrade, and replacing undercuts with suitable engineered fill. To address budgetary concerns, we recommend including a budget contingency for additional earthwork (e.g., undercutting, in-place compaction, removal of unsuitable fill, importing suitable fill, etc.) that may be required to improve subsurface conditions where existing fill is left in-place.

4.1.2 GENERAL SITE SUBGRADE PREPARATION

We anticipate earthwork operations will consist of removing the existing pavements, utilities and other structures, followed by installation of an Earth Retention System (ERS) to facilitate construction of the building’s foundations and basement level. Refer to Section 4.5 for recommendations regarding the earth retention system. We anticipate some minor grading for the sidewalk/pavement areas north of the main building structure. We recommend site clearing extend a minimum 5 feet beyond the limits of the proposed improvement areas, or to the edge of existing structures to remain, to ensure uniform support of proposed improvements. Take care during earthwork to protect adjoining/neighboring utilities and building structures to remain.

If neighboring structures/tenants will be sensitive to noises or vibrations generated by subgrade compaction or other construction activities, then we recommend setting up a monitoring program to record noise and vibrations generated during (and prior to) these operations. It would also be beneficial to perform a pre-condition assessment of sensitive, neighboring structures to document their existing condition prior to demolition/construction.

Any remaining existing utilities within the proposed building footprint (that will remain active) must be rerouted around the new construction. We recommend all abandoned utilities be removed and backfilled (if required) with granular engineered fill to the design subgrade level. Abandoned utilities outside of the building footprint could be left in place and fully grouted, provided the existing utility backfill is suitable for pavement support. Some additional subgrade preparation and testing may be required to improve the condition of the existing backfill, depending on the condition of the existing utility backfill. Further assessment regarding the suitability of the in-place backfill for pavement support can be made during site earthwork operations.

The existing subgrade (particularly, the existing fill) is sensitive to disturbances during construction and the overall success of the subgrade preparation during mass earthwork operations will directly affect the suitability of slab/pavement bearing soils. As such, take care during site earthwork operations to prepare the subgrade for structural support. Even in the natural sands, due to the limited fines content in some of these soils, the subgrade can be easily displaced under high-stress, point-type, construction loads such as those from narrow tires on a dump truck, despite its relatively dense condition. Also, the subgrade may be especially sensitive during/after receiving precipitation. Disturbed subgrade loses strength as a result. To limit subgrade disturbance, the subgrade can be capped with a dense-graded aggregate material and possibly with a geotextile separator fabric. Also, diverting surface runoff away from the construction areas, and not allowing surface water to accumulate onsite, would be helpful for limiting subgrade disturbances. Summer construction is desirable at this site to reduce the amount of subgrade disturbance and required improvements.

Disturbed areas of subgrade will need to be improved in-place or be removed and replaced with engineered fill. The amount and type of subgrade stabilization will depend on the soil conditions encountered, construction traffic, and associated weather conditions. Subgrade stabilization techniques could also include removal and replacement of very loose/disturbed areas with a crushed material; or placing a woven geotextile (e.g., Mirafi 600X, or approved equal) on the subgrade followed by placement of crushed aggregate on the geotextile. The specific technique(s) to be implemented will depend on the specific site conditions encountered during construction. We recommend an SME representative review the subsurface conditions in the field and provide recommendations for the thickness and type(s) of crushed materials, if required.

After the earth retention system is installed, excavation can continue to design bottom of excavation levels. We recommend the exposed subgrade (within the building footprint and other structural areas, e.g. pavements) then be uniformly compacted using large construction equipment. Take care during compaction not to damage nearby existing structures and underground utilities. As predominantly sandy soil conditions are expected, we recommend using large, smooth-drum vibratory rollers for the compaction operations. A vibratory hoe-pac mounted onto a large excavator can also be used for compactive efforts where the use of a large roller is not practical. We recommend at least several passes be made with the compaction equipment. In some areas, moisture conditioning and/or undercutting may be necessary to enhance the effectiveness of the compaction operations.

Once the subgrade is compacted, we recommend testing the subgrade for stability. Typically, such testing involves a proofroll with a large piece of construction equipment. Where areas are accessible for proofrolling, we recommend using a fully loaded tandem axle truck (50,000 lbs. minimum) to perform the proofroll test. Since the building pad subgrade will be in a relatively confined excavation, the use of hand-operated tests (e.g., in-place density tests, dynamic cone penetrometer tests, hand augers, etc.) will likely be required to test the subgrade. Regardless of the approach, we recommend an SME representative be on-site to observe and test the exposed subgrade. Based on the results of the field tests and observations (and lab tests, as applicable), the SME representative can provide recommendations in the field regarding the suitability of the subgrade for structural support. Areas of unsuitably loose/wet subgrade will need to be either improved in-place (e.g., dried and recompacted) or be removed and replaced with engineered fill.

After making cuts to design grades and after the exposed subgrade is evaluated (as mentioned above) and improved as necessary, engineered fill may be placed on the exposed subgrade to establish final subgrade levels. Refer to Section 4.1.4 of this report for materials and compaction requirements for engineered fill.

4.1.3 SUBGRADE PREPARATION FOR FLOOR SLABS

We understand the basement slab will be subjected to loads from mechanical and electrical equipment, substation equipment, and residential storage items. We anticipate maximum point loads of 1 kip acting on the slab.

We anticipate the final subgrade for the basement level slab-on-grade will consist of suitable natural soils, or engineered fill placed over properly prepared natural soils. Any existing fill remaining after performing the mass excavation for the basement level will need to be reevaluated in the field and improved (or removed and replaced with engineered fill) as necessary. Assuming the subgrade is properly prepared according to the recommendations presented in this report, we recommend a vertical modulus of subgrade (k) of 200 pounds per cubic-inch (pci) for slab design. We base the recommended subgrade modulus value on our experience and empirical relationships between soil type and plate load tests performed with a 30-inch-diameter bearing plate. The subgrade modulus is the ratio of load in psi to a 0.05-inch vertical deflection.

The slab subgrade will need to be fine-graded, compacted, and level prior to placement of the aggregate leveling course. Prior to concrete placement, the subgrade will again need to be observed and tested for suitability of floor slab support. The purpose of the re-evaluation is to identify any areas of subgrade disturbed during construction activities and verify subgrade conditions are suitable for floor slab support. The re-evaluation of the subgrade will need to consist of a thorough proofroll unless the area is not accessible with proofrolling equipment. Otherwise, the evaluation of the exposed subgrade will need to consist of density testing or the use of appropriate hand-operated equipment such as hand augers and dynamic cone penetrometers. Unsuitable subgrade indicated by SME must be recompacted or removed and replaced with engineered fill.

We recommend the top 6 inches of the slab subgrade consist of an approved granular material. The purpose of this is to provide a leveling surface for construction of the slab and a moisture capillary break between the slab and the underlying soils. We recommend MDOT Class II granular material for this purpose. Note that the onsite natural soils may comply with MDOT Class II gradation criteria, and could be considered adequate for reuse as the leveling course below the basement slab. Alternatively, an approved aggregate (such as MDOT 21AA dense-graded aggregate) may be considered in lieu of the sand. The advantage of using an aggregate is it provides better protection of the subgrade than sand and a more stable working platform for construction of the slab. The granular material must also be compacted per the "Engineered Fill Requirements" section of this report (refer to Section 4.1.4). We do not recommend relying on the leveling course to protect the underlying subgrade from disturbances. Therefore, place the concrete slab soon after the leveling course, and ensure proper placement and compaction of the underlying subgrade.

Provide a vapor retarder below the floor slab if the slab is to receive an impermeable floor finish/seal or a floor covering which would act as a vapor retarder. Even if these floor coverings are not planned, the vapor retarder can reduce the transmission of moisture vapor from the ground into the structure due to thermal and humidity variations, and other conditions. However, the placement of a vapor retarder affects construction of the floor slab, concrete curing, and the rate of moisture loss as the concrete dries. The flatwork contractor must use the appropriate equipment, materials, and methods to prevent undesirable slab curling/warping.

We recommend floor slabs be separated by isolation joints from structural walls and columns bearing on their own foundations to permit relative movement. Provide a minimum of 6 inches of engineered fill between the bottom of the slab and the top of the spread foundations or pile cap below. Otherwise, we recommend the structural engineer account for potential relative settlements using grade beams, thickened slabs with appropriate reinforcing steel, or other appropriate details.

Protect the slab-on-grade subgrade soils from frost action during winter construction. Any frozen soils must be thawed and compacted or removed and replaced prior to slab-on-grade construction.

Concrete mixes are regularly changing to optimize performance and economy. We recommend using only concrete contractor(s) with substantial experience in concrete mixing, placement and curing methods (e.g., to prevent undesirable slab curling, shrinkage, segregation, bleeding, etc.). The contractor may need to retain a concrete mix designer to develop the appropriate mix(es) for the project. We recommend using only specific type(s) of well-established concrete mixes that have been ‘tried and tested’ to deliver successful long-term performance for each specific type of concrete application.

4.1.4 ENGINEERED FILL REQUIREMENTS

Any fill placed within the construction area, including utility trench backfill, must be an approved material, free of frozen soil, organics, or other unsuitable materials. If the proposed fill contains more than 4 percent organics, do not use such materials for engineered fill. We recommend the fill be spread in level layers not exceeding 9 inches in loose thickness and be compacted to a minimum 95 percent of the maximum dry density as determined in accordance with the Modified Proctor Test. A higher compaction criterion of a minimum 97 percent of the soil’s maximum dry density based on the Modified Proctor test is required for select backfill (e.g., crushed aggregate) below shallow foundations utilizing a relatively high soil bearing pressure (refer to Section 4.2.1 of this report).

Thicker lifts of backfill may be acceptable, provided the compaction equipment can achieve the minimum compaction criterion throughout the entire thickness of the lift within the area of placement and with the type of backfill used. SME can provide recommendations in the field for adjusting lift thicknesses based on the specific type of compaction equipment/methods used during construction and verification the entire lift of fill is compacted to the project requirements. We recommend vibratory equipment such as a steel-drum roller or plate compactor be used to compact granular fill. Regarding the compaction of open-graded aggregates (e.g., MDOT 6AA crushed stone, or 1 to 3-inch size crushed aggregate), we recommend the material be compacted to a degree where is stable (does not deflect) under the weight of heavy construction equipment.

The onsite natural sands are considered suitable for re-use as engineered fill. We do not recommend reusing topsoil and other soils containing (one or more of the following) more than 4 percent organics, significant (greater than 5 percent) debris/rubble, or any undesirable materials (e.g., trash, expansive aggregates, etc.) as engineered fill. Also, we do not recommend reusing cobbles (greater than 3 inches in nominal diameter) as engineered fill as they are difficult to properly place and compact. Based on the borings, some segregation of cobbles from the natural sands is expected if the sands will be reused as engineered fill.

We do not recommend reusing the existing fill (as engineered fill) that contains a relatively high amount of debris/rubble. Overall, the amount of fill required for the site is expected to be minimal, and an excess amount of natural sands available (generated from the basement excavation) for reuse as engineered fill. The natural granular soils can be stockpiled (if site constraints allow) for later use as backfill onsite. Also, the natural granular soils visually classified as ‘SP’ or ‘SP-SM’ type soils (refer to the boring logs) may be suitable for reuse as MDOT Class II sand. To verify soils are suitable for reuse as MDOT Class II sand, we recommend performing particle size distribution tests on representative sample(s).

Some moisture conditioning (e.g., wetting) of the granular soils may be required to allow for proper compaction, depending on the site conditions and weather during the time of construction. We recommend construction specifications include moisture conditioning for engineered fill (within 2 percent of optimum moisture content).

The successful reuse of the on-site soils for engineered fill will depend on the time of year and the care the earthwork contractor uses during construction. During cold and wet periods of the year, the subgrade soils (in particular, soils containing significant silt and/or clay content) may become saturated and disturbed and the soils can be difficult to dry. If such conditions occur, the contractor may have to use more imported granular fill (sand) as engineered fill on the site.

For backfill in confined areas, and where drainage is required, we recommend using imported granular backfill such as MDOT Class II granular material, MDOT 21AA crushed aggregate, and/or MDOT 6A crushed stone. The specific type of imported fill will depend on a variety of factors. For most instances, we anticipate MDOT Class II granular material will be adequate. Crushed aggregate/stone would be necessary where the existing subgrade is in a wet condition (which is unlikely at this site due to the predominantly granular profile) and/or where site drainage is critical. In addition to the use of crushed stone, it would likely be necessary to cap the stone with MDOT 21AA crushed aggregate or wrap the crushed stone with a heavy-duty non-woven geotextile fabric, to prevent the surrounding soils from infiltrating into the crushed stone.

4.2 FOUNDATIONS

SME performed in-situ pressuremeter testing of the natural sands at borings B6, B7, and B9 (between depths of about 20 to 35 below existing ground surface) for this project. The pressuremeter test results were used to develop our recommendations for both shallow and deep foundations, which are described in the following sections.

Pressuremeter testing in the field models the static loading characteristics of the soil and is considered a more accurate indicator of the ultimate bearing pressure that can be achieved for foundations, and associated settlement, than performing analyses using empirical correlations based on dynamic test methods, such as the Standard Penetration Test (SPT) performed with split-barrel sampling. The pressuremeter test depths were selected to provide representative information corresponding to the bearing soils anticipated within a critical portion of the anticipated stress influence zone of the proposed foundations and near the design bearing level.

In the pressuremeter test, a radial expandable cylindrical probe is inserted into a prepared borehole at the selected test depth. The cylindrical probe was inserted into the borehole to the sampling depth and then expanded against the sides of the borehole by pressurizing fluid within the system using a hydraulic screw-jack console positioned at the ground surface.

Simultaneous measurements of pressure and injected volume within the probe were observed at the pressuremeter console and recorded. The injected fluid volume was incrementally increased until inflating the probe to near its maximum volume, or until significant creep deformation (soil failure) was observed.

Graphical results of the pressuremeter tests are included in Appendix A of this report. In addition, the results of the pressuremeter tests are tabulated below.

PRESSUREMETER TEST RESULTS

BORING NO.	TEST DEPTH (feet)	N_{60} VALUE (blows/foot)	YIELD PRESSURE (tsf)	LIMIT PRESSURE (tsf)	PRESSUREMETER MODULUS (tsf)
B6	29 – 31	29	24.1	N/A*	238
B6	34 – 36	62	23.2	N/A*	249
B7	19 – 21	25	18.0	N/A*	160
B7	24 – 26	40	21.0	50	369
B7	29 – 31	37	20.3	48	302
B7	34 – 36	74	31.4	N/A*	432
B9	19 – 21	19	12.1	25	132
B9	24 – 26	42	26.5	N/A*	541

*Pressuremeter probe could not be sufficiently expanded to estimate the soil's limit pressure.

The soil conditions at the pressuremeter test locations generally consisted of fine to coarse sand with gravel. Refer to the test results and boring logs in Appendix A for more information.

Based on the pressuremeter test results, we recommend shallow spread or continuous foundations, bearing on suitable natural sands for foundation support. Alternatively, we consider deep foundations consisting of Auger Cast-in-Place (ACIP) piles to be a viable foundation system for this project. Refer to the following sections for more information.

4.2.1 SHALLOW FOUNDATIONS

Shallow foundations are feasible for foundation support of the new building. We recommend shallow spread or continuous foundations, bearing on suitable natural sands, or on engineered fill (compacted per the specifications in this section) placed over suitable natural sands for foundation support. We understand column bays will be approximately 30 ft x 30 ft. Column loads for the main building are expected to range from 450 to 3,000 kips, with the design bottom of foundation elevation at about 20 feet bgs (approximately, elevation 830 feet). Canopy foundations will be located outside of the main building footprint (to the north) near the bus lanes. We assume canopy foundations will carry maximum loads of 300 kips, and be designed to bear near typical frost depth, i.e. about 4 feet below the final ground surface. The project's structural design is in the preliminary stage, and any deviations from the assumptions above must be brought to SME's attention for reevaluation of our foundation recommendations.

We recommend a maximum net allowable bearing pressure of 15,000 pounds per square-foot (psf) (based on a factor of safety of 3 or more) for the foundations bearing directly on suitable natural sands at depths of about 20 feet or greater bgs. A corresponding vertical subgrade modulus of 540 kcf (ksf/ft) may be used for shallow mat-type foundation design. This subgrade modulus value is based on the load applied to a 12-inch square plate that experiences 1 inch of deflection.

Based on the borings, we anticipate suitable bearing soils will typically be encountered at the main building's design bottom of footing level(s) (near 20 feet bgs). The natural soils will also need to be uniformly improved to achieve the relatively high design soil bearing pressure. This improvement can be accomplished by thorough compaction of the foundation bearing soils and/or undercutting to remove and replace some of the natural soils with compacted crushed aggregate. The following information in this section provides additional recommendations for foundation subgrade improvement.

We understand a partial (shallower) basement level will be located near the northwest corner of the building, although the depth (from existing grade) is unknown at this time. Based on the nearby borings (i.e. near where the former YMCA pool was located), the depth of existing fill could extend several feet below the planned bottom of foundation elevation(s). Therefore, we expect some relatively significant undercut depths will be required to extend these foundations to suitable natural sands. Another option would be to support this portion of the building on deep foundations (see Section 4.2.2).

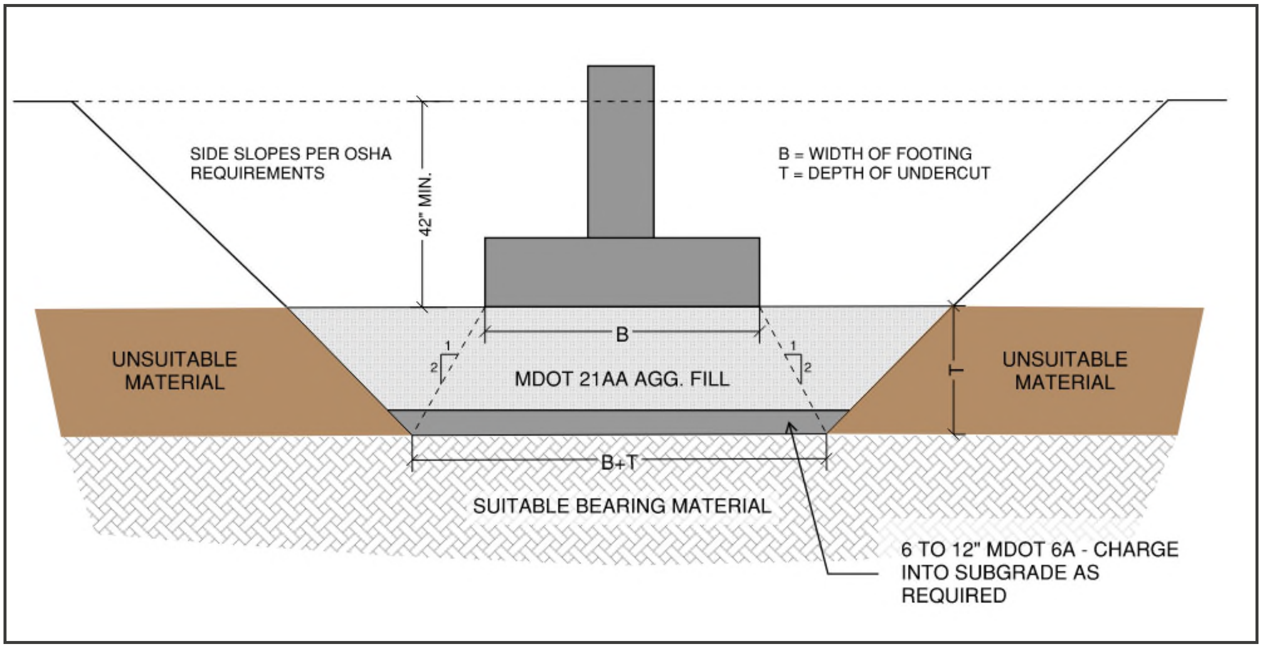
The depth of existing fill varied from about 8 to 22 feet bgs in the bus/service lane areas outside of the main building footprint where canopy foundations are planned (refer to current borings B1A – B6, B11, and IT1 and previous borings B101, B102, B4, and B8). Due to the significant undercut depths required to reach the underlying natural sands (for footings designed to bear near typical frost depth), we recommend deep foundations for support of the canopy columns. Refer to Section 4.2.2 for more information.

Natural granular soil deposits can vary in resistance and relative density, as indicated by the N_{60} values and pressuremeter test results. Also, the granular soils can become disturbed from the excavation activities and/or construction traffic. A “loosening” effect commonly occurs when existing soil overburden pressure is removed as a relatively deep (e.g. 20 feet) excavation is performed. Due to the expected variability in soil resistance, some areas of the site may not be sufficiently dense for the above recommended allowable bearing pressure after completing the excavation. Therefore, it will be important to compact (or improve) the foundation subgrade (in a uniform manner) to limit total and differential settlement between neighboring foundations. If subgrade compaction can adequately improve the strength of the subgrade, then the subgrade compaction will aid in reducing the settlement of the sands due to the applied building load. For subgrade compaction, we recommend the foundation subgrade be thoroughly compacted with several passes from a vibratory hoe-pac mounted onto a large excavator (e.g., CAT 330, or larger). In addition, a relatively large (1,000 lb) plate compactor will likely be required to suitably densify the upper subgrade after hoe-pac compaction. It may also be necessary to moisture condition the granular soils to achieve the required compaction. Take care during the compaction operations to not damage nearby, existing structures.

Once the subgrade at the bottom of foundation elevation has been compacted, an SME field representative will need to test the bearing soils and verify the subgrade is suitable for the recommended soil bearing pressures. Due to the relatively high soil bearing pressures, the test method(s) implemented will need to extend approximately 5 to 6 feet (or possibly deeper) below the bearing surface. The purpose of the field testing is to verify the recommended design soil bearing pressure is achieved and the soils are suitably compacted to limit differential settlement.

If the subgrade compaction operation is unsuccessful in achieving a properly prepared subgrade, then foundation undercuts would need to be performed so that the bearing soils below the proposed footings can be replaced with a crushed aggregate rather than the onsite sands. Specifically, some of the sands may not have a relatively high internal friction angle (e.g., sand particles are too rounded, or low gravel content) necessary for the high soil bearing pressure. For backfilling a foundation undercut, and replacement with a crushed stone/aggregate, a more stringent compaction criterion (to a minimum of 97 percent compaction based on the Modified Proctor test) would be required.

Where crushed aggregate is required for backfilling undercuts, we recommend using MDOT 21AA crushed limestone. The foundation undercut will need to extend laterally on a two vertical to one horizontal slope from the outside edge of the foundation. Please refer to the Typical Foundation Undercutting Diagram below:



NOTES:
1. Foundations constructed on engineered fill placed in foundation undercuts cannot be earth-formed and will require placement of formwork.
2. Oversizing the excavation is not required along the edge of a perimeter foundation adjacent to a temporary earth retention wall.

The crushed limestone will need to be placed in lifts no greater than 9-inches in loose thickness and must be compacted to a minimum of 97 percent of the maximum dry density as determined by the Modified Proctor test. We recommend a heavy-duty hoe-pac mounted onto a large excavator (e.g., CAT 330, or larger) for compacting the crushed aggregate. Compaction tests using a combination of nuclear density gauge testing and dynamic cone penetrometer (DCP) testing would need to be performed on each lift to verify suitable compaction and that the required soil bearing pressure is achieved. Additionally, we recommend using the hoe-pac to densify the natural sand subgrade at the base of the undercut prior to placing the first lift of the crushed aggregate material.

The requirements for subgrade compaction need to be included in the project specifications. We recommend including a contingency in the budget for undercutting (about 3 feet) the footing subgrade and replacing it with MDOT 21AA crushed limestone (compacted to the recommended compaction criterion provided in this report). Also, we recommend selecting a foundation contractor with substantial experience in performing foundation subgrade improvement via compactive efforts in the Ann Arbor area.

For bearing capacity and settlement considerations, we recommend the dimensions for the heavily-loaded isolated spread foundations be at least 72 inches. Minimum widths for continuous (strip) footings are dependent upon design wall loads as recommended in the table below. Based on the current plans, we anticipate relatively light wall loads (10 klf or less).

MINIMUM CONTINUOUS FOOTING LENGTHS

MAXIMUM WALL LOAD (klf)	MINIMUM STRIP FOOTING WIDTH (feet)
20 or less	3.0
30	4.0
40	5.0

Foundations must be situated a minimum of 42 inches below final site grades along exterior walls or in any unheated areas for protection against frost action during normal winters. Also, the foundations and proposed bearing soils must be protected from freezing during construction if work occurs in the winter months.

The natural sands encountered at the site are subject to sloughing and caving. Due to these conditions, along with the fact that the excavation sidewalls will likely be disturbed by vibrations generated during foundation subgrade compaction, earth-formed foundations constructed within the natural sands (neat trench methods) are not considered feasible for this project. Rather, we anticipate the foundations will require formwork construction prior to concrete placement. Vertical excavation sidewalls (where practical) must be maintained during foundation concrete placement and must not be allowed to “mushroom out” at the top, particularly for exterior foundations (e.g. canopy foundations) as this can create a “frost lip”.

We estimate total settlement for spread/continuous foundations using the recommended maximum net allowable bearing pressure and bearing on suitable soils as described above to be 1 inch or less. We believe differential settlement between neighboring foundations can be limited to ½-inch provided the subgrade is uniformly improved. Based on the granular site profile, settlements are generally anticipated to be elastic in nature, and are expected to occur (immediately to within a couple weeks) after the foundations are loaded. The settlement estimates provided are based on the available soil boring information, pressuremeter tests, the estimated maximum column loads, our experience with similar structures and soil conditions, preparation of the foundation bearing soils as recommended in this report, and field verification of suitable bearing soils by SME.

4.2.2 AUGER CAST-IN-PLACE PILES

A deep foundation system can also be considered for the building, particularly if/where shallow foundations are not feasible due to relatively heavy column loads, insufficient setback from adjacent properties, or other factors (e.g., canopy foundations designed to bear near typical frost depth within a zone of deep existing fill). We recommend auger cast-in-place (ACIP) piles as a deep foundation option for the project. The augercast pile installation is performed using drilling methods, which would limit unwanted vibrations (as compared to a driven deep foundation system). Also, project costs could be reduced by installing the foundation piles within the same mobilization as the augercast piles installed for the earth retention system (ERS) around the main building (rather than in separate mobilizations). Refer to Section 4.5 for more information regarding the ERS.

It must be noted that when two foundation types are used to support a structure (e.g. ACIP piles and shallow spread footings), there is some potential for differential settlement between the two foundations. This can result in stress cracks in the new building. For this option, we would recommend the building design include requirements to reduce the potential for differential settlement between the two foundation types. Such methods would be focused on the areas where the foundations transition from one type to the other. One method would be to maintain a minimum of 15 feet of lateral distance between the center of ACIP piles and the nearest interior column(s) that are supported on shallow foundations. The purpose of this is to distribute the differential settlement between two foundation types over a relatively significant distance. Also, spread foundations that are near the ACIP piles can be designed using a lower design soil bearing pressure (i.e. to reduce settlement) before transitioning to the recommended soil bearing pressure of 15,000 psf presented in Section 4.2.1. Another method would be to design construction joints at any transitions between the two foundation types. In addition, we recommend installing the interior building finishes between the two foundation types at the end of the project, after most of the building load has been applied to the foundations.

In general, we expect the ACIP piles would consist of a sand-cement grout mix (possibly with admixtures) pumped under pressure through the auger stem as the auger is slowly withdrawn from the hole. Add reinforcing steel to the column of grout once the augers are extracted to provide suitable reinforcement to resist uplift and/or lateral loads.

As the building’s column loads could vary greatly (e.g. lighter canopies compared to heavier main building columns), a range of design working loads can be considered for the ACIP piles. A reduced pile capacity (and length) would be advantageous for light column loads to minimize the number of cobbles encountered during the pile installation. For illustrative purposes, the following table presents axial and uplift capacities for various pile diameters/lengths. We can review and comment on various pile diameters/depths/capacities the structural engineer may consider efficient for this project as the design plans are finalized.

ESTIMATED ACIP PILE CAPACITIES

LOCATION	PILE DIAMETER (inches)	PILE LENGTH (feet)	ALLOWABLE DOWNWARD PILE CAPACITY (kips)(3)	ALLOWABLE UPWARD PILE CAPACITY (kips)(3)
Canopy Columns(1)	18	40	250	150
	24	40	350	250
Main Building Footprint(2)	24	40	350	250
	24	55	500	425
	24	70	600	525

NOTES:

(1) Assumes top of pile begins at 5 feet bgs.
(2) Assumes top of pile begins at 20 feet bgs.
(3) Based on a factor of safety of 2.0 and neglecting resistance in the upper 5 feet of the pile.

The above pile capacities do not include down-drag forces as we do not expect site grades will be raised more than 1 to 3 feet for the project.

We base the pile capacities described above on a factor of safety of 2.0 (assuming performing a pile load test to confirm these capacities). We recommend the pile load test(s) be performed prior to installing production piles, and additional pile load tests if additional pile depth/diameter combinations are considered. SME can assist the design team with developing the pile load test program, which could also include lateral or tensile tests (if applicable to the pile design). We recommend performing the load test(s) based on ASTM D-1143, and the total load applied during the load test(s) based on at least twice the allowable working capacity. Where load testing is not practical or desirable (i.e., limited number of piles and/or lower pile capacities), the pile capacities can be designed for a factor of safety of 3.0 in lieu of performing the load testing.

We estimate total settlement of 1/2-inch to 3/4-inch can be achieved for ACIP piles (depending on the pile length) bearing on dense to extremely dense sands, under the design working capacities in compression and the recommended pile lengths (to be finalized during the design process as mentioned above), and constructed according to the recommendations of this report. About half of the estimated settlement would be due to elastic compression of the pile.

For lateral support, we recommend a design lateral resistance of 25 kips for an 18-inch diameter pile, and 40 kips for a 24-inch diameter pile. This resistance assumes the pile is in a fixed condition, and is based on a maximum ¼ inch of lateral deflection. For group piles, the actual lateral resistance will vary depending on specific pile spacing and direction(s) of the lateral load. We would be pleased to be retained to verify the lateral load capacity of grouped piles, as requested.

Steel reinforcement will depend on the final pile design needed to provide resistance to lateral and tensile loads in the pile, and (to a lesser degree) for axial loads. For tensile loads only, a single, large-diameter steel bar is often used for reinforcement extending through either part of, or the entire, pile length. For compression loads a set of smaller-diameter steel bars are recommended for either part of (or the entire) pile length. Reinforcing steel cages can also be installed in the upper portion of the piles to resist bending moments.

We recommend using a minimum design spacing of at least three pile diameters between adjacent piles (center-to-center) within a group. The use of closer pile spacing would require additional evaluation of the group effect. Generally, we recommend using a minimum of three piles per pile group for stability. Groups of one or two piles can be used if grade beams, rigid mats or other suitable methods are used to provide the required lateral structural support.

The bottom of exterior pile caps and grade beams must be situated a minimum of 42 inches below final site grades to mitigate the potential for frost action on the bottom of these elements. Pile caps and grade beams that may be located in heated areas can be situated at shallower depths.

The augercast pile equipment will need to be capable of readily advancing into the very/extremely dense natural sands (and past cobbles and construction debris within the existing fill) without overdrilling. Overdrilling can lead to reduced pile capacity and possible ground loss around the piles. Piles encountering ‘auger refusal’ above the design terminal depth (e.g., due to cobbles/boulders) will need to be further evaluated on a case-by-case basis to assess the design pile capacity, and if a reduced pile capacity is required. We recommend auger refusal be defined as a rate of less than 1 foot of penetration per minute under full operating torque of at least 75,000 foot-pounds.

There are inherent risks associated with installation of ACIP piles near existing buildings, roads, utilities and other structures. We recommend the contractor consider the following comments to reduce the risk of oversized holes due to mining, decompression, or loss of soil. To achieve the design tip elevation without excessive auger rotation, we recommend the contractor use a drill rig with a minimum torque of 75,000 ft.-lbs. and the ability to use full torque at a slow rotational speed. Also, exercise care to not excessively rotate the augers when penetrating the sands, or when attempting to penetrate obstructions. Excessive rotation of the augers can result in a condition where the adjacent soils pull into the augered hole. Care must also be taken when pumping grout into the pile (during extraction of the augers) so a sufficient volume of grout is pumped (to prevent ‘necking’ of the pile), but not at too high of a pressure near existing structures/utilities to prevent damaging those structures/utilities. In addition, where overly loose/soft subgrade exists near/below existing structures, special shoring, bracing, and/or underpinning of the existing structures may be necessary to protect those structures from undesirable movement due to the aggravation of subgrade during pile installation. Maintain a minimum distance of 3 feet from the edges of existing structures/utilities to limit such disruptions.

We also recommend performing condition surveys and monitoring existing structures nearby the site. The monitoring program would need to include criteria for maximum allowable movement and protocol to proactively address recorded movement that could put nearby structures at an increased risk for undesirable movements.

Another consideration for the successful installation of ACIP piles is to coordinate the rate of auger withdrawal with the pumping rate of grout while providing an adequate grout head (pressure) to support the hole, resist hydrostatic pressures, and ensure all voids are completely filled with grout. Based on our experience, expect additional grout volumes within the granular soils (especially where cobble/boulders are encountered), and to densify overly loose soils (e.g., loose fill). During ACIP pile installation, the contractor needs to carefully sequence operations to avoid damage to previously installed piles during the installation of adjacent piles. The 2015 MBC indicates piles shall not be installed within six pile diameters, measured center to center, to an adjacent pile with grout less than 12 hours old. We suggest this spacing be used as a guide, and if interconnection between recently grouted piles is observed during construction, it may be necessary to increase this spacing or to provide a longer delay between pile installations.

The contractor may encounter obstructions and/or refusal to auger penetration above the target tip elevation during pile installation due to naturally occurring dense to extremely dense soil layers or cobbles and boulders. The type, size, and frequency of these obstructions will have varying effects on the installation. When possible, the contractor needs to penetrate the obstruction, maneuver around the obstruction (provided pile plumbness/alignment requirements are not exceeded) or remove the obstruction by augering or excavation from the surface, and then backfill the resulting excavation and resume pile installation. Excavations to remove obstructions must not undermine existing structures or new improvements.

If encountering auger refusal above the design tip bearing elevation, and the obstruction cannot be removed, or if the pile is knocked out of vertical alignment, it will be necessary to grout the pile from the point of refusal. The obstructed pile may either be rejected, or evaluated and assigned a reduced capacity, depending on circumstances and installation records. SME will need to evaluate these situations on a case-by-case basis during construction. Also, the project structural engineer will need to be contacted to evaluate the design loads at such locations, and to recommend locations of additional piles (if needed) and any design modifications to the associated pile caps. We recommend prospective contractors include unit rates in their bids for obstruction removal, downtime, additional grout volumes, and installation of additional pile footage due to obstructions. We also recommend allocating a project budget contingency for obstructions during pile installation.

The contractor will need to have grout on-site prior to the beginning of auger withdrawal. The contractor must grout piles abandoned due to obstructions. We recommend the contractor maintain a minimum grout volume ratio of 1.3, which is the ratio of the actual grout volume to the theoretical pile volume, but anticipate higher grout volume ratios in the range of about 1.4 to 1.6 in some cases. During auger withdrawal, we recommend maintaining a minimum pressure head equivalent to 10 feet of grout above the auger tip, but the pressure can be reduced to a pressure head equivalent to 5 feet of grout when pumping near existing, and sensitive, structures, or within the upper 15 to 20 feet of the existing ground surface. We also recommend the contractor use a pile installation recorder during the installation of load test and production piles.

4.3 SEISMIC SITE CLASS

The site is located approximately at geographic location latitude N42.27818 degrees and longitude W83.74684 degrees. From available topographical information available for purposes of identifying the depth to bedrock, the approximate ground surface at the site is about elevation 850 feet. Based on Plate 13 – (Topography of the Bedrock Surface) in the Hydrogeologic Atlas of Michigan, the estimated top of rock is about elevation 675 feet from linear interpolation of contours plotted at 50-foot intervals. Based on the above information, the glacial drift is roughly 175 feet thick.

The known N-values and shear strengths for drift at this site are limited to the explored depth of about 90 feet below the ground surface at the borings drilled for this evaluation. Based on the borings performed for this evaluation, our previous borings performed onsite, and our experience with the local geologic conditions, we anticipate the soil to be of similar or better resistance for the remaining geologic profile to 100 feet below the ground surface. Preliminarily, Seismic Site Class C applies to this site in accordance with the 2015 Michigan Building Code (MBC) (referencing Table 20.3-1 in ASCE Standard ASCE/SEI 7-10), based on the available borings and shear wave velocities measured by SME at other, nearby project sites. Given the scope of this project, we recommend retaining SME to measure the shear wave velocity profile (in the upper 100 feet of the soil profile) to confirm the seismic site class (and resulting design category).

Based on the location of the site, the mapped and calculated accelerations are summarized in the table below. Based on the referenced design values, preliminarily, Seismic Design Category A is anticipated to be applicable for this site.

SEISMIC ACCELERATION PARAMETERS SUMMARY TABLE

ACCELERATION TYPE	ACCELERATION DESCRIPTION	VALUE (g's)	DESIGN CATEGORY A ACCELERATION REQUIREMENTS (g's)
S_S	Mapped Ground Motion (0.2 second period)	0.104	---
S_1	Mapped Ground Motion (1.0 second period)	0.048	---
S_{DS}	Seismic Design Value (0.2 second period)	0.090	$S_{DS} < 0.167$
S_{D1}	Seismic Design Value (1.0 second period)	0.048	$S_{D1} < 0.067$

NOTE: Risk Category 3 assumed for the building.

4.4 BELOW-GRADE WALLS AND DRAINAGE

Below grade walls will be constructed around the building perimeter for this project, which are anticipated to be up to 18 feet tall. In addition, we anticipate that some shorter walls with be constructed inside of the building for the elevator pits and be up to 7 feet tall. At these depths, we anticipate that walls will be supported by shallow spread-type foundations that are suitable for the recommended design soil bearing pressure provided in Section 4.2 of this report. Another option would be to utilize the perimeter earth retention system (ERS) required for construction of the new building for the perimeter below-grade walls (as a permanent earth retention system). Refer to Section 4.5 for details. However, we understand the project team prefers a standard offset (i.e. a few feet) between the ERS and below-grade walls.

Below-grade walls need to be backfilled with MDOT Class II granular material. We recommend establishing positive surface drainage away from exterior below-grade walls (where practical). Below-grade wall backfill that will support floor slabs and other improvements will need to be compacted to a minimum of 95 percent of the maximum dry density determined by the Modified Proctor test. As a minimum, backfill not used for structural support of floor slabs or sidewalks must be compacted to the degree where it is stable under construction equipment. Exercise care during compaction of the wall backfill to avoid overstressing the walls and design the walls to accommodate the additional stresses associated with operating compaction equipment adjacent to the walls.

For rigid walls backfilled with a free-draining granular material and a level finish surface behind the wall, we recommend an equivalent fluid pressure of 55 pcf for design. Also, any additional lateral pressures due to surcharge loading, such as adjacent floor or column loads, traffic loads, sloping ground, parking loads, or adjacent structures must be added to the above lateral earth pressures for design.

We encountered groundwater during drilling at about 42 to 48 feet bgs. Based on the short-term groundwater levels observed in the borings, it appears that static groundwater levels are located well below the proposed bottom of the structure. However, the groundwater seepage from temporary/perched sources will fluctuate and could be heavy at times, and we recommend the design of the below-grade walls consider the potential for a (temporary) buildup of hydrostatic pressures.

In the long term, the groundwater needs to be controlled to minimize water seepage and hydrostatic pressures against the walls. We recommend drainage controls (i.e. edge drains) be installed around the perimeter of below-grade walls. We recommend the perimeter edge drains consist of a minimum 4-inch-diameter perforated, rigid, plastic drainpipe, surrounded by 6 inches of filter material, such as pea gravel (MDOT 34G), which is completely wrapped with a filter fabric. The backfill behind the walls will need to consist of a well-draining granular backfill (e.g. MDOT Class II sand). Due to the height of the walls, the drains will need to be tied into a sump system discharging water accumulations into a nearby storm drain or stormwater management system. Clean-outs must be provided that are easily accessible to access the drains to maintain them in proper working condition. If walls are designed without drainage controls, then we recommend using a higher lateral earth pressure of 95 pcf for sizing the permanent walls. In addition, we recommend waterproofing below-grade walls in areas that are sensitive to groundwater seepage (e.g. substation room, mechanical and electrical utility rooms, elevator shafts, etc.). At a minimum, below-grade walls need to be dampproofed as a precaution against water infiltration through the walls. We would be pleased to be retained to provide waterproofing design details for this project, if requested.

Due to the relatively well-draining subgrade, we do not consider the installation of a below-slab drainage system (below the basement slab-on-grade) necessary provided water accumulations behind the below-grade walls are managed per the recommendations in this section.

The following parameters for evaluating the stability of the retaining walls assume the base of the wall bears directly on suitable natural, granular soils and the wall is backfilled with a well-draining granular backfill. To evaluate the sliding of the wall, compute the sliding resistance at the base and the passive (resisting) and active (driving) earth forces. For below-grade walls bearing on the medium dense to dense natural sands encountered at the site, we recommend an ultimate sliding coefficient of 0.50. Passive, active and at-rest earth pressure coefficients of 3.0, 0.33 and 0.50, respectively, may be used for design in combination with a unit weight of backfill of 120 pcf. This assumes a granular backfill will be in contact with the wall on the backside and on the front, at the toe of the wall. Typically, a safety factor of 1.5 to 2.0 is used for the lateral sliding resistance analysis. Consider the movement required to achieve the full passive pressure when using passive pressure for resistance.

When using the active earth pressure coefficient, it assumes the wall is flexible enough to permit the active earth pressure condition to be reached. An outward movement away from the backfill equal to approximately 0.001 times the height of the wall is generally required to achieve the active earth pressure condition for granular backfill. If the wall is restrained or is rigid enough so that it does not rotate sufficiently to reach the active earth condition, a higher lateral earth pressure (at-rest condition) would need to be used for design. In addition to checking sliding stability of the walls, evaluate the safety factor from overturning, location of the resultant force at the base, mass stability, and contact pressure at the base.

4.5 EARTH RETENTION AND UNDERPINNING

Due to the proposed building footprint and excavation depths, an earth retention system (ERS) will be required around the entire building perimeter. The perimeter earth retention system will need to provide temporary lateral earth support (during construction) and can also be designed to provide some permanent lateral support of the building perimeter if needed. For this option, additional permanent lateral earth support will need to be provided by the below-grade (and at-grade) concrete floors. To provide additional building space, shotcrete could be applied to the inside face of the ERS (instead of constructing a perimeter cast-in-place concrete wall as discussed in Section 4.4) provided that the ERS is designed as a permanent system.

Depending upon the proximity of nearby structures to the proposed excavation and the sensitivity of those structures to movements, additional measures such as underpinning may be required to maintain the integrity of the existing site grades and building structures.

We recommend the perimeter ERS consist of a tangential augercast pile wall. We also considered a pre-drilled soldier pile and lagging wall. However, such a system could be prone to ground loss from behind the wall, as (based on our experience in Ann Arbor) the natural sands have the propensity to slough, or ‘run’, once exposed. Thus, grouting behind the lagging boards as the excavation proceeds would be required to control running and sloughing of the subgrade. The tangential augercast pile wall system is preferred because it has the ability to reduce the potential for ground loss from behind the wall. However, we recommend an SME representative be onsite during the installation of the ERS and also during the excavation process, to verify that pile alignment is maintained and any gaps between the piles discovered during the excavation are fully grouted/covered (with structural shotcrete) to prevent ground loss from behind the walls. Even with a tangent wall system, there can be gaps between the auger cast piles where soil can slough/cave through the wall.

Regarding foundation underpinning (if needed), several methods are considered viable for this project. Underpinning with segmental cast-in-place concrete units is one option. However, prior to constructing the segmental concrete units, it would be necessary to pre-grout within/around the area to be underpinned as the natural granular soils at this site are subject to caving/sloughing. Another option is mini-piles, such as push-piers or drilled micro-piles. The piles are typically designed to restrain axial loads from existing foundations. In addition to the piles, some lateral restraint of the soils below the foundations would be required. This can be accomplished by pre-grouting the soils and/or constructing a shotcrete and soil nail wall.

Due to the relatively deep excavation proposed for this project, we anticipate that at least one row of grouted tiebacks will be required along the building perimeter to resist the lateral earth pressures. This assumes that there is sufficient working space within the excavation and conflicts with neighboring below-grade structures can be avoided. For tiebacks that extend beyond the property boundaries, authorization from the neighboring property owner(s) would be required. As an alternative to the tiebacks, internal bracing could be installed in some areas. The contractor would need to carefully sequence the installation (and removal) of the bracing to avoid conflict with the construction of the building elements.

The design of the ERS and foundation underpinning depends upon a number of design-focused variables (e.g., minimum setback/space requirements, design load combinations, final site grades, conflicts with existing or new construction, etc.) requiring consideration in selecting an appropriate system. The design must also consider construction sequencing to achieve a completed (built) product implemented in harmony with the overall progress of construction. In addition, the successful performance of these systems will be based on limiting the movements of the nearby structures. Strict settlement/movement criteria will need to be assigned for critical structures, whereas less-stringent criteria may be adequate for an ERS only supporting non-structural subgrade. The limits on settlement/movement, as well as the specific type of system and sequencing required, will need to be determined by the design engineer on a case-by-case basis. SME is capable of, and would be pleased to provide, design services for the ERS and any required foundation underpinning.

Controlling lateral movements of the ERS is a critical issue in limiting potential damage to nearby existing structures. Please note the cost of the system will be directly related to the limits placed on the lateral movement. We also recommend a baseline condition assessment be performed to record and document the existing condition of any structures within at least 50 feet of the proposed ERS prior to its installation. It appears the Blake Transit Center to the north, and road right-of-ways to the east, west, and south, are within these limits of the perimeter ERS.

This condition assessment could assist in evaluating if distress to existing structures occurred during below-grade construction or was a pre-existing condition (particularly for structures with limited tolerance for movement/distress). In addition, a post-condition survey may also be required. We would be pleased to provide the baseline and post-condition assessments for this project, if requested.

We also recommend monitoring the ERS and nearby structures for movement using survey-grade equipment and monitoring techniques. The survey readings will need to be accurate to within 0.01-foot and will need to be obtained regularly (at least daily) throughout the monitoring period. We anticipate the monitoring period will begin prior to performing the excavation for the basement, and will end soon after the below-grade construction of the permanent structure is substantially completed. We would be pleased to provide the survey services for this project, if requested.

4.6 STABILITY OF SLOPES

Where there is enough space or setback within the mass excavation, we expect excavations can be temporarily sloped back in accordance with applicable MIOSHA regulations. For the natural sands (where no groundwater is present), we recommend excavations be temporarily sloped at a 1.5 horizontal to 1 vertical slope. A steeper temporary slope (up to 1 horizontal to 1 vertical) may be adequate for a temporary excavation depending upon specific subsurface conditions and the expected performance of the slope. Generally, temporary slopes consisting of well-compacted soils with appreciable fines content (e.g. silt and/or clay) are more likely to perform adequately at a 1H:1V slope, whereas granular soils with little fines content (and overly loose/soft soils) are subject to raveling/sloughing and cannot maintain a relatively steep angle (1H:1V) for a significant period of time.

Shallower slopes may be required to address other constraints, such as to provide easier access and maneuverability for construction traffic on the slope. The contractor must provide a safely sloped excavation or an adequately constructed and braced shoring system in accordance with federal, state and local safety regulations for individuals working in an excavation that may expose them to the danger of moving ground. If material is stored, or if operating heavy equipment near an excavation, use appropriate shoring to resist the extra pressure due to the superimposed loads.

4.7 SOIL CORROSIVITY

SME submitted four composite samples of the existing fill soils to Brighton Analytical for corrosion testing, including soluble sulfate and chloride concentrations, redox potential, and soil pH. SME also performed laboratory resistivity testing of these samples. We selected the test depths/locations based on anticipated locations of underground utilities that could be installed for the project. Refer to the tables below.

CORROSIVITY TEST RESULTS

BORING NO.	SAMPLE DEPTH (ft.)	USCS SOIL TYPE	SOIL pH	SOLUBLE CHLORIDES (ppm)	SOLUBLE SULFATES (ppm)	REDOX POTENTIAL (mV)
B1A	1 – 10	SP, SP-SM (Fill)	11.3	13	27	140
B2, B4	1 – 7.5	SP, SP-SM (Fill)	11.2	7.6	24	140
IT1	1 – 10	SP-SM (Fill)	11.3	18	14	120
B11	1 – 10	SP-SM (Fill)	11.6	10	17	130

RESISTIVITY TEST RESULTS

BORING NO.	SAMPLE DEPTH (ft.)	USCS SOIL TYPE	RESISTIVITY (OHM-CM)	
			NATURAL MOISTURE CONTENT	SATURATED
B1A	1 – 10	SP, SP-SM (Fill)	10,950	1,468
B2, B4	1 – 7.5	SP, SP-SM (Fill)	13,560	1,443
IT1	1 – 10	SP-SM (Fill)	12,682	1,003
B11	1 – 10	SP-SM (Fill)	34,866	1,254

In general, based on the test results, we consider the subgrade mildly to essentially non-corrosive to buried metals. Refer to the table below. The corrosion potential could be further reduced if a mass removal of the existing fill (and replacement with a well-draining granular fill) if performed. While the existing fill is debris-laden, it did not appear to be potentially expansive, explosive, or chemically active.

SOIL RESISTIVITY CORROSIVITY RATING

SOIL RESISTIVITY (ohm-cm)	CORROSIVITY RATING
>20,000	Essentially non-corrosive
10,000 – 20,000	Mildly corrosive
5,000 – 10,000	Moderately corrosive
3,000 – 5,000	Corrosive
1,000 – 3,000	Highly corrosive
< 1,000	Extremely corrosive

Corrosion Basics: 2nd Edition by Pierre R. Roberge (2006)

Per ACI 318-14, Table 19.3.1.1, corrosion protection of reinforcement exposed to these samples categorize as C1 in most areas (measured chloride levels were relatively low) but categorize as C2 for exterior concrete pavement or other areas exposed to moisture and external sources of chlorides (e.g., deicing chemicals, salt, etc.). The highest reading for sulfates is 27 parts per million (ppm). Per ACI 318-14, Table 19.3.1.1, sulfate levels in these samples categorize as S0 for potential corrosion of metals and cement. Refer to the table below.

ACI 318 EXPOSURE CATEGORIES AND CLASSES

CATEGORY	CLASS	CONDITION
Sulfates (S)	S0	< 150 ppm
	S1	150 to 1,500
	S2	1,500 to 10,000
	S3	>10,000
Chlorides (C)	C0	Concrete dry or protected from moisture
	C1	Concrete exposed to moisture but not to an external source of chlorides
	C2	Concrete exposed to moisture and an external source of chlorides from deicing chemicals, salt, brackish water, seawater, or spray from these sources

Table 19.3.1.1 from ACI 318-14 Chapter 9

Metallic conduits, pipelines, and other below-grade utilities in contact with relatively low-permeable granular soils (e.g. containing significant silt and/or clay content), could potentially experience aggressive corrosion. Balance the risk of failure due to corrosion against the type of corrosion protection used. For critical utilities or structures (underground storage tanks, natural gas lines, fire protection lines, etc.) in contact with saturated soils, a high level of corrosion protection (such as cathodic protection) may be warranted. For other less critical structures, a suitable coating material could be used for these elements, or the utilities can be surrounded by a well-draining granular backfill with underdrain(s) (where required) located below the structures to maintain moist conditions around the structures. However, to limit corrosion on all buried structures, we recommend the following soils not be placed adjacent to buried metallic utilities: topsoil, organic soils, fill soils, cinders, shale, clay/silt or other deleterious materials, and mixtures of sand and clay.

In general, we recommend covering metallic conduits and structures with a suitable coating material and embedding these structures in a clean granular soil backfill (e.g. MDOT Class II sand) free of salts or other materials increasing corrosion potential. Where practical, we recommend locating metallic conduits/structures away from areas exposed to, or impacted by, road salts as they can increase the chloride concentrations in the soil over time. If necessary, an appropriate underdrain system can be installed below the conduits/structures to control possible “perched” groundwater. Also, electrically isolate buried utilities of different metallic construction from each other to minimize galvanic corrosion problems. In addition, we recommend new piping and conduits be electrically isolated from existing ones so the older metallic structure will not increase the rate of corrosion of the new piping.

4.8 INFILTRATION AND STORMWATER CONSIDERATIONS

SME completed a single double-ring infiltration test near boring IT1 on January 10, 2023. Per the project team’s request, we performed the infiltration test at about 10 feet bgs. We understand a below-grade stormwater detention system is being considered in this area.

After drilling boring IT1 to 10 feet bgs, we used a 7-inch diameter hand auger to remove caved subgrade from the borehole before inserting 4- and 6-inch diameter PVC casings into the subgrade for performing the infiltration test. The soil conditions at the test depth consisted of existing sand fill with varying amounts of concrete debris (no measurable groundwater was present in the borehole). After completing the test, we advanced a hand auger an additional 2 feet (about 12 feet bgs) within the borehole. The stratum of existing fill continued to the terminal boring depth (12 feet). Refer to boring log IT1 for more information.

We drove the PVC pipes about 2.5 inches into the subgrade below the bottom of the borehole. We filled both PVC pipes with about 12 inches of water and used a water level measuring tape with markings every 0.01 feet to measure the rate of drop of the water. We maintained the water level within about 6 to 12 inches above the bottom of the boreholes for one hour to “pre-soak” the test holes.

Per the Low Impact Development (LID) Design Manual for Michigan developed by SEMCOG, we performed a minimum of four trials while recording a stabilized rate of drop (a difference of 0.25 inches or less between the highest and lowest water readings of four consecutive tests).

The table below summarizes the results of the infiltration test.

INFILTRATION TESTING RESULTS

INFILTRATION TEST	TEST DEPTH (feet)	SOIL AT BASE OF INFILTRATION RING	DURATION OF TEST (hours)	ESTIMATED INFILTRATION RATE (cm/sec)	ESTIMATED INFILTRATION RATE (inch/hour)
IT1	10.0	Fill – Fine to Coarse Sand with Silt and Gravel – Few Concrete Fragments – Brown – Moist – Medium Dense (SP-SM)	2.3	4.1×10^{-3}	5.8

For the proposed detention chamber, we present the following considerations/recommendations:

- The existing fill at the infiltration boring IT1 extends at least 12 feet bgs. Near boring IT1 (e.g. boring B5, B6, and previous boring B102), the existing fill extended 9 to 22 feet bgs. It appears the depth of existing fill could vary substantially near the proposed detention chamber. While we measured some infiltration capability (i.e. 5.8 inches per hour, unfactored) at test IT1, we anticipate the underlying cleaner, natural sands could provide higher infiltration rates (if needed for design).
- We expect that the infiltration capability of the fill soils will vary depending on its composition, notably the percentage of debris (concrete, brick, etc.). Therefore, establish infiltration areas in soils that consist of predominantly granular material (e.g., natural sands or sand fill with trace silt/clay content). Remove larger pieces of debris from the subgrade within the infiltration area. Design the infiltration area to include a minimum thickness of 30 inches of granular soils directly below the design infiltration elevation and above groundwater levels. Due to the depth of existing fill, this will require likely require undercutting of the existing fill and replacement with a granular material. The granular material could include imported fill, or relatively clean natural sands excavated from the building area.
- After excavating to the design bottom of the chamber (and undercutting as necessary, as described above), it will be critical to perform a field evaluation of the exposed subgrade as the subsurface conditions will likely vary. Perform hand auger borings and particle-size distribution tests to verify the infiltration characteristics of the in-situ subgrade.
- We recommend using a design infiltration rate of up to 2.5 inches per hour for design of the stormwater system within similar subgrade and elevation as IT1. The design infiltration rate is based on applying a minimum factor of safety of 2 to the measured rate, and is relatively conservative given the limited amount of infiltration test data available. If plans are changed during the course of the project (e.g. alternate location for the proposed chamber), it must be brought to SME’s attention, as our recommendations may need to be revised.

As with any storm water infiltration, changes to subsurface conditions (e.g. due to climate, changing ground surface levels, natural variations in the subsurface profile, nearby construction, etc.) will influence water infiltration into the subgrade. We recommend considering such changes as part of the design of the stormwater infiltration system. In addition, future maintenance (e.g. removing debris, sediments, inhibiting vegetation and other materials that would obstruct the infiltration of surface water into the subgrade) is expected. The maintenance will depend upon a variety of factors (e.g. accumulation of sediments, groundwater levels, frequency of precipitation event(s), etc.). We recommend a regularly implemented maintenance program of infiltration system(s), preferably during and shortly after periods of wet weather, to assess the system(s) ability to infiltrate surface water over time.

4.9 CONSTRUCTION CONSIDERATIONS

Based on our experience and observed groundwater levels at the borings, groundwater is not expected to be encountered during construction. However, water from precipitation, surface runoff, perched groundwater source(s), or other events could be encountered. Where natural granular soils are exposed, we anticipate the water will drain into the subgrade. If water accumulates on the ground surface, we expect it can be controlled using standard sump pit and pumping procedures.

Excavations for new foundations shall not extend below existing foundations (within the zone of influence of those foundations) without first properly underpinning or shoring the existing foundations. Underpinning or shoring must be properly designed by a qualified professional engineer and installed by a contractor experienced with construction of underpinning or shoring systems. Take care during subgrade compaction (for utility trench backfill, foundation subgrade improvement, etc.) to not damage nearby, existing structures.

The contractor will need to remove ponded or standing water from areas where water collects and prevent surface water runoff from reaching foundation excavations or the prepared subgrade. We recommend subgrade soils which become disturbed be removed and replaced with engineered fill. Under adverse weather conditions, areas of exposed subgrade at the site may be protected by placement of crushed concrete or crushed aggregate on the exposed subgrade. In addition, we recommend the placement of foundation concrete be done as soon as foundation excavations have been completed and approved to reduce the potential for disturbance of the foundation subgrade.

Take care during demolition and earthwork operations to protect adjoining and adjacent structures to remain. Do not undermine existing structures. Where necessary, install temporary shoring/bracing to properly shore/brace existing structures and protect them from distress. Any shoring/bracing will need to be designed by a professional engineer licensed in the State of Michigan.

The contractor must provide a safely sloped excavation or an adequately constructed and braced shoring system in accordance with federal, state and local safety regulations for individuals working in an excavation that may expose them to the danger of moving ground. Additionally, if storing material or operating equipment near an excavation, use appropriate shoring to resist the extra pressure due to the superimposed loads.

Special handling and/or disposal of onsite soils and/or groundwater may be required at this site. Refer to the project environmental consultant for additional information regarding handling and/or disposal of onsite soils and/or groundwater.

5. DESIGN DEVELOPMENT CONSIDERATIONS – ALTERNATE CONCEPT

This section provides design development considerations for the 7-story, slab-on-grade building option being considered by the project team. Our intent is to present considerations expected to significantly affect project cost, schedule, and complexity for the alternate option. We can provide more detailed recommendations for this alternate concept (i.e. similar to Section 4 above) if it is selected later as the primary option.

5.1 SLAB AND FOUNDATION SUPPORT OPTIONS

We have encountered a relatively deep profile of existing fill at this site, extending up to 22 feet bgs. The existing fill is unsuitable for conventional grade slab/shallow foundation support. We recommend three options to consider for supporting the building slab and foundations, which are discussed in greater detail throughout Section 5:

- **Option 1**: Completely remove and replace the existing fill with engineered fill and then construct a conventional slab-on-grade and shallow foundation system. This would require constructing a temporary earth retention system (TERS) to protect the neighboring properties/road right-of-ways before completely removing the existing fill. We expect at least a portion of the existing fill will need to be removed from the site (with associated environmental costs). The existing fill that is predominantly granular could be reused as engineered fill; however, segregation of debris from the sands would be required first. Depending on the compaction specification for engineered fill (and material type), we estimate net allowable bearing pressures of 4,000 – 8,000 psf are achievable for shallow foundations supported by granular engineered fill.
- **Option 2**: Leave the existing fill in place and support the slab and structure on a deep foundation system (e.g. augercast piles) extending through the fill into natural sands. The project team needs to consider utility support from the structural slab compared to utilities supported on the fill, with resulting settlement in the debris laden fill. Due to the debris-laden fill, it will be difficult (if not impractical) to install the piles, and there could be significant associated costs (e.g. due to down time, robust equipment requirements, redrilling piles, etc.). Some pre-excavation may be required to remove known obstructions (e.g. buried pool slab) prior to pile installation. For this option, we recommend engaging a deep foundation contractor with local experience to further review feasibility of this option.
- **Option 3**: Leave the existing fill in place and install a ground improvement system prior to constructing the slab-on-grade and shallow foundations. In general, ground improvement systems consist of a grid of piles (i.e. vertical elements) installed below a load transfer platform (LTP). Therefore, we expect similar installation challenges as described for Option 2. The advantage of this option over Option 2 is that the slab-on-grade would not be structurally supported, and therefore utilities (e.g. mechanical, electrical, plumbing, etc.) could be installed below the slab and maintained as necessary without damaging a structural slab system. More information on ground improvement systems is provided in the following section.

5.2 GROUND IMPROVEMENT OPTIONS

We considered several intermediate foundation options for this site, including aggregate pier methods, Controlled Modulus Columns™ (CMC), and rigid inclusions. CMCs are a patented technology by Menard (www.dgi-menard.com). Rigid inclusions are grouted elements installed in a similar fashion to auger cast-in-place (ACIP) piles, i.e. by augering into the soil and pumping grout through the hollow auger under pressure.

Aggregate piers consist of vertical columns of aggregate compacted in controlled lifts. There are several methods of installing aggregate piers, including the Impact Pier or Rampact method performed by Geopier® Foundation Company; or using vibro-compaction type vibrators as used by Hayward Baker, Nicholson Construction Company, and others. The advantage of rigid inclusions (and CMCs) over aggregate piers is the increased lateral stiffness and confinement provided by the grout, which can provide higher design bearing pressures.

CMCs consist of cement grout or concrete-filled columns installed with specially designed augers or mandrels. The augers used to install CMCs are specially designed to displace the soil laterally, with virtually no spoils or vibration during column construction. The diameter, spacing, and installation techniques are designed to be a composite soil/cement ground improvement and improve the overall subgrade modulus to control settlement (deformation). It could be difficult to install CMCs through the fill as it is debris-laden and may not displace laterally.

Preliminarily, we recommend rigid inclusions as a preferred option when considering the installation challenges and required allowable bearing pressure for the foundation loads. Also, we recommend further discussing the feasibility of these options with experienced specialty contractors.

Ground improvement elements are not installed to be in direct contact with the building slab or structure. Rather, the elements are terminated in an aggregate transfer platform located between the subgrade and building slab/spread foundations. This aggregate layer can include geotextiles for reinforcement and is sometimes referred to as a Load Transfer Platform (LTP). The performance specification needs to indicate if geotextiles are acceptable or not. LTPs are typically in the range of about 2 to 4 feet thick. The slab and foundation loads are transferred to the LTP and then to the vertical elements, reducing the overburden pressure applied directly to the slab subgrade. The ground improvement/aggregate layer/ slab and foundation system is typically designed as a complete system, often by a design-build contractor completing the work. Therefore, the material used to raise grades (if any) must be coordinated with the ground improvement system designer.

Shallow spread foundations to support the proposed building are placed on the LTP underlain by existing fill after these soils are improved by installing the rigid inclusions (vertical elements). An area of replacement ratio is commonly used to determine the number of vertical elements required beneath each foundation. A triangular or square grid pattern is commonly used beneath grade slabs. The specialty contractor is responsible for the design and successful performance of the ground improvement system, including any necessary structural fill layer(s). The performance requirements typically include improving the site soils to a specified design bearing pressure and maximum settlement values beneath foundations. For grade slab areas, the performance requirements also include a minimum specified average subgrade modulus. The performance requirements also commonly include a warranty period that begins after building occupancy. A 1-year warranty is common, but a longer warranty period can also be specified. SME can provide performance-based technical specifications under separate cover, if requested.

Scaled plate load testing on an individual rigid inclusion will need to be performed near the beginning of the project to verify the design parameters used to design the ground improvement system. One plate load test is commonly performed for every 300 ground improvement elements of the same type installed. A full-scale foundation load test could be performed to verify the foundation performance requirements are met, however, a full-scaled foundation load test is more costly to perform than a plate load test on an individual element.

Based on our experience with similar projects using ground improvement methods, it will likely be necessary to vertically form the foundations due to the potential for sloughing of the existing fill soils and structural fill layer (if used). Any caved soils must be removed from the foundation excavations before placing concrete.

Excavations for foundations and utilities must be coordinated with the ground improvement contractor and must be completed as recommended by the contractor or the performance warranty might not be enforceable.

5.3 SEISMIC SITE CLASS

The alternate concept is a slab-on-grade structure that would be situated about 20 feet higher (relative to the existing ground surface) than the primary concept. Based on the subsurface profile, Seismic Site Class D would apply for this situation as the average N-values for the soil profile (averaged over the upper 100 feet) and anticipated shear wave velocity values would be lower relative to the primary concept. It is possible that Seismic Site Class C could still apply; however, shear wave velocity testing would be required for confirmation.

6. PAVEMENT DESIGN RECOMMENDATIONS

Based on the provided site plan for the primary concept, new pavements will be constructed north of the main building. The pavements will be used for bus travel routes and parking areas, in addition to emergency vehicle access and trash pickup. Given the loading and traffic conditions, we recommend using a heavy-duty concrete section. Please contact SME if a heavy-duty asphalt section is being considered. However, note that a concrete section is preferred over asphalt to handle the heavy point-type loading, turning loads (from buses entering/exiting the site), and to help “bridge” over marginal subgrade conditions.

For this report, we have assumed final site grades around the pavement perimeter will slope (downward) away from the new pavements. Specific traffic counts are not available at this time. Please contact us when the pavement locations, grading plans, and traffic conditions are finalized. Consider the following pavement recommendations preliminary and subject to change based on final pavement locations, traffic conditions, grades, site drainage, etc.

6.1 PAVEMENT DESIGN CRITERIA

Specific traffic information was not provided for use in developing pavement recommendations for this project. Please note that recommended pavement cross sections are highly dependent on traffic loading conditions (i.e. number of equivalent single axle loads, or ESALs). For example, the number of daily bus arrivals/departures at the residential complex could significantly impact the recommended pavement profile thickness.

For this report, we estimated 0.57 ESALs per bus per the Traffic Monitoring Guide developed by the Federal Highway Administration. We estimated 45 buses at the complex per day (3 per hour for 15 hours per day) for 365 days per year. Our traffic estimates also include additional traffic loads over 20 years to account for anticipated heavy equipment used for snow removal between November and March. Our snow removal assumption includes about four passes (in each direction) of a plow truck and/or loader and gravel truck per snow event (amounting to 3 ESALs per event) and assumes 40 snow events per year (two events per week over five months). This results in an additional 2,400 ESALs for a 20-year design pavement lifetime (over all the pavement types).

We did not account for construction traffic loads in our design. Please contact SME if the pavement will be subjected to construction traffic, e.g. if the pavement needs to be utilized during the building construction.

We designed the pavements for this project based on:

- The findings from the borings and our experience with sites with similar subgrade conditions (used to estimate the Modulus of Subgrade Reaction).
- Design parameters using the AASHTO Guide for Design of Pavement Structures.
- Estimated vehicle traffic counts (as described above).

DESIGN PARAMETERS – CONCRETE PAVEMENT

PARAMETER	RIGID PAVEMENT
Design Period	20 years
Traffic	350,000 ESALs (Heavy Duty)
Design Reliability	85%
Standard Deviation	0.35 (rigid pavements)
Modulus of Subgrade Reaction	150 pci
Drainage Coefficient (aggregate base)	1.0
Initial Serviceability Index	4.2
Terminal Serviceability Index	2.0
Concrete Compressive Strength	4,000 psi
Concrete Elastic Modulus	3,600,000 psi
Concrete Modulus of Rupture	600 psi
Load Transfer Coefficient	3.6

The design subgrade reaction assumes a portion of the existing fill will be left in-place during construction, given the extent and depth of the existing fill. Completely removing the existing fill and replacing it with engineered fill, as described earlier in this report, would reduce the risk of poor pavement performance and it is possible a thinner pavement section could also be used for design. As such, consider our pavement recommendations preliminary until the project team has made a decision regarding the options available for subgrade improvement at the site.

6.2 SUBGRADE PREPARATION

Assuming constructing pavements over the existing fill is acceptable (refer to Section 4.1.1 of this report), the subgrade preparation for the new pavement areas would consist of complete removal of the existing surficial pavements and other site features, subgrade assessment and preparation (i.e., a field evaluation of the condition of the exposed subgrade with thorough compaction, proofrolling, fine grading, and undercutting to remove and replace low-strength subgrade), and placement of new pavement layers. Protect utilities, curbs, and other existing structures to remain. Field locate existing utilities prior to excavation and take the necessary precautions to work safely around active utilities.

Due to the variable condition of the existing subgrade, subgrade undercuts may be required in some areas of the site. We recommend the earthwork and pavement construction occur in the summer months, and when large construction equipment can effectively operate on the site, to limit the potential for significant undercutting. The pavement thickness recommendations in this report assume a marginal strength subgrade to help account for some of the variable strength conditions, but additional crushed stone (and possibly geotextile or geogrid layer(s)) may be required. We recommend an SME representative be onsite during site earthwork and pavement construction to assist in making judgments in the field regarding subgrade stability.

We expect subsurface conditions (after site stripping of pavements/aggregate base and other surficial materials) will largely consist of existing fill soils. In addition to following the subgrade preparation recommendations in Section 4 of this report, we recommend subgrade preparation and the aggregate base layer extend out to at least 12 inches beyond the edge of pavement or curbs to provide support for the outer edges of pavement. Where existing curbs are to remain, prepare the subgrade to the edge of the curb and protect the curb from damage/distress.

Prior to the placement of the aggregate base, we recommend fine-grading the subgrade to slope downward toward the stormwater drainage structures. Fine-grading of the underlying subgrade will be critical to minimize low spots below the aggregate base where water can pond, likely resulting in moisture changes and undesirable early pavement distress. Fine-grading the subgrade is important for the drainage of perched groundwater, and to achieve a uniform thickness of base course to be placed throughout each of the pavement sections. Also, we recommend installing underdrains at/through low spots in the prepared subgrade to facilitate the drainage of perched groundwater. See Section 5.4 for additional information.

We recommend testing the exposed subgrade for stability via a proofroll as recommended in Section 4.1.2. We recommend using a fully loaded tandem axle truck (50,000 lbs. minimum) for the proofroll test. We recommend the criteria for the proofroll be a maximum of 1/2 inch of deflection or rutting below the aggregate base layer, and a maximum 1/4 inch of deflection or rutting on the aggregate base layer. Site-specific conditions may require adjusting the proofroll criteria, which would only be considered if agreed upon in writing by the Owner and Engineer. A qualified geotechnical engineering firm must be on-site to observe the proofroll and make judgments regarding the suitability of the subgrade for pavement support.

Any loose or soft areas identified from the proofrolling will need to be recompacted in-place, undercut and replaced with additional engineered fill, or stabilized by other means as dictated by the site conditions at the time of construction. Based on the subsurface conditions encountered in the borings, we anticipate the contractor will encounter loose/soft portions of existing fill soils after making cuts to design subgrade levels. The contractor's means and methods and time of year (temperature/precipitation) will directly affect the suitability of the subgrade for pavement performance. As such, take care during subgrade preparation to prevent water from ponding in the pavement areas and do not allow construction traffic to randomly traffic the site as this would likely result in significant disturbance to the subgrade.

We recommend including a contingency in the project budget for improving poor subgrade conditions/performing undercuts. Due to the overall poor condition of the existing fill, constructing the pavement profile over the existing fill could require the placement of a relatively thick profile of crushed stone or 1 to 3-inch sized aggregate, possibly in conjunction with a geotextile and/or geogrid layer, to “bridge over” the subgrade.

Once the subgrade passes the final proofroll test, we recommend fine-grading the subgrade again and then placing the pavement layers soon thereafter to avoid further subgrade disturbance. If subgrade disturbance occurs, we recommend the subgrade be proofrolled again to evaluate the severity of disturbance and undercuts (where required) be performed to re-establish a suitably stable subgrade. It may be necessary to use crushed stone backfill, possibly in combination with a high-strength woven geotextile fabric or geogrid, to stabilize the subgrade. A qualified geotechnical engineering firm will need to determine the type and quantity of stabilization required based on field conditions during construction.

We recommend engineered fill below the proposed pavement system (i.e. pavement and aggregate base layers) consist of a relatively clean and dense graded aggregate base material (e.g. MDOT 21AA crushed limestone), or possibly MDOT Class II sand, to facilitate drainage, and reduce time and effort during construction with subgrade preparation (e.g., discing, drying, and compaction of clay and clayey sand soils). Another option would include reusing the natural sands excavated from within the proposed building footprint as an engineered fill.

6.3 RECOMMENDED RIGID PAVEMENT SECTION

We consider the section contained herein the minimum section for the expected loading, described above. We base our recommendations on the suggested subgrade preparations and the final subgrade passing a thorough proofroll under a fully loaded tandem axle truck.

6.3.1 RECOMMENDED RIGID PAVEMENT SECTION

Utilizing the previously described design parameters and the American Association of State Highway Transportation Officials (AASHTO) “Guide for Design of Pavement Structures” 1993 edition, the following table presents the layer material and thickness recommendations for a heavy-duty rigid pavement section:

PORTLAND CEMENT CONCRETE PAVEMENT

LAYER	MATERIAL	THICKNESS (inches)
Surface	MDOT P1	8.0
Aggregate Base	MDOT Crushed Limestone	8.0

We recommend MDOT P1 concrete mix be used and modified as noted below. The coarse aggregate must meet the specifications of MDOT 6AA crushed limestone. We do not recommend gravel or slag aggregates be allowed as the coarse aggregate. We recommend performing ASTM C1567 tests on the blended materials of aggregate and cement to test the potential of Akalia Silica Reactivity (ASR). The blend needs to provide less than 0.1 percent. We recommend a mix design be submitted documenting the results of the ASTM C1567 test program. Ground granulated blast furnace slag (GGBFS) may be used as a mitigation agent for ASR at a cement replacement rate of 20 to 40 percent. The cement type will need to be Type I/II with air content specified at 5 to 8 percent. We recommend the minimum specified compressive strength of the concrete mix be 4,000 psi at 28 days.

We recommend installing the concrete at paving lane joint spacing between 12 to 15 feet wide. We recommend contraction joints be spaced between 12 and 15 feet. The length-to-width ratio of slabs must not exceed 1.25.

We recommend 1.25-inch diameter, 18-inch long smooth epoxy dowel bars spaced every 12 inches along contraction joints. We recommend tie bars be No. 5, 30-inch long epoxy-coated deformed bars spaced at 30 inches at longitudinal joints. Tie bars must not be placed within 15 inches of contraction joints, so they do not interfere with joint movement. All tie bars and dowel bars need to be epoxy coated and installed at mid depth within the slabs.

We recommend a broom finish and installing a uniform curing compound meeting the requirements of ASTM C309 Type 2 at a rate of one gallon per 225 square feet. Perform all saw cutting as soon as possible after concrete placement, without damaging the finish of the pavement. We recommend the use of soft cut saws so sawing can be performed within four hours after placement. We do not recommend traffic be allowed on the concrete until the concrete has reached at least 75 percent of the design strength. We recommend a saw cut depth of 2.5 inches. We recommend sealing all joints with hot poured rubber.

6.3.2 GENERAL PAVEMENT CONSTRUCTION COMMENTS

Proper subgrade preparation includes removing unsuitable fill and buried topsoil (if any), uniformly compacting the exposed subgrade with appropriate compaction equipment, performing proofroll tests, undercutting overly soft/loose (and/or debris/organic-laden) subgrade, and replacing undercuts with suitable engineered fill. On that basis, SME needs to assess the existing subgrade in the field at the time of construction. We recommend this occur on a case-by-case basis to address the specific needs of each situation. To address budgetary concerns, we recommend including a contingency for additional earthwork (e.g., undercutting, in-place compaction, removal of unsuitable fill, importing suitable fill, etc.) that may be required to improve subsurface conditions.

As with any pavement, cracking is inevitable particularly due to thermal changes, trapped groundwater, and frost action. Cracking will occur, and some pavement repairs are expected, before reaching the design life of the pavement. Proper drainage, protection from oversized loads, and regular maintenance can help reduce pavement distress. Routine maintenance such as crack sealing, joint sealing, and patching needs to be performed so water infiltration and frost heave effects associated with the local climate are minimized on the pavements.

6.4 DRAINAGE

The pavement system must be properly drained to reduce the possibility of frost heaving and softening of the subgrade due to water infiltrating through cracks. The infiltrated water, if not properly drained, is expected to adversely affect the long-term pavement performance. During subgrade preparation, we recommend fine-grading the existing subgrade prior to placing the aggregate base layer. This is important to 1) achieve a uniform thickness of aggregate base, and 2) direct water that may collect in the aggregate base layer toward the catch basins. We recommend a surveyor review subgrade elevations prior to aggregate base placement and assist the contractor in achieving a uniformly graded subgrade prior to aggregate base placement.

Based on typical construction, we expect the proposed pavements will be drained by an internal drainage system consisting of curb inlets and catch basins spaced throughout the system. We recommend catch basins have 20-foot long sections of underdrains installed in two directions along curb lines and four directions if they are in the open parking areas or drives to provide subsurface drainage. We also recommend re-grading surrounding areas to provide drainage away from the pavement (where practical). In areas where the surrounding grades are higher than the new pavements, we recommend installing perimeter underdrains to cut-off and/or collect groundwater that may accumulate in the aggregate base or underlying subgrade below the pavements. We recommend underdrains consist of a minimum of 1-foot wide trenches, located a minimum of 18 inches deep below the aggregate base layer. We recommend a nonwoven geotextile fabric be placed in the trench to provide separation between the peastone and the existing subgrade. We recommend the trench be backfilled with MDOT 34R peastone. The underdrains need to consist of a 4-inch perforated, rigid, polyethylene pipe. Providing proper drainage of pavements is essential in achieving suitable long-term pavement performance. Depending upon the final site grades, additional underdrains may be required. Also, we recommend installing additional underdrains in areas as recommended by a qualified SME representative based upon observed field conditions during construction.

6.5 PAVEMENT CONSTRUCTION NOTES

1. Earthwork and pavement construction must be performed in accordance with the 2020 MDOT Standard Specifications for Construction unless otherwise noted in this report.
2. Earthwork and pavement construction is recommended during the summer months of June through September. Summer conditions are preferred to reduce the potential for disturbance of the subgrade soils due to relatively cold temperatures and precipitation.
3. Remove any existing pavements, base material, topsoil, organic soils, unsuitable fill and other undesirable materials to expose a suitable subgrade. Tree roots must be removed. Existing structures (if encountered) must be removed and replaced with engineered fill to within a minimum of 3 feet below the proposed pavement surface to provide a uniform subgrade.
4. Excavate to the depth of the final subgrade elevation to allow for grade changes and the placement of the recommended pavement system.
5. Undocumented fill materials are suitable for reuse if they are clean and free of frozen soil, organics, or other deleterious materials and specified compaction requirements are attainable.
6. The top 12 inches of the exposed subgrade as well as individual engineered fill layers shall be compacted to achieve a minimum of 95 percent of the maximum Modified Proctor dry density.
7. The final subgrade shall be thoroughly proofrolled using a loaded tandem axle truck under the observation of a geotechnical/pavement engineer. Remove and replace loose or yielding areas that cannot be mechanically stabilized with engineered fill or as dictated by field conditions and recommended by a geotechnical/pavement engineer.
8. The aggregate base shall be compacted to achieve a minimum of 95 percent of the maximum Modified Proctor dry density. The base and subgrade compaction must extend a minimum of 12 inches beyond the paved edge or back of new concrete curb. Backfill behind unsupported concrete curbs and gutters to provide lateral resistance.
9. Final pavement elevations shall be so designed to provide positive surface drainage. A minimum surface slope of 1.5 percent is recommended. Per the 2015 MBC, impervious surfaces within 10 feet of building foundations shall be sloped a minimum of 2 percent away from the building.
10. Install interceptor drains along the perimeter of paved areas where runoff from higher ground would flow towards the pavement. Finger drains must be installed at catch basins and gutter inlets.

7. SIGNATURES

PREPARED BY:

Alex Kuisell, PE
Senior Project Engineer

REVIEWED BY:

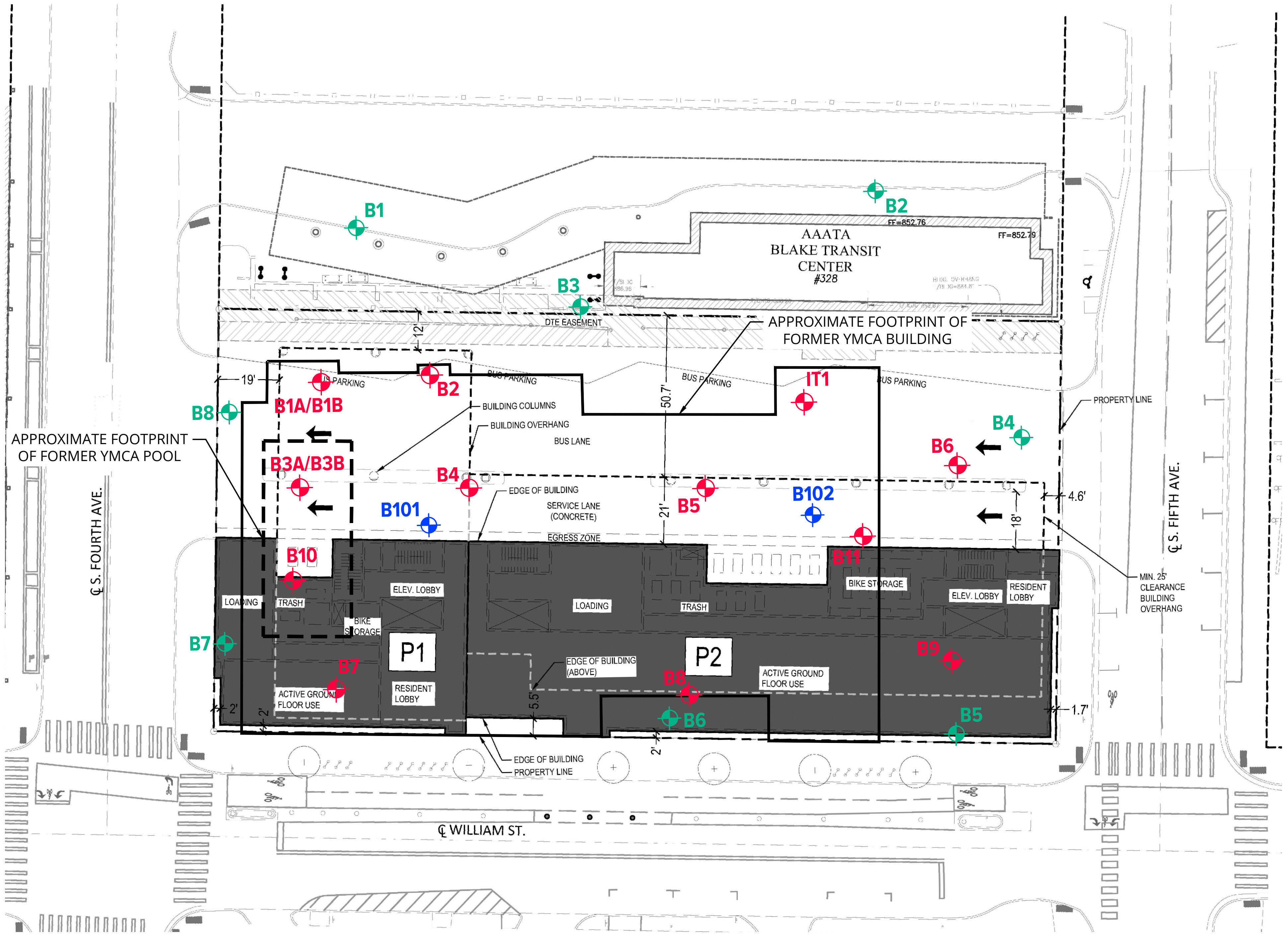
Christopher Naida

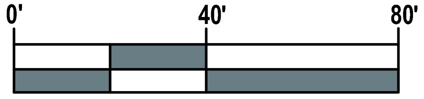
Christopher G. Naida, PE
Senior Consultant

APPENDIX A

FIGURE 1: BORING LOCATION DIAGRAM
BORING LOG TERMINOLOGY
CURRENT BORING LOGS (B1 – B11 AND IT1)
PREVIOUS BORING LOGS – SME PROJECT NO. 073815.00 (B101 – B102)
PREVIOUS BORING LOGS – SME PROJECT NO. 051735.00 (B1 – B8)
FIGURE 2: DOUBLE RING INFILTROMETER TEST RESULTS (IT1)
PRESSUREMETER TEST RESULTS (8 PLOTS)

PLOT DATE: Jan 26, 2023 - 11:09am - matt.nowakrochford \\sme-inc\pz\WIP\084868.01\CAD\Design Files\BLD\Rev0\084868.01-BLD.dwg

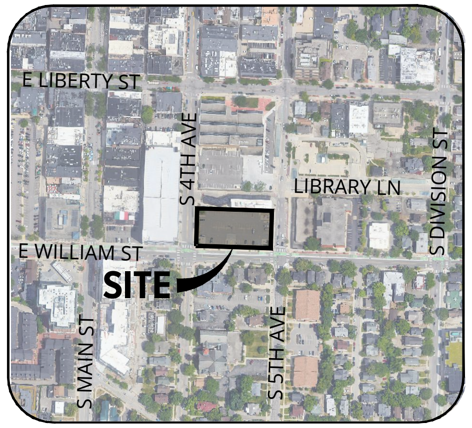




GRAPHIC SCALE: 1" = 40'

LEGEND

⊕	APPROXIMATE BORING LOCATION (SME PROJECT NO. 084868.01)
⊕	APPROXIMATE BORING LOCATION (SME PROJECT NO. 073815.00)
⊕	APPROXIMATE BORING LOCATION (SME PROJECT NO. 051735.00)



LOCATION MAP

NOT TO SCALE

NOTE:

1. BASE DRAWING INFORMATION TAKEN FROM A DRAWING TITLED "PROPOSED SOIL BORING LOCATION PLAN" (SHEET SB-1) WITH A LATEST REVISION DATE OF 11-9-2021, PREPARED BY SMITHGROUP.
2. AERIAL IMAGE TAKEN FROM GOOGLE EARTH PRO WITH AN IMAGE DATE OF 6-30-2022.

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Project

350 SOUTH 5TH AVENUE PROPOSED MIXED-USE DEVELOPMENT

Project Location

ANN ARBOR, MICHIGAN

Sheet Name

BORING LOCATION DIAGRAM

No.	Revision Date

Date	1-26-2023
CADD	MNR
Designer	AK
Scale	AS NOTED
Project	084868.01
Figure No.	1

DRAWING NOTE: SCALE DEPICTED IS MEANT FOR 11" X 17" AND WILL SCALE INCORRECTLY IF PRINTED ON ANY OTHER SIZE MEDIA

SME

BORING LOG TERMINOLOGY

UNIFIED SOIL CLASSIFICATION AND SYMBOL CHART

COARSE-GRAINED SOIL (more than 50% of material is larger than No. 200 sieve size.)			
GRAVEL More than 50% of coarse fraction larger than No. 4 sieve size	Clean Gravel (Less than 5% fines)		
	▨	GW	Well-graded gravel; gravel-sand mixtures, little or no fines
	▨	GP	Poorly-graded gravel; gravel-sand mixtures, little or no fines
	Gravel with fines (More than 12% fines)		
	▨	GM	Silty gravel; gravel-sand-silt mixtures
	▨	GC	Clayey gravel; gravel-sand-clay mixtures
SAND 50% or more of coarse fraction smaller than No. 4 sieve size	Clean Sand (Less than 5% fines)		
	▨	SW	Well-graded sand; sand-gravel mixtures, little or no fines
	▨	SP	Poorly graded sand; sand-gravel mixtures, little or no fines
	Sand with fines (More than 12% fines)		
	▨	SM	Silty sand; sand-silt-gravel mixtures
	▨	SC	Clayey sand; sand–clay-gravel mixtures
FINE-GRAINED SOIL (50% or more of material is smaller than No. 200 sieve size)			
SILT AND CLAY Liquid limit less than 50%	▨	ML	Inorganic silt; sandy silt or gravelly silt with slight plasticity
	▨	CL	Inorganic clay of low plasticity; lean clay, sandy clay, gravelly clay
	🟩	OL	Organic silt and organic clay of low plasticity
SILT AND CLAY Liquid limit 50% or greater	▨	MH	Inorganic silt of high plasticity, elastic silt
	▨	CH	Inorganic clay of high plasticity, fat clay
	▨	OH	Organic silt and organic clay of high plasticity
HIGHLY ORGANIC SOIL	▨	PT	Peat and other highly organic soil

OTHER MATERIAL SYMBOLS

■	Topsoil	□	Void	▨	Sandstone
▨	Asphalt Concrete	▨	Glacial Till	▨	Siltstone
▨	Aggregate Base	▨	Coal	▨	Limestone
▨	Portland Cement Concrete	▨	Shale	▨	Fill

LABORATORY CLASSIFICATION CRITERIA

GW	$C_U = \frac{D_{60}}{D_{10}}$ greater than 4; $C_C = \frac{D_{30}{}^{2}}{D_{10} \times D_{60}}$ between 1 and 3	
GP	Not meeting all gradation requirements for GW	
GM	Atterberg limits below “A” line or PI less than 4	Above “A” line with PI between 4 and 7 are borderline cases requiring use of dual symbols
GC	Atterberg limits above “A” line with PI greater than 7	
SW	$C_U = \frac{D_{60}}{D_{10}}$ greater than 6; $C_C = \frac{D_{30}{}^{2}}{D_{10} \times D_{60}}$ between 1 and 3	
SP	Not meeting all gradation requirements for SW	
SM	Atterberg limits below “A” line or PI less than 4	Above “A” line with PI between 4 and 7 are borderline cases requiring use of dual symbols
SC	Atterberg limits above “A” line with PI greater than 7	

Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows:

Less than 5 percent……………………….……..GW, GP, SW, SP
More than 12 percent……………………..…….GM, GC, SM, SC
5 to 12 percent……………...……..Cases requiring dual symbols

- SP-SM or SW-SM (SAND with Silt or SAND with Silt and Gravel)
- SP-SC or SW-SC (SAND with Clay or SAND with Clay and Gravel)
- GP-GM or GW-GM (GRAVEL with Silt or GRAVEL with Silt and Sand)
- GP-GC or GW-GC (GRAVEL with Clay or GRAVEL with Clay and Sand)

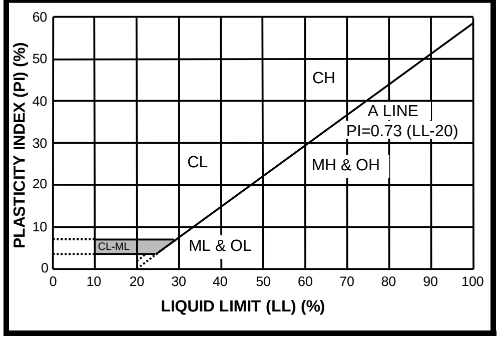
If the fines are CL-ML:

- SC-SM (SILTY CLAYEY SAND or SILTY CLAYEY SAND with Gravel)
- SM-SC (CLAYEY SILTY SAND or CLAYEY SILTY SAND with Gravel)
- GC-GM (SILTY CLAYEY GRAVEL or SILTY CLAYEY GRAVEL with Sand)

PARTICLE SIZES

Boulders		-	Greater than 12 inches
Cobbles		-	3 inches to 12 inches
Gravel-	Coarse	-	3/4 inches to 3 inches
	Fine	-	No. 4 to 3/4 inches
Sand-	Coarse	-	No. 10 to No. 4
	Medium	-	No. 40 to No. 10
	Fine	-	No. 200 to No. 40
Silt and Clay		-	Less than (0.074 mm)

PLASTICITY CHART



VISUAL MANUAL PROCEDURE

When laboratory tests are not performed to confirm the classification of soils exhibiting borderline classifications, the two possible classifications would be separated with a slash, as follows:

For soils where it is difficult to distinguish if it is a coarse or fine-grained soil:

- SC/CL (CLAYEY SAND to Sandy LEAN CLAY)
- SM/ML (SILTY SAND to SANDY SILT)
- GC/CL (CLAYEY GRAVEL to Gravelly LEAN CLAY)
- GM/ML (SILTY GRAVEL to Gravelly SILT)

For soils where it is difficult to distinguish if it is sand or gravel, poorly or well-graded sand or gravel; silt or clay; or plastic or non-plastic silt or clay:

- SP/GP or SW/GW (SAND with Gravel to GRAVEL with Sand)
- SC/GC (CLAYEY SAND with Gravel to CLAYEY GRAVEL with Sand)
- SM/GM (SILTY SAND with Gravel to SILTY GRAVEL with Sand)
- SW/SP (SAND or SAND with Gravel)
- GP/GW (GRAVEL or GRAVEL with Sand)
- SC/SM (CLAYEY to SILTY SAND)
- GM/GC (SILTY to CLAYEY GRAVEL)
- CL/ML (SILTY CLAY)
- ML/CL (CLAYEY SILT)
- CH/MH (FAT CLAY to ELASTIC SILT)
- CL/CH (LEAN to FAT CLAY)
- MH/ML (ELASTIC SILT to SILT)

DRILLING AND SAMPLING ABBREVIATIONS

2ST	–	Shelby Tube – 2” O.D.
3ST	–	Shelby Tube – 3” O.D.
AS	–	Auger Sample
GS	–	Grab Sample
LS	–	Liner Sample
NR	–	No Recovery
PM	–	Pressuremeter
RC	–	Rock Core diamond bit. NX size, except where noted
SB	–	Split Barrel Sample 1-3/8” I.D., 2” O.D., except where noted
VS	–	Vane Shear
WS	–	Wash Sample

OTHER ABBREVIATIONS

WOH	–	Weight of Hammer
WOR	–	Weight of Rods
SP	–	Soil Probe
PID	–	Photo Ionization Device
FID	–	Flame Ionization Device

DEPOSITIONAL FEATURES

Parting	–	as much as 1/16 inch thick
Seam	–	1/16 inch to 1/2 inch thick
Layer	–	1/2 inch to 12 inches thick
Stratum	–	greater than 12 inches thick
Pocket	–	deposit of limited lateral extent
Lens	–	lenticular deposit
Hardpan/Till	–	an unstratified, consolidated or cemented mixture of clay, silt, sand and/or gravel, the size/shape of the constituents vary widely
Lacustrine	–	soil deposited by lake water
Mottled	–	soil irregularly marked with spots of different colors that vary in number and size
Varved	–	alternating partings or seams of silt and/or clay
Occasional	–	one or less per foot of thickness
Frequent	–	more than one per foot of thickness
Interbedded	–	strata of soil or beds of rock lying between or alternating with other strata of a different nature

DESCRIPTION OF RELATIVE QUANTITIES

The visual-manual procedure uses the following terms to describe the relative quantities of notable foreign materials, gravel, sand or fines:

Trace	–	particles are present but estimated to be less than 5%
Few	–	5 to 10%
Little	–	15 to 25%
Some	–	30 to 45%
Mostly	–	50 to 100%

CLASSIFICATION TERMINOLOGY AND CORRELATIONS

Cohesionless Soils

Relative Density	**N_{60} (N-Value) (Blows per foot)**
Very Loose	0 to 4
Loose	5 to 10
Medium Dense	11 to 30
Dense	31 to 50
Very Dense	51 to 80
Extremely Dense	Over 81

Cohesive Soils

Consistency	**N_{60} (N-Value) (Blows per foot)**	**Undrained Shear Strength (kips/ft^2)**
Very Soft	<2	0.25 or less
Soft	2 - 4	> 0.25 to 0.50
Medium	5 - 8	> 0.50 to 1.0
Stiff	9 - 15	> 1.0 to 2.0
Very Stiff	16 - 30	> 2.0 to 4.0
Hard	> 30	> 4.0 or greater

Standard Penetration ‘N-Value’ = Blows per foot of a 140-pound hammer falling 30 inches on a 2-inch O.D. split barrel sampler, except where noted. N60 values as reported on boring logs represent raw N-values corrected for hammer efficiency only.

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SME

BORING B 1A

PAGE 1 OF 1

BORING DEPTH: 16 FEET

PROJECT NAME: 350 South Fifth Avenue Redevelopment
PROJECT NUMBER: 084868.01
CLIENT: SmithGroup
PROJECT LOCATION: Ann Arbor, Michigan
DATE STARTED: 1/11/23
COMPLETED: 1/11/23
BORING METHOD: Hollow-stem Augers
DRILLER: JR
RIG NO.: 552 (CME 55)
LOGGED BY: EJK
CHECKED BY: AK

NORTHING: 284249.975 FT
EASTING: 13291004.84 FT
ELEVATION: 847.3 FT

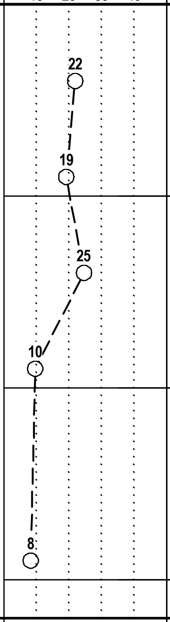
HAMMER EFFICIENCY: 82%
DATE: 9/29/2022
N_{60} -- ○

DRY DENSITY (pcf) -- ■
MOISTURE & ATTERBERG LIMITS (%) PL MC LL

▼ HAND PENE.
☒ TORVANE SHEAR
● UNC. COMP.
⊡ VANE SHEAR (PK)
× VANE SHEAR (REM)
◈ TRIAXIAL (UU)
SHEAR STRENGTH (KSF)

DEPTH (FEET)	PROFILE DESCRIPTION	ELEVATION (FEET)	SAMPLE TYPE/NO. INTERVAL	RECOVERY LENGTH (INCHES)	SPT BLOWS PER SIX INCHES	N_{60}	REMARKS
0.3	4 Inches of PAVEMENT- See Note 3	847.0					
3.0	FILL- Mix of Sand, Gravel and Concrete Debris- Gray	844.3	SB1	10	6 9 7	22	
6.0	FILL- Fine to Medium SAND with Silt- Brown- Moist- Medium Dense (SP-SM)	841.3	SB2	16	5 6 8	19	
8.0	FILL- Mix of Sand, Gravel & Concrete Debris- Trace Brick Fragments	839.3	SB3	12	8 8 10	25	
16.0	FILL- Fine to Coarse SAND with Gravel- Trace Plastic, Glass, and Concrete Fragments- Brown- Moist- Loose (SP)	831.3	SB4 SB5	6 3	6 4 3 3 3 3	10 8	

END OF BORING AT 16.0 FEET.



GROUNDWATER & BACKFILL INFORMATION

GROUNDWATER WAS NOT ENCOUNTERED

BACKFILL METHOD: Auger Cuttings & EPCO Hole Plug & Asphalt Cold Patch

NOTES:
1. The indicated stratification lines are approximate. The in-situ transitions between materials may be gradual.
2. The colors depicted on the symbolic profile are solely for visualization purposes and do not necessarily represent the in-situ colors encountered.
3. Pavement appeared to consist of cemented gravel.
4. Driller encountered an unknown obstruction at 16.0 feet, then offset the boring and blind drilled to 13.5 feet before resuming sampling. See boring log B 1B.
5. Boring log elevations provided by SmithGroup.

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SME

BORING B 1B

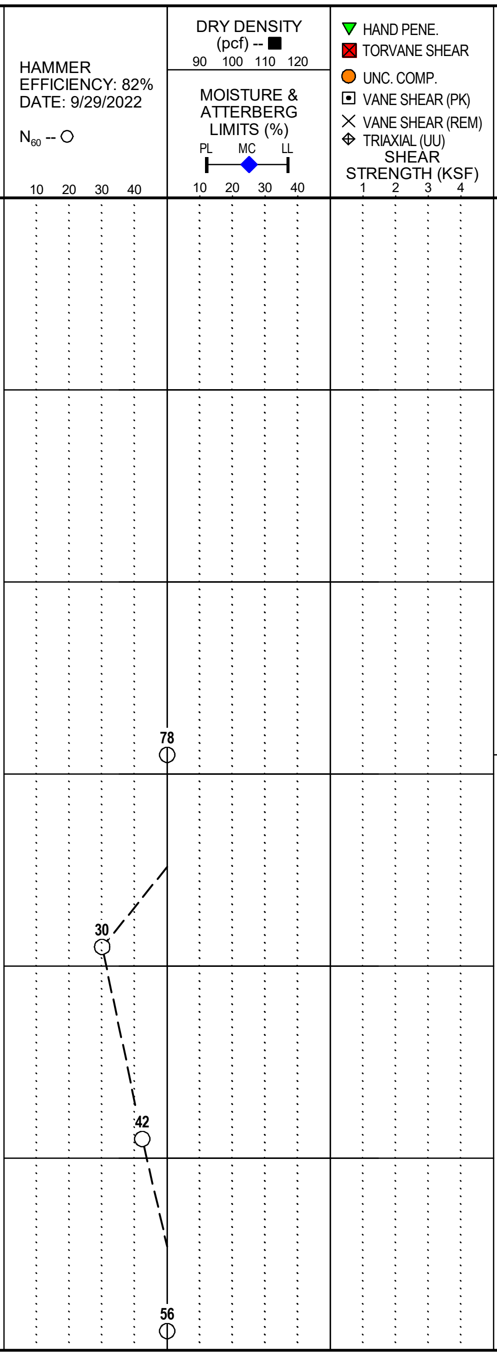
PAGE 1 OF 2

BORING DEPTH: 50 FEET

PROJECT NAME: 350 South Fifth Avenue Redevelopment
PROJECT NUMBER: 084868.01
CLIENT: SmithGroup
PROJECT LOCATION: Ann Arbor, Michigan
DATE STARTED: 1/11/23
COMPLETED: 1/11/23
BORING METHOD: Hollow-stem Augers
DRILLER: JR
RIG NO.: 552 (CME 55)
LOGGED BY: EJK
CHECKED BY: AK

NORTHING: 284255.67 FT
EASTING: 13291007.91 FT
ELEVATION: 847.5 FT

ELEVATION (FEET)	DEPTH (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL	RECOVERY LENGTH (INCHES)	SPT BLOWS PER SIX INCHES	REMARKS
847.3	0.3	3 Inches of PAVEMENT- See Note 3				
834.0	13.5	BLIND DRILL				
			SB5	6	15 27 30	Blow counts likely influenced by debris.
830.5	17.0	FILL- Fine to Medium SAND with Silt & Gravel- Trace Brick Fragments- Brown- Moist (SP-SM)				
			SB6	16	10 11 11	
			SB7	10	13 15 16	
820.5	27.0	Fine to Coarse SAND with Gravel- Occasional Cobbles- Brown- Moist- Medium Dense to Dense (SP)				
		Fine to Coarse SAND with Gravel- Brown- Moist- Very Dense (SP)	SB8	15	20 21 20	



GROUNDWATER & BACKFILL INFORMATION	DEPTH (FT)	ELEV (FT)
▽ DURING BORING:	43.0	804.5
▼ AT END OF BORING:	43.0	804.5

BACKFILL METHOD: Auger Cuttings & EPCO Hole Plug & Asphalt Cold Patch

NOTES:
1. The indicated stratification lines are approximate. The in-situ transitions between materials may be gradual.
2. The colors depicted on the symbolic profile are solely for visualization purposes and do not necessarily represent the in-situ colors encountered.
3. Pavement appeared to consist of cemented gravel.
4. Boring was offset from boring B 1A.
5. Boring log elevations provided by SmithGroup.

(Continued Next Page)

SME

BORING B 1B

PAGE 2 OF 2

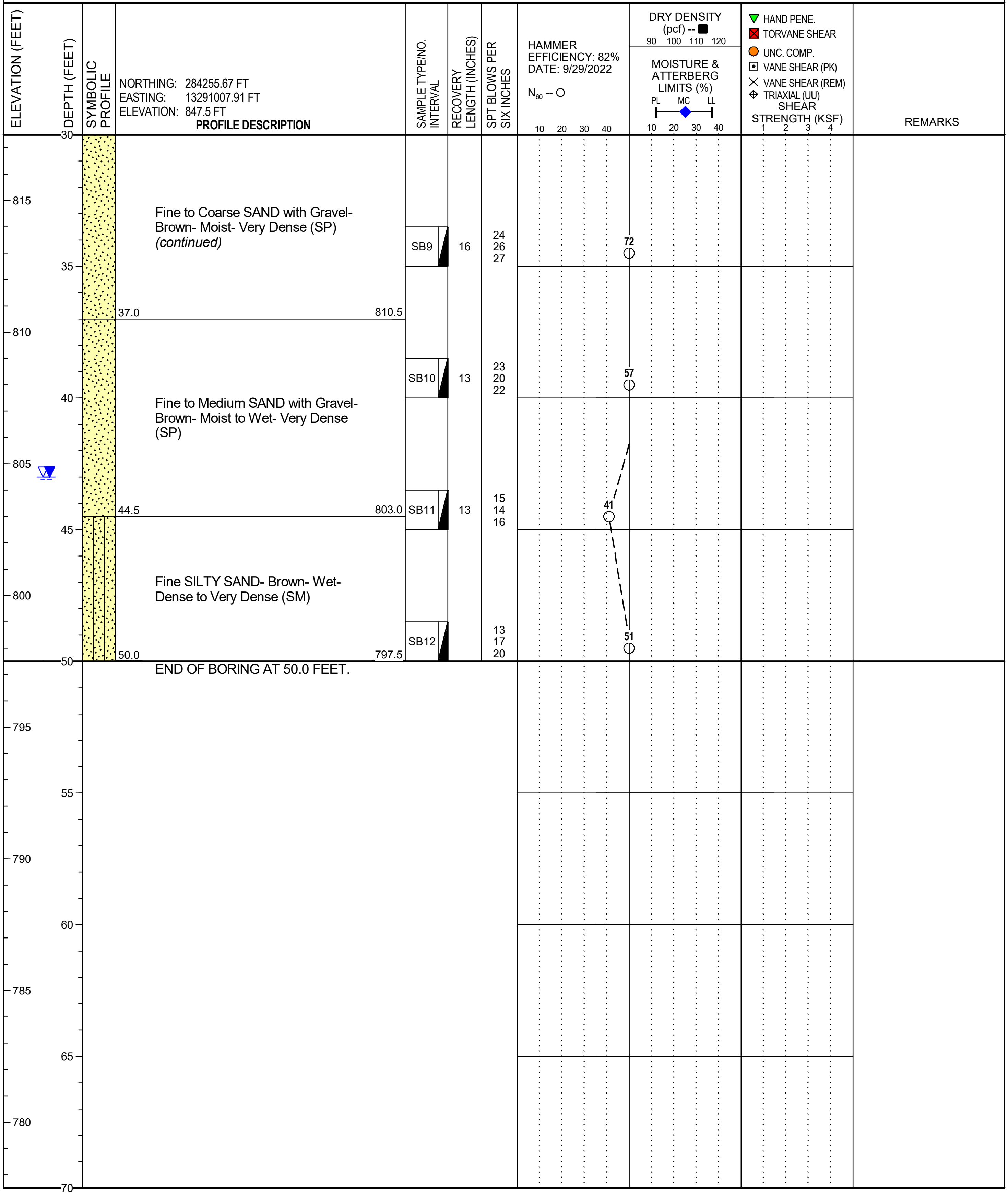
BORING DEPTH: 50 FEET

PROJECT NAME: 350 South Fifth Avenue Redevelopment

PROJECT NUMBER: 084868.01

CLIENT: SmithGroup

PROJECT LOCATION: Ann Arbor, Michigan



ELEVATION (FEET)	DEPTH (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL	RECOVERY LENGTH (INCHES)	SPT BLOWS PER SIX INCHES	N60
	30	Fine to Coarse SAND with Gravel- Brown- Moist- Very Dense (SP) *(continued)*				
			SB9	16	24 26 27	72
810.5	37.0	Fine to Medium SAND with Gravel- Brown- Moist to Wet- Very Dense (SP)				
			SB10	13	23 20 22	57
803.0	44.5	Fine SILTY SAND- Brown- Wet- Dense to Very Dense (SM)	SB11	13	15 14 16	41
			SB12		13 17 20	51
797.5	50.0	END OF BORING AT 50.0 FEET.				

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BORING B 2

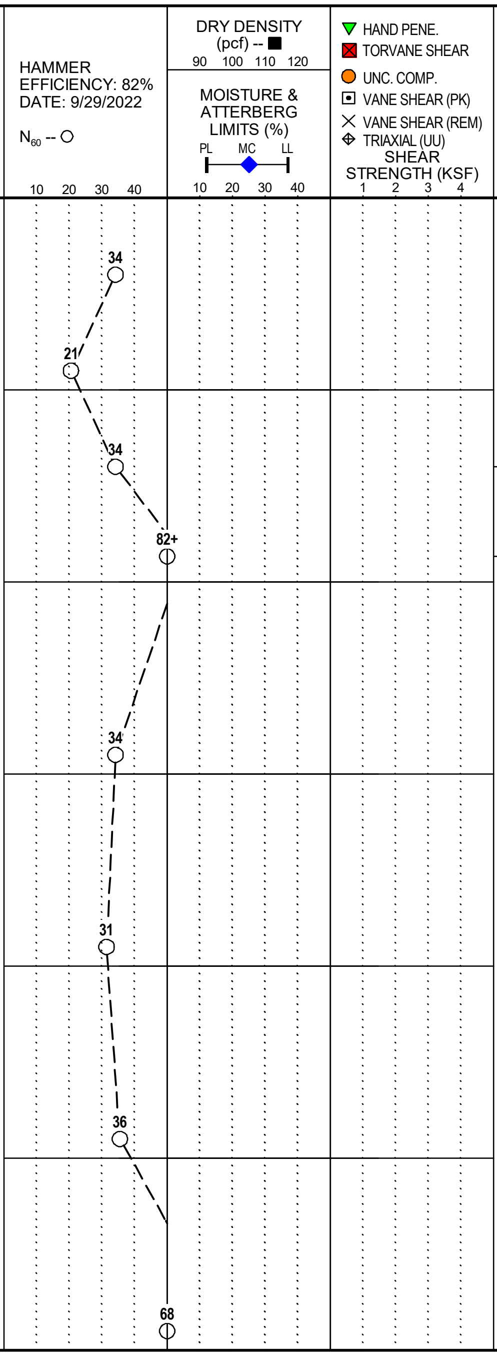
PAGE 1 OF 2

BORING DEPTH: 50 FEET

PROJECT NAME: 350 South Fifth Avenue Redevelopment
PROJECT NUMBER: 084868.01
CLIENT: SmithGroup
PROJECT LOCATION: Ann Arbor, Michigan
DATE STARTED: 1/10/23
COMPLETED: 1/10/23
BORING METHOD: Hollow-stem Augers
DRILLER: JR
RIG NO.: 552 (CME 55)
LOGGED BY: EJK
CHECKED BY: AK

ELEVATION: 848 FT

DEPTH (FEET)	PROFILE DESCRIPTION	ELEVATION (FEET)	SAMPLE TYPE/NO. INTERVAL	RECOVERY LENGTH (INCHES)	SPT BLOWS PER SIX INCHES	N60	REMARKS
0.3	3 Inches of PAVEMENT- See Note 3	847.8					
3.0	FILL- Mix of Sand, Gravel & Concrete Debris- Gray	845.0	SB1	12	10 11 14	34	
6.0	FILL- Fine to Medium SAND with Silt- Brown- Moist- Medium Dense (SP-SM)	842.0	SB2	16	7 8 7	21	
12.0	FILL- Fine to Coarse SAND with Gravel- Few Concrete, Brick, and Metal Fragments- Brown- Moist (SP)	836.0	SB3	6	10 8 17	34	Blow counts likely influenced by debris.
			SB4	8	7 10 50/2"	82+	Blow counts likely influenced by debris.
22.0	Fine to Coarse SAND with Gravel- Brown- Moist- Dense (SP)	826.0	SB5	14	16 12 13	34	
			SB6	16	12 11 12	31	
27.0	Fine to Coarse SAND with Silt & Gravel- Brown- Moist- Dense (SP-SM)	821.0	SB7	4	12 12 14	36	
	Fine to Coarse SAND with Gravel- Brown- Moist- Very Dense to Dense (SP)		SB8	13	21 24 26	68	



GROUNDWATER & BACKFILL INFORMATION

	DEPTH (FT)	ELEV (FT)
▽ **DURING BORING:**	43.0	805.0
▼ **AT END OF BORING:**	43.0	805.0

BACKFILL METHOD: Auger Cuttings & EPCO Hole Plug & Asphalt Cold Patch

NOTES:
1. The indicated stratification lines are approximate. The in-situ transitions between materials may be gradual.
2. The colors depicted on the symbolic profile are solely for visualization purposes and do not necessarily represent the in-situ colors encountered.
3. Pavement appeared to consist of cemented gravel.
4. Soil boring elevation was not provided, and was estimated by SME to the nearest 0.5-foot using provided topographic data.

(Continued Next Page)

SME

BORING B 2

PAGE 2 OF 2

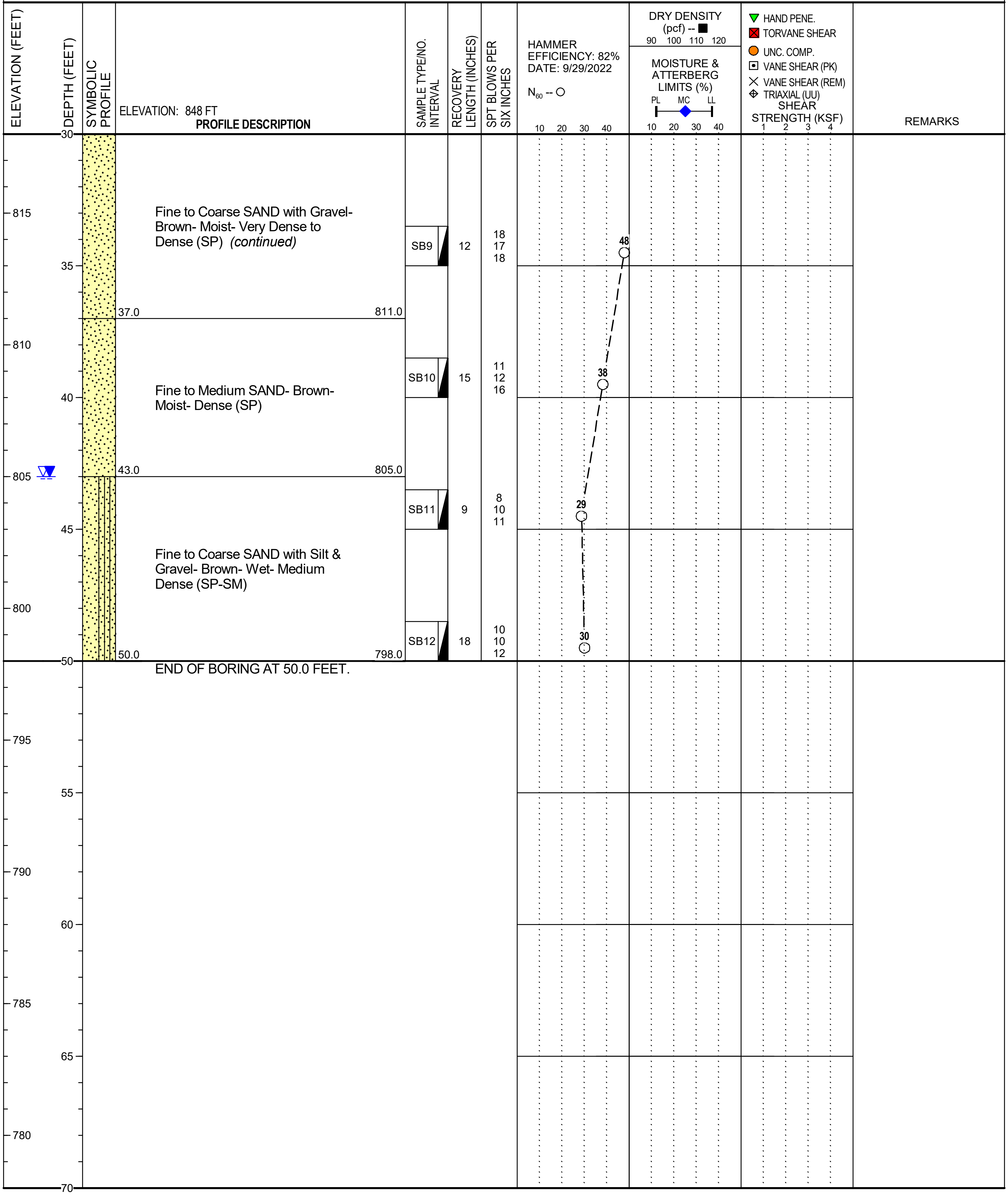
BORING DEPTH: 50 FEET

PROJECT NAME: 350 South Fifth Avenue Redevelopment

PROJECT NUMBER: 084868.01

CLIENT: SmithGroup

PROJECT LOCATION: Ann Arbor, Michigan



ELEVATION (FEET)	DEPTH (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL	RECOVERY LENGTH (INCHES)	SPT BLOWS PER SIX INCHES	N_{60}
811.0	37.0	Fine to Coarse SAND with Gravel- Brown- Moist- Very Dense to Dense (SP) *(continued)*	SB9	12	18 17 18	48
805.0	43.0	Fine to Medium SAND- Brown- Moist- Dense (SP)	SB10	15	11 12 16	38
798.0	50.0	Fine to Coarse SAND with Silt & Gravel- Brown- Wet- Medium Dense (SP-SM)	SB11	9	8 10 11	29
			SB12	18	10 10 12	30

END OF BORING AT 50.0 FEET.

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SME

BORING B 3A

PAGE 1 OF 1

BORING DEPTH: 8 FEET

PROJECT NAME: 350 South Fifth Avenue Redevelopment
PROJECT NUMBER: 084868.01
CLIENT: SmithGroup
PROJECT LOCATION: Ann Arbor, Michigan
DATE STARTED: 1/9/23
COMPLETED: 1/10/23
BORING METHOD: Hollow-stem Augers
DRILLER: JR
RIG NO.: 552 (CME 55)
LOGGED BY: EJK
CHECKED BY: AK

NORTHING: 284222.25 FT
EASTING: 13291001.25 FT
ELEVATION: 847.5 FT

HAMMER EFFICIENCY: 82%
DATE: 9/29/2022
N_{60} -- ○

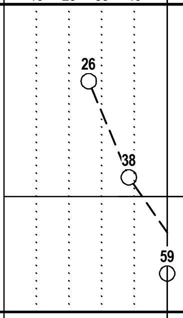
DRY DENSITY (pcf) -- ■ 90 100 110 120

MOISTURE & ATTERBERG LIMITS (%) PL MC LL 10 20 30 40

▼ HAND PENE.
☒ TORVANE SHEAR
● UNC. COMP.
⊡ VANE SHEAR (PK)
× VANE SHEAR (REM)
⊕ TRIAXIAL (UU)
SHEAR STRENGTH (KSF) 1 2 3 4

DEPTH (FEET)	PROFILE DESCRIPTION	ELEVATION (FEET)
0.3	3 Inches of PAVEMENT- See Note 3	847.3
3.0	FILL- Mix of Sand, Gravel, and Concrete Debris- Gray	844.5
8.0	FILL- Fine to Medium SAND with Silt- Few Brick, Wood, and Concrete Fragments- Brown- Moist (SP-SM)	839.5
	END OF BORING AT 8.0 FEET.	

SAMPLE TYPE/NO. INTERVAL	RECOVERY LENGTH (INCHES)	SPT BLOWS PER SIX INCHES	REMARKS
SB1	16	10 10 9	
SB2	18	12 13 15	Blow counts likely influenced by debris.
SB3	6	15 18 25	Blow counts likely influenced by debris.



GROUNDWATER & BACKFILL INFORMATION

GROUNDWATER WAS NOT ENCOUNTERED

BACKFILL METHOD: Auger Cuttings & EPCO Hole Plug & Asphalt Cold Patch

NOTES:
1. The indicated stratification lines are approximate. The in-situ transitions between materials may be gradual.
2. The colors depicted on the symbolic profile are solely for visualization purposes and do not necessarily represent the in-situ colors encountered.
3. Pavement appeared to consist of cemented gravel.
4. Driller encountered an unknown obstruction at 8.0 feet, then offset the boring and blind drilled to 8.0 feet before resuming sampling. See boring log B 3B.
5. Boring log elevations provided by SmithGroup.

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SME

BORING B 3B

PAGE 1 OF 2

BORING DEPTH: 50 FEET

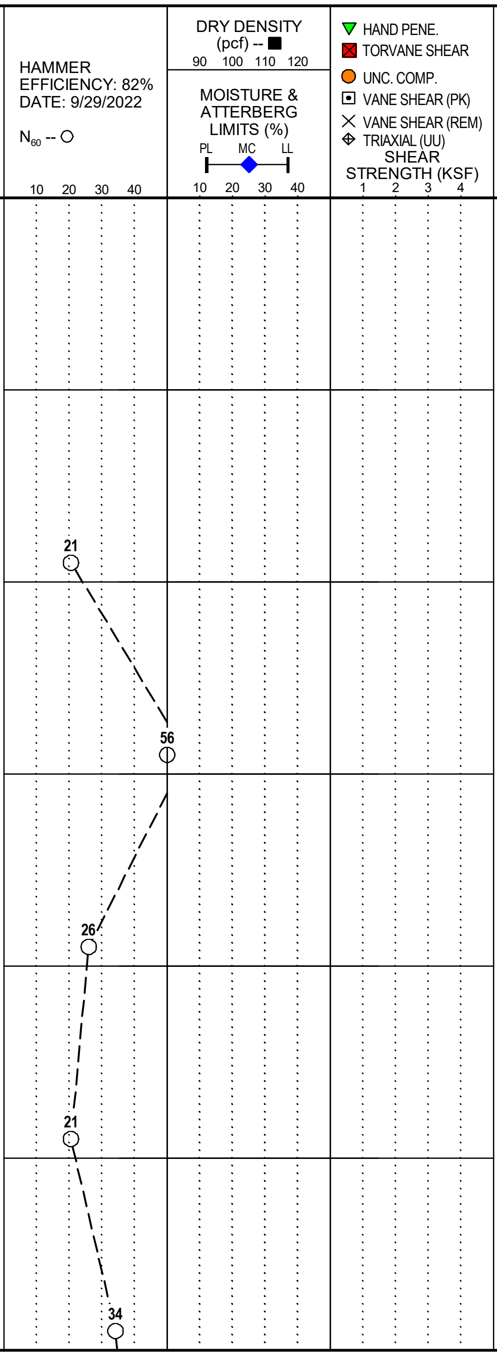
PROJECT NAME: 350 South Fifth Avenue Redevelopment
PROJECT NUMBER: 084868.01
CLIENT: SmithGroup
PROJECT LOCATION: Ann Arbor, Michigan

DATE STARTED: 1/9/23
COMPLETED: 1/10/23
BORING METHOD: Hollow-stem Augers
DRILLER: JR
RIG NO.: 552 (CME 55)
LOGGED BY: EJK
CHECKED BY: AK

NORTHING: 284217.786 FT
EASTING: 13291003.34 FT
ELEVATION: 847.6 FT

HAMMER EFFICIENCY: 82%
DATE: 9/29/2022

DEPTH (FEET)	ELEVATION (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL	RECOVERY LENGTH (INCHES)	SPT BLOWS PER SIX INCHES	N_{60}
0	847.6	BLIND DRILL				
8.0	839.6	FILL- Fine to Medium SAND with Silt- Few Brick, Wood, Concrete, and Metal Fragments- Brown- Moist- Medium Dense (SP-SM)	SB4	8	8 7 8	21
12.0	835.6	Fine to Coarse SAND with Gravel- Brown- Moist- Very Dense (SP)	SB5	12	19 23 18	56
17.0	830.6	Fine to Coarse SAND with Silt & Gravel- Brown- Moist- Medium Dense (SP-SM)	SB6	6	6 9 10	26
			SB7	16	7 7 8	21
27.0	820.6	Fine to Coarse SAND with Gravel- Brown- Moist- Dense (SP)	SB8	8	10 13 12	34



REMARKS

GROUNDWATER & BACKFILL INFORMATION	DEPTH (FT)	ELEV (FT)
DURING BORING:	43.0	804.6
AT END OF BORING:	43.0	804.6

BACKFILL METHOD: Auger Cuttings & EPCO Hole Plug & Asphalt Cold Patch

NOTES:
1. The indicated stratification lines are approximate. The in-situ transitions between materials may be gradual.
2. The colors depicted on the symbolic profile are solely for visualization purposes and do not necessarily represent the in-situ colors encountered.
3. Pavement appeared to consist of cemented gravel.
4. Boring was offset from boring B 3A.
5. Boring log elevations provided by SmithGroup.

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BORING B 3B

PAGE 2 OF 2

BORING DEPTH: 50 FEET

PROJECT NAME: 350 South Fifth Avenue Redevelopment **PROJECT NUMBER:** 084868.01

CLIENT: SmithGroup **PROJECT LOCATION:** Ann Arbor, Michigan

NORTHING: 284217.786 FT
EASTING: 13291003.34 FT
ELEVATION: 847.6 FT

HAMMER EFFICIENCY: 82%
DATE: 9/29/2022
N_{60} -- ○

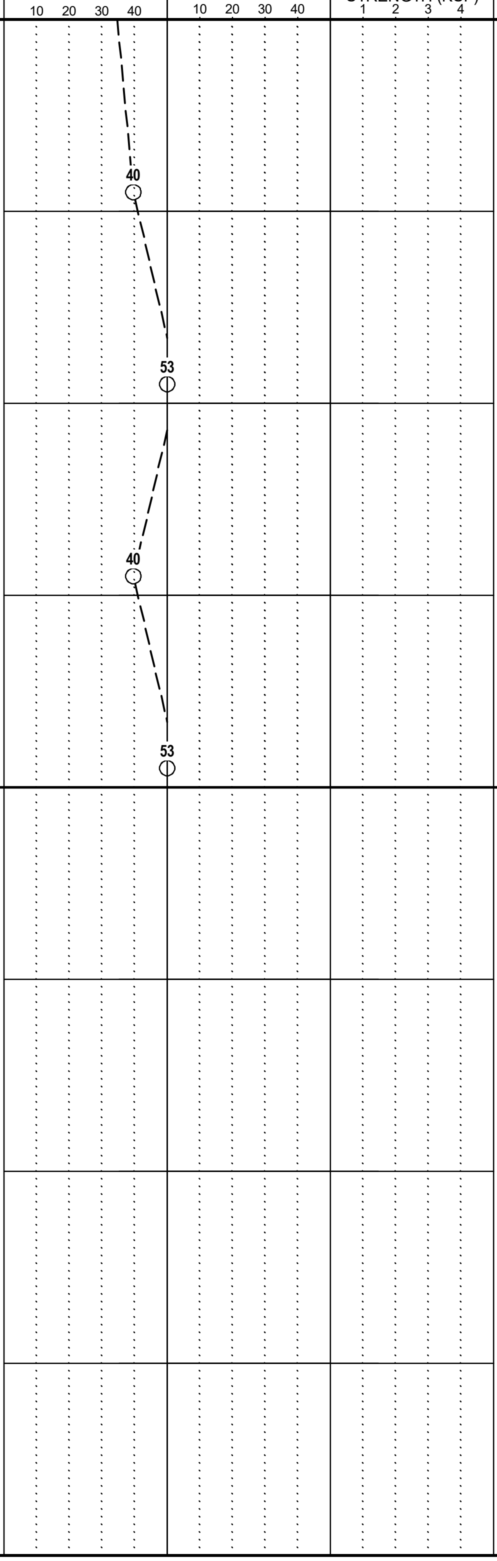
DRY DENSITY (pcf) -- ■ 90 100 110 120

MOISTURE & ATTERBERG LIMITS (%) PL MC LL 10 20 30 40

▼ HAND PENE.
☒ TORVANE SHEAR
● UNC. COMP.
⊡ VANE SHEAR (PK)
× VANE SHEAR (REM)
⊕ TRIAXIAL (UU)
SHEAR STRENGTH (KSF) 1 2 3 4

ELEVATION (FEET)	DEPTH (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL	RECOVERY LENGTH (INCHES)	SPT BLOWS PER SIX INCHES	REMARKS
	30	Fine to Coarse SAND with Gravel- Brown- Moist- Dense (SP) *(continued)*	SB9	14	13 13 16	
810.6	37.0	Fine to Medium SAND- Brown- Moist to Wet- Very Dense to Dense (SP)	SB10	12	20 18 21	
▽			SB11	16	12 14 15	
797.6	50.0		SB12	18	18 17 22	
		END OF BORING AT 50.0 FEET.				

Elevation scale: 815, 810, 805, 800, 795, 790, 785, 780
Depth scale: 30, 35, 40, 45, 50, 55, 60, 65, 70



SME

BORING B 4

PAGE 1 OF 2

BORING DEPTH: 50 FEET

PROJECT NAME: 350 South Fifth Avenue Redevelopment
PROJECT NUMBER: 084868.01
CLIENT: SmithGroup
PROJECT LOCATION: Ann Arbor, Michigan
DATE STARTED: 1/9/23
COMPLETED: 1/9/23
BORING METHOD: Hollow-stem Augers
DRILLER: JR
RIG NO.: 552 (CME 55)
LOGGED BY: EJK
CHECKED BY: AK

NORTHING: 284216.702 FT
EASTING: 13291059.65 FT
ELEVATION: 848.6 FT

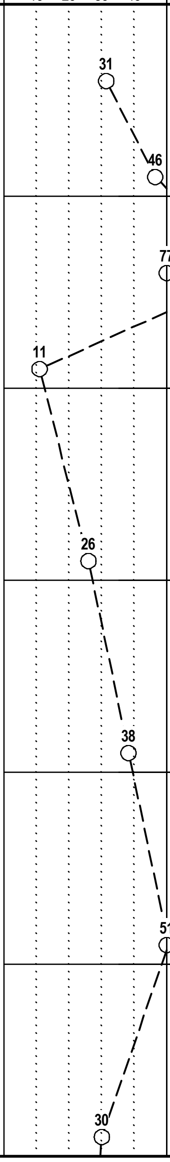
HAMMER EFFICIENCY: 82%
DATE: 9/29/2022
N_{60} -- ○

DRY DENSITY (pcf) -- ■ 90 100 110 120
MOISTURE & ATTERBERG LIMITS (%) PL MC LL 10 20 30 40

SHEAR STRENGTH (KSF) 1 2 3 4
- ▼ HAND PENE.
- ☒ TORVANE SHEAR
- ● UNC. COMP.
- ▣ VANE SHEAR (PK)
- × VANE SHEAR (REM)
- ⊕ TRIAXIAL (UU)

DEPTH (FEET)	ELEVATION (FEET)	PROFILE DESCRIPTION
0.3	848.3	4 Inches of PAVEMENT- See Note 3
2.0	846.6	FILL- Mix of Sand, Gravel, and Concrete Debris- Gray
8.0	840.6	FILL- Fine to Medium SAND- Few Brick & Wood Fragments- Brown- Moist (SP)
11.0	837.6	FILL- Fine to Medium SAND with Silt- Trace Brick Fragments- Brown- Moist- Medium Dense (SP-SM)
27.0	821.6	Fine to Coarse SAND with Gravel- Brown- Moist- Medium Dense to Very Dense (SP)
		Fine to Medium SAND- Brown- Moist- Medium Dense (SP)

SAMPLE TYPE/NO. INTERVAL	RECOVERY LENGTH (INCHES)	SPT BLOWS PER SIX INCHES	N_{60}	REMARKS
SB1	10	8 7 16	31	Blow counts likely influenced by debris.
SB2	16	25 17 17	46	Blow counts likely influenced by debris.
SB3	9	25 25 31	77	Blow counts likely influenced by debris.
SB4	6	3 4 4	11	
SB5	6	10 9 10	26	
SB6	14	9 12 16	38	
SB7	10	16 18 19	51	
SB8	16	9 10 12	30	



GROUNDWATER & BACKFILL INFORMATION

	DEPTH (FT)	ELEV (FT)
▽ **DURING BORING:**	43.0	805.6
▼ **AT END OF BORING:**	43.0	805.6

BACKFILL METHOD: Auger Cuttings & EPCO Hole Plug & Asphalt Cold Patch

NOTES:
1. The indicated stratification lines are approximate. The in-situ transitions between materials may be gradual.
2. The colors depicted on the symbolic profile are solely for visualization purposes and do not necessarily represent the in-situ colors encountered.
3. Pavement appeared to consist of cemented gravel.
4. Boring log elevations provided by SmithGroup.

(Continued Next Page)

BORING B 4

PAGE 2 OF 2

BORING DEPTH: 50 FEET

PROJECT NAME: 350 South Fifth Avenue Redevelopment

PROJECT NUMBER: 084868.01

CLIENT: SmithGroup

PROJECT LOCATION: Ann Arbor, Michigan

NORTHING: 284216.702 FT
EASTING: 13291059.65 FT
ELEVATION: 848.6 FT

HAMMER EFFICIENCY: 82%
DATE: 9/29/2022

N_{60} -- ○

DRY DENSITY (pcf) -- ■ 90 100 110 120

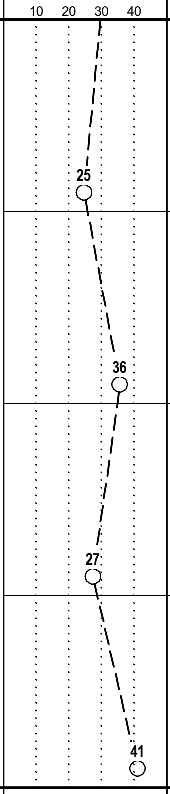
MOISTURE & ATTERBERG LIMITS (%) PL MC LL 10 20 30 40

▼ HAND PENE.
☒ TORVANE SHEAR
● UNC. COMP.
▣ VANE SHEAR (PK)
✕ VANE SHEAR (REM)
◈ TRIAXIAL (UU)

SHEAR STRENGTH (KSF) 1 2 3 4

ELEVATION (FEET)	DEPTH (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL	RECOVERY LENGTH (INCHES)	SPT BLOWS PER SIX INCHES	REMARKS
817.6	31.0					
		Fine to Coarse SAND with Gravel- Brown- Moist- Medium Dense (SP)	SB9	16	9 9 9	
811.6	37.0					
		Fine to Medium SAND- Brown- Moist- Dense (SP)	SB10	18	11 14 12	
805.6	43.0					
		Fine to Coarse SAND with Gravel- Brown- Wet- Medium Dense to Dense (SP)	SB11	13	9 9 11	
			SB12	15	13 14 16	
798.6	50.0					

END OF BORING AT 50.0 FEET.



SME

BORING B 5

PAGE 1 OF 2

BORING DEPTH: 50 FEET

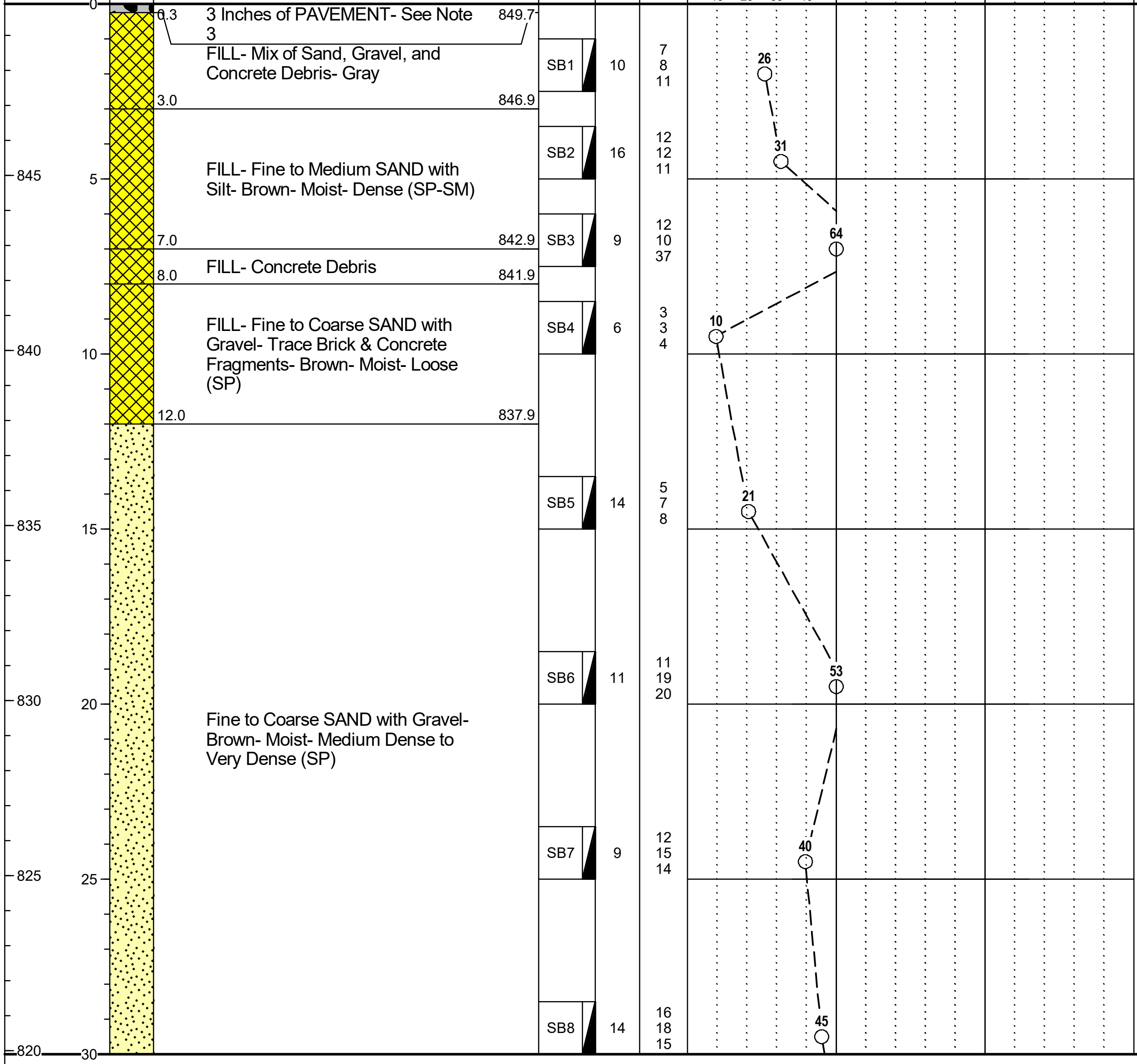
PROJECT NAME: 350 South Fifth Avenue Redevelopment
PROJECT NUMBER: 084868.01
CLIENT: SmithGroup
PROJECT LOCATION: Ann Arbor, Michigan
DATE STARTED: 1/9/23
COMPLETED: 1/9/23
BORING METHOD: Hollow-stem Augers
DRILLER: JR
RIG NO.: 552 (CME 55)
LOGGED BY: EJK
CHECKED BY: AK

NORTHING: 284211.876 FT
EASTING: 13291130.34 FT
ELEVATION: 849.9 FT

HAMMER EFFICIENCY: 82%
DATE: 9/29/2022

DEPTH (FEET)	PROFILE DESCRIPTION	ELEVATION (FEET)
0.3	3 Inches of PAVEMENT- See Note 3	849.7
3.0	FILL- Mix of Sand, Gravel, and Concrete Debris- Gray	846.9
7.0	FILL- Fine to Medium SAND with Silt- Brown- Moist- Dense (SP-SM)	842.9
8.0	FILL- Concrete Debris	841.9
12.0	FILL- Fine to Coarse SAND with Gravel- Trace Brick & Concrete Fragments- Brown- Moist- Loose (SP)	837.9
	Fine to Coarse SAND with Gravel- Brown- Moist- Medium Dense to Very Dense (SP)	

SAMPLE TYPE/NO. INTERVAL	RECOVERY LENGTH (INCHES)	SPT BLOWS PER SIX INCHES
SB1	10	7 8 11
SB2	16	12 12 11
SB3	9	12 10 37
SB4	6	3 3 4
SB5	14	5 7 8
SB6	11	11 19 20
SB7	9	12 15 14
SB8	14	16 18 15



GROUNDWATER & BACKFILL INFORMATION

	DEPTH (FT)	ELEV (FT)
▽ **DURING BORING:**	44.5	805.4
▼ **AT END OF BORING:**	46.0	803.9

BACKFILL METHOD: Auger Cuttings & EPCO Hole Plug & Asphalt Cold Patch

NOTES:
1. The indicated stratification lines are approximate. The in-situ transitions between materials may be gradual.
2. The colors depicted on the symbolic profile are solely for visualization purposes and do not necessarily represent the in-situ colors encountered.
3. Pavement appeared to consist of cemented gravel.
4. Boring log elevations provided by SmithGroup.

(Continued Next Page)

SME

BORING B 5

PAGE 2 OF 2

BORING DEPTH: 50 FEET

PROJECT NAME: 350 South Fifth Avenue Redevelopment

PROJECT NUMBER: 084868.01

CLIENT: SmithGroup

PROJECT LOCATION: Ann Arbor, Michigan

NORTHING: 284211.876 FT
EASTING: 13291130.34 FT
ELEVATION: 849.9 FT

HAMMER EFFICIENCY: 82%
DATE: 9/29/2022

N_{60} -- ○

DRY DENSITY (pcf) -- ■ 90 100 110 120

MOISTURE & ATTERBERG LIMITS (%) PL MC LL 10 20 30 40

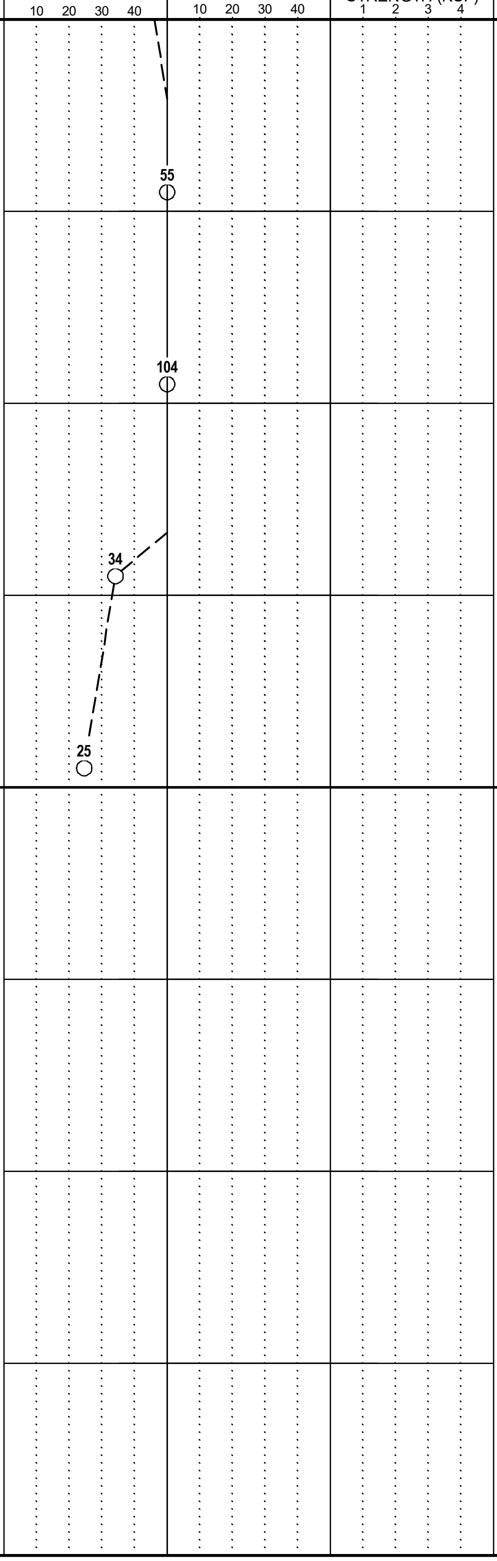
▼ HAND PENE.
☒ TORVANE SHEAR
● UNC. COMP.
⊡ VANE SHEAR (PK)
× VANE SHEAR (REM)
⊕ TRIAXIAL (UU)

SHEAR STRENGTH (KSF) 1 2 3 4

REMARKS

ELEVATION (FEET)	DEPTH (FEET)	PROFILE DESCRIPTION
	30	Fine to Coarse SAND with Gravel- Brown- Moist- Medium Dense to Very Dense (SP) *(continued)*
812.9	37.0	Fine to Coarse SAND with Gravel- Occasional Cobbles- Brown- Moist- Extremely Dense (SP)
807.9	42.0	Fine to Coarse SAND with Gravel- Brown- Moist to Wet- Dense to Medium Dense (SP)
799.9	50.0	END OF BORING AT 50.0 FEET.

SAMPLE TYPE/NO. INTERVAL	RECOVERY LENGTH (INCHES)	SPT BLOWS PER SIX INCHES
SB9	18	18 20 20
SB10	10	32 35 41
SB11	13	11 11 14
SB12	16	9 8 10



ELEVATION (FEET)	DEPTH (FEET)
815	35
810	40
805	45
800	50
795	55
790	60
785	65
780	70

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BORING B 6

PAGE 1 OF 2

BORING DEPTH: 50 FEET

PROJECT NAME: 350 South Fifth Avenue Redevelopment

PROJECT NUMBER: 084868.01

CLIENT: SmithGroup

PROJECT LOCATION: Ann Arbor, Michigan

DATE STARTED: 1/4/23

COMPLETED: 1/4/23

BORING METHOD: Hollow-stem Augers

DRILLER: JR

RIG NO.: 552 (CME 55)

LOGGED BY: EJK

CHECKED BY: AK

NORTHING: 284217.643 FT
EASTING: 13291216.64 FT
ELEVATION: 852.2 FT

HAMMER EFFICIENCY: 82%
DATE: 9/29/2022
N_{60} -- ○

DRY DENSITY (pcf) -- ■ 90 100 110 120

MOISTURE & ATTERBERG LIMITS (%) PL MC LL 10 20 30 40

▼ HAND PENE.
☒ TORVANE SHEAR
● UNC. COMP.
⊡ VANE SHEAR (PK)
× VANE SHEAR (REM)
⊕ TRIAXIAL (UU)

SHEAR STRENGTH (KSF) 1 2 3 4

ELEVATION (FEET)	DEPTH (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL	RECOVERY LENGTH (INCHES)	SPT BLOWS PER SIX INCHES	N_{60}	MOISTURE (%)	SHEAR STRENGTH (KSF)	REMARKS
851.5	0.7	8 Inches of PAVEMENT- See Note 3							
849.2	3.0	FILL- Mix of Sand, Gravel, and Concrete Debris- Gray	SB1	12	8 7 8	21			
846.2	6.0	FILL- Sandy LEAN CLAY with Gravel- Brown- Very Stiff (CL)	SB2	16	5 4 4	11	16	▼	
843.2	9.0	FILL- Fine to Coarse SAND with Gravel- Few Concrete Fragments- Gray- Moist- Medium Dense (SP)	SB3 SB4	13 14	7 8 12 6 7 9	27 22			
		Fine to Coarse SAND with Gravel- Brown- Moist- Medium Dense to Dense (SP)	SB5 SB6 SB7 SB8	16 14 10 16	8 7 8 11 10 16 12 14 12 16 11 10	21 36 36 29			

GROUNDWATER & BACKFILL INFORMATION

GROUNDWATER WAS NOT ENCOUNTERED

BACKFILL METHOD: Auger Cuttings & EPCO Hole Plug & Asphalt Cold Patch

NOTES:
1. The indicated stratification lines are approximate. The in-situ transitions between materials may be gradual.
2. The colors depicted on the symbolic profile are solely for visualization purposes and do not necessarily represent the in-situ colors encountered.
3. Pavement appeared to consist of cemented gravel.
4. Boring log elevations provided by SmithGroup.

(Continued Next Page)

BORING B 6

PAGE 2 OF 2

BORING DEPTH: 50 FEET

PROJECT NAME: 350 South Fifth Avenue Redevelopment
PROJECT NUMBER: 084868.01
CLIENT: SmithGroup
PROJECT LOCATION: Ann Arbor, Michigan

NORTHING: 284217.643 FT
EASTING: 13291216.64 FT
ELEVATION: 852.2 FT

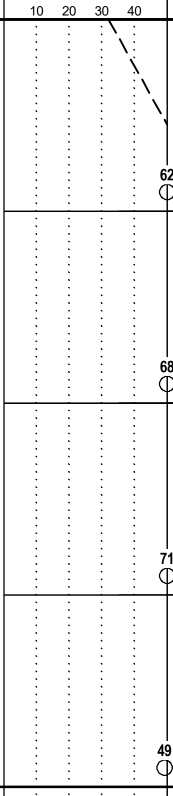
HAMMER EFFICIENCY: 82%
DATE: 9/29/2022
N_{60} -- ○

DRY DENSITY (pcf) -- ■ (90 100 110 120)
MOISTURE & ATTERBERG LIMITS (%) PL MC LL (10 20 30 40)

SHEAR STRENGTH (KSF) (1 2 3 4)
▼ HAND PENE.
☒ TORVANE SHEAR
● UNC. COMP.
▣ VANE SHEAR (PK)
✕ VANE SHEAR (REM)
⊕ TRIAXIAL (UU)

ELEVATION (FEET)	DEPTH (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL	RECOVERY LENGTH (INCHES)	SPT BLOWS PER SIX INCHES	N_{60}	REMARKS
821.2	31.0						
		Fine to Coarse SAND with Gravel- Brown- Moist- Very Dense (SP)	SB9	13	23 22 23	62	
			SB10	18	22 25 25	68	
810.2	42.0						
		Fine to Medium SAND- Brown- Moist- Very Dense (SP)	SB11	14	17 24 28	71	
806.2	46.0						
		Fine to Medium SAND with Gravel- Brown- Moist- Dense (SP)	SB12	16	21 17 19	49	
802.2	50.0						

END OF BORING AT 50.0 FEET.



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SME

BORING B 7

PAGE 1 OF 2

BORING DEPTH: 50 FEET

PROJECT NAME: 350 South Fifth Avenue Redevelopment
PROJECT NUMBER: 084868.01
CLIENT: SmithGroup
PROJECT LOCATION: Ann Arbor, Michigan
DATE STARTED: 1/5/23
COMPLETED: 1/5/23
BORING METHOD: Hollow-stem Augers
DRILLER: JR
RIG NO.: 552 (CME 55)
LOGGED BY: EJK
CHECKED BY: AK

NORTHING: 284158.023 FT
EASTING: 13291009.75 FT
ELEVATION: 848.3 FT

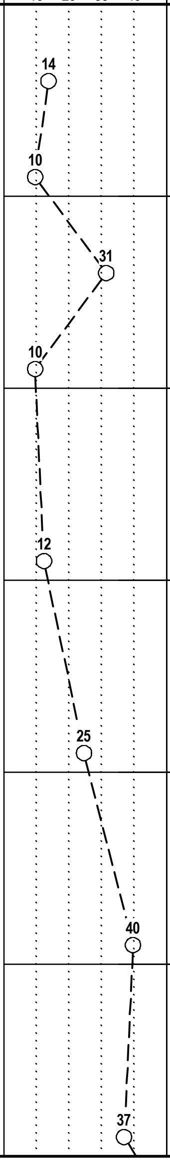
HAMMER EFFICIENCY: 82%
DATE: 9/29/2022
N_{60} -- ○

DRY DENSITY (pcf) -- ■ 90 100 110 120
MOISTURE & ATTERBERG LIMITS (%) PL MC LL 10 20 30 40

▼ HAND PENE.
☒ TORVANE SHEAR
● UNC. COMP.
⊡ VANE SHEAR (PK)
✕ VANE SHEAR (REM)
⊕ TRIAXIAL (UU)
SHEAR STRENGTH (KSF) 1 2 3 4

DEPTH (FEET)	PROFILE DESCRIPTION	ELEVATION (FEET)
0.5	6 Inches of PAVEMENT- See Note 3	847.8
3.0	FILL- Mix of Sand, Gravel, and Concrete Debris- Gray	845.3
6.0	FILL- Fine to Medium SAND with Silt- Brown- Moist- Loose (SP-SM)	842.3
8.0	FILL- Fine to Coarse SAND- Few Concrete Fragments- Trace Brick & Wood Fragments- Brown- Moist (SP)	840.3
17.0	FILL- Fine to Coarse SAND with Silt & Gravel- Brown- Moist- Loose to Medium Dense (SP-SM)	831.3
21.0	Fine to Coarse SAND with Gravel- Brown- Moist- Medium Dense (SP)	827.3
27.0	Fine to Coarse SAND- Few Sandstone Fragments- Brown- Moist- Dense (SP)	821.3
	Fine to Coarse SAND with Gravel- Brown- Moist- Dense to Very Dense (SP)	

SAMPLE TYPE/NO. INTERVAL	RECOVERY LENGTH (INCHES)	SPT BLOWS PER SIX INCHES	N_{60}	REMARKS
SB1	16	4 5 5	14	
SB2	12	4 5 2	10	
SB3	9	6 12 11	31	Blow counts likely influenced by debris.
NR4	0	4 4 3	10	No recovery at sample SB4.
SB5	6	7 3 6	12	
SB6	13	9 8 10	25	
SB7	16	14 13 16	40	
SB8	14	12 12 15	37	



ELEVATION (FEET): 845, 840, 835, 830, 825, 820
DEPTH (FEET): 0, 5, 10, 15, 20, 25, 30

GROUNDWATER & BACKFILL INFORMATION

	DEPTH (FT)	ELEV (FT)
▽ **DURING BORING:**	42.0	806.3
▼ **AT END OF BORING:**	43.0	805.3

BACKFILL METHOD: Auger Cuttings & EPCO Hole Plug & Asphalt Cold Patch

NOTES:
1. The indicated stratification lines are approximate. The in-situ transitions between materials may be gradual.
2. The colors depicted on the symbolic profile are solely for visualization purposes and do not necessarily represent the in-situ colors encountered.
3. Pavement appeared to consist of cemented gravel.
4. Boring log elevations provided by SmithGroup.

(Continued Next Page)

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SME

BORING B 7

PAGE 2 OF 2

BORING DEPTH: 50 FEET

PROJECT NAME: 350 South Fifth Avenue Redevelopment
PROJECT NUMBER: 084868.01
CLIENT: SmithGroup
PROJECT LOCATION: Ann Arbor, Michigan

NORTHING: 284158.023 FT
EASTING: 13291009.75 FT
ELEVATION: 848.3 FT

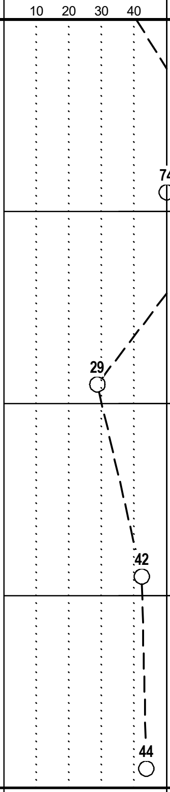
HAMMER EFFICIENCY: 82%
DATE: 9/29/2022
N_{60} -- ○

DRY DENSITY (pcf) -- ■ 90 100 110 120
MOISTURE & ATTERBERG LIMITS (%) PL MC LL 10 20 30 40

▼ HAND PENE.
☒ TORVANE SHEAR
● UNC. COMP.
⊡ VANE SHEAR (PK)
✕ VANE SHEAR (REM)
⊕ TRIAXIAL (UU)
SHEAR STRENGTH (KSF) 1 2 3 4

DEPTH (FEET)	ELEVATION (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL	RECOVERY LENGTH (INCHES)	SPT BLOWS PER SIX INCHES	N_{60}	REMARKS
30.0–39.0	809.3	Fine to Coarse SAND with Gravel- Brown- Moist- Dense to Very Dense (SP) *(continued)*	SB9	15	20 26 28	74	
39.0–42.0	806.3	Fine to Medium SAND- Brown- Moist to Wet- Medium Dense (SP)	SB10	10	16 10 11	29	
42.0–46.0	802.3	Fine to Medium SAND with Silt- Brown- Wet- Dense (SP-SM)	SB11	16	15 15 16	42	
46.0–50.0	798.3	Fine SILTY SAND- Brown- Wet- Dense (SM)	SB12		12 15 17	44	

END OF BORING AT 50.0 FEET.



Elevation scale: 815, 810, 805, 800, 795, 790, 785, 780
Depth scale: 30, 35, 40, 45, 50, 55, 60, 65, 70

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SME

BORING B 8

PAGE 1 OF 2

BORING DEPTH: 50 FEET

PROJECT NAME: 350 South Fifth Avenue Redevelopment
PROJECT NUMBER: 084868.01
CLIENT: SmithGroup
PROJECT LOCATION: Ann Arbor, Michigan
DATE STARTED: 1/11/23
COMPLETED: 1/11/23
BORING METHOD: Hollow-stem Augers
DRILLER: JR
RIG NO.: 552 (CME 55)
LOGGED BY: EJK
CHECKED BY: AK

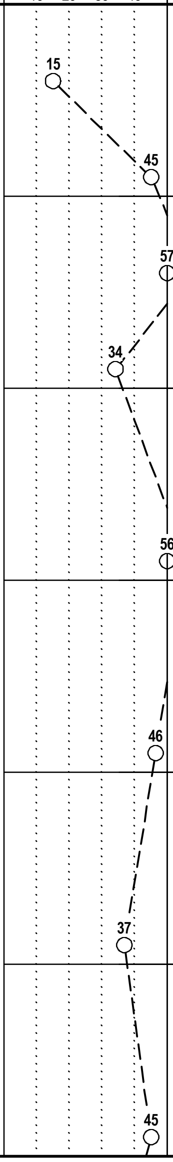
NORTHING: 284154.183 FT
EASTING: 13291118.54 FT
ELEVATION: 850.2 FT

HAMMER EFFICIENCY: 82%
DATE: 9/29/2022
N_{60} -- ○

DRY DENSITY (pcf) -- ■ 90 100 110 120
MOISTURE & ATTERBERG LIMITS (%) PL MC LL 10 20 30 40

▼ HAND PENE.
☒ TORVANE SHEAR
● UNC. COMP.
⊡ VANE SHEAR (PK)
× VANE SHEAR (REM)
⊕ TRIAXIAL (UU)
SHEAR STRENGTH (KSF) 1 2 3 4

DEPTH (FEET)	ELEVATION (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL	RECOVERY LENGTH (INCHES)	SPT BLOWS PER SIX INCHES	N_{60}	REMARKS
0.3	850.0	3 Inches of PAVEMENT- See Note 3					
3.0	847.2	FILL- Mix of Sand, Gravel, and Concrete Debris- Gray	SB1	14	6 5 6	15	
6.0	844.2	FILL- Mix of Sand, Gravel, and Debris (Concrete, Wood, Glass, and Brick)- Brown- Moist	SB2	10	11 8 25	45	Blow counts likely influenced by debris.
9.0	841.2	FILL- Fine to Coarse SAND with Gravel- Few Concrete Fragments- Brown & Gray- Moist (SP)	SB3	6	26 28 14	57	Blow counts likely influenced by debris.
		Fine to Coarse SAND with Gravel- Brown- Moist- Dense to Very Dense (SP)	SB4	10	9 12 13	34	
			SB5	12	11 15 26	56	
			SB6	10	15 16 18	46	
			SB7	16	13 13 14	37	
			SB8	14	17 16 17	45	



Depth scale: 0, 5, 10, 15, 20, 25, 30
Elevation scale: 850, 845, 840, 835, 830, 825

GROUNDWATER & BACKFILL INFORMATION

	DEPTH (FT)	ELEV (FT)
▽ **DURING BORING:**	46.0	804.2
▼ **AT END OF BORING:**	46.0	804.2

BACKFILL METHOD: Auger Cuttings & EPCO Hole Plug & Asphalt Cold Patch

NOTES:
1. The indicated stratification lines are approximate. The in-situ transitions between materials may be gradual.
2. The colors depicted on the symbolic profile are solely for visualization purposes and do not necessarily represent the in-situ colors encountered.
3. Pavement appeared to consist of cemented gravel.
4. Boring log elevations provided by SmithGroup.

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BORING B 8

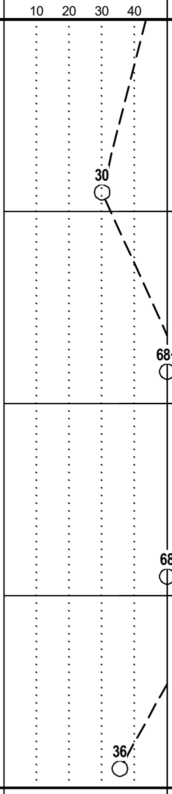
BORING DEPTH: 50 FEET

PROJECT NAME: 350 South Fifth Avenue Redevelopment
PROJECT NUMBER: 084868.01
CLIENT: SmithGroup
PROJECT LOCATION: Ann Arbor, Michigan

NORTHING: 284154.183 FT
EASTING: 13291118.54 FT
ELEVATION: 850.2 FT

HAMMER EFFICIENCY: 82%
DATE: 9/29/2022
N_{60} -- ○

ELEVATION (FEET)	DEPTH (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL	RECOVERY LENGTH (INCHES)	SPT BLOWS PER SIX INCHES	N_{60}	REMARKS
820	30	Fine to Coarse SAND with Gravel- Brown- Moist- Dense to Very Dense (SP) *(continued)*					
818.2	32.0	Fine to Medium SAND- Brown- Moist- Medium Dense (SP)	SB9	13	9 11 11	30	
813.2	37.0	Fine to Coarse SAND with Gravel- Brown- Moist to Wet- Very Dense to Dense (SP)	SB10	10	28 50/4"	68+	Driller reported driving a rock.
			SB11	12	20 24 26	68	
			SB12		11 13 13	36	
800.2	50.0	END OF BORING AT 50.0 FEET.					



DRY DENSITY (pcf) -- ■
90 100 110 120

MOISTURE & ATTERBERG LIMITS (%)
PL MC LL
10 20 30 40

▼ HAND PENE.
☒ TORVANE SHEAR
● UNC. COMP.
▣ VANE SHEAR (PK)
✕ VANE SHEAR (REM)
⊕ TRIAXIAL (UU)
SHEAR STRENGTH (KSF)
1 2 3 4

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BORING B 9

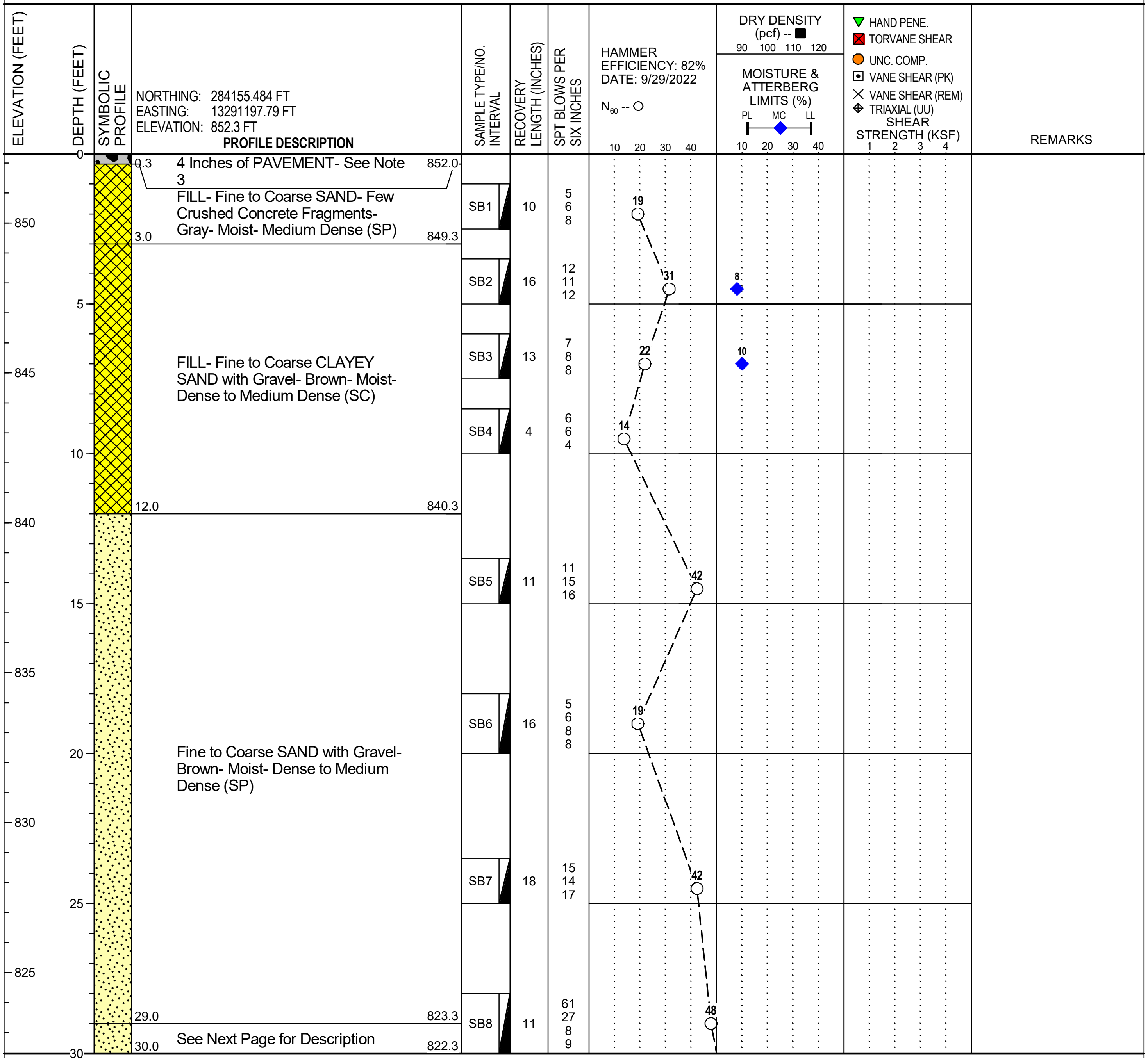
PAGE 1 OF 2

BORING DEPTH: 50 FEET

PROJECT NAME: 350 South Fifth Avenue Redevelopment
PROJECT NUMBER: 084868.01
CLIENT: SmithGroup
PROJECT LOCATION: Ann Arbor, Michigan
DATE STARTED: 1/5/23
COMPLETED: 1/5/23
BORING METHOD: Hollow-stem Augers
DRILLER: JR
RIG NO.: 552 (CME 55)
LOGGED BY: EJK
CHECKED BY: AK

NORTHING: 284155.484 FT
EASTING: 13291197.79 FT
ELEVATION: 852.3 FT

HAMMER EFFICIENCY: 82%
DATE: 9/29/2022



Depth (ft)	Profile Description	Elevation (ft)
0.3	4 Inches of PAVEMENT- See Note 3	852.0
3.0	FILL- Fine to Coarse SAND- Few Crushed Concrete Fragments- Gray- Moist- Medium Dense (SP)	849.3
12.0	FILL- Fine to Coarse CLAYEY SAND with Gravel- Brown- Moist- Dense to Medium Dense (SC)	840.3
29.0	Fine to Coarse SAND with Gravel- Brown- Moist- Dense to Medium Dense (SP)	823.3
30.0	See Next Page for Description	822.3

Sample Type/No.	Recovery Length (Inches)	SPT Blows per Six Inches	N60	MC
SB1	10	5 6 8	19	
SB2	16	12 11 12	31	8
SB3	13	7 8 8	22	10
SB4	4	6 6 4	14	
SB5	11	11 15 16	42	
SB6	16	5 6 8 8	19	
SB7	18	15 14 17	42	
SB8	11	61 27 8 9	48	

GROUNDWATER & BACKFILL INFORMATION

GROUNDWATER WAS NOT ENCOUNTERED

BACKFILL METHOD: Auger Cuttings & EPCO Hole Plug & Asphalt Cold Patch

NOTES:
1. The indicated stratification lines are approximate. The in-situ transitions between materials may be gradual.
2. The colors depicted on the symbolic profile are solely for visualization purposes and do not necessarily represent the in-situ colors encountered.
3. Pavement appeared to consist of cemented gravel.
4. Boring log elevations provided by SmithGroup.

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BORING B 9

PAGE 2 OF 2

BORING DEPTH: 50 FEET

PROJECT NAME: 350 South Fifth Avenue Redevelopment
PROJECT NUMBER: 084868.01
CLIENT: SmithGroup
PROJECT LOCATION: Ann Arbor, Michigan

NORTHING: 284155.484 FT
EASTING: 13291197.79 FT
ELEVATION: 852.3 FT

HAMMER EFFICIENCY: 82%
DATE: 9/29/2022
N_{60} -- ○

DRY DENSITY (pcf) -- ■ 90 100 110 120
MOISTURE & ATTERBERG LIMITS (%) PL MC LL 10 20 30 40

▼ HAND PENE.
☒ TORVANE SHEAR
● UNC. COMP.
⊡ VANE SHEAR (PK)
✕ VANE SHEAR (REM)
⟐ TRIAXIAL (UU)
SHEAR STRENGTH (KSF) 1 2 3 4

DEPTH (FEET)	ELEVATION (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL	RECOVERY LENGTH (INCHES)	SPT BLOWS PER SIX INCHES	N_{60}	REMARKS
30.0–32.0	820.3	Fine to Medium SAND- Trace Gravel- Brown- Moist- Dense (SP)					
32.0–38.0	814.3	Fine to Coarse SAND with Gravel- Brown- Moist- Very Dense (SP)	SB9	16	12 27 16 15	59	
38.0–47.0	805.3	Fine to Coarse SAND with Gravel- Brown- Moist- Very Dense (SP)	SB10		24 28 26 54	74	
			SB11		24 26 20 46	63	
47.0–50.0	802.3	Fine to Medium SAND- Brown- Moist- Very Dense (SP)	SB12		20 21 23 44	60	

END OF BORING AT 50.0 FEET.

SME

BORING B10

PAGE 1 OF 3

BORING DEPTH: 90 FEET

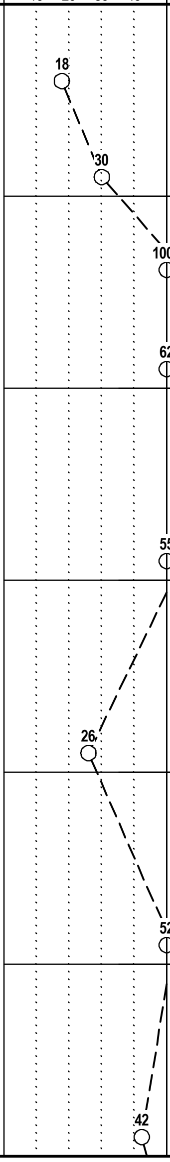
PROJECT NAME: 350 South Fifth Avenue Redevelopment
PROJECT NUMBER: 084868.01
CLIENT: SmithGroup
PROJECT LOCATION: Ann Arbor, Michigan
DATE STARTED: 1/12/23
COMPLETED: 1/12/23
BORING METHOD: Hollow-stem Augers
DRILLER: JR
RIG NO.: 552 (CME 55)
LOGGED BY: EJK
CHECKED BY: AK

NORTHING: 284185.007 FT
EASTING: 13290997.94 FT
ELEVATION: 847.9 FT

DEPTH (FEET)	PROFILE DESCRIPTION	ELEVATION (FEET)
0.3	3 Inches of PAVEMENT- See Note 3	847.6
3.0	FILL- Mix of Sand, Gravel, and Concrete Debris- Gray	844.9
7.0	FILL- Fine to Medium SAND with Silt- Brown- Moist- Medium Dense (SP)	840.9
8.5	FILL- Fine to Coarse SAND with Gravel- Trace Brick, Glass, concrete, and Plastic Fragments- Brown- Moist (SP)	839.4
9.5	FILL- Fine to Medium SAND with Silt- Brown- Moist (SP)	838.4
11.0	FILL- Concrete Debris- Gray	836.9
16.0	FILL- Fine to Coarse SAND with Silt & Gravel- Brown- Moist- Very Dense (SP-SM)	831.9
22.0	Fine to Coarse SAND- Brown- Moist- Medium Dense (SP)	825.9
	Fine to Coarse SAND with Gravel- Brown- Moist- Dense to Very Dense (SP)	

SAMPLE TYPE/NO. INTERVAL	RECOVERY LENGTH (INCHES)	SPT BLOWS PER SIX INCHES	N_{60}	REMARKS
SB1	10	8 6 7	18	
SB2	14	8 11 11	30	
SB3	11	18 29 50/4"	100+	Blow counts likely influenced by debris.
SB4	16	17 21 24	62	Blow counts likely influenced by debris.
SB5	6	16 18 22	55	
SB6	14	7 9 10	26	
SB7	16	12 12 26	52	
SB8	12	13 14 17	42	

HAMMER EFFICIENCY: 82%
DATE: 9/29/2022
N_{60} -- ○



DRY DENSITY (pcf) -- ■ 90 100 110 120

MOISTURE & ATTERBERG LIMITS (%) PL MC LL 10 20 30 40

▼ HAND PENE.
☒ TORVANE SHEAR
● UNC. COMP.
⊡ VANE SHEAR (PK)
× VANE SHEAR (REM)
⊕ TRIAXIAL (UU)

SHEAR STRENGTH (KSF) 1 2 3 4

GROUNDWATER & BACKFILL INFORMATION

	DEPTH (FT)	ELEV (FT)
▽ **DURING BORING:**	42.0	805.9
▼ **AT END OF BORING:**	Note 3	

BACKFILL METHOD: Auger Cuttings & EPCO Hole Plug & Asphalt Cold Patch

NOTES:
1. The indicated stratification lines are approximate. The in-situ transitions between materials may be gradual.
2. The colors depicted on the symbolic profile are solely for visualization purposes and do not necessarily represent the in-situ colors encountered.
3. Pavement appeared to consist of cemented gravel.
4. Drilling mud used in hollow-stem augers beginning at a depth of 50 feet, therefore, an accurate groundwater level measurement could not be obtained after the completion of drilling activities.
5. Boring log elevations provided by SmithGroup.

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BORING B10

PAGE 2 OF 3

BORING DEPTH: 90 FEET

PROJECT NAME: 350 South Fifth Avenue Redevelopment

PROJECT NUMBER: 084868.01

CLIENT: SmithGroup

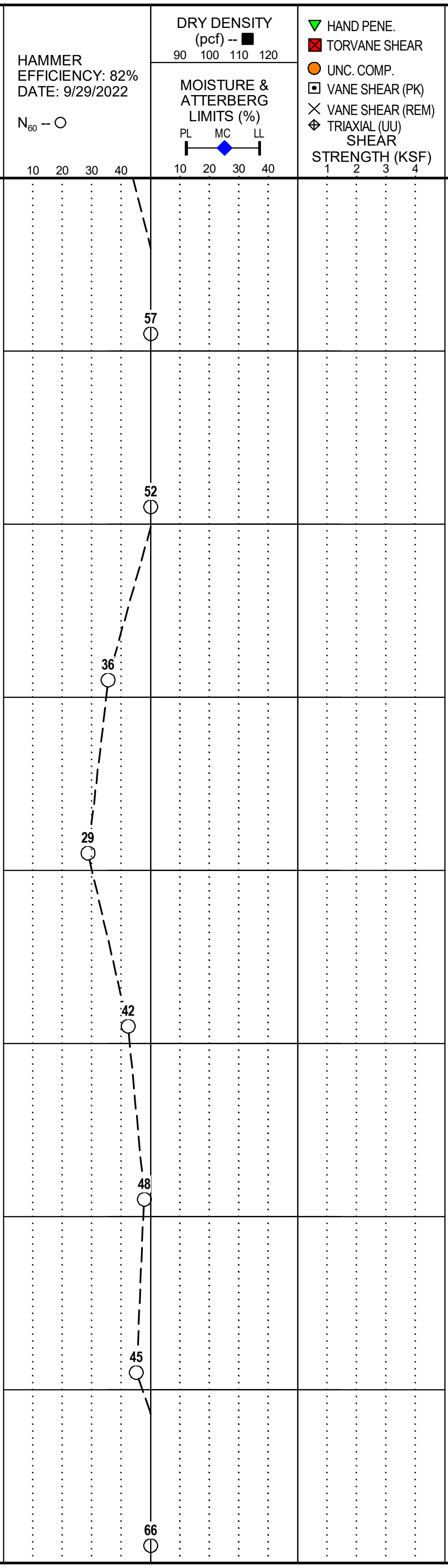
PROJECT LOCATION: Ann Arbor, Michigan

NORTHING: 284185.007 FT
EASTING: 13290997.94 FT
ELEVATION: 847.9 FT

HAMMER EFFICIENCY: 82%
DATE: 9/29/2022

ELEVATION (FEET)	DEPTH (FEET)	PROFILE DESCRIPTION	Bottom depth	Bottom elevation
	30	Fine to Coarse SAND with Gravel- Brown- Moist- Dense to Very Dense (SP) *(continued)*	42.0	805.9
		Fine to Medium SAND- Brown- Wet- Dense (SP)	47.0	800.9
		Fine to Coarse SAND with Gravel- Brown- Wet- Medium Dense to Dense (SP)	57.0	790.9
		Fine to Coarse SAND- Brown- Wet- Dense (SP)	67.0	780.9
		Fine to Coarse SAND- Gray- Wet- Very Dense (SP)		

SAMPLE TYPE/NO. INTERVAL	RECOVERY LENGTH (INCHES)	SPT BLOWS PER SIX INCHES	N_{60}
SB9	15	17 24 18	57
SB10	13	17 19 19	52
SB11	16	9 12 14	36
SB12	15	11 10 11	29
SB13	12	13 16 15	42
SB14	18	14 18 17	48
SB15	11	15 16 17	45
SB16	12	19 22 26	66



REMARKS

(Continued Next Page)

SME

BORING B10

PAGE 3 OF 3

BORING DEPTH: 90 FEET

PROJECT NAME: 350 South Fifth Avenue Redevelopment

PROJECT NUMBER: 084868.01

CLIENT: SmithGroup

PROJECT LOCATION: Ann Arbor, Michigan

NORTHING: 284185.007 FT
EASTING: 13290997.94 FT
ELEVATION: 847.9 FT

HAMMER EFFICIENCY: 82%
DATE: 9/29/2022
N_{60} -- ○

DRY DENSITY (pcf) -- ■ 90 100 110 120

MOISTURE & ATTERBERG LIMITS (%) PL MC LL 10 20 30 40

▼ HAND PENE.
☒ TORVANE SHEAR
● UNC. COMP.
⊡ VANE SHEAR (PK)
× VANE SHEAR (REM)
⊕ TRIAXIAL (UU)
SHEAR STRENGTH (KSF) 1 2 3 4

DEPTH (FEET)	ELEVATION (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL	RECOVERY LENGTH (INCHES)	SPT BLOWS PER SIX INCHES	N_{60}	REMARKS
70.0 – 72.0	775.9	Fine to Coarse SAND- Gray- Wet- Very Dense (SP) *(continued)*					
72.0 – 86.0	761.9	Fine to Coarse SAND with Gravel- Gray- Wet- Very Dense (SP)	SB17	9	20 20 24	60	
			SB18	6	55 50	68+	
			SB19	14	20 26 25	70	
86.0 – 90.0	757.9	Fine SAND- Gray- Wet- Very Dense (SP)	SB20	9	28 26 30	77	

END OF BORING AT 90.0 FEET.

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SME

BORING B11

PAGE 1 OF 3

BORING DEPTH: 75 FEET

PROJECT NAME: 350 South Fifth Avenue Redevelopment
PROJECT NUMBER: 084868.01
CLIENT: SmithGroup
PROJECT LOCATION: Ann Arbor, Michigan

DATE STARTED: 1/4/23
COMPLETED: 1/4/23
BORING METHOD: Hollow-stem Augers
DRILLER: JR
RIG NO.: 552 (CME 55)
LOGGED BY: EJK
CHECKED BY: AK

NORTHING: 284193.697 FT
EASTING: 13291175.11 FT
ELEVATION: 851.1 FT

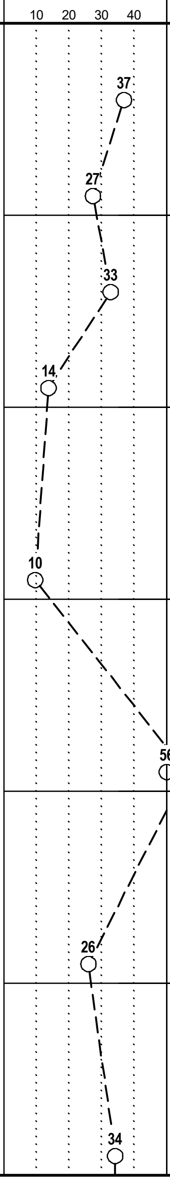
HAMMER EFFICIENCY: 82%
DATE: 9/29/2022
N_{60} -- ○

DRY DENSITY (pcf) -- ■ 90 100 110 120
MOISTURE & ATTERBERG LIMITS (%) PL MC LL 10 20 30 40

▼ HAND PENE.
☒ TORVANE SHEAR
● UNC. COMP.
⊡ VANE SHEAR (PK)
× VANE SHEAR (REM)
⊕ TRIAXIAL (UU)
SHEAR STRENGTH (KSF) 1 2 3 4

DEPTH (FEET)	PROFILE DESCRIPTION	ELEVATION (FEET)
0.8	10 Inches of PAVEMENT- See Note 3	850.3
3.0	FILL- Mix of Sand, Gravel, and Concrete Debris- Gray	848.1
8.0	FILL- Fine to Medium SAND with Silt- Brown- Moist- Medium Dense to Dense (SP-SM)	843.1
9.0	FILL- Concrete Debris	842.1
15.0	FILL- Fine to Coarse SAND with Silt & Gravel- Brown- Moist- Medium Dense to Loose (SP-SM)	836.1
22.0	Fine to Coarse SAND with Gravel- Brown- Moist- Very Dense (SP)	829.1
27.0	Fine to Medium SAND- Brown- Moist- Medium Dense (SP)	824.1
	Fine to Coarse SAND with Gravel- Brown- Moist- Dense (SP)	

SAMPLE TYPE/NO. INTERVAL	RECOVERY LENGTH (INCHES)	SPT BLOWS PER SIX INCHES	N_{60}	REMARKS
SB1	10	12 11 16	37	
SB2	16	9 10 10	27	
SB3	15	10 11 13	33	
SB4	8	21 6 4	14	
SB5	10	6 3 4	10	
SB6	16	18 19 22	56	
SB7	18	8 8 11	26	
SB8	16	10 11 14	34	



GROUNDWATER & BACKFILL INFORMATION

	DEPTH (FT)	ELEV (FT)
▽ **DURING BORING:**	48.0	803.1
▼ **AT END OF BORING:**	40.0	811.1

BACKFILL METHOD: Auger Cuttings & EPCO Hole Plug & Asphalt Cold Patch

NOTES:
1. The indicated stratification lines are approximate. The in-situ transitions between materials may be gradual.
2. The colors depicted on the symbolic profile are solely for visualization purposes and do not necessarily represent the in-situ colors encountered.
3. Pavement appeared to consist of cemented gravel.
4. Boring log elevations provided by SmithGroup.

(Continued Next Page)

BORING B11

BORING DEPTH: 75 FEET

PROJECT NAME: 350 South Fifth Avenue Redevelopment

PROJECT NUMBER: 084868.01

CLIENT: SmithGroup

PROJECT LOCATION: Ann Arbor, Michigan

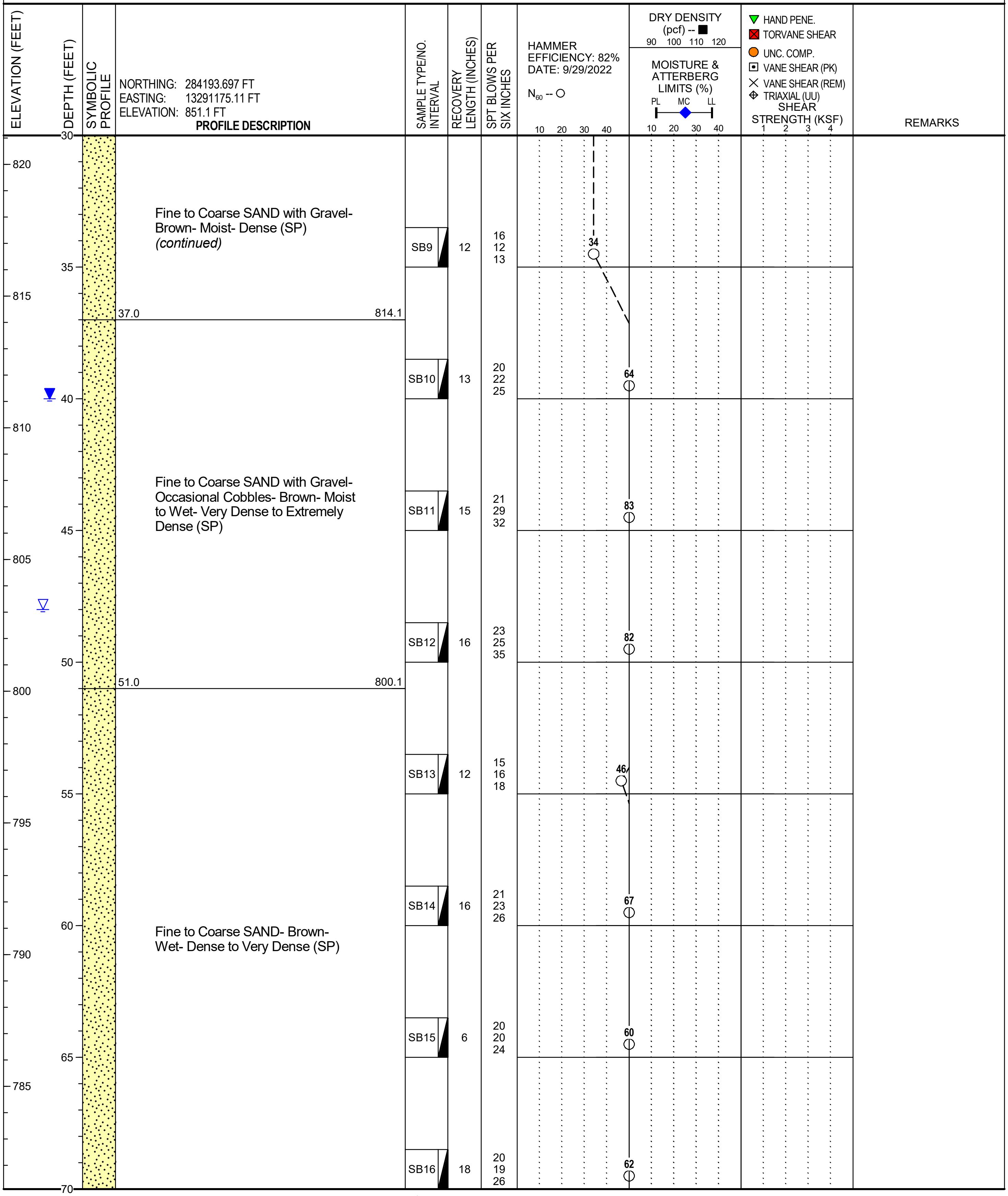
NORTHING: 284193.697 FT
EASTING: 13291175.11 FT
ELEVATION: 851.1 FT

HAMMER EFFICIENCY: 82%
DATE: 9/29/2022
N_{60} -- ○

DRY DENSITY (pcf) -- ■

MOISTURE & ATTERBERG LIMITS (%)
PL MC LL

▼ HAND PENE.
☒ TORVANE SHEAR
● UNC. COMP.
⊡ VANE SHEAR (PK)
× VANE SHEAR (REM)
◈ TRIAXIAL (UU)



Fine to Coarse SAND with Gravel- Brown- Moist- Dense (SP) *(continued)*

37.0 814.1

Fine to Coarse SAND with Gravel- Occasional Cobbles- Brown- Moist to Wet- Very Dense to Extremely Dense (SP)

51.0 800.1

Fine to Coarse SAND- Brown- Wet- Dense to Very Dense (SP)

SAMPLE TYPE/NO. INTERVAL	RECOVERY LENGTH (INCHES)	SPT BLOWS PER SIX INCHES	N_{60}
SB9	12	16 12 13	34
SB10	13	20 22 25	64
SB11	15	21 29 32	83
SB12	16	23 25 35	82
SB13	12	15 16 18	46
SB14	16	21 23 26	67
SB15	6	20 20 24	60
SB16	18	20 19 26	62

(Continued Next Page)

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BORING B11

PAGE 3 OF 3

BORING DEPTH: 75 FEET

PROJECT NAME: 350 South Fifth Avenue Redevelopment **PROJECT NUMBER:** 084868.01

CLIENT: SmithGroup **PROJECT LOCATION:** Ann Arbor, Michigan

NORTHING: 284193.697 FT
EASTING: 13291175.11 FT
ELEVATION: 851.1 FT

HAMMER EFFICIENCY: 82%
DATE: 9/29/2022
N_{60} -- ○

DRY DENSITY (pcf) -- ■

MOISTURE & ATTERBERG LIMITS (%) PL MC LL

▼ HAND PENE.
☒ TORVANE SHEAR
● UNC. COMP.
⊡ VANE SHEAR (PK)
× VANE SHEAR (REM)
⊕ TRIAXIAL (UU)

ELEVATION (FEET)	DEPTH (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL	RECOVERY LENGTH (INCHES)	SPT BLOWS PER SIX INCHES	N_{60} (10 20 30 40)	DRY DENSITY (pcf) 90 100 110 120 / MOISTURE & ATTERBERG LIMITS (%) 10 20 30 40	SHEAR STRENGTH (KSF) 1 2 3 4	REMARKS
780	70	Fine to Coarse SAND- Brown- Wet- Dense to Very Dense (SP) *(continued)*							
776.1	75.0		SB17	15	20 20 22	57			
	75	END OF BORING AT 75.0 FEET.							
775									
770	80								
765	85								
760	90								
755	95								
750	100								
745	105								
	110								

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SME

BORING IT1

PAGE 1 OF 1

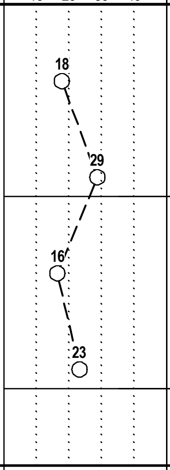
BORING DEPTH: 12 FEET

PROJECT NAME: 350 South Fifth Avenue Redevelopment
PROJECT NUMBER: 084868.01
CLIENT: SmithGroup
PROJECT LOCATION: Ann Arbor, Michigan
DATE STARTED: 1/10/23
COMPLETED: 1/10/23
BORING METHOD: Hollow-stem Augers
DRILLER: JR
RIG NO.: 552 (CME 55)
LOGGED BY: EJK
CHECKED BY: AK

NORTHING: 284239.584 FT
EASTING: 13291174.02 FT
ELEVATION: 851.2 FT

HAMMER EFFICIENCY: 82%
DATE: 9/29/2022

DEPTH (FEET)	PROFILE DESCRIPTION	ELEVATION (FEET)	SAMPLE TYPE/NO. INTERVAL	RECOVERY LENGTH (INCHES)	SPT BLOWS PER SIX INCHES	N_{60}	REMARKS
0.3	3 Inches of PAVEMENT- See Note 3	851.0					
3.5	FILL- Mix of Sand, Gravel, and Debris (Concrete and Brick)- Gray	847.7	SB1	16	10 6 7	18	
			SB2	14	11 10 11	29	
9.5	FILL- Fine to Medium SAND with Silt- Brown- Moist- Medium Dense (SP-SM)	841.7	SB3	16	8 6 6	16	
			SB4	16	10 12 5	23	
12.0	FILL- Fine to Coarse SAND with Silt & Gravel- Few Concrete Fragments- Brown- Moist SP-SM	839.2					
	END OF BORING AT 12.0 FEET.						Driller reported auger refusal at 12 feet.



DRY DENSITY (pcf) -- ■ 90 100 110 120

MOISTURE & ATTERBERG LIMITS (%) PL MC LL 10 20 30 40

SHEAR STRENGTH (KSF) 1 2 3 4

🟩 HAND PENE.
☒ TORVANE SHEAR
● UNC. COMP.
▣ VANE SHEAR (PK)
× VANE SHEAR (REM)
⊕ TRIAXIAL (UU)

GROUNDWATER & BACKFILL INFORMATION

GROUNDWATER WAS NOT ENCOUNTERED

BACKFILL METHOD: Auger Cuttings & EPCO Hole Plug & Asphalt Cold Patch

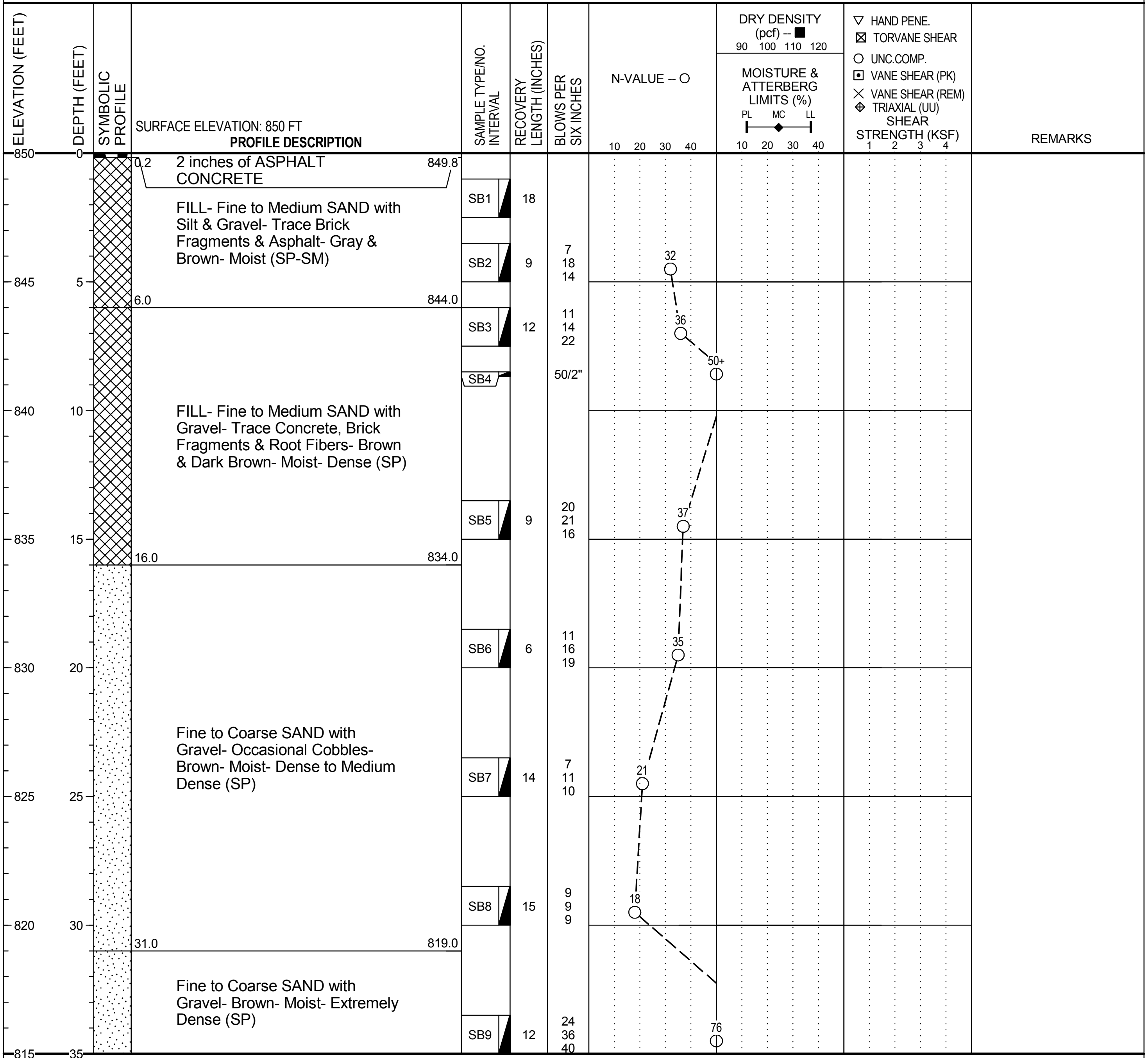
NOTES:
1. The indicated stratification lines are approximate. The in-situ transitions between materials may be gradual.
2. The colors depicted on the symbolic profile are solely for visualization purposes and do not necessarily represent the in-situ colors encountered.
3. Pavement appeared to consist of cemented gravel.
4. Boring log elevations provided by SmithGroup.

SME

BORING B101

PAGE 1 OF 2

PROJECT NAME: 350 South Fifth Avenue
PROJECT NUMBER: 073815.00
CLIENT: The Habitat Company
PROJECT LOCATION: Ann Arbor, Michigan
DATE STARTED: 2/23/16
COMPLETED: 2/23/16
BORING METHOD: Hollow-stem Augers
DRILLER: JR
RIG NO.: 253
LOGGED BY: KJT
CHECKED BY: CGN



Depth (ft)	Elev (ft)	Profile Description
0.2	849.8	2 inches of ASPHALT CONCRETE
6.0	844.0	FILL- Fine to Medium SAND with Silt & Gravel- Trace Brick Fragments & Asphalt- Gray & Brown- Moist (SP-SM)
16.0	834.0	FILL- Fine to Medium SAND with Gravel- Trace Concrete, Brick Fragments & Root Fibers- Brown & Dark Brown- Moist- Dense (SP)
31.0	819.0	Fine to Coarse SAND with Gravel- Occasional Cobbles- Brown- Moist- Dense to Medium Dense (SP)
		Fine to Coarse SAND with Gravel- Brown- Moist- Extremely Dense (SP)

SAMPLE TYPE/NO.	RECOVERY LENGTH (INCHES)	BLOWS PER SIX INCHES	N-VALUE
SB1	18		
SB2	9	7 18 14	32
SB3	12	11 14 22	36
SB4		50/2"	50+
SB5	9	20 21 16	37
SB6	6	11 16 19	35
SB7	14	7 11 10	21
SB8	15	9 9 9	18
SB9	12	24 36 40	76

GROUNDWATER & BACKFILL INFORMATION

	DEPTH (FT)	ELEV (FT)
▽ **DURING BORING:**	44.0	806.0
▼ **AT END OF BORING:**	44.0	806.0

BACKFILL METHOD: Auger Cuttings capped with Asphalt Cold Patch

NOTES: 1. The indicated stratification lines are approximate. In situ, the transition between materials may be gradual.

(Continued Next Page)

SME

BORING B101

PROJECT NAME: 350 South Fifth Avenue **PROJECT NUMBER:** 073815.00

CLIENT: The Habitat Company **PROJECT LOCATION:** Ann Arbor, Michigan

SURFACE ELEVATION: 850 FT

DRY DENSITY (pcf) -- ■ 90 100 110 120

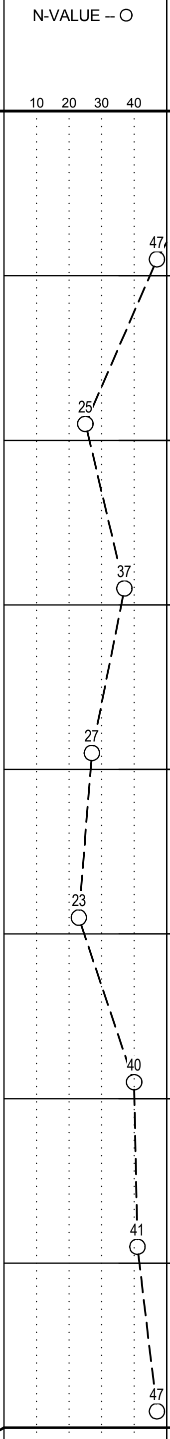
MOISTURE & ATTERBERG LIMITS (%) PL MC LL 10 20 30 40

▽ HAND PENE.
☒ TORVANE SHEAR
○ UNC.COMP.
⊡ VANE SHEAR (PK)
× VANE SHEAR (REM)
⊕ TRIAXIAL (UU)

SHEAR STRENGTH (KSF) 1 2 3 4

REMARKS

ELEVATION (FEET)	DEPTH (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL	RECOVERY LENGTH (INCHES)	BLOWS PER SIX INCHES
815	35	Fine to Coarse SAND with Gravel- Brown- Moist- Extremely Dense (SP) *(continued)*			
812.0	38.0	Fine to Coarse SAND with Silt & Gravel- Brown- Moist- Dense (SP-SM)			
810	40		SB10	16	18 22 25
808.0	42.0	Fine to Medium SAND with Gravel- Brown- Moist- Medium Dense (SP)			
805	45 ▽		SB11	15	16 12 13
803.0	47.0	Fine to Coarse SAND with Silt & Gravel- Brown & Gray- Wet- Medium Dense to Dense (SP-SM)			
800	50		SB12	16	14 18 19
795	55		SB13	18	12 12 15
790	60		SB14	16	11 10 13
785	65		SB15	18	19 18 22
780	70		SB16	13	20 20 21
775.0	75.0		SB17	15	26 22 25
775	75	END OF BORING AT 75.0 FEET.			
770	80				

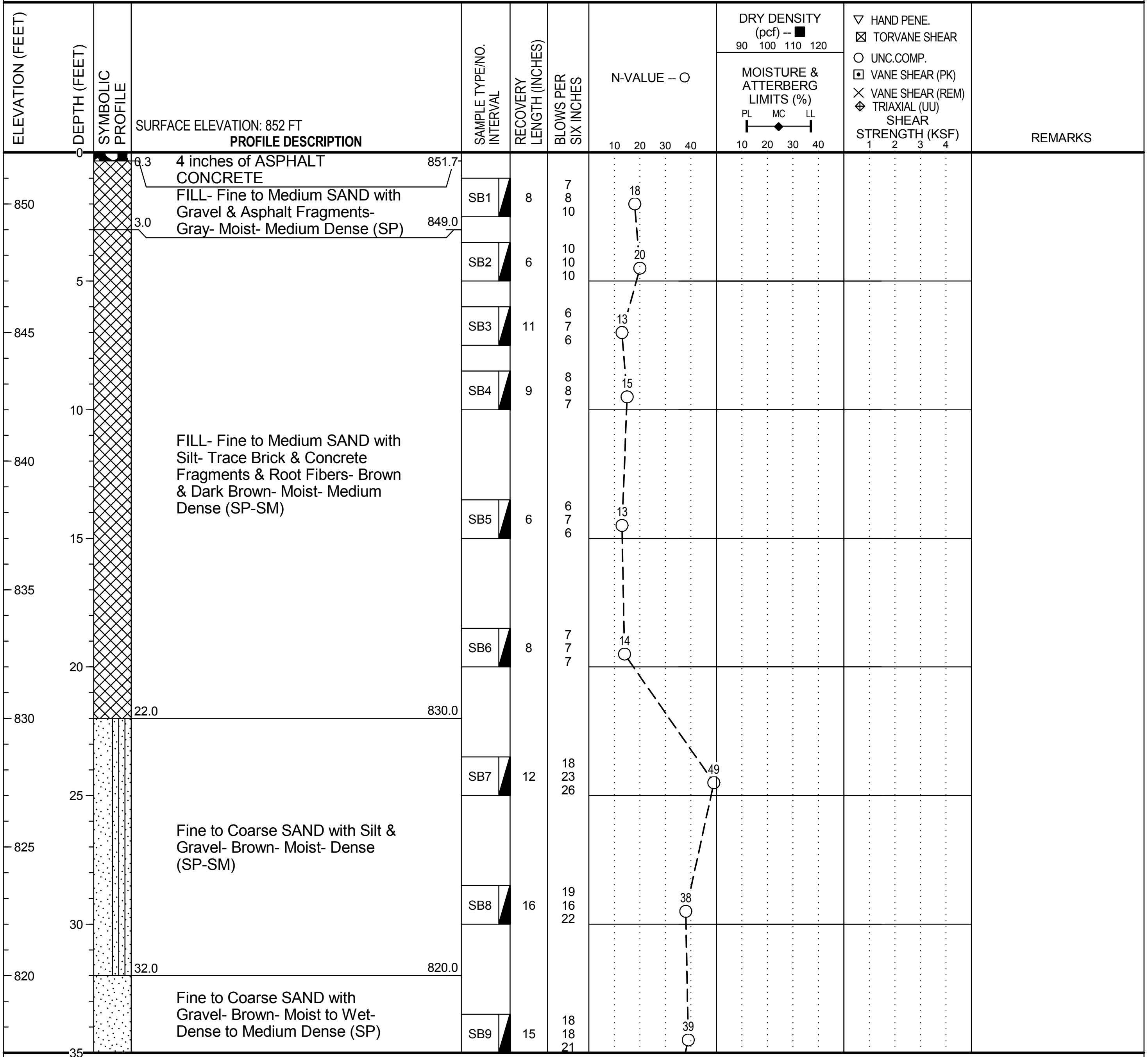


SME

BORING B102

PAGE 1 OF 2

PROJECT NAME: 350 South Fifth Avenue
PROJECT NUMBER: 073815.00
CLIENT: The Habitat Company
PROJECT LOCATION: Ann Arbor, Michigan
DATE STARTED: 2/22/16
COMPLETED: 2/22/16
BORING METHOD: Hollow-stem Augers
DRILLER: JR
RIG NO.: 253
LOGGED BY: KJT
CHECKED BY: CGN



DEPTH (FEET)	ELEVATION (FEET)	PROFILE DESCRIPTION
0.3	851.7	4 inches of ASPHALT CONCRETE
3.0	849.0	FILL- Fine to Medium SAND with Gravel & Asphalt Fragments- Gray- Moist- Medium Dense (SP)
22.0	830.0	FILL- Fine to Medium SAND with Silt- Trace Brick & Concrete Fragments & Root Fibers- Brown & Dark Brown- Moist- Medium Dense (SP-SM)
32.0	820.0	Fine to Coarse SAND with Silt & Gravel- Brown- Moist- Dense (SP-SM)
		Fine to Coarse SAND with Gravel- Brown- Moist to Wet- Dense to Medium Dense (SP)

SAMPLE TYPE/NO.	RECOVERY LENGTH (INCHES)	BLOWS PER SIX INCHES	N-VALUE
SB1	8	7 8 10	18
SB2	6	10 10 10	20
SB3	11	6 7 6	13
SB4	9	8 8 7	15
SB5	6	6 7 6	13
SB6	8	7 7 7	14
SB7	12	18 23 26	49
SB8	16	19 16 22	38
SB9	15	18 18 21	39

GROUNDWATER & BACKFILL INFORMATION

	DEPTH (FT)	ELEV (FT)
▽ **DURING BORING:**	44.0	808.0
▼ **AT END OF BORING:**	44.0	808.0

BACKFILL METHOD: Auger Cuttings capped with Asphalt Cold Patch

NOTES: 1. The indicated stratification lines are approximate. In situ, the transition between materials may be gradual.

(Continued Next Page)

BORING B102

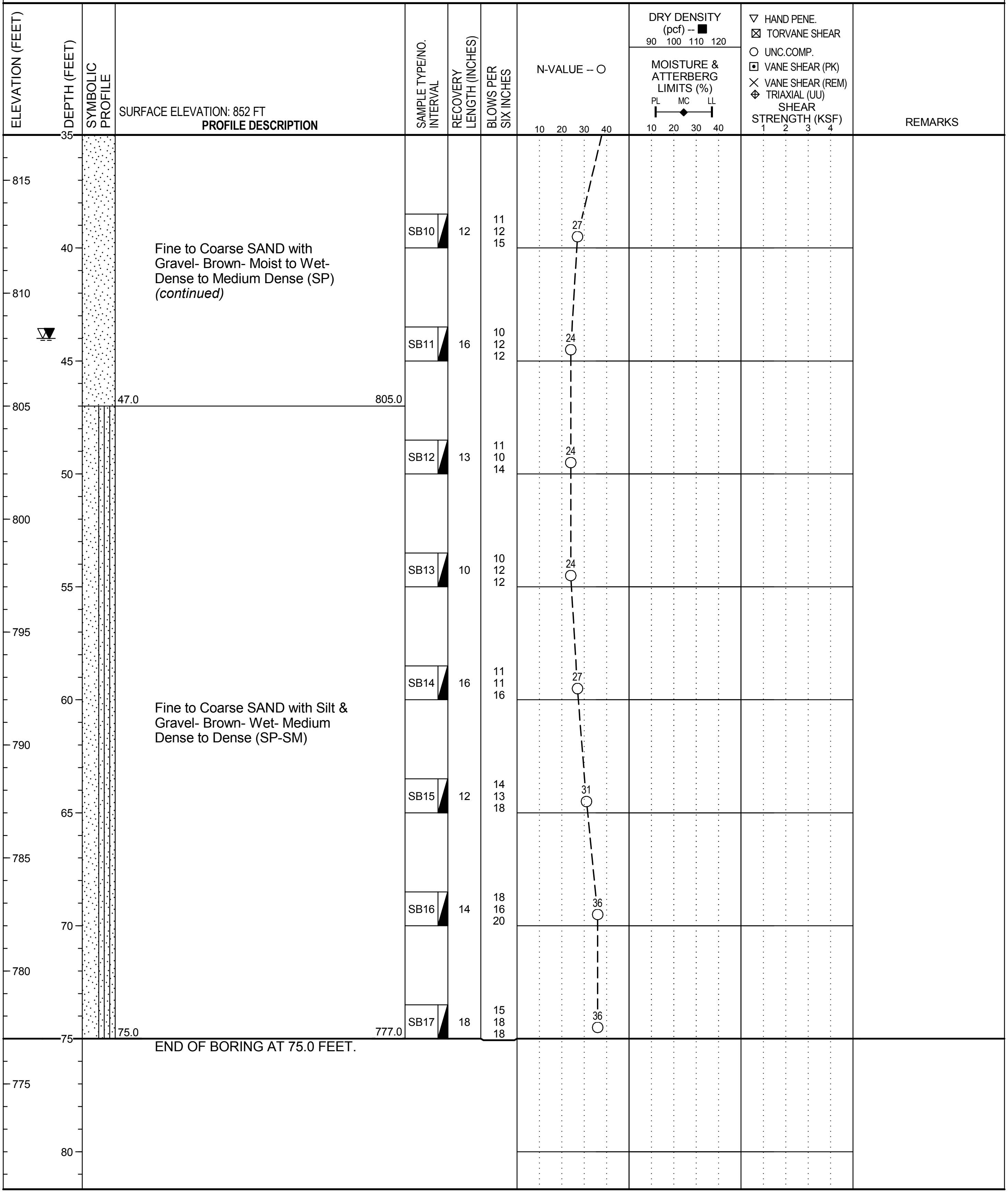
PAGE 2 OF 2

PROJECT NAME: 350 South Fifth Avenue

PROJECT NUMBER: 073815.00

CLIENT: The Habitat Company

PROJECT LOCATION: Ann Arbor, Michigan



47.0 Fine to Coarse SAND with Gravel- Brown- Moist to Wet- Dense to Medium Dense (SP) *(continued)* 805.0

75.0 Fine to Coarse SAND with Silt & Gravel- Brown- Wet- Medium Dense to Dense (SP-SM) 777.0

END OF BORING AT 75.0 FEET.

SAMPLE TYPE/NO. INTERVAL	RECOVERY LENGTH (INCHES)	BLOWS PER SIX INCHES	N-VALUE
SB10	12	11 12 15	27
SB11	16	10 12 12	24
SB12	13	11 10 14	24
SB13	10	10 12 12	24
SB14	16	11 11 16	27
SB15	12	14 13 18	31
SB16	14	18 16 20	36
SB17	18	15 18 18	36

soil and materials engineers, inc.

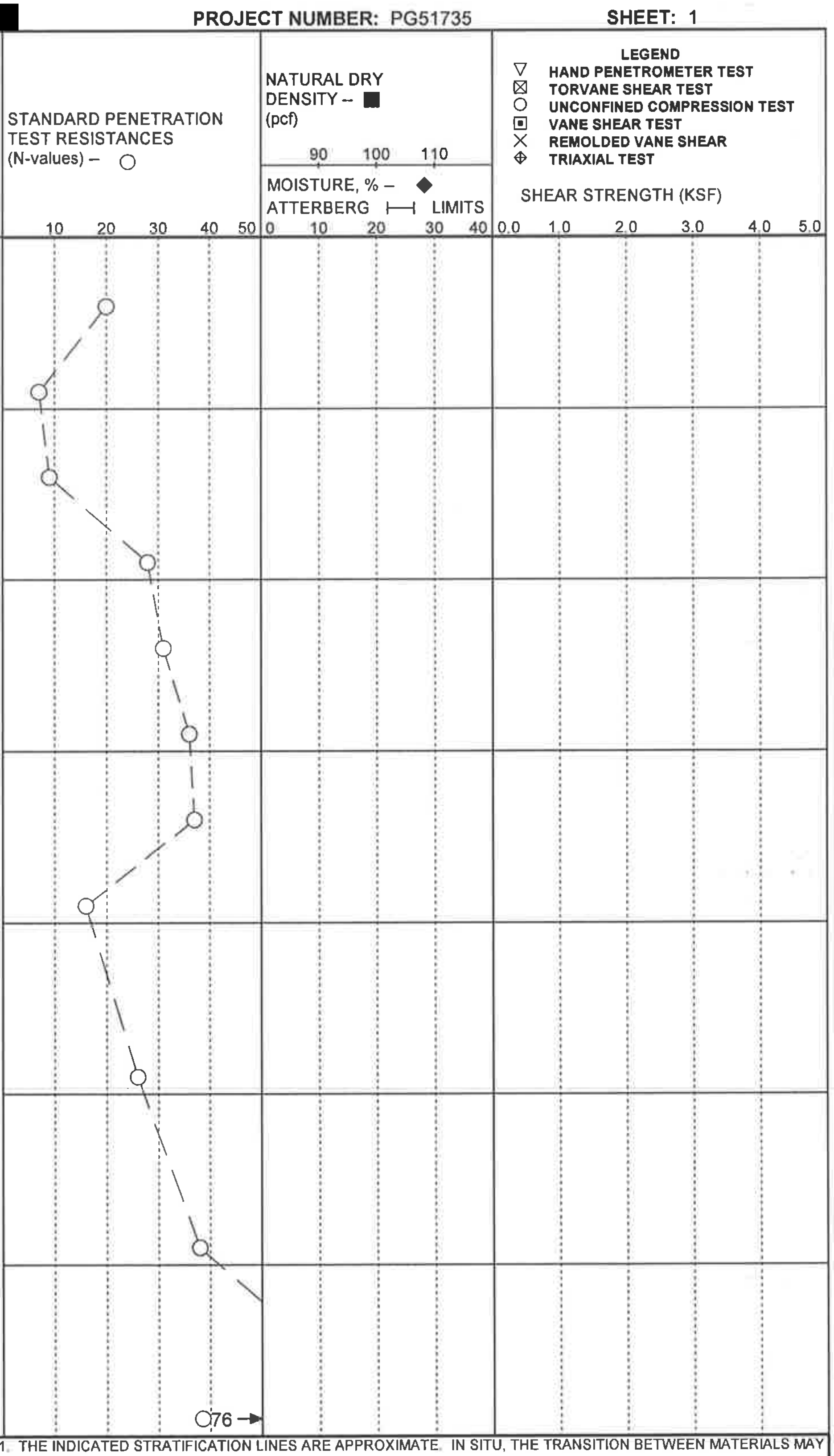
PROJECT NAME: [redacted] **A/E:** [redacted]

PROJECT LOCATION: ANN ARBOR, MICHIGAN **BY:** SB/EOL **DATE:** 12/21/05 **BORING** B1

CLIENT: [redacted] **PROJECT NUMBER:** PG51735 **SHEET:** 1

EASTING:
NORTHING:
GROUND SURFACE ELEVATION= 848

DEPTH (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NUMBER INTERVAL	BLOWS PER SIX INCHES
0	Driller reported 6 inches of Portland Cement Concrete		
	Driller reported 6 inches of Coarse Sand & Gravel Base	SS1	7 10 10
5	Fine Sand- Trace to Some Silt- Trace Gravel- Occasional Clay Partings- Brown- Moist- Medium Dense to Loose (SP-SM/Fill)	SS2	2 3 4
		SS3	3 4 5
10	Fine to Coarse Sand- Trace to Some Silt & Gravel- Occasional Cobble & Gravel Layers- Brown- Moist- Medium Dense to Very Dense (SP-SM)	SS4	11 14 14
		SS5	12 15 16
15		SS6	12 14 22
		SS7	13 16 21
20		SS8	7 7 9
25		SS9	8 10 16
30		SS10	15 16 22
35		SS11	52 46 30



LEGEND
- ▽ HAND PENETROMETER TEST
- ☒ TORVANE SHEAR TEST
- ○ UNCONFINED COMPRESSION TEST
- ▣ VANE SHEAR TEST
- ✕ REMOLDED VANE SHEAR
- ⊕ TRIAXIAL TEST

WATER LEVEL OBSERVATIONS
- GROUNDWATER ENCOUNTERED DURING DRILLING
- GROUNDWATER ENCOUNTERED UPON COMPLETION OF DRILLING

Notes: 1. THE INDICATED STRATIFICATION LINES ARE APPROXIMATE. IN SITU, THE TRANSITION BETWEEN MATERIALS MAY BE GRADUAL.
2. DRILLER REPORTED ENCOUNTERING COBBLES AT SAMPLE SS11.

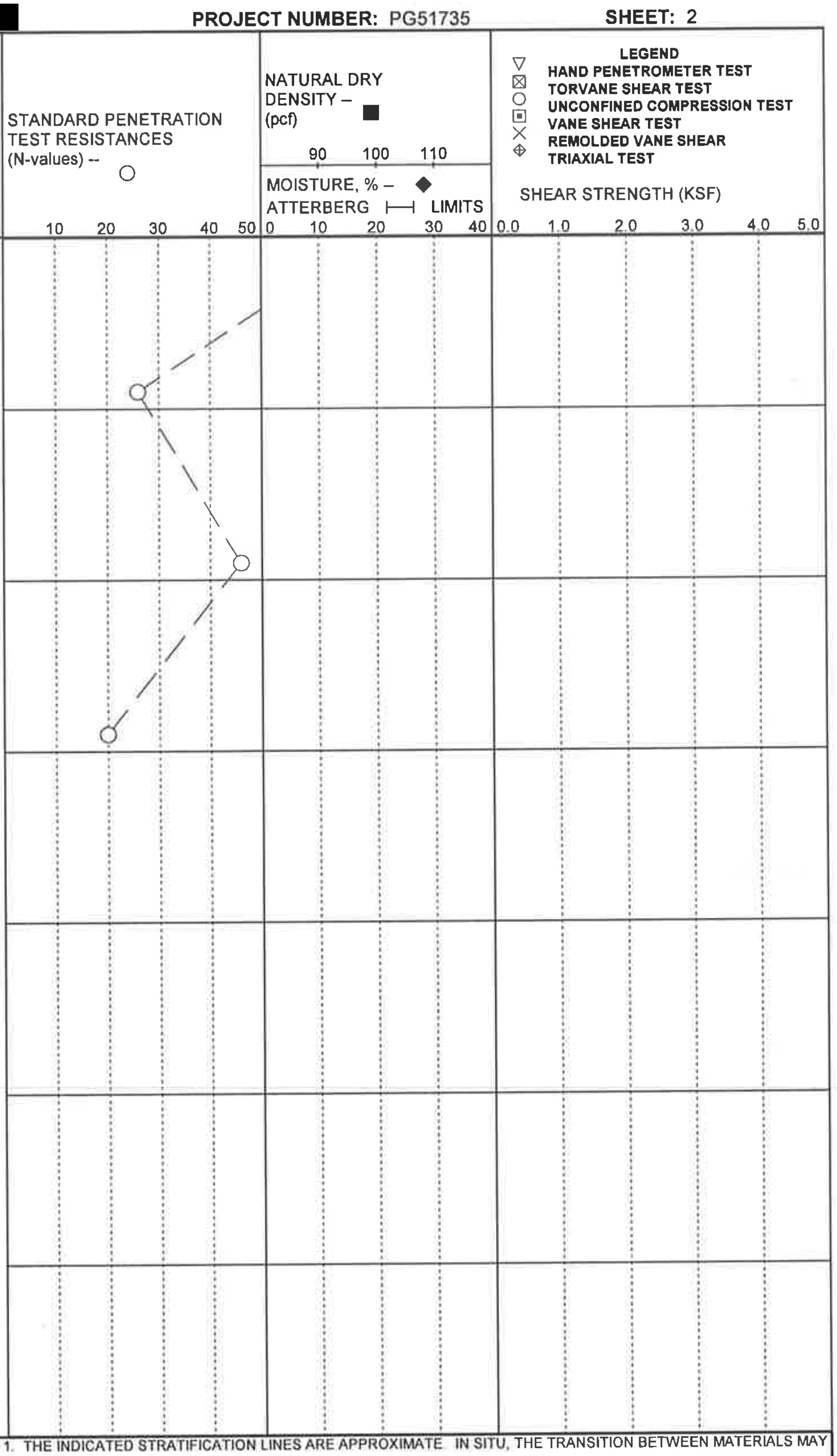
DRILLER: RM **DRILL METHOD:** Hollow-stem Augers **WATER LEVEL DURING DRILLING:** 47 **WATER LEVEL HOURS AFTER COMPLETION:**

RIG NO.: 26 **BACKFILL METHOD:** Auger Cuttings **WATER LEVEL UPON COMPLETION:** 47 **CAVE OF BOREHOLE AT**

PROJECT NAME: [redacted]
A/E: [redacted]
PROJECT LOCATION: ANN ARBOR, MICHIGAN
BY: SB/EOL **DATE:** 12/21/05
BORING B1
CLIENT: [redacted]
PROJECT NUMBER: PG51735
SHEET: 2

EASTING:
NORTHING:
GROUND SURFACE ELEVATION= 848

DEPTH (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NUMBER INTERVAL	BLOWS PER SIX INCHES
35	Fine to Coarse Sand- Trace to Some Silt & Gravel- Occasional Cobble & Gravel Layers- Brown- Moist- Medium Dense to Very Dense (SP-SM)	SS12	14 14 12
40	Fine to Medium Sand- Some Silt- Trace Gravel- Brown- Moist- Medium Dense to Dense (SM)	SS13	18 22 24
47	Fine to Coarse Sand- Trace to Some Silt & Gravel- Brown- Wet- Medium Dense (SP-SM)	SS14	10 10 10
50	END OF BORING AT 50 FEET.		



WATER LEVEL OBSERVATIONS
- ▼ GROUNDWATER ENCOUNTERED DURING DRILLING
- ▽ GROUNDWATER ENCOUNTERED UPON COMPLETION OF DRILLING

Notes:
1. THE INDICATED STRATIFICATION LINES ARE APPROXIMATE. IN SITU, THE TRANSITION BETWEEN MATERIALS MAY BE GRADUAL.
2. DRILLER REPORTED ENCOUNTERING COBBLES AT SAMPLE SS11.

DRILLER: RM
DRILL METHOD: Hollow-stem Augers
WATER LEVEL DURING DRILLING: 47
WATER LEVEL
HOURS AFTER COMPLETION:
RIG NO.: 26
BACKFILL METHOD: Auger Cuttings
WATER LEVEL UPON COMPLETION: 47
CAVE OF BOREHOLE AT

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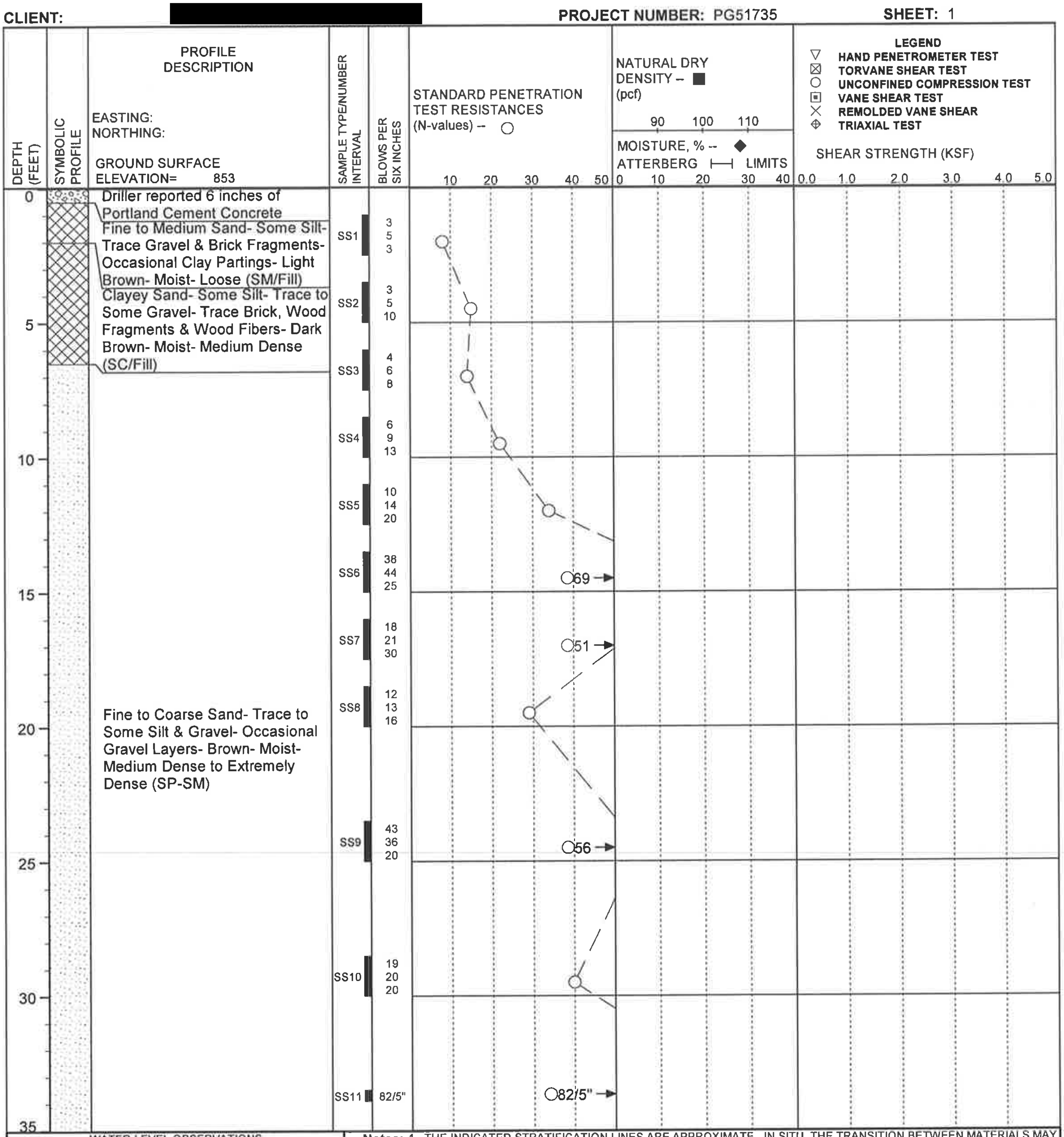
soil and materials engineers, inc.

PROJECT NAME: [redacted]
A/E: [redacted]
PROJECT LOCATION: ANN ARBOR, MICHIGAN
BY: SB/EOL **DATE:** 12/22/05
BORING B2
CLIENT: [redacted]
PROJECT NUMBER: PG51735
SHEET: 1

EASTING:
NORTHING:
GROUND SURFACE ELEVATION= 853

PROFILE DESCRIPTION	SAMPLE TYPE/NUMBER INTERVAL	BLOWS PER SIX INCHES
Driller reported 6 inches of Portland Cement Concrete		
Fine to Medium Sand- Some Silt- Trace Gravel & Brick Fragments- Occasional Clay Partings- Light Brown- Moist- Loose (SM/Fill)	SS1	3 5 3
Clayey Sand- Some Silt- Trace to Some Gravel- Trace Brick, Wood Fragments & Wood Fibers- Dark Brown- Moist- Medium Dense (SC/Fill)	SS2	3 5 10
	SS3	4 6 8
Fine to Coarse Sand- Trace to Some Silt & Gravel- Occasional Gravel Layers- Brown- Moist- Medium Dense to Extremely Dense (SP-SM)	SS4	6 9 13
	SS5	10 14 20
	SS6	38 44 25
	SS7	18 21 30
	SS8	12 13 16
	SS9	43 36 20
	SS10	19 20 20
	SS11	82/5"



WATER LEVEL OBSERVATIONS

- GROUNDWATER ENCOUNTERED DURING DRILLING
- GROUNDWATER ENCOUNTERED UPON COMPLETION OF DRILLING

Notes:
1. THE INDICATED STRATIFICATION LINES ARE APPROXIMATE. IN SITU, THE TRANSITION BETWEEN MATERIALS MAY BE GRADUAL.
2. GROUNDWATER WAS NOT ENCOUNTERED.
3. MINIMUM SAMPLE RECOVERY FROM SAMPLES SS7, SS9, SS11 & SS12 DUE TO ENCOUNTERING COBBLES & GRAVEL.

DRILLER: RM
DRILL METHOD: Hollow-stem Augers
WATER LEVEL DURING DRILLING: None
WATER LEVEL HOURS AFTER COMPLETION:
RIG NO.: 26
BACKFILL METHOD: Auger Cuttings
WATER LEVEL UPON COMPLETION: None
CAVE OF BOREHOLE AT

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soil and materials engineers, inc.

PROJECT NAME: [redacted]
A/E: [redacted]
PROJECT LOCATION: ANN ARBOR, MICHIGAN
BY: SB/EOL **DATE:** 12/22/05
BORING B2
CLIENT: [redacted]
PROJECT NUMBER: PG51735
SHEET: 2

EASTING:
NORTHING:
GROUND SURFACE ELEVATION= 853

LEGEND
▽ HAND PENETROMETER TEST
☒ TORVANE SHEAR TEST
○ UNCONFINED COMPRESSION TEST
⊡ VANE SHEAR TEST
X REMOLDED VANE SHEAR
⊕ TRIAXIAL TEST

DEPTH (FEET)	SYMBOLIC PROFILE	PROFILE DESCRIPTION	SAMPLE TYPE/NUMBER INTERVAL	BLOWS PER SIX INCHES	STANDARD PENETRATION TEST RESISTANCES (N-values) – ○ 10 20 30 40 50	NATURAL DRY DENSITY – ■ (pcf) 90 100 110 MOISTURE, % – ◆ ATTERBERG ⊢⊣ LIMITS 0 10 20 30 40	SHEAR STRENGTH (KSF) 0.0 1.0 2.0 3.0 4.0 5.0
35		Fine to Coarse Sand- Trace to Some Silt & Gravel- Occasional Gravel Layers- Brown- Moist- Medium Dense to Extremely Dense (SP-SM)					
			SS12	25 50 50	○100 →		
40		Fine to Medium Sand- Trace to Some Silt- Trace Gravel- Light Brown- Moist- Extremely Dense to Very Dense (SP-SM)					
			SS13	23 43 50	○93 →		
45							
			SS14	12 21 31	○52 →		
50		END OF BORING AT 50 FEET.					
55							
60							
65							
70							

WATER LEVEL OBSERVATIONS
- ▼ GROUNDWATER ENCOUNTERED DURING DRILLING
- ▽ GROUNDWATER ENCOUNTERED UPON COMPLETION OF DRILLING

Notes: 1. THE INDICATED STRATIFICATION LINES ARE APPROXIMATE. IN SITU, THE TRANSITION BETWEEN MATERIALS MAY BE GRADUAL.
2. GROUNDWATER WAS NOT ENCOUNTERED.
3. MINIMUM SAMPLE RECOVERY FROM SAMPLES SS7, SS9, SS11 & SS12 DUE TO ENCOUNTERING COBBLES & GRAVEL.

DRILLER: RM
DRILL METHOD: Hollow-stem Augers
WATER LEVEL DURING DRILLING: None
WATER LEVEL HOURS AFTER COMPLETION:
RIG NO.: 26
BACKFILL METHOD: Auger Cuttings
WATER LEVEL UPON COMPLETION: None
CAVE OF BOREHOLE AT

soil and materials engineers, inc.

PROJECT NAME: [redacted]
A/E: [redacted]
PROJECT LOCATION: ANN ARBOR, MICHIGAN
BY: EPE/EOL **DATE:** 12/12/05
BORING B3
CLIENT: [redacted]
PROJECT NUMBER: PG51735
SHEET: 1

LEGEND
- ▽ HAND PENETROMETER TEST
- ☒ TORVANE SHEAR TEST
- ○ UNCONFINED COMPRESSION TEST
- ▣ VANE SHEAR TEST
- × REMOLDED VANE SHEAR
- ⊕ TRIAXIAL TEST

EASTING:
NORTHING:
GROUND SURFACE ELEVATION= 850

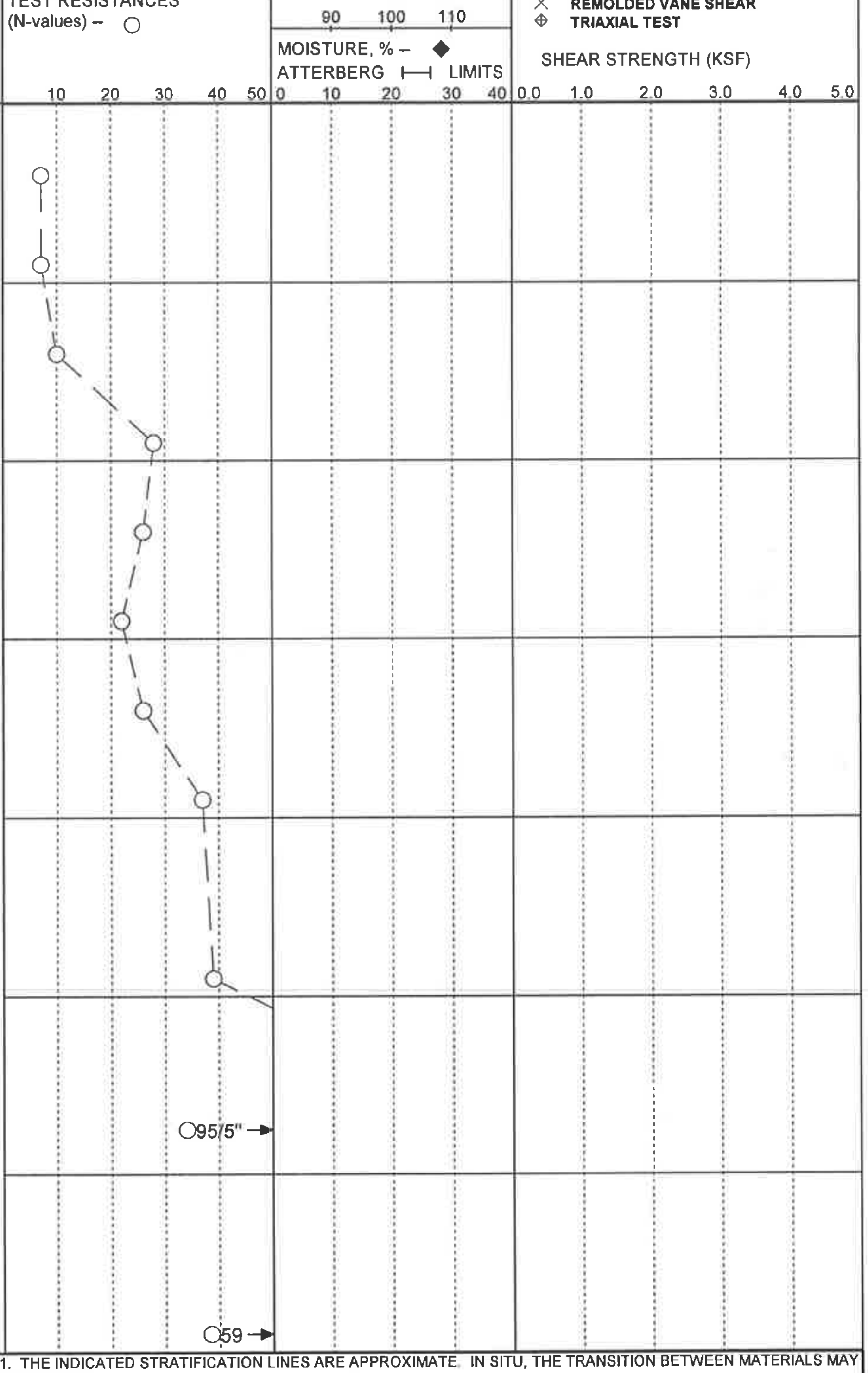
DEPTH (FEET)	SYMBOLIC PROFILE	PROFILE DESCRIPTION	SAMPLE TYPE/NUMBER INTERVAL	BLOWS PER SIX INCHES
0	▨	Driller reported 12 inches of Sand & Gravel Fill		
	▨	Clayey Fine to Medium Sand- Some Silt- Trace to Some Gravel- Dark Brown- Moist- Loose (SC/Fill)	SS1	3 3 4
▼	▨			
	▨		SS2	3 3 4
5				
			SS3	3 4 6
			SS4	10 12 16
10				
			SS5	8 11 15
			SS6	10 10 12
15				
			SS7	12 12 14
		Fine to Medium Sand- Trace to Some Silt & Gravel- Occasional Gravel & Cobble Layers- Brown- Moist- Medium Dense to Extremely Dense (SP-SM)	SS8	15 16 21
20				
			SS9	9 17 22
25				
			SS10	95/5"
30				
			SS11	52 35 24
35				

STANDARD PENETRATION TEST RESISTANCES (N-values) – ○

NATURAL DRY DENSITY – ■ (pcf)

MOISTURE, % – ◆
ATTERBERG ├─┤ LIMITS

SHEAR STRENGTH (KSF)



WATER LEVEL OBSERVATIONS
- ▼ GROUNDWATER ENCOUNTERED DURING DRILLING
- ▽ GROUNDWATER ENCOUNTERED UPON COMPLETION OF DRILLING

Notes:
1. THE INDICATED STRATIFICATION LINES ARE APPROXIMATE. IN SITU, THE TRANSITION BETWEEN MATERIALS MAY BE GRADUAL.
2. GROUNDWATER WAS NOT ENCOUNTERED UPON COMPLETION OF DRILLING.
3. DRILLER REPORTED ENCOUNTERING COBBLES & GRAVEL AT SAMPLE SS10.

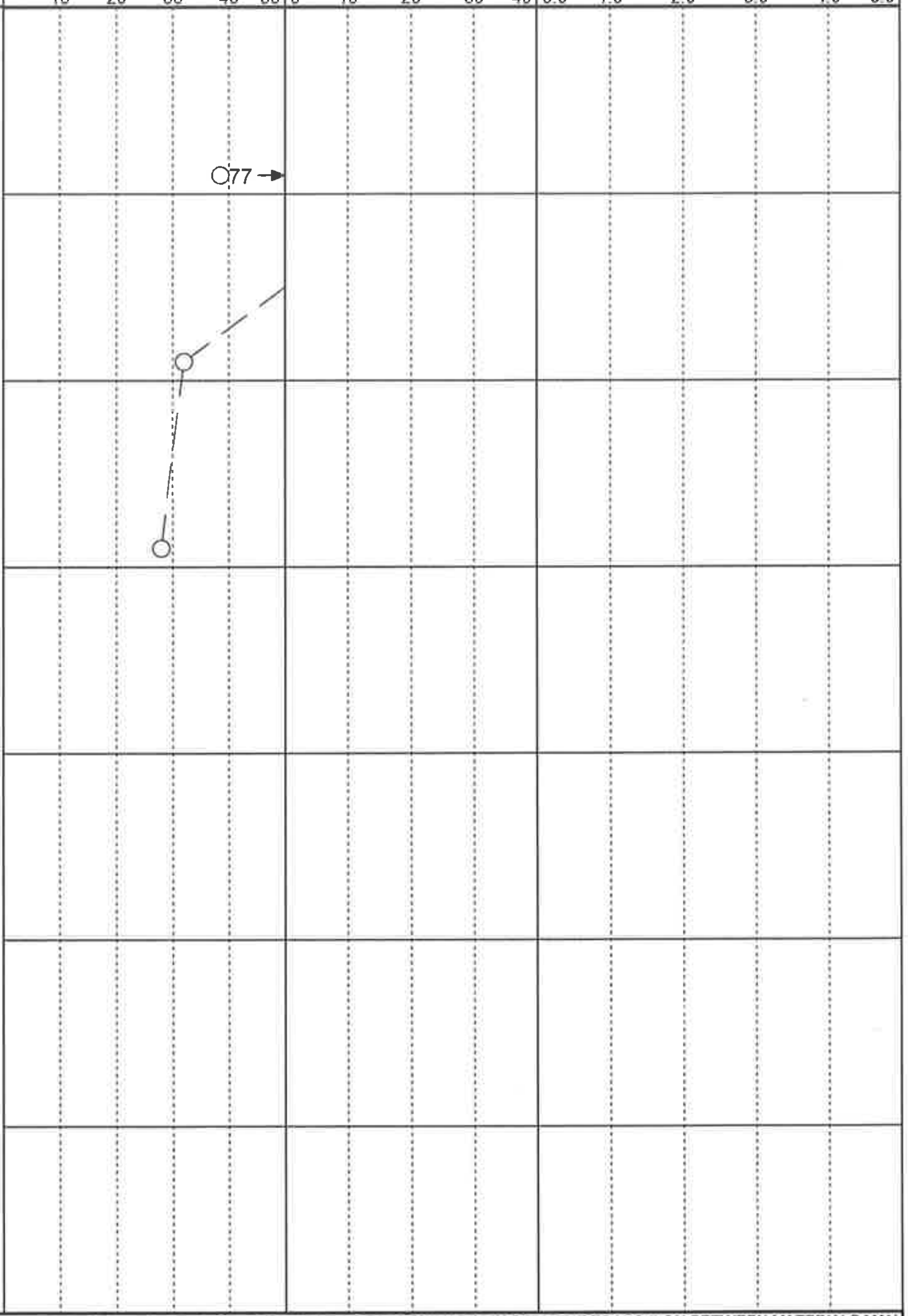
DRILLER: RM
DRILL METHOD: Hollow-stem Augers
WATER LEVEL DURING DRILLING: 3
WATER LEVEL HOURS AFTER COMPLETION:
RIG NO.: 26
BACKFILL METHOD: Auger Cuttings
WATER LEVEL UPON COMPLETION: None
CAVE OF BOREHOLE AT

soil and materials engineers, inc.

PROJECT NAME: [redacted]
A/E: [redacted]
PROJECT LOCATION: ANN ARBOR, MICHIGAN
BY: EPE/EOL **DATE:** 12/12/05
BORING B3
CLIENT: [redacted]
PROJECT NUMBER: PG51735
SHEET: 2

DEPTH (FEET)	SYMBOLIC PROFILE	PROFILE DESCRIPTION EASTING: NORTHING: GROUND SURFACE ELEVATION= 850	SAMPLE TYPE/NUMBER INTERVAL	BLOWS PER SIX INCHES	STANDARD PENETRATION TEST RESISTANCES (N-values) – ○ 10 20 30 40 50	NATURAL DRY DENSITY – ■ (pcf) 90 100 110 MOISTURE, % – ◆ ATTERBERG ├─┤ LIMITS 0 10 20 30 40	SHEAR STRENGTH (KSF) 0.0 1.0 2.0 3.0 4.0 5.0
35–42		Fine to Medium Sand- Trace to Some Silt & Gravel- Occasional Gravel & Cobble Layers- Brown- Moist- Medium Dense to Extremely Dense (SP-SM)	SS12	55 41 36	77		
42–50		Fine to Medium Sand- Trace to Some Silt- Trace Gravel- Brown- Moist- Dense to Medium Dense (SP-SM)	SS13	12 14 18			
			SS14	14 12 16			
50		END OF BORING AT 50 FEET.					

LEGEND
▽ HAND PENETROMETER TEST
☒ TORVANE SHEAR TEST
○ UNCONFINED COMPRESSION TEST
▣ VANE SHEAR TEST
✕ REMOLDED VANE SHEAR
⊕ TRIAXIAL TEST



WATER LEVEL OBSERVATIONS
▽ GROUNDWATER ENCOUNTERED DURING DRILLING
▽ GROUNDWATER ENCOUNTERED UPON COMPLETION OF DRILLING

Notes: 1. THE INDICATED STRATIFICATION LINES ARE APPROXIMATE. IN SITU, THE TRANSITION BETWEEN MATERIALS MAY BE GRADUAL.
2. GROUNDWATER WAS NOT ENCOUNTERED UPON COMPLETION OF DRILLING.
3. DRILLER REPORTED ENCOUNTERING COBBLES & GRAVEL AT SAMPLE SS10.

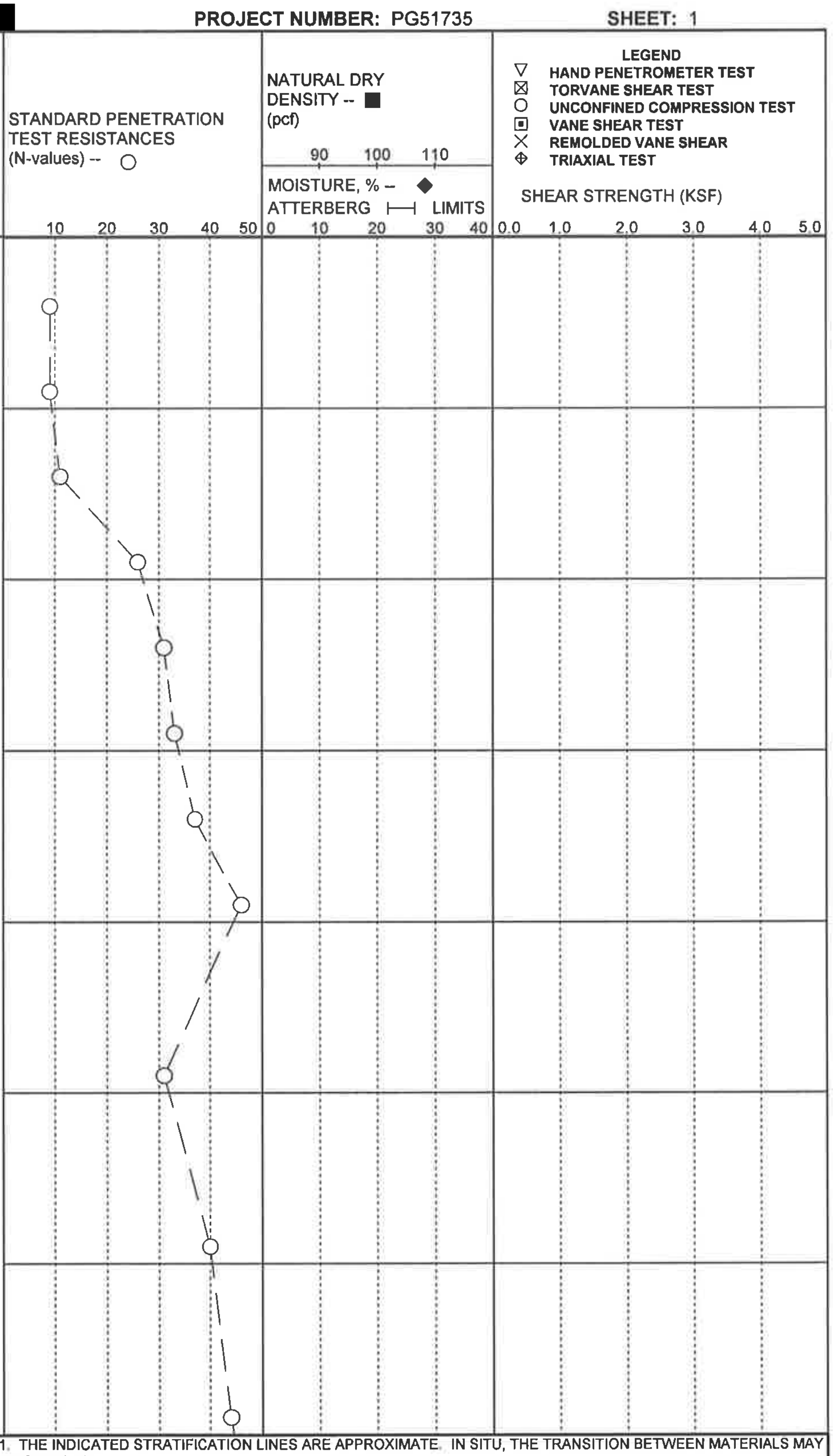
DRILLER: RM **DRILL METHOD:** Hollow-stem Augers **WATER LEVEL DURING DRILLING:** 3 **WATER LEVEL HOURS AFTER COMPLETION:**
RIG NO.: 26 **BACKFILL METHOD:** Auger Cuttings **WATER LEVEL UPON COMPLETION:** None **CAVE OF BOREHOLE AT**

soil and materials engineers, inc.

PROJECT NAME: [redacted] **A/E:** [redacted]
PROJECT LOCATION: ANN ARBOR, MICHIGAN **BY:** GD/EOL **DATE:** 12/19/05 **BORING** B4
CLIENT: [redacted] **PROJECT NUMBER:** PG51735 **SHEET:** 1

EASTING:
NORTHING:
GROUND SURFACE ELEVATION= 854

DEPTH (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NUMBER INTERVAL	BLOWS PER SIX INCHES
0	Driller reported 5 inches of Asphalt Concrete		
	Driller reported 8 inches of Coarse Sand & Gravel Base	SS1	3 4 5
	Clayey Sand- Some Silt- Trace to Some Gravel- Trace Brick- Dark Brown- Moist- Loose to Medium Dense (SC/Fill)	SS2	3 4 5
5		SS3	4 5 6
	Fine to Coarse Sand- Some Gravel- Trace to Some Silt- Occasional Cobble & Gravel Layers- Brown- Moist- Medium Dense to Dense (SP-SM)	SS4	8 12 14
10		SS5	14 15 16
		SS6	16 16 17
15		SS7	15 16 21
		SS8	18 22 24
20			
		SS9	18 18 13
25			
		SS10	12 18 22
30			
		SS11	20 22 22
35			



WATER LEVEL OBSERVATIONS
- GROUNDWATER ENCOUNTERED DURING DRILLING
- GROUNDWATER ENCOUNTERED UPON COMPLETION OF DRILLING

Notes: 1. THE INDICATED STRATIFICATION LINES ARE APPROXIMATE. IN SITU, THE TRANSITION BETWEEN MATERIALS MAY BE GRADUAL.
2. GROUNDWATER WAS NOT ENCOUNTERED.

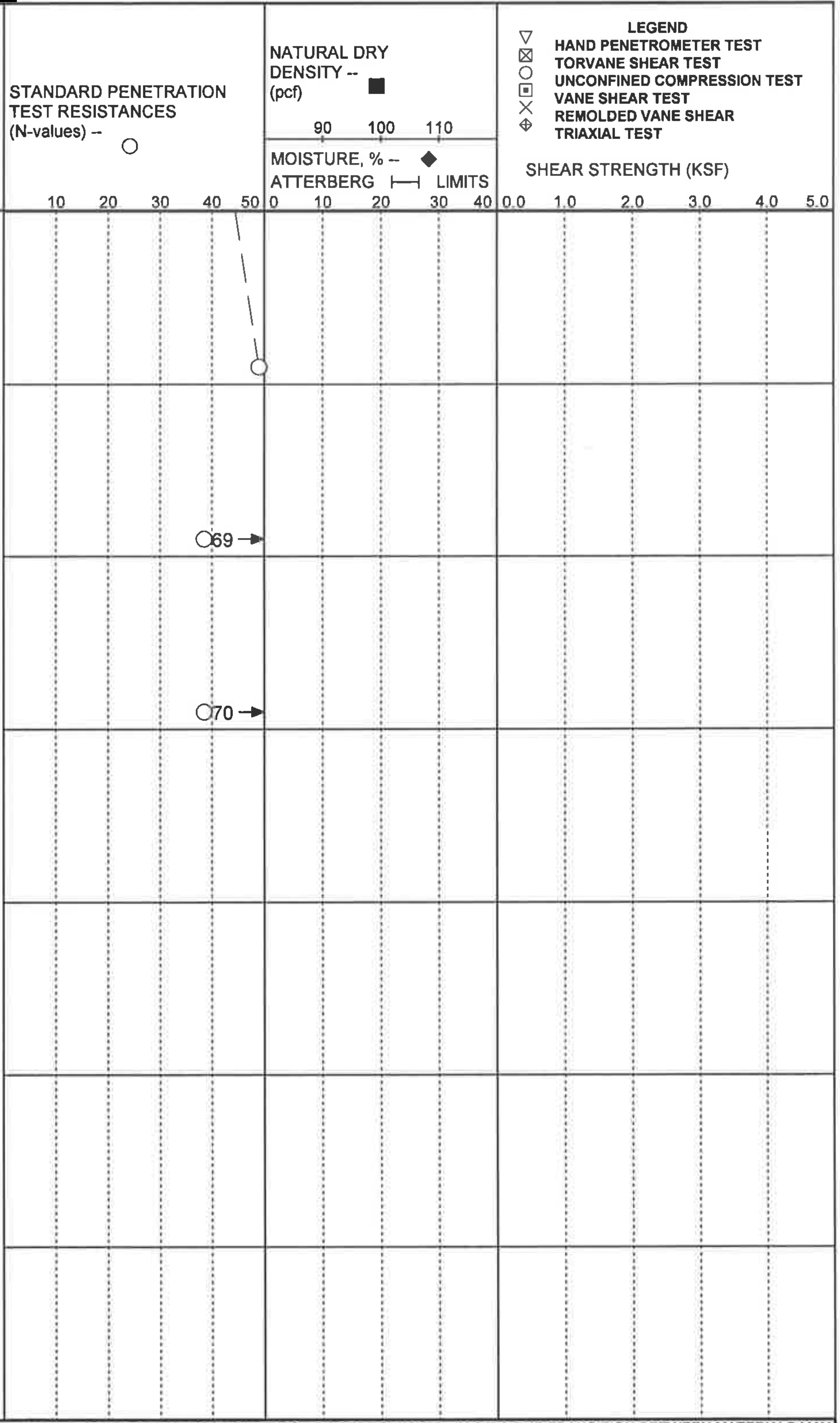
DRILLER: RM **DRILL METHOD:** Hollow-stem Augers **WATER LEVEL DURING DRILLING:** None **WATER LEVEL HOURS AFTER COMPLETION:**
RIG NO.: 26 **BACKFILL METHOD:** Auger Cuttings **WATER LEVEL UPON COMPLETION:** None **CAVE OF BOREHOLE AT**

soil and materials engineers, inc.

PROJECT NAME: [redacted]
A/E: [redacted]
PROJECT LOCATION: ANN ARBOR, MICHIGAN
BY: GD/EOL **DATE:** 12/19/05
BORING B4
CLIENT: [redacted]
PROJECT NUMBER: PG51735
SHEET: 2

EASTING:
NORTHING:
GROUND SURFACE ELEVATION= 854

DEPTH (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NUMBER INTERVAL	BLOWS PER SIX INCHES
35	Fine to Coarse Sand- Some Gravel- Trace to Some Silt- Occasional Cobble & Gravel Layers- Brown- Moist- Medium Dense to Dense (SP-SM)	SS12	20 24 25
40	Fine to Medium Sand- Trace to Some Silt- Trace Gravel- Brown- Moist- Very Dense (SP-SM)	SS13	20 25 44
45		SS14	18 34 36
50	END OF BORING AT 50 FEET.		
55			
60			
65			
70			



WATER LEVEL OBSERVATIONS
GROUNDWATER ENCOUNTERED DURING DRILLING
GROUNDWATER ENCOUNTERED UPON COMPLETION OF DRILLING

Notes: 1. THE INDICATED STRATIFICATION LINES ARE APPROXIMATE. IN SITU, THE TRANSITION BETWEEN MATERIALS MAY BE GRADUAL.
2. GROUNDWATER WAS NOT ENCOUNTERED.

DRILLER: RM **DRILL METHOD:** Hollow-stem Augers **WATER LEVEL DURING DRILLING:** None **WATER LEVEL** **HOURS AFTER COMPLETION:**
RIG NO.: 26 **BACKFILL METHOD:** Auger Cuttings **WATER LEVEL UPON COMPLETION:** None **CAVE OF BOREHOLE AT**

soil and materials engineers, inc.

PROJECT NAME: [redacted]
A/E: [redacted]
PROJECT LOCATION: ANN ARBOR, MICHIGAN
BY: GD/EOL **DATE:** 12/20/05
BORING B5
CLIENT: [redacted]
PROJECT NUMBER: PG51735
SHEET: 1

PROFILE DESCRIPTION

EASTING:
NORTHING:

GROUND SURFACE ELEVATION= 854

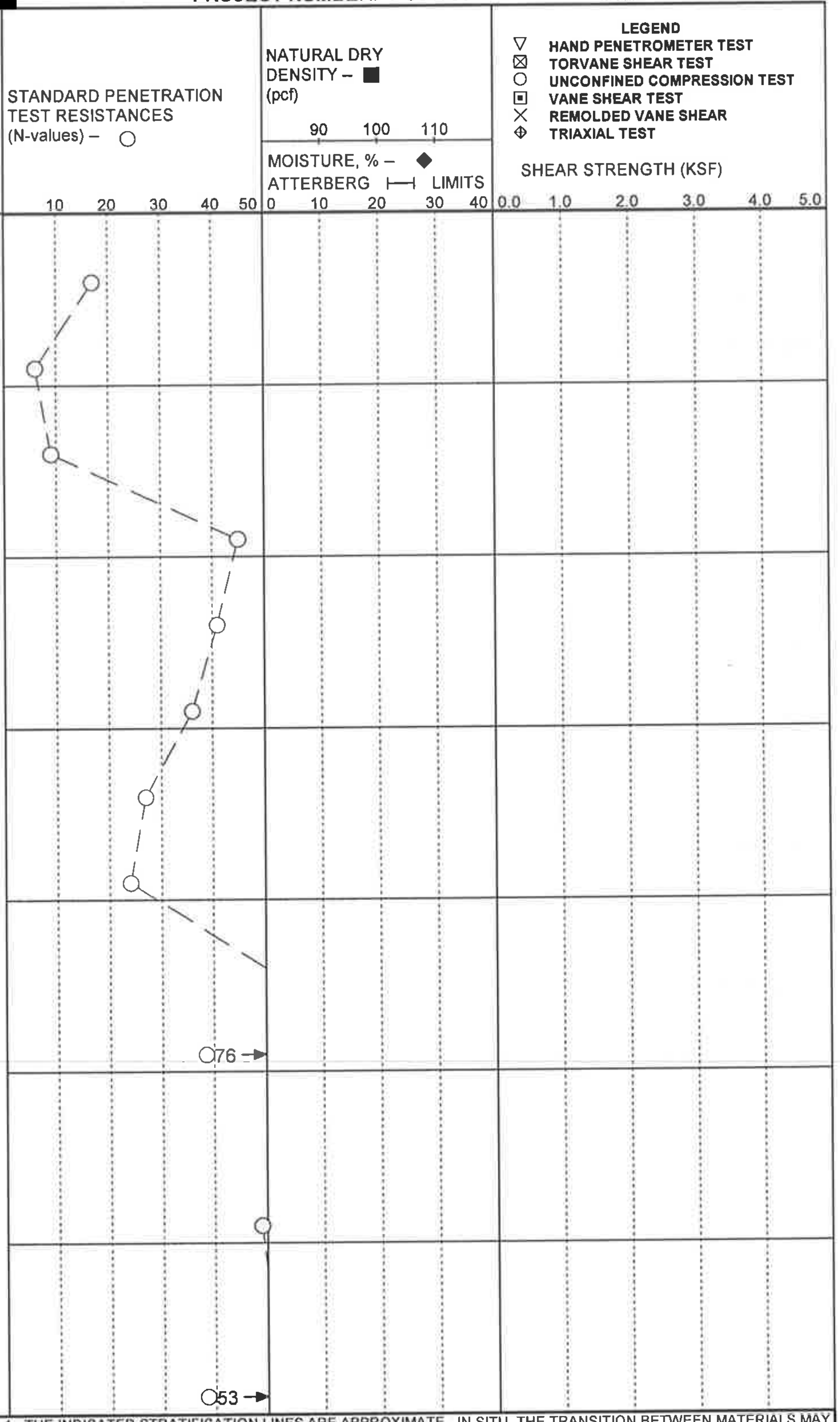
Driller reported 3 inches of Asphalt Concrete

Driller reported 9 inches of Coarse Sand & Gravel Base

Clayey Sand- Some Silt & Gravel- Trace Concrete, Brick & Slag- Dark Brown- Moist- Medium Dense to Loose (SC/Fill)

Fine to Coarse Sand- Trace to Some Silt & Gravel- Occasional Gravel & Cobble Layers- Brown- Moist- Medium Dense to Very Dense (SP-SM)

SAMPLE TYPE/NUMBER INTERVAL	BLOWS PER SIX INCHES
SS1	10 10 7
SS2	2 3 3
SS3	2 3 6
SS4	25 25 20
SS5	8 15 26
SS6	10 12 24
SS7	12 12 15
SS8	12 12 12
SS9	25 24 52
SS10	12 17 32
SS11	25 25 28



LEGEND
- ▽ HAND PENETROMETER TEST
- ☒ TORVANE SHEAR TEST
- ○ UNCONFINED COMPRESSION TEST
- ▣ VANE SHEAR TEST
- × REMOLDED VANE SHEAR
- ⊕ TRIAXIAL TEST

WATER LEVEL OBSERVATIONS
- ▽ GROUNDWATER ENCOUNTERED DURING DRILLING
- ▽ GROUNDWATER ENCOUNTERED UPON COMPLETION OF DRILLING

Notes:
1. THE INDICATED STRATIFICATION LINES ARE APPROXIMATE. IN SITU, THE TRANSITION BETWEEN MATERIALS MAY BE GRADUAL.
2. GROUNDWATER WAS NOT ENCOUNTERED.
3. DRILLER REPORTED ENCOUNTERING COBBLES & GRAVEL AT SAMPLES SS4, SS5 & SS9.

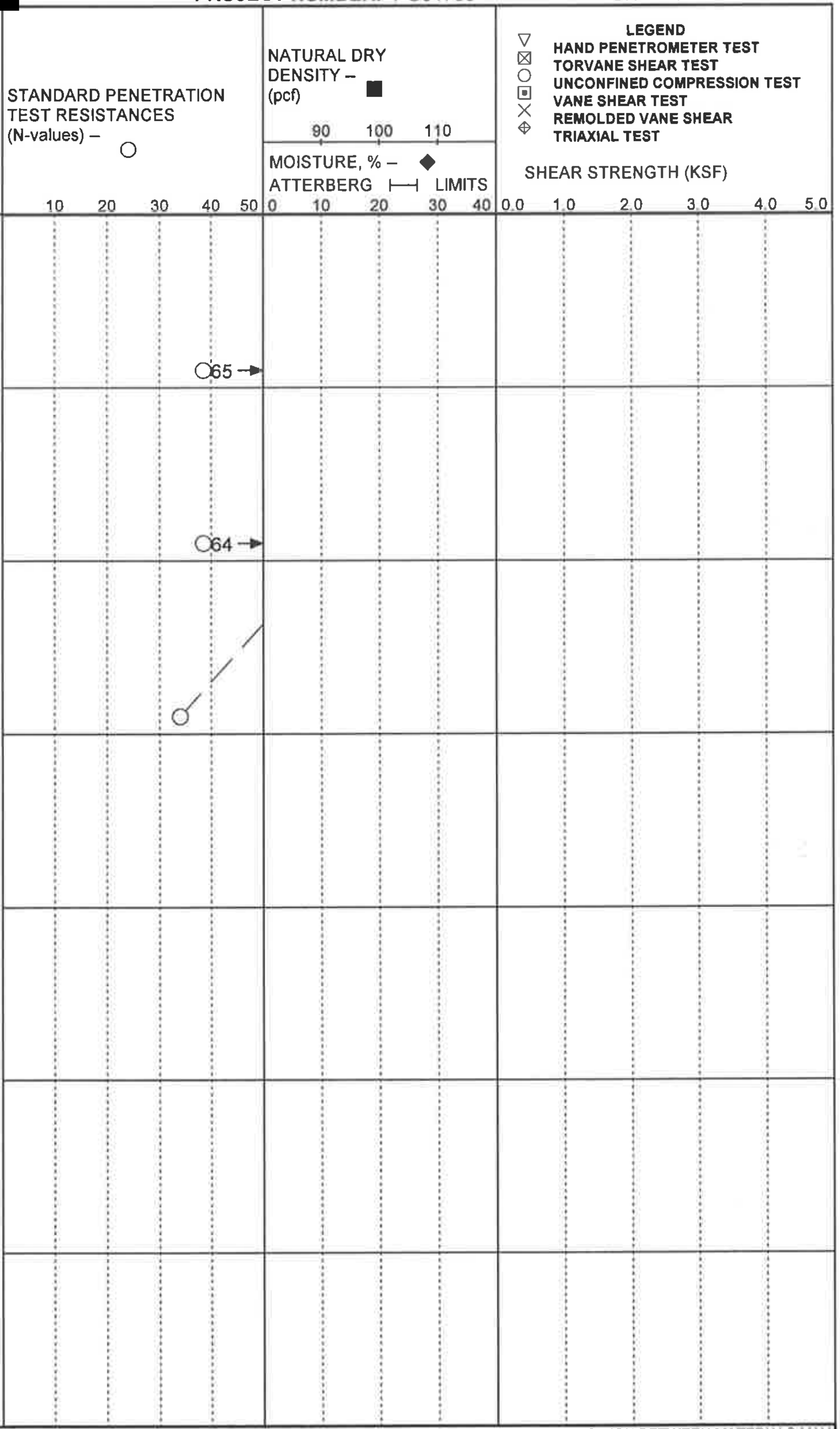
DRILLER: RM **DRILL METHOD:** Hollow-stem Augers **WATER LEVEL DURING DRILLING:** None **WATER LEVEL** **HOURS AFTER COMPLETION:**
RIG NO.: 26 **BACKFILL METHOD:** Auger Cuttings **WATER LEVEL UPON COMPLETION:** None **CAVE OF BOREHOLE AT**

soil and materials engineers, inc.

PROJECT NAME: [redacted]
A/E: [redacted]
PROJECT LOCATION: ANN ARBOR, MICHIGAN
BY: GD/EOL **DATE:** 12/20/05 **BORING** B5
CLIENT: [redacted]
PROJECT NUMBER: PG51735 **SHEET:** 2

EASTING:
NORTHING:
GROUND SURFACE ELEVATION= 854

DEPTH (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NUMBER INTERVAL	BLOWS PER SIX INCHES
35	Fine to Coarse Sand- Trace to Some Silt & Gravel- Occasional Gravel & Cobble Layers- Brown- Moist- Medium Dense to Very Dense (SP-SM)		
40		SS12	16 24 41
45	Fine Sand- Some Silt- Trace Gravel- Brown- Moist- Very Dense to Dense (SM)	SS13	28 28 36
50		SS14	12 14 20
50	END OF BORING AT 50 FEET.		
55			
60			
65			
70			



WATER LEVEL OBSERVATIONS

GROUNDWATER ENCOUNTERED DURING DRILLING
GROUNDWATER ENCOUNTERED UPON COMPLETION OF DRILLING

Notes:
1. THE INDICATED STRATIFICATION LINES ARE APPROXIMATE. IN SITU, THE TRANSITION BETWEEN MATERIALS MAY BE GRADUAL.
2. GROUNDWATER WAS NOT ENCOUNTERED.
3. DRILLER REPORTED ENCOUNTERING COBBLES & GRAVEL AT SAMPLES SS4, SS5 & SS9.

DRILLER: RM **DRILL METHOD:** Hollow-stem Augers **WATER LEVEL DURING DRILLING:** None **WATER LEVEL HOURS AFTER COMPLETION:**
RIG NO.: 26 **BACKFILL METHOD:** Auger Cuttings **WATER LEVEL UPON COMPLETION:** None **CAVE OF BOREHOLE AT**

soil and materials engineers, inc.

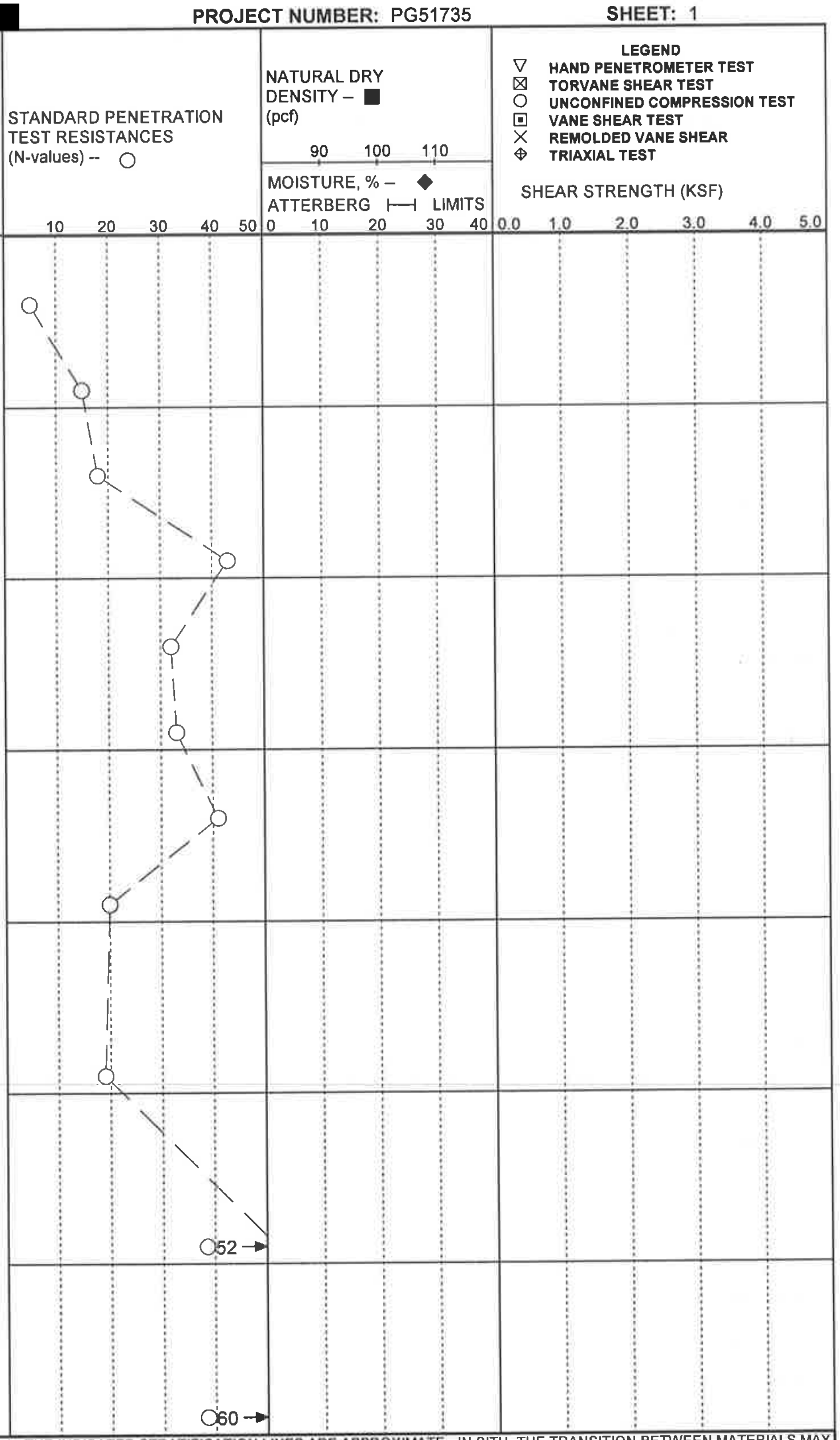
PROJECT NAME: [redacted]
PROJECT LOCATION: ANN ARBOR, MICHIGAN
CLIENT: [redacted]

A/E: [redacted]
BY: SB/EOL **DATE:** 12/22/05
PROJECT NUMBER: PG51735

BORING B6
SHEET: 1

EASTING:
NORTHING:
GROUND SURFACE ELEVATION= 852

DEPTH (FEET)	SYMBOLIC PROFILE	PROFILE DESCRIPTION	SAMPLE TYPE/NUMBER INTERVAL	BLOWS PER SIX INCHES
0		Driller reported 13 inches of Black Sand & Topsoil		
		Fine Sand- Trace to Some Silt- Trace Gravel- Light Brown to Dark Brown- Moist- Loose to Medium Dense (SP-SM/Fill)	SS1	2 2 3
			SS2	5 6 9
5		Fine to Coarse Sand- Some Gravel- Trace to Some Silt- Occasional Cobble & Gravel Layers- Brown- Moist- Medium Dense to Very Dense (SP-SM)	SS3	8 8 10
			SS4	10 21 22
10			SS5	8 16 16
			SS6	10 17 16
15			SS7	20 20 21
			SS8	8 8 12
20				
			SS9	10 9 10
25				
			SS10	19 31 21
30				
			SS11	21 29 31
35				



WATER LEVEL OBSERVATIONS

▼ GROUNDWATER ENCOUNTERED DURING DRILLING
▽ GROUNDWATER ENCOUNTERED UPON COMPLETION OF DRILLING

Notes:
1. THE INDICATED STRATIFICATION LINES ARE APPROXIMATE. IN SITU, THE TRANSITION BETWEEN MATERIALS MAY BE GRADUAL.
2. GROUNDWATER WAS NOT ENCOUNTERED.

DRILLER: RM **DRILL METHOD:** Hollow-stem Augers **WATER LEVEL DURING DRILLING:** None **WATER LEVEL HOURS AFTER COMPLETION:**

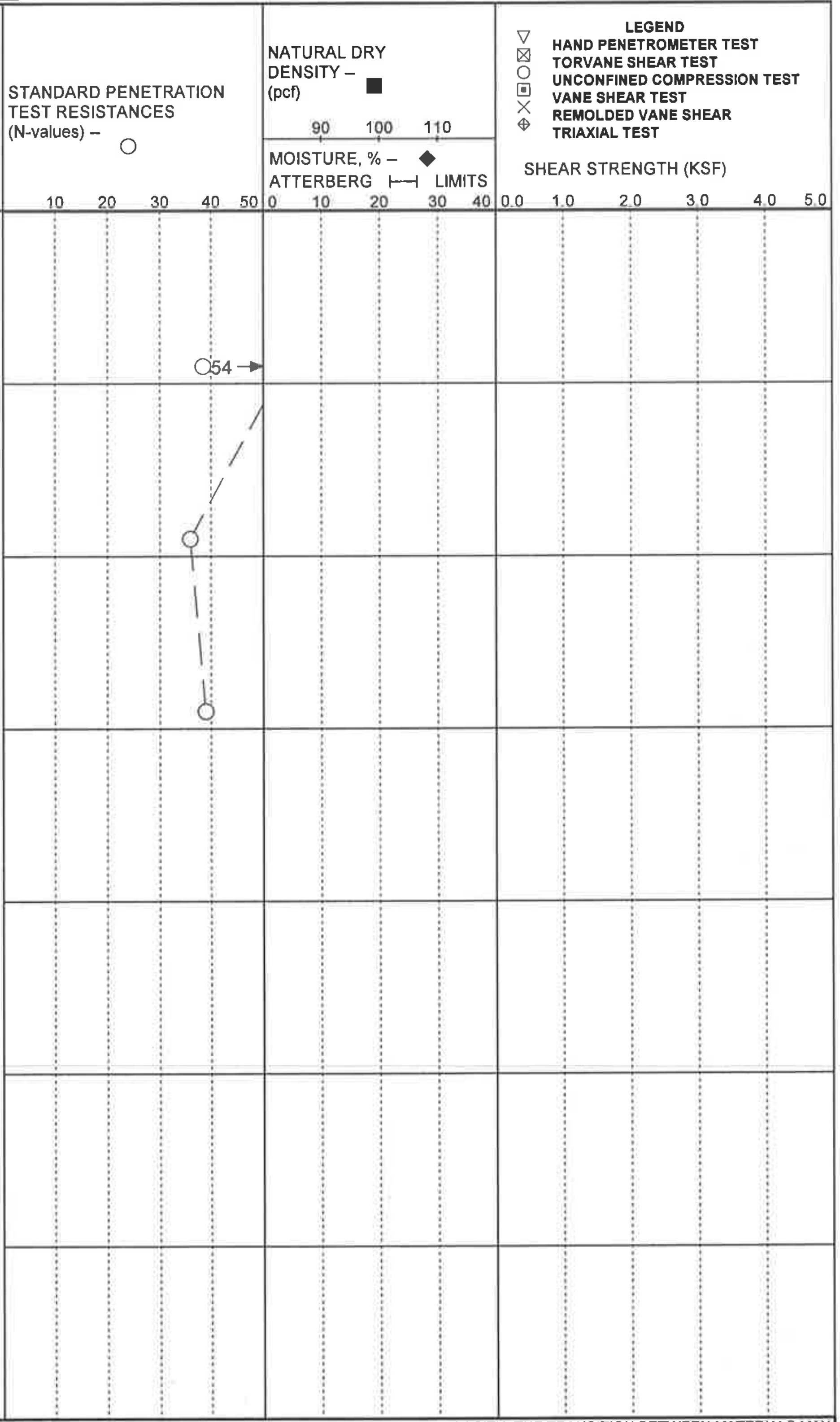
RIG NO.: 26 **BACKFILL METHOD:** Auger Cuttings **WATER LEVEL UPON COMPLETION:** None **CAVE OF BOREHOLE AT**

soil and materials engineers, inc.

PROJECT NAME: [redacted]
A/E: [redacted]
PROJECT LOCATION: ANN ARBOR, MICHIGAN
BY: SB/EOL **DATE:** 12/22/05 **BORING** B6
CLIENT: [redacted]
PROJECT NUMBER: PG51735 **SHEET:** 2

EASTING:
NORTHING:
GROUND SURFACE ELEVATION= 852

DEPTH (FEET)	SYMBOLIC PROFILE	PROFILE DESCRIPTION	SAMPLE TYPE/NUMBER INTERVAL	BLOWS PER SIX INCHES
35		Fine to Coarse Sand- Some Gravel- Trace to Some Silt- Occasional Cobble & Gravel Layers- Brown- Moist- Medium Dense to Very Dense (SP-SM)	SS12	21 21 33
40				
		Fine Sand- Trace to Some Silt & Gravel- Brown- Moist- Dense (SP-SM)	SS13	12 18 18
45			SS14	18 21 18
50		END OF BORING AT 50 FEET.		
55				
60				
65				
70				



LEGEND
- ▽ HAND PENETROMETER TEST
- ☒ TORVANE SHEAR TEST
- ○ UNCONFINED COMPRESSION TEST
- ⊡ VANE SHEAR TEST
- × REMOLDED VANE SHEAR
- ⊕ TRIAXIAL TEST

WATER LEVEL OBSERVATIONS
- ▽ GROUNDWATER ENCOUNTERED DURING DRILLING
- ▽ GROUNDWATER ENCOUNTERED UPON COMPLETION OF DRILLING

Notes: 1. THE INDICATED STRATIFICATION LINES ARE APPROXIMATE. IN SITU, THE TRANSITION BETWEEN MATERIALS MAY BE GRADUAL.
2. GROUNDWATER WAS NOT ENCOUNTERED.

DRILLER: RM **DRILL METHOD:** Hollow-stem Augers **WATER LEVEL DURING DRILLING:** None **WATER LEVEL HOURS AFTER COMPLETION:**
RIG NO.: 26 **BACKFILL METHOD:** Auger Cuttings **WATER LEVEL UPON COMPLETION:** None **CAVE OF BOREHOLE AT**

soil and materials engineers, inc.

PROJECT NAME: [redacted]
A/E: [redacted]
PROJECT LOCATION: ANN ARBOR, MICHIGAN
BY: EPE/EOL **DATE:** 12/20/05
BORING B7
CLIENT: [redacted]
PROJECT NUMBER: PG51735
SHEET: 1

EASTING:
NORTHING:
GROUND SURFACE ELEVATION= 848

DEPTH (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NUMBER INTERVAL	BLOWS PER SIX INCHES
0	Driller reported 3 inches of Sandy Topsoil- Dark Brown		
	Clayey Fine to Coarse Sand- Some Silt- Trace to Some Gravel- Trace Brick Fragments- Dark Brown- Moist- Medium Dense (SC/Fill)	SS1	7 8 5
5		SS2	5 6 8
	Fine to Coarse Sand- Trace to Some Silt & Gravel- Occasional Cobble & Gravel Layers- Brown- Moist- Medium Dense to Extremely Dense (SP-SM)	SS3	5 8 8
10		SS4	8 10 11
		SS5	10 12 16
15		SS6	8 15 24
		SS7	32 16 12
20		SS8	10 12 16
25		SS9	25 46 40
30		SS10	28 34 39
35		SS11	16 20 24

STANDARD PENETRATION TEST RESISTANCES (N-values) -- ○

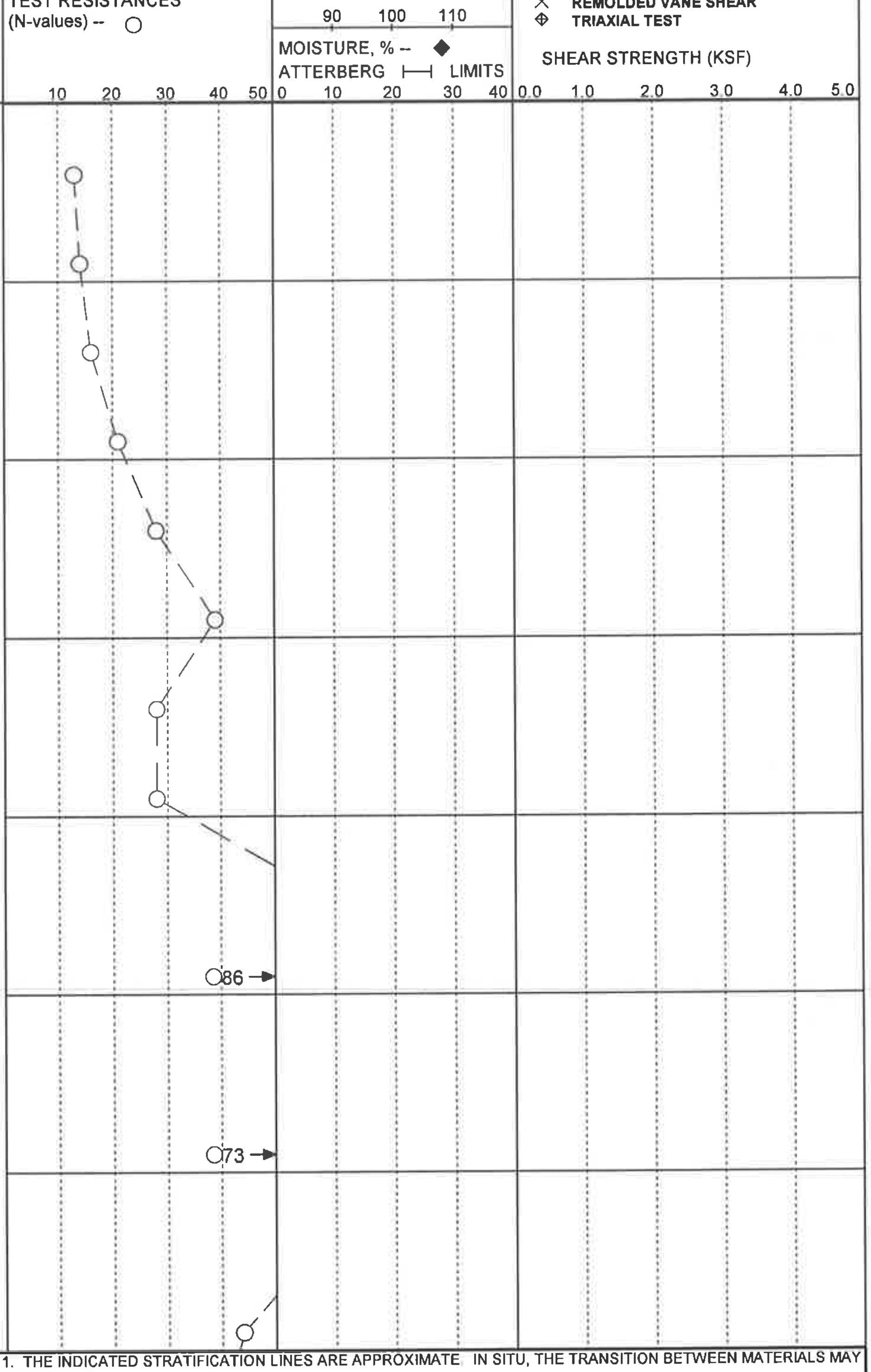
NATURAL DRY DENSITY -- ■ (pcf)

MOISTURE, % -- ◆

ATTERBERG ├─┤ LIMITS

SHEAR STRENGTH (KSF)

LEGEND
- ▽ HAND PENETROMETER TEST
- ☒ TORVANE SHEAR TEST
- ○ UNCONFINED COMPRESSION TEST
- ▣ VANE SHEAR TEST
- ╳ REMOLDED VANE SHEAR
- ⌖ TRIAXIAL TEST



WATER LEVEL OBSERVATIONS
- GROUNDWATER ENCOUNTERED DURING DRILLING
- GROUNDWATER ENCOUNTERED UPON COMPLETION OF DRILLING

Notes:
1. THE INDICATED STRATIFICATION LINES ARE APPROXIMATE. IN SITU, THE TRANSITION BETWEEN MATERIALS MAY BE GRADUAL.
2. DRILLER REPORTED ENCOUNTERING COBBLES & GRAVEL AT SAMPLE SS7.

DRILLER: RM
DRILL METHOD: Hollow-stem Augers
WATER LEVEL DURING DRILLING: 47.5
WATER LEVEL
HOURS AFTER COMPLETION:
RIG NO.: 26
BACKFILL METHOD: Auger Cuttings
WATER LEVEL UPON COMPLETION: 47.5
CAVE OF BOREHOLE AT

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soil and materials engineers, inc.

PROJECT NAME: [redacted]
PROJECT LOCATION: ANN ARBOR, MICHIGAN
CLIENT: [redacted]

A/E: [redacted]
BY: EPE/EOL **DATE:** 12/20/05
PROJECT NUMBER: PG51735

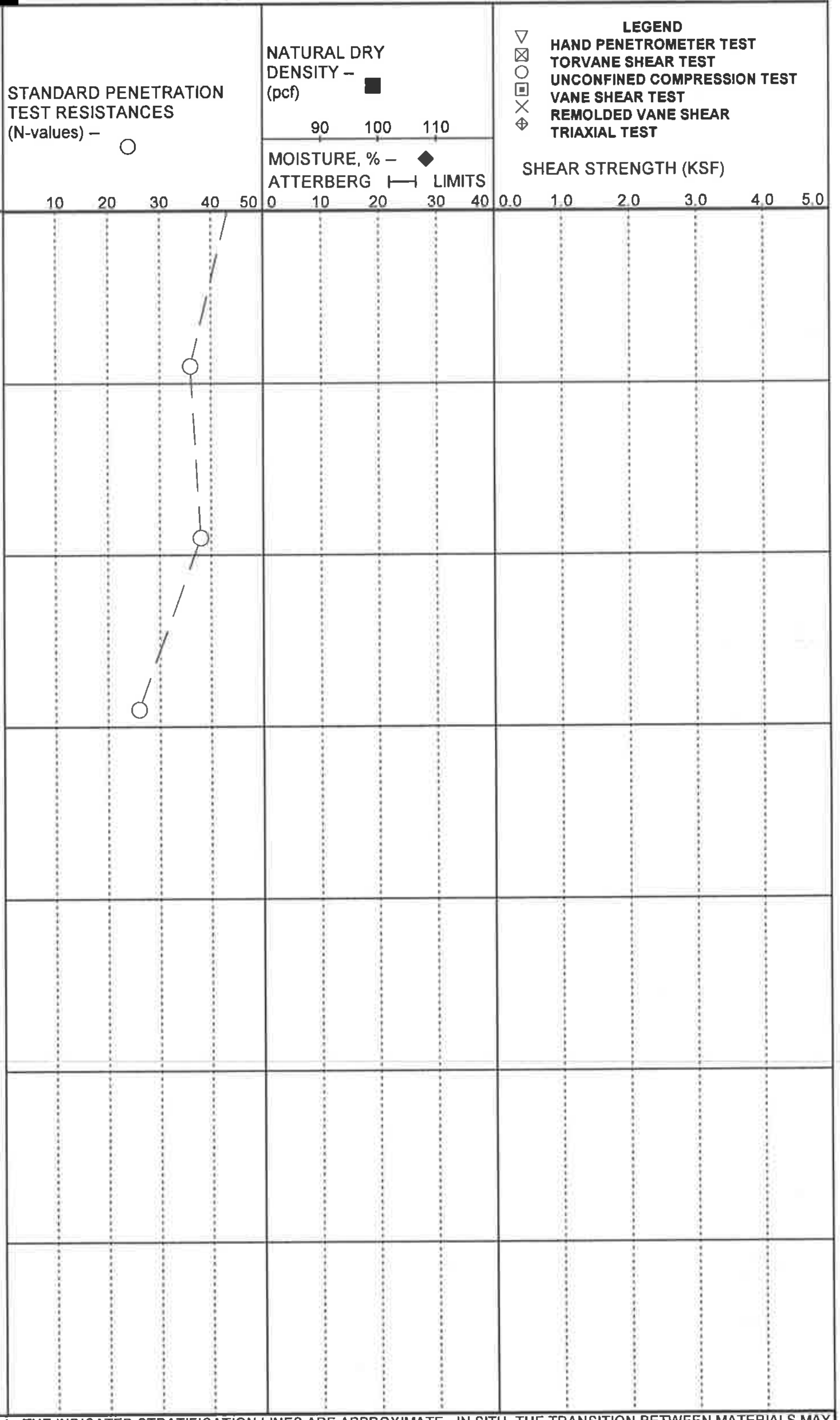
BORING B7
SHEET: 2

PROFILE DESCRIPTION

EASTING:
NORTHING:

GROUND SURFACE ELEVATION= 848

DEPTH (FEET)	SYMBOLIC PROFILE	PROFILE DESCRIPTION	SAMPLE TYPE/NUMBER INTERVAL	BLOWS PER SIX INCHES
35		Fine to Coarse Sand- Trace to Some Silt & Gravel- Occasional Cobble & Gravel Layers- Brown- Moist- Medium Dense to Extremely Dense (SP-SM)		
		Fine to Medium Sand- Trace to Some Silt- Trace Gravel- Brown- Moist- Dense (SP-SM)	SS12	16 20 16
40				
			SS13	12 17 21
45				
▼ ▽		Fine to Coarse Sand- Trace to Some Silt & Gravel- Brown- Wet- Medium Dense (SP-SM)	SS14	10 10 16
50		END OF BORING AT 50 FEET.		
55				
60				
65				
70				



LEGEND
- ▽ HAND PENETROMETER TEST
- ☒ TORVANE SHEAR TEST
- ○ UNCONFINED COMPRESSION TEST
- ▣ VANE SHEAR TEST
- ✕ REMOLDED VANE SHEAR
- ⊕ TRIAXIAL TEST

WATER LEVEL OBSERVATIONS
- ▼ GROUNDWATER ENCOUNTERED DURING DRILLING
- ▽ GROUNDWATER ENCOUNTERED UPON COMPLETION OF DRILLING

Notes: 1. THE INDICATED STRATIFICATION LINES ARE APPROXIMATE. IN SITU, THE TRANSITION BETWEEN MATERIALS MAY BE GRADUAL.
2. DRILLER REPORTED ENCOUNTERING COBBLES & GRAVEL AT SAMPLE SS7.

DRILLER: RM
RIG NO.: 26
DRILL METHOD: Hollow-stem Augers
BACKFILL METHOD: Auger Cuttings
WATER LEVEL DURING DRILLING: 47.5
WATER LEVEL UPON COMPLETION: 47.5
WATER LEVEL HOURS AFTER COMPLETION:
CAVE OF BOREHOLE AT

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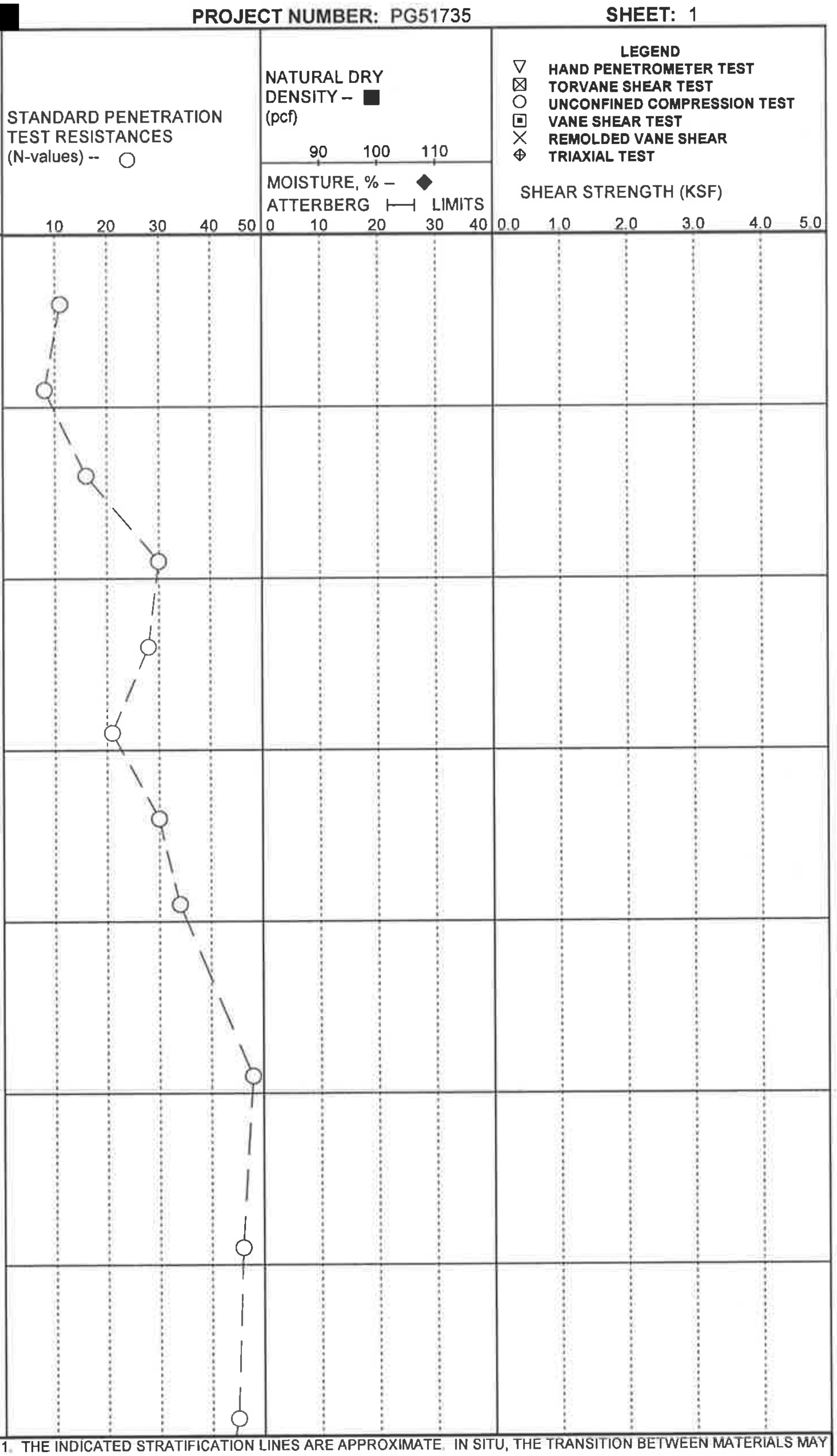
soil and materials engineers, inc.

PROJECT NAME: [redacted]
A/E: [redacted]
PROJECT LOCATION: ANN ARBOR, MICHIGAN
BY: EPE/EOL **DATE:** 12/21/05
BORING B8
CLIENT: [redacted]
PROJECT NUMBER: PG51735
SHEET: 1

DEPTH (FEET)	SYMBOLIC PROFILE	PROFILE DESCRIPTION EASTING: NORTHING: GROUND SURFACE ELEVATION= 848	SAMPLE TYPE/NUMBER INTERVAL	BLOWS PER SIX INCHES
0		Driller reported 6 inches of Sandy Topsoil- Dark Brown		
		Fine to Coarse Sand- Some Silt- Trace to Some Gravel- Dark Brown- Moist (SM/Fill)	SS1	4 5 6
		Fine to Coarse Sand- Some Gravel- Trace to Some Silt- Brown- Moist- Loose to Medium Dense (SP-SM/Fill)	SS2	4 4 4
5			SS3	6 8 8
		Fine to Medium Sand- Trace to Some Silt & Gravel- Occasional Gravel & Cobble Layers- Brown- Moist- Medium Dense to Dense (SP-SM)	SS4	7 14 16
10			SS5	8 14 14
			SS6	10 12 9
15			SS7	12 14 16
			SS8	12 16 18
20				
			SS9	18 23 25
25				
			SS10	25 23 23
30				
			SS11	20 22 23
35				



WATER LEVEL OBSERVATIONS

- GROUNDWATER ENCOUNTERED DURING DRILLING
- GROUNDWATER ENCOUNTERED UPON COMPLETION OF DRILLING

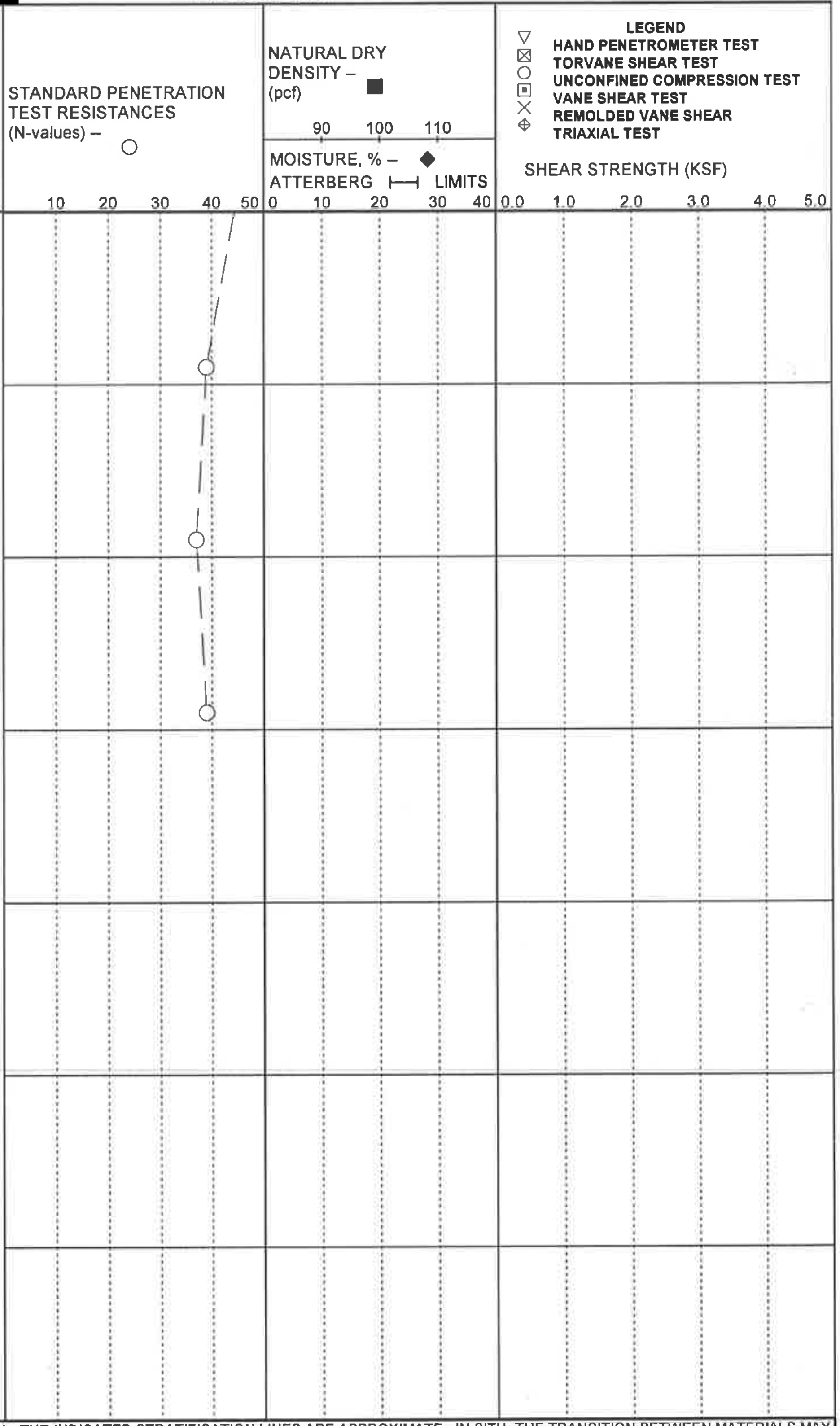
Notes: 1. THE INDICATED STRATIFICATION LINES ARE APPROXIMATE. IN SITU, THE TRANSITION BETWEEN MATERIALS MAY BE GRADUAL.
2. DRILLER REPORTED ENCOUNTERING COBBLES & GRAVEL AT SAMPLES SS2, SS3 & SS10.

DRILLER: RM
DRILL METHOD: Hollow-stem Augers
WATER LEVEL DURING DRILLING: 45
WATER LEVEL **HOURS AFTER COMPLETION:**
RIG NO.: 26
BACKFILL METHOD: Auger Cuttings
WATER LEVEL UPON COMPLETION: 46
CAVE OF BOREHOLE AT

soil and materials engineers, inc.

PROJECT NAME: [redacted]
A/E: [redacted]
PROJECT LOCATION: ANN ARBOR, MICHIGAN
BY: EPE/EOL **DATE:** 12/21/05
BORING B8
CLIENT: [redacted]
PROJECT NUMBER: PG51735
SHEET: 2

DEPTH (FEET)	SYMBOLIC PROFILE	PROFILE DESCRIPTION EASTING: NORTHING: GROUND SURFACE ELEVATION= 848	SAMPLE TYPE/NUMBER INTERVAL	BLOWS PER SIX INCHES
35		Fine to Medium Sand- Trace to Some Silt & Gravel- Occasional Gravel & Cobble Layers- Brown- Moist- Medium Dense to Dense (SP-SM)		
40		Fine to Medium Sand- Trace to Some Silt- Trace Gravel- Brown- Moist to Wet- Dense (SP-SM)	SS12	12 19 20
45			SS13	9 17 20
			SS14	12 15 24
50		END OF BORING AT 50 FEET.		
55				
60				
65				
70				



WATER LEVEL OBSERVATIONS
- ▼ GROUNDWATER ENCOUNTERED DURING DRILLING
- ▽ GROUNDWATER ENCOUNTERED UPON COMPLETION OF DRILLING

Notes: 1. THE INDICATED STRATIFICATION LINES ARE APPROXIMATE. IN SITU, THE TRANSITION BETWEEN MATERIALS MAY BE GRADUAL.
2. DRILLER REPORTED ENCOUNTERING COBBLES & GRAVEL AT SAMPLES SS2, SS3 & SS10.

DRILLER: RM
DRILL METHOD: Hollow-stem Augers
WATER LEVEL DURING DRILLING: 45
WATER LEVEL HOURS AFTER COMPLETION:
RIG NO.: 26
BACKFILL METHOD: Auger Cuttings
WATER LEVEL UPON COMPLETION: 46
CAVE OF BOREHOLE AT

SME

Figure 2: 4 & 6 Inch Double Ring Infiltrometer Test

Project Name:	350 South Fifth Avenue Redevelopment			**Constants**	**Area (in^2)**	**Pipe Lengths (ft)**	**Pipe Length at Start Test (ft)**	**Penetration Depth of Rings (in)**
Project Number:	84868.01			**Inner Ring**	12.56	10.00	9.79	2.50
Test Location:	IT-1	**Tested By:**	KPA	**Annular Space**	28.26	9.70	9.49	2.50
Surface Elev., ft:		**G.W. Elev, ft:**	N/E	**Water level maintained by:** Hose and Buckets				
Test Elev., ft:		**Test Depth, ft:**	10.0'					

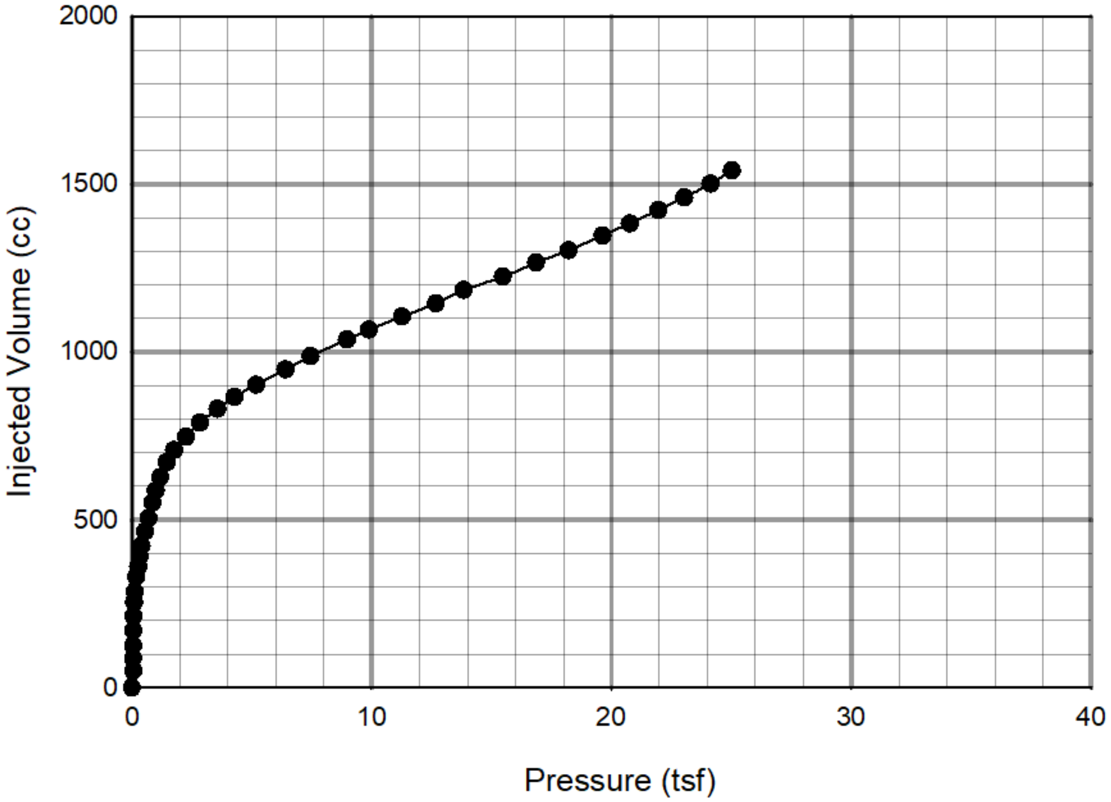
								Infiltration Rate		Remarks
Trial #	Start / End	Date	Time	Inner Ring Reading, ft	Inner Ring Infiltrated Water, ft	Annular Space Reading, ft	Anular Space Infiltrated Water, ft	Inner Infiltration, inches/hour	Annular Infiltration, inches/hour	Test Conditions, etc
1	Start Test	1/10/2023	12:25	1.09	0.14	1.09	0.15	10.1	10.8	Subsurface Conditions at Test Depth: FILL - Fine to Coarse Sand with Silt and Gravel - Few Concrete Fragments - Brown - Moist - Medium Dense (SP-SM). Groundwater was not encountered.
	End Test	1/10/2023	12:35	0.95		0.94				
2	Start Test	1/10/2023	12:35	1.10	0.14	1.08	0.14	10.1	10.1	
	End Test	1/10/2023	12:45	0.96		0.94				
3	Start Test	1/10/2023	12:45	1.09	0.11	1.08	0.10	7.9	7.2	
	End Test	1/10/2023	12:55	0.98		0.98				
4	Start Test	1/10/2023	12:55	0.98	0.08	0.98	0.09	5.8	6.5	
	End Test	1/10/2023	13:05	0.90		0.89				
5	Start Test	1/10/2023	13:05	1.08	0.10	1.09	0.10	7.2	7.2	
	End Test	1/10/2023	13:15	0.98		0.99				
6	Start Test	1/10/2023	13:15	0.98	0.11	0.99	0.11	7.9	7.9	
	End Test	1/10/2023	13:25	0.87		0.88				
7	Start Test	1/10/2023	13:25	1.10	0.12	1.10	0.12	8.6	8.6	
	End Test	1/10/2023	13:35	0.98		0.98				
8	Start Test	1/10/2023	13:35	0.97	0.12	0.99	0.11	8.6	7.9	
	End Test	1/10/2023	13:45	0.85		0.88				
9	Start Test									
	End Test									
10	Start Test									
	End Test									
11	Start Test									
	End Test									
12	Start Test									
	End Test									

NOTES: The test area was presoaked with a minimum of 12 inches of water for 1 hour prior to testing.
The drop in the water level during the last 30 minutes of the presoaking was greater than two inches,
so 10 minute measurement intervals were used for testing as recommended in the Low Impact Devolopment Manual for Michigan.

Pressuremeter Test Results

Project Name: 350 South Fifth Ave Redevelopment
Project Location: Ann Arbor, Michigan
SME Project No.: 084868.01
Test Date: January 7, 2023

Boring No.: B6
Test Depth: 29-31 feet
Soil Description: Fine to Coarse Sand with Gravel
Standard Penetration Test Blow Counts: 16-11-10 (N60=29)
USCS Symbol: SP



Initial Pressure (Pi): 5.2 tsf

Yield Pressure (Pf): 24.1 tsf

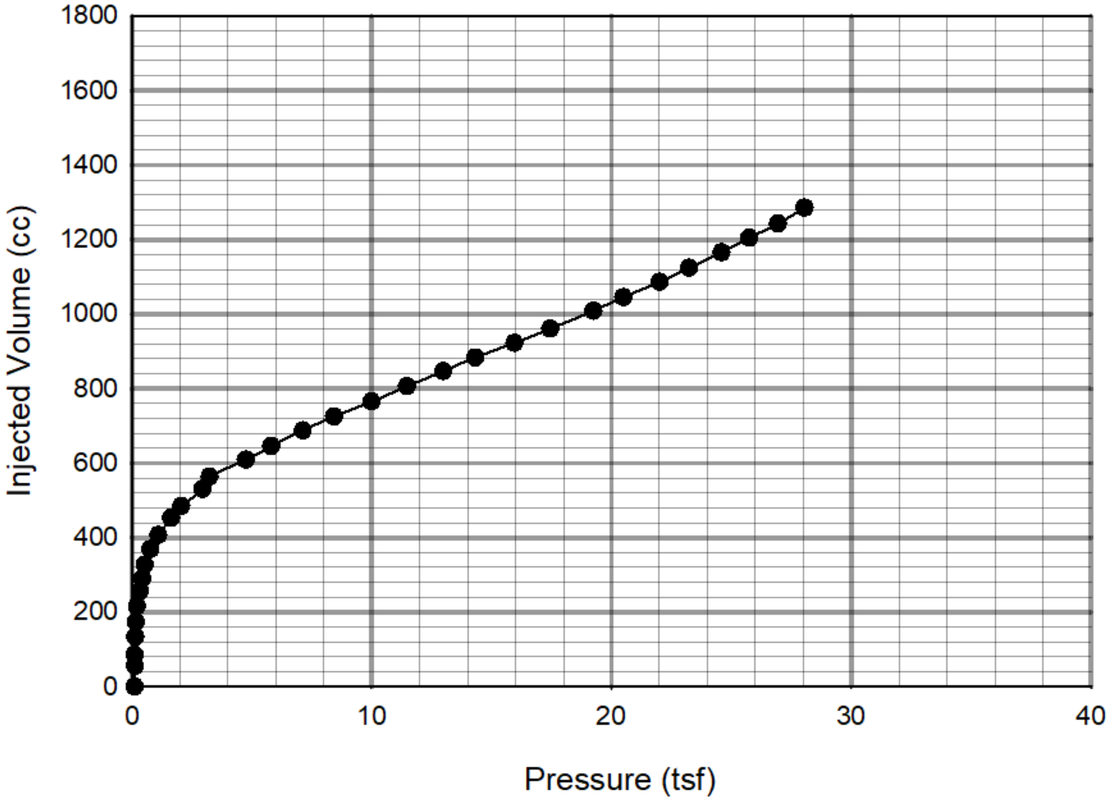
Limit Pressure (Pl): Could not be determined from test data.

Pressuremeter Modulus (Ed): 238 tsf

Pressuremeter Test Results

Project Name: 350 South Fifth Ave Redevelopment
Project Location: Ann Arbor, Michigan
SME Project No.: 084868.01
Test Date: January 7, 2023

Boring No.: B6
Test Depth: 34-36 feet
Soil Description: Fine to Coarse Sand with Gravel
Standard Penetration Test Blow Counts: 23-22-23 (N60=62)
USCS Symbol: SP



Initial Pressure (Pi): 7.1 tsf

Yield Pressure (Pf): 23.2 tsf

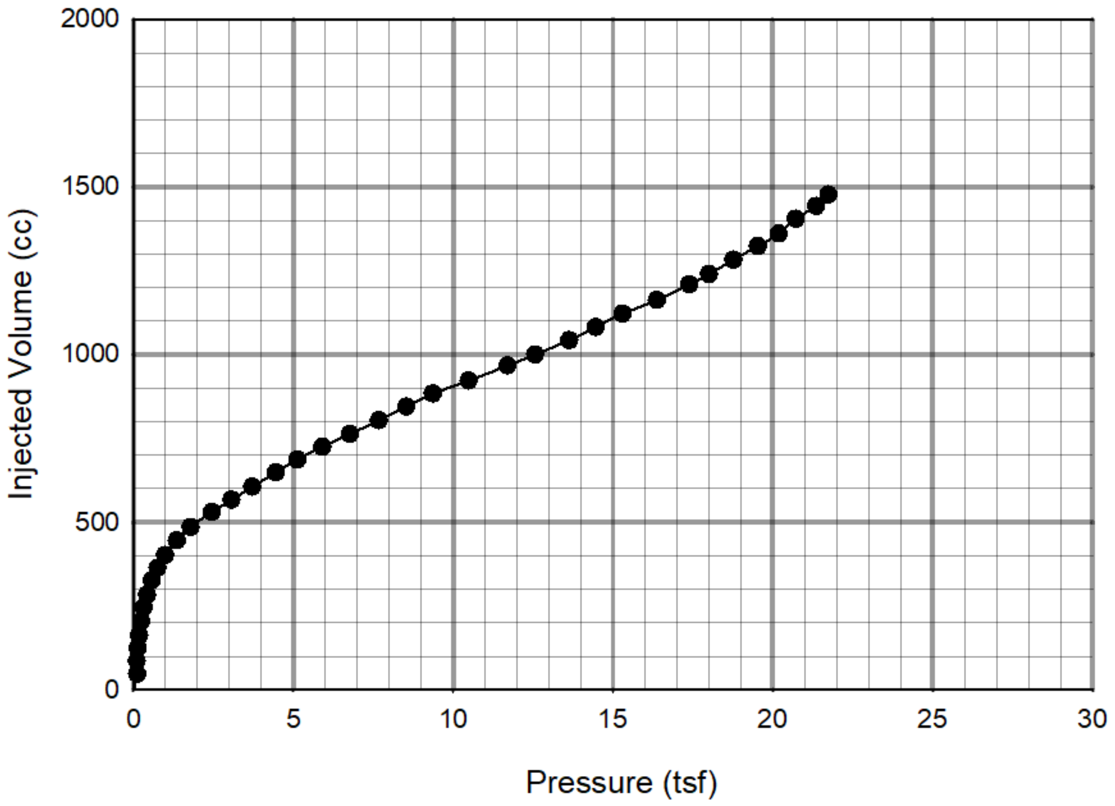
Limit Pressure (Pl): Could not be determined from test data.

Pressuremeter Modulus (Ed): 249 tsf

Pressuremeter Test Results

Project Name: 350 South Fifth Ave Redevelopment
Project Location: Ann Arbor, Michigan
SME Project No.: 084868.01
Test Date: January 6, 2023

Boring No.: B7
Test Depth: 19-21 feet
Soil Description: Fine to Coarse Sand with Gravel
Standard Penetration Test Blow Counts: 9-8-10 (N60=25)
USCS Symbol: SP



Initial Pressure (Pi): 5.1 tsf

Yield Pressure (Pf): 18.0 tsf

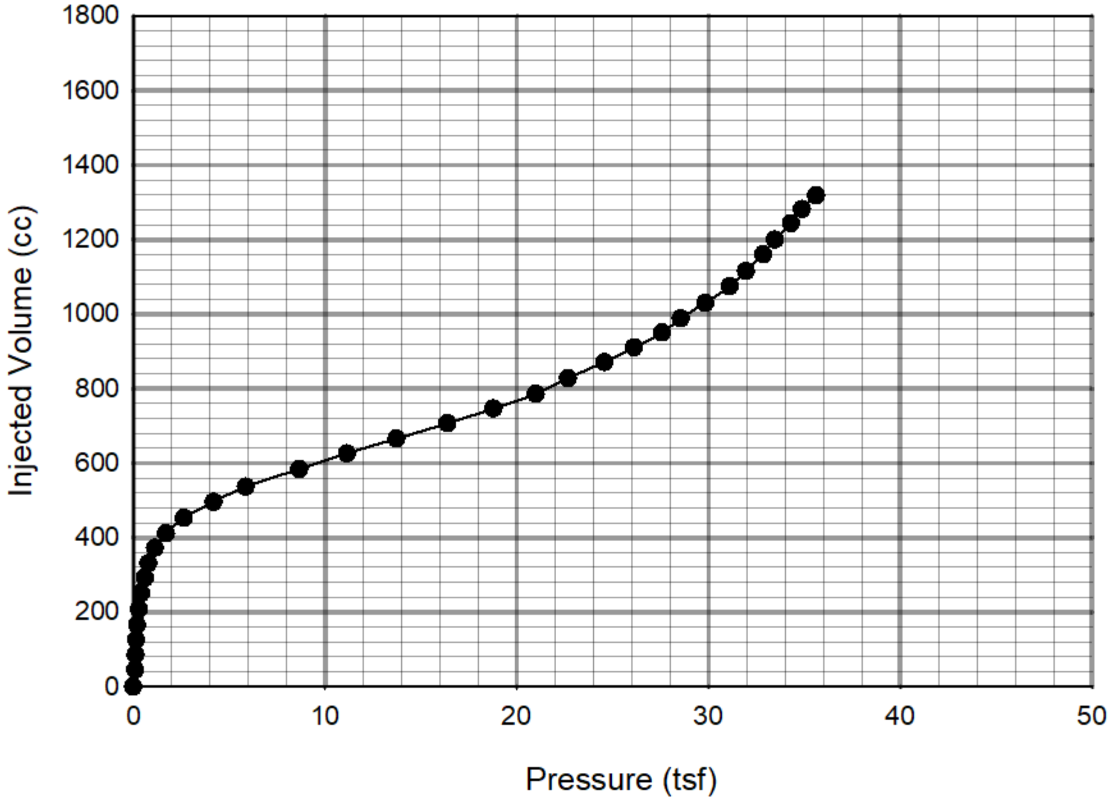
Limit Pressure (Pl): Could not be determined from test data.

Pressuremeter Modulus (Ed): 160 tsf

Pressuremeter Test Results

Project Name: 350 South Fifth Ave Redevelopment
Project Location: Ann Arbor, Michigan
SME Project No.: 084868.01
Test Date: January 6, 2023

Boring No.: B7
Test Depth: 24-26 feet
Soil Description: Fine to Coarse Sand - Few Sandstone Fragments
Standard Penetration Test Blow Counts: 14-13-16 (N60=40)
USCS Symbol: SP



Initial Pressure (Pi): 5.9 tsf

Yield Pressure (Pf): 21.0 tsf

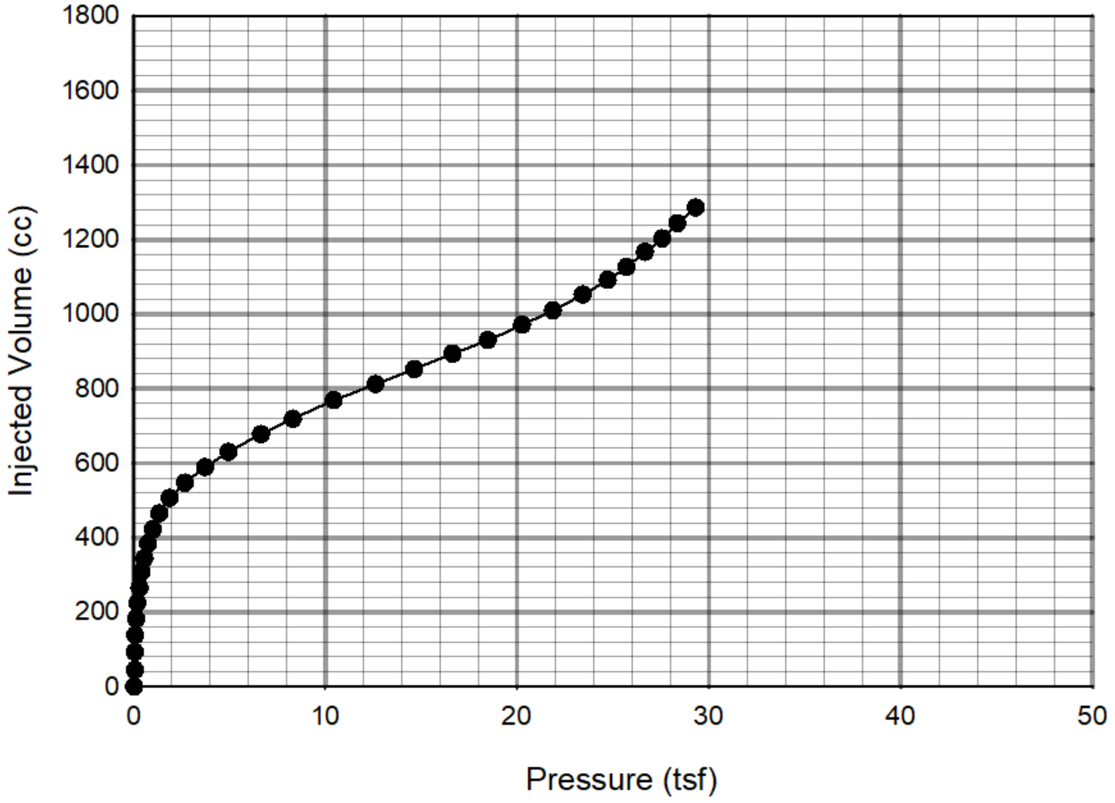
Limit Pressure (Pl): 50 tsf

Pressuremeter Modulus (Ed): 369 tsf

Pressuremeter Test Results

Project Name: 350 South Fifth Ave Redevelopment
Project Location: Ann Arbor, Michigan
SME Project No.: 084868.01
Test Date: January 6, 2023

Boring No.: B7
Test Depth: 29-31 feet
Soil Description: Fine to Coarse Sand with Gravel
Standard Penetration Test Blow Counts: 12-12-15 (N60=37)
USCS Symbol: SP



Initial Pressure (Pi): 6.7 tsf

Yield Pressure (Pf): 20.3 tsf

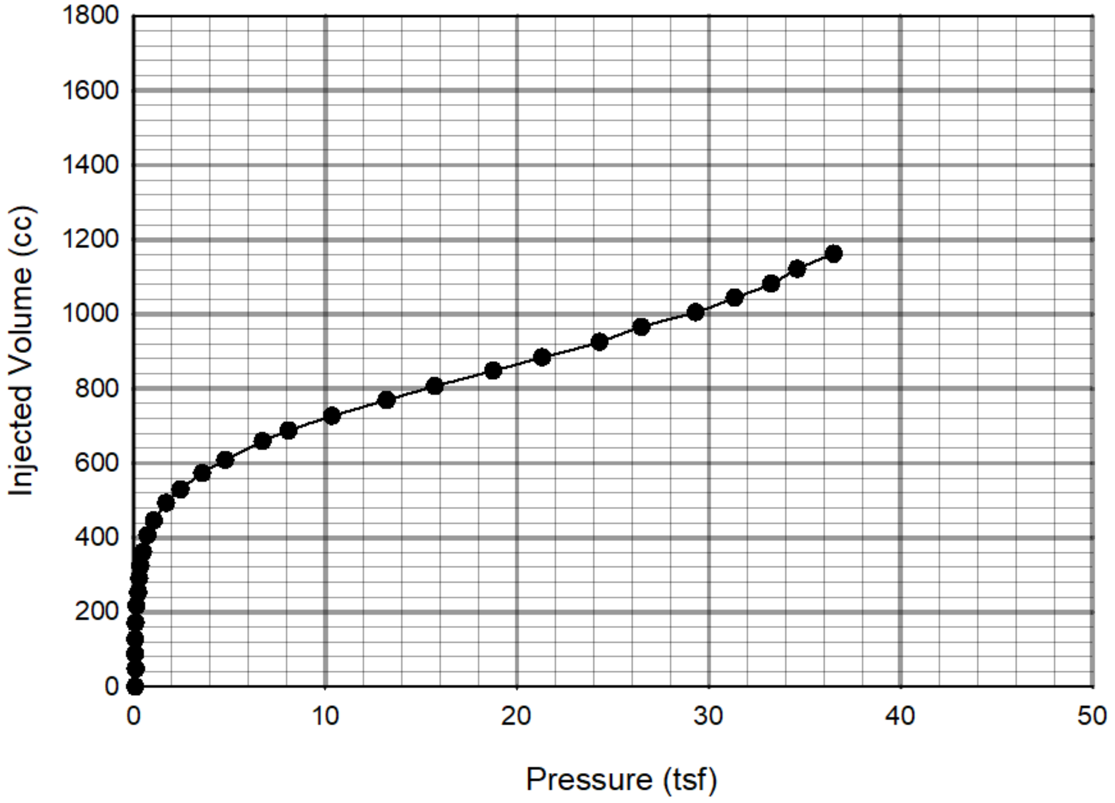
Limit Pressure (Pl): 48 tsf

Pressuremeter Modulus (Ed): 302 tsf

Pressuremeter Test Results

Project Name: 350 South Fifth Ave Redevelopment
Project Location: Ann Arbor, Michigan
SME Project No.: 084868.01
Test Date: January 6, 2023

Boring No.: B7
Test Depth: 34-36 feet
Soil Description: Fine to Coarse Sand with Gravel
Standard Penetration Test Blow Counts: 20-26-28 (N60=74)
USCS Symbol: SP



Initial Pressure (Pi): 8.1 tsf

Yield Pressure (Pf): 31.4 tsf

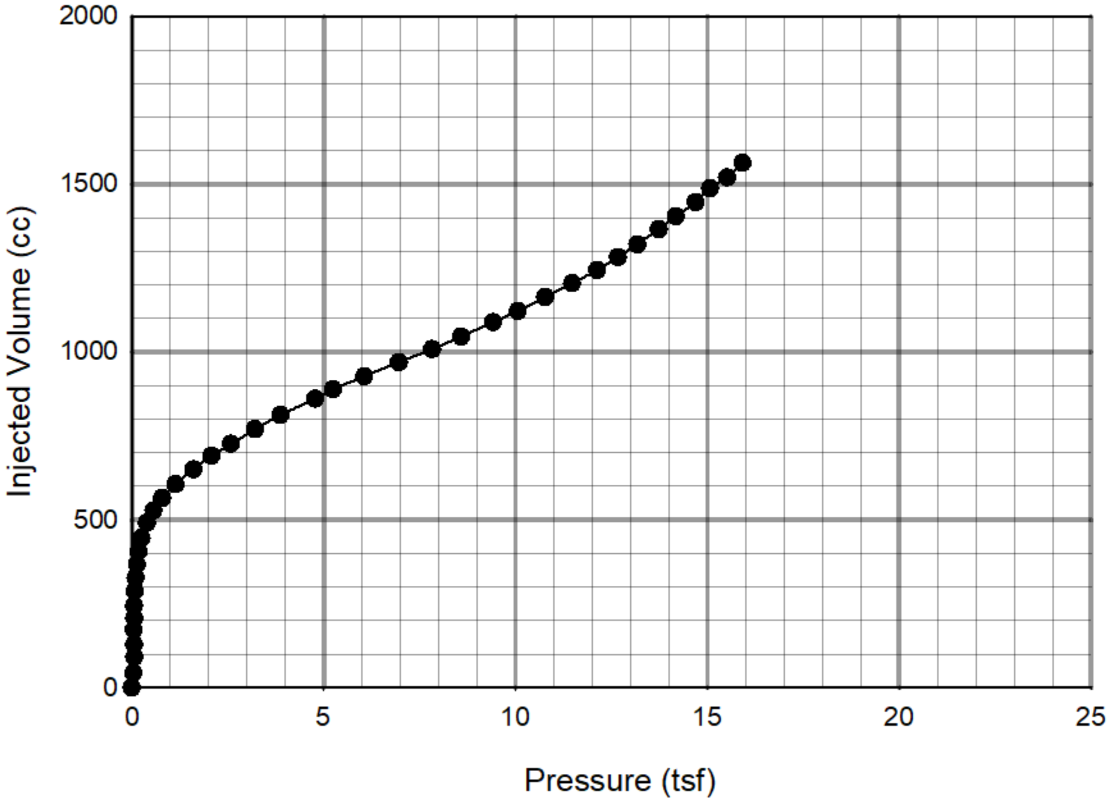
Limit Pressure (Pl): Could not be determined from test data.

Pressuremeter Modulus (Ed): 432 tsf

Pressuremeter Test Results

Project Name: 350 South Fifth Ave Redevelopment
Project Location: Ann Arbor, Michigan
SME Project No.: 084868.01
Test Date: January 5, 2023

Boring No.: B9
Test Depth: 19-21 feet
Soil Description: Fine to Coarse Sand with Gravel
Standard Penetration Test Blow Counts: 5-6-8-8 (N60=19)
USCS Symbol: SP



Initial Pressure (Pi): 3.2 tsf

Yield Pressure (Pf): 12.1 tsf

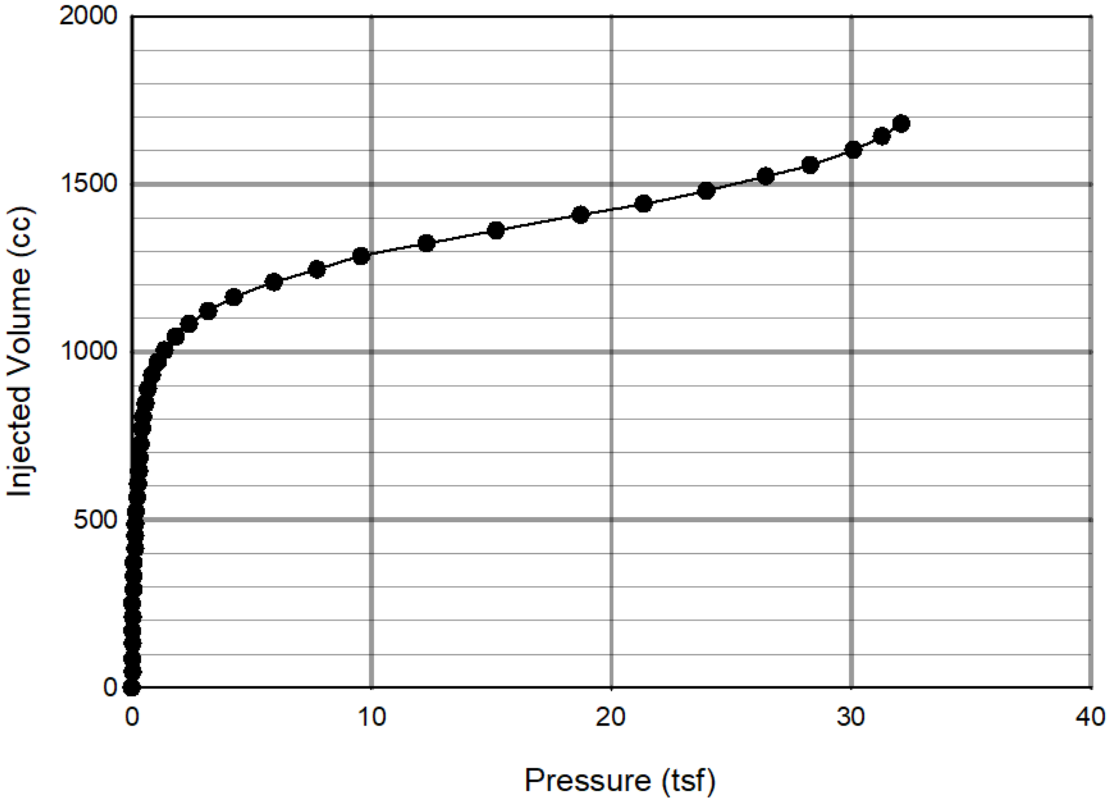
Limit Pressure (Pl): 25 tsf

Pressuremeter Modulus (Ed): 132 tsf

Pressuremeter Test Results

Project Name: 350 South Fifth Ave Redevelopment
Project Location: Ann Arbor, Michigan
SME Project No.: 084868.01
Test Date: January 5, 2023

Boring No.: B9
Test Depth: 24-26 feet
Soil Description: Fine to Coarse Sand with Gravel
Standard Penetration Test Blow Counts: 15-14-17 (N60=42)
USCS Symbol: SP



Initial Pressure (Pi): 7.7 tsf

Yield Pressure (Pf): 26.5 tsf

Limit Pressure (Pl): Could not be determined from test data.

Pressuremeter Modulus (Ed): 541 tsf

APPENDIX B

IMPORTANT INFORMATION ABOUT THIS GEOTECHNICAL-ENGINEERING REPORT

GENERAL COMMENTS

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and development of them that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will not be adequate to develop geotechnical design recommendations for the project.

Do not rely on this report if your geotechnical engineer prepared it:
- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. *Read and refer to the report in full.*

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:
- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept* *responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface using various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are not final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals' plans and specifications; and
- be available whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for information purposes only.* To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer's services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration. Confront the risk of moisture infiltration*** by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists.***

GEOPROFESSIONAL
BUSINESS
ASSOCIATION

Telephone: 301/565-2733
e-mail: info@geoprofessional.org www.geoprofessional.org

GENERAL COMMENTS

BASIS OF GEOTECHNICAL REPORT

This report has been prepared in accordance with generally accepted geotechnical engineering practices to assist in the design and/or evaluation of this project. If the project plans, design criteria, and other project information referenced in this report and utilized by SME to prepare our recommendations are changed, the conclusions and recommendations contained in this report are not considered valid unless the changes are reviewed, and the conclusions and recommendations of this report are modified or approved in writing by our office.

The discussions and recommendations submitted in this report are based on the available project information, described in this report, and the geotechnical data obtained from the field exploration at the locations indicated in the report. Variations in the soil and groundwater conditions commonly occur between or away from sampling locations. The nature and extent of the variations may not become evident until the time of construction. If significant variations are observed during construction, SME should be contacted to reevaluate the recommendations of this report. SME should be retained to continue our services through construction to observe and evaluate the actual subsurface conditions relative to the recommendations made in this report.

In the process of obtaining and testing samples and preparing this report, procedures are followed that represent reasonable and accepted practice in the field of soil and foundation engineering. Specifically, field logs are prepared during the field exploration that describe field occurrences, sampling locations, and other information. Samples obtained in the field are frequently subjected to additional testing and reclassification in the laboratory and differences may exist between the field logs and the report logs. The engineer preparing the report reviews the field logs, laboratory classifications, and test data and then prepares the report logs. Our recommendations are based on the contents of the report logs and the information contained therein.

REVIEW OF DESIGN DETAILS, PLANS, AND SPECIFICATIONS

SME should be retained to review the design details, project plans, and specifications to verify those documents are consistent with the recommendations contained in this report.

REVIEW OF REPORT INFORMATION WITH PROJECT TEAM

Implementation of our recommendations may affect the design, construction, and performance of the proposed improvements, along with the potential inherent risks involved with the proposed construction. The client and key members of the design team, including SME, should discuss the issues covered in this report so that the issues are understood and applied in a manner consistent with the owner’s budget, tolerance of risk, and expectations for performance and maintenance.

FIELD VERIFICATION OF GEOTECHNICAL CONDITIONS

SME should be retained to verify the recommendations of this report are properly implemented during construction. This may avoid misinterpretation of our recommendations by other parties and will allow us to review and modify our recommendations if variations in the site subsurface conditions are encountered.

PROJECT INFORMATION FOR CONTRACTOR

This report and any future addenda or other reports regarding this site should be made available to prospective contractors prior to submitting their proposals for their information only and to supply them with facts relative to the subsurface evaluation and laboratory test results. If the selected contractor encounters subsurface conditions during construction, which differ from those presented in this report, the contractor should promptly describe the nature and extent of the differing conditions in writing and SME should be notified so that we can verify those conditions. The construction contract should include provisions for dealing with differing conditions and contingency funds should be reserved for potential problems during earthwork and foundation construction. We would be pleased to assist you in developing the contract provisions based on our experience.

The contractor should be prepared to handle environmental conditions encountered at this site, which may affect the excavation, removal, or disposal of soil; dewatering of excavations; and health and safety of workers. Any Environmental Assessment reports prepared for this site should be made available for review by bidders and the successful contractor.

THIRD PARTY RELIANCE/REUSE OF THIS REPORT

This report has been prepared solely for the use of our Client for the project specifically described in this report. This report cannot be relied upon by other parties not involved in the project, unless specifically allowed by SME in writing. SME also is not responsible for the interpretation by other parties of the geotechnical data and the recommendations provided herein.

Passionate People Building
and Revitalizing our World

SME