



## **Geotechnical Engineering Report**

### **Proposed Improvements at Baltimore National Cemetery Catonsville Baltimore City, Maryland**

*KCI Project No. 27133363.14*



**Prepared For**  
*Department of Veterans Affairs  
VA Project No. 802CM3021*

**Prepared By**  
*KCI Technologies, Inc.  
December 2015*

December 1, 2015

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Subject: Geotechnical Engineering Report  
Proposed Improvements at  
Baltimore National Cemetery (VA Project No. 802CM3021)  
Catonsville, Maryland  
*KCI Project No. 27133363.14*

Dear Ms. Roggenkamp:


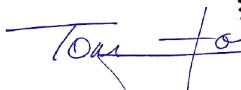
KCI Technologies, Inc. (KCI) has completed the requested subsurface explorations and geotechnical engineering services for the proposed improvements at the Baltimore National Cemetery in Catonsville, Maryland. This report presents our review of the project information, a description of the site, subsurface conditions encountered, geotechnical evaluations, foundation, and construction recommendations for the proposed five niche high columbarium and in-ground cremains burials.

KCI appreciates the opportunity to provide geotechnical engineering consulting services on this important project and looks forward to completing it successfully. Please contact us if you have any questions regarding the information presented in this report, or if we can be of further assistance to you during the planning or construction phases of the project.

Most sincerely,

**KCI TECHNOLOGIES, INC.**

Brian Morgan  
Sr. Associate



Tomasz Labuda, PE  
Sr. Associate

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## **1.0 INTRODUCTION**

### **1.1 GENERAL**

This is the geotechnical engineering report for the proposed improvements at the Baltimore National Cemetery located at 5501 Frederick Avenue in Catonsville, Maryland. This work has been performed per our agreement with MTR Landscape Architects (MTR) dated June 2, 2015.

This report contains the results of our geotechnical subsurface explorations performed at the project site, soils laboratory testing results, geotechnical evaluations and analyses, foundation and subgrade recommendations for design and construction of the proposed columbarium and road improvements. The site vicinity map is shown on Figure 1 in Appendix A.

### **1.2 PROPOSED CONSTRUCTION AND SITE CONDITIONS**

Our understanding of this project is based on information provided to us by MTR and our site visits during subsurface exploration. The proposed cemetery improvements will consist of a new 975 niche columbarium, in-ground cremains burial site, and a new access road. The proposed cemetery improvements are located along the Frederick Avenue in the cemetery's northern perimeter. The future columbarium site is currently relatively flat open grass covered area while the new access road traverses through mainly wooded area along a toe of a moderately steep slope. Based on the provided site plan, the existing ground surface elevation at the location of future columbarium ranges from about EL 292 feet (ft) to EL 300 ft. The existing ground surface along the proposed access road ranges from about EL 315 ft at the entrance gate located on the northwest side of the cemetery to a low of about EL 294 ft at the northeast road end (turnaround circle). A retaining wall up to 4-foot high is proposed along the access road traversing the steepest portion of the slope. The cemetery topography generally slopes downward from south to north toward Frederick Avenue. Similarly, the surface runoff is in general south to north direction toward a swale/ditch collector along the northern perimeter fence.

The new construction consists of a single row of five-niche high columbarium. We understand that the new columbarium will consist of a concrete block stem wall and precast concrete columbarium wall with decorative granite slab cover. The proposed columbarium structure will be supported on a shallow spread footing. A new access road along the Frederick Avenue will provide a vehicular access to the columbarium site.

### 1.3 SCOPE OF SERVICES

The purpose of this exploration was to obtain site specific subsurface data for the proposed cemetery improvements and develop geotechnical and earthwork recommendations for the proposed construction. In accordance with the scope of services included in our proposal, the subsurface exploration program consisted of nine (9) soil test borings. Borings for the proposed columbarium were designated as C-1 through C-3 and drilled to a depth of 20 ft each below existing grade (bgs). Borings R-1 through R-4 were drilled to a depth of 10 feet bgs each along the proposed roadway alignment. Two borings I-1 and I-2 were drilled to a depth of 10 feet bgs for the proposed storm water management facilities. In addition, two offset 4-foot deep temporary PVC stand pipes were installed next to I-1 and I-2 boreholes for the in-situ infiltration test. All borings were drilled in general accordance with ASTM D 1586 standards. The approximate boring locations are presented on Figure 3 in the Appendix A.

The scope of services for this exploration included the following:

- Review available site and subsurface information including published geological maps and reports;
- Coordinate site access requirements and perform site reconnaissance to evaluate existing site features, access, and constraints that will impact subsurface investigations;
- Prepare a Subsurface Exploration Program Plan including a test boring location plan;
- Review of area and site geologic conditions;
- Review of subsurface soil and groundwater conditions encountered with strata descriptions and available physical properties;
- Develop subgrade and foundation recommendations;
- Develop lateral earth pressure recommendations;
- Subsurface drainage, and potential difficulties with groundwater;
- Potential excavation difficulties and foundation systems construction recommendations;
- Evaluation of on-site soil materials for reuse as structural and non-structural fill;
- Prepare a Geotechnical Engineering Report (GER) in accordance with generally accepted standards and in general accordance with the VA NCA Facilities Design Guide.

Assessments of site environmental conditions or for the presence or absence of pollutants in the soil, rock, surface water, or groundwater of the site were beyond the proposed objectives of our exploration.

## 2.0 INVESTIGATION PROCEDURES

### 2.1 SUBSURFACE EXPLORATION

KCI evaluated the subsurface soil and groundwater conditions at the project site using test borings. KCI's subcontractor, D&S Drilling, Inc., performed nine (9) standard penetration test (SPT) borings at the site. Borings were drilled to depths of 10 to 20 feet bgs. Borings were advanced in general accordance with the ASTM procedures presented in Appendix B. Approximate boring locations are shown on Figure 3 in Appendix A. Boring logs are presented in Appendix B.

**SPT Borings:** SPT borings were performed in accordance with ASTM D 1586 using Hollow Stem Auger

(HSA) procedures. The SPT method consisted of advancing a 2-inch diameter sampling spoon to a depth of 18 inches by driving it with an automated 140-pound hammer falling 30 inches. The values reported on the boring logs are the blows required to advance three successive 6-inch increments. The first 6-inch increment is considered as seating. The sum of the number of blows for the second and third increments is the "N" value.

N-values can be used to provide a qualitative indication of the in-place relative density of cohesionless soils. In a less reliable way, N-values also provide an indication of consistency for cohesive soils. The indications of relative density and consistency are qualitative, since many factors can significantly affect N-values and prevent direct correlations, including differences among drill crews, drill rigs, drilling procedures, and hammer-rod-sampler assemblies.

**Soil Sampling:** KCI obtained soil samples at 2.5-foot intervals to a depth of 10 feet bgs and then at every 5 feet below the top 10 feet to boring termination depths thereafter at each location. Soil samples extracted from a split spoon sampler were visually classified in the field and then placed and sealed in glass jars and transported to the laboratory for testing. The sampling sequence and associated jar samples for each boring may be referenced from Boring Logs in Appendix B.

## 2.1 LABORATORY TESTING PROGRAM

The laboratory testing program included visual classifications of all soil samples collected from the borings by an experienced Geotechnical Engineer. The visual classification generally was based on texture and plasticity in accordance with the Unified Soil Classification System (USCS). A brief explanation of the USCS is included in the Appendix of this report. The USCS group symbol for each soil type is indicated in bold followed by the soil descriptions on the Boring Logs.

During the visual classification procedures, the Geotechnical Engineer grouped the various soil types into the major strata noted on the logs. The stratification lines designating the interfaces between various soil strata on the Boring Logs are approximate. In situ, these transitions will likely be gradual and could occur at slightly different levels from those shown on Boring Logs.

The limited laboratory testing program included index property tests, such as moisture-density relationship per Modified Proctor, moisture contents, gradation analyses, Atterberg Limits, and USDA soil classification on selected boring samples to estimate engineering properties of the soils and to help verify the visual classifications. The results of the laboratory testing are shown in the Appendix C.

The soil samples will be retained in the KCI laboratory for a period of 60 days following the date of this report. After that holding period, the samples will be disposed, unless KCI receives other instructions regarding sample disposition.

### **3.0 SUBSURFACE CONDITIONS**

#### **3.1 GEOLOGIC SETTING**

Based on the USGS Geologic Map of Maryland (1968), the project site is located within the Piedmont physiographic province. The site is underlain by residual soils derived from the in-situ weathering of the Precambrian geologic age Baltimore Gabbro Complex (bgb), which is described by the Maryland Geologic Survey as:

“Hypersthene gabbro with subordinate amounts of olivine gabbro, norite, anorthositic gabbro, and pyroxenite; igneous minerals and textures well preserved in some rocks, other rocks exhibit varying degrees of alteration and recrystallization, and still others are completely recrystallized with a new metamorphic mineral assemblage”.

According to the United States Department of Agriculture Natural Resource Conservation Service (USDA NRCS) Web Soil Survey, soils at the site are classified as Legore Loam, Legore Silt Loam, and Sunnyside fine Sandy Loam as shown on Figure 2 in the Appendix A.

#### **3.2 SUBSURFACE PROFILES**

The subsurface conditions encountered at the boring locations are shown on the test boring logs and soil profile included in Appendix B. The test boring records represent our interpretation of the subsurface conditions based on visual examination of field samples by a KCI geotechnical engineer and laboratory tests of selected soil samples. The lines designating the interfaces between various strata on the test boring records represent approximate interface locations; however, actual transitions between strata may be gradual.

In general, the conditions encountered during our field exploration consisted of several inches of topsoil overlying natural soils and fill within the boring termination depths. Fill (or possible fill) was encountered in borings C-3 and R-4. Encountered fill extends to depths ranging from approximately 3 ft to 4 ft below existing grades. The encountered existing fill generally consists of Silty SAND (SM) soil types with variable amounts of Clay and small weathered rock fragments. N-values for the granular soils in the fill ranged from 3 blows per foot (bpf) to 10 bpf, indicating very loose to loose relative densities.

The natural soils underlying topsoil and fill (in C-3 and R-4 locations) were classified as Silty SAND (SM), Sandy LEAN CLAY (CL), Sandy SILT (ML), and ELASTIC SILT (MH). N-values for the granular soils ranged from 7 bpf to 48 bpf, indicating loose to very dense relative densities. N-values recorded in the cohesive soils ranged from 6 bpf to 22 bpf, indicating medium to very stiff consistencies. The natural residual soil like material with N-values over 60 is classified as a Highly Weathered Rock (or Disintegrated Rock). A hard rock or refusal was not encountered to depths of investigation. However, shallow bedrock should be anticipated, especially below the existing slope. The encountered natural soil strata are consistent with published geology. More detailed descriptions of the encountered subsurface conditions are provided on Boring Logs and Soil Profile in the Appendix B.



### **3.3 GROUNDWATER LEVEL OBSERVATIONS**

Groundwater level observations were made in each of the boreholes during the drilling operations and at the completion of drilling operations, both before and after removal of the drilling augers. Based on those observations, groundwater was encountered only in one boring C-2 location at approximately 16.8 ft below the existing ground surface. Other borings were dry to cave-in depths. Cave-in depths for the borings also were observed after removal of the drilling augers from the boreholes and ranged from 7.3 ft to 17.1 ft below existing grades. Details regarding the groundwater observations are shown on Boring Logs in the Appendix B.

It should be recognized that fluctuations in groundwater levels and perched water conditions, and degree of soil saturation may occur due to seasonal variations in rainfall, surface runoff, evaporation, ground cover and land use, construction activity, water leakages from buried utility mains and other site-specific factors. Therefore, observations made at the time of the field investigations may vary from those to be encountered both during construction phase and the design life of the project. The evaluation of such factors was beyond the scope of this investigation.

## **4.0 GEOTECHNICAL EVALUATIONS AND RECOMMENDATIONS**

Based on the project characteristics, the encountered subsurface conditions and the geotechnical engineering analysis, it is KCI's opinion that the proposed site improvements are feasible.

### **4.1 FOUNDATION RECOMMENDATIONS**

We understand that minimum grading is planned for the proposed columbarium and access road. Based on the conceptual site drawings cuts of up to about 4 feet will be required for the new access roadway construction. Based on the anticipated proposed finished grading level and the soil boring results, the soils at the subgrade level are anticipated to consist generally of natural soils. Loose to medium dense Silty SAND (SM) may be encountered at the foundation levels along the columbarium site. An existing shallow fill may be encountered in the northern portion of the columbarium (C-3) and turnaround traffic circle (R-4), in close proximity to Frederick Avenue.

The exposed subgrade should be thoroughly proofrolled prior to foundation construction and prior to placement of any additional fill or pavement subbase layer to identify soft or yielding areas. The proofrolling should be observed by a qualified representative of the Geotechnical Engineer. Very loose natural soils, if present, should be undercut and replaced with approved fill or densified in place, if feasible. The existing fill should be undercut to a minimum depth of 24 inches below the subgrade elevation and replaced with new approved compacted fill.

Foundations placed on competent natural ground or on new engineered fill placed on firm ground can be designed for net allowable bearing pressures no to exceed 2,500 pounds per square foot (psf). The net allowable soil bearing pressure refers to the pressure that can be transmitted to the foundation bearing soils in excess of the final overburden pressure at the base of a footing.

Prior to the placement of reinforcement and concrete for footings, the bases of the strip footing excavation should be observed, tested, and approved by a qualified representative of the Geotechnical Engineer to

verify that soil conditions at the footing location are suitable for the design bearing pressure. If unsuitable soils are encountered at planned subgrade levels the unsuitable soils should be undercut to suitable bearing materials. The footing can be directly supported on the competent soils at greater depths or, alternatively, the design footing bearing level can be restored through placement of lean concrete or select engineered fill materials. If the design bearing level is restored using select engineered fill, then the excavation to remove the unsuitable soils should extend at least 0.5 ft laterally beyond the bottom edge of the footing for each 1 ft of vertical undercut below the footing bearing level. The select engineered fill materials should be placed and compacted as discussed in greater detail later in this report.

Settlement of the columbarium foundation will be a function of the compressibility of the underlying subgrade soils, the actual applied loads, and other factors. In order to reduce the possibility of foundation bearing failure and excessive settlement due to local shear or "punching" action, we recommend that continuous footing has a minimum width of 2.5 ft. We recommend that the columbarium footing be placed at a minimum depth of 30 inches below finished grade.

The columbarium continuous foundation should be suitably reinforced. Prior to placing any foundation concrete, the steel reinforcement should be examined to ensure that the bars are properly sized and positioned in accordance with the foundation plans and specifications.

A perimeter underdrain consisting of a corrugated slotted PVC pipe placed in aggregate material wrapped in filter fabric should be placed along the foundation. Collected water should be allowed to drain away from the structure.

## **4.2 GROUND SUPPORTED CONCRETE SLABS**

Concrete slabs may be ground-supported on subgrades prepared in accordance with the recommendations in the sections titled Subgrade Preparation and Fill Placement. It is important that the slab subgrade be firm and stable before the placement of the granular subbase materials and the concrete. The existing subgrade should be thoroughly proofrolled with suitable equipment and/or probed by a qualified representative of the Geotechnical Engineer in an effort to detect unstable or otherwise unacceptable soil conditions. Soils in any excessively unstable areas should be undercut and replaced with new engineered fill. Recommendations for construction of engineered fill are presented in the Fill Placement section of this report.

It is recommended that ground-supported slabs be underlain by a minimum of 4 inches of dense-graded aggregate or approved equivalents. Acceptable granular subbase materials should have no aggregate size greater than 1.5 inches, 95 to 100 percent passing the 1 inch sieve, and less than 10 percent by total weight passing the Number 200 sieve. The granular subbase materials will provide a capillary break between the subgrade and the concrete slab, a higher modulus of subgrade reaction, and more uniform support conditions. All granular materials should be compacted; however, if the granular subbase materials have more than 5 percent fines, those materials should be compacted to a minimum of 98 percent of the maximum dry density as determined by the Modified Proctor compaction test method (ASTM D 1557). For structural design purposes, a modulus of subgrade reaction (k) of 100 pounds per cubic inch (pci) may be utilized for the structural design of slabs, provided a 4-inch subbase is utilized and the subgrade has been prepared in accordance with the recommendations presented herein.

In the event there is a significant time lag between the site grading work and the fine grading of concrete slab areas prior to the placement of the subbase stone or concrete, the Geotechnical Engineer should verify

the condition of the prepared subgrade. Prior to final slab construction, the subgrade may require scarification and re-compaction to provide firm and stable conditions.

Slabs must be provided with proper control joints to minimize the effects of concrete shrinkage and differential settlements. To minimize the widths of any shrinkage cracks that may develop near the surface of the slab, it is recommended that welded-wire mesh reinforcement be provided. The welded-wire mesh should be located in the top half of the slab to be effective.

#### **4.3 SITE RETAINING WALLS**

It is very important with regard to construction of retaining walls that soils within the critical zones behind the walls meet certain criteria with regard to soil type. For below-grade walls, the critical zone can be considered as the zone between the bottom back edge of the wall footing and an imaginary line extending upward and rearward from the bottom back edge of the wall footing at a 45-degree angle.

It is recommended that all natural soils and backfill soils within the critical zones should have USCS classifications of Silty SAND (SM) or more granular. Any soils having classifications less granular than Silty SAND (SM) may need to be removed from the critical zones of the wall, as determined by the Geotechnical Engineer at the time of construction. Based upon the results of the borings and anticipated laboratory results, it would appear that the soils at the site classified as SM or more granular should be suitable for use as wall backfill.

Backfill materials behind the wall should be placed and compacted in accordance with criteria outlined in the Earthwork section of this report. The minimum degree of compaction for backfill soils behind conventional retaining walls should be 95 percent of the Standard Proctor maximum dry density (ASTM D 698), unless otherwise approved by the Geotechnical Engineer.

Walls that are flexible and free to rotate at the top can be designed for active earth pressure conditions. Based on consideration of active earth pressures and typical properties for Silty SAND (SM) or more granular soil types, it is recommended that equivalent fluid pressures on walls from retained soils be calculated as  $40H$ , in units of pounds per square foot, where  $H$  is the height of the wall retaining soils in units of feet.

Retaining walls that are rigid and not free to rotate at the top should be designed for at-rest earth pressure conditions. Based on consideration of at-rest earth pressure conditions and typical properties for Silty SAND (SM) or more granular soil types, it is recommended that equivalent fluid pressures on walls from the retained soils be calculated as  $60H$ , in units of pounds per square foot, where  $H$  is the height of the wall retaining soils in units of feet.

The design criteria presented above for evaluation of horizontal earth pressures on retaining walls are based on the assumption of level backfill conditions and the absence of free water within the wall backfill materials. A perimeter underdrain consisting of a corrugated slotted PVC pipe placed in aggregate material wrapped in filter fabric should be placed along the foundation. Collected water should be allowed to drain away from the structure.

Lateral pressures induced by sloping backfills and/or by any surcharge loadings adjacent to walls will also need to be considered in the wall designs. In addition, suitable drainage will need to be provided to intercept and to dispose of any surface infiltration and groundwater behind walls.

Sliding resistance for retaining wall footings can be computed using a coefficient of friction of 0.36 for granular soils and 0.30 for silty and clayey soils. Additional resistance to sliding from passive earth pressure resistance also can be considered, if the earth materials considered for passive resistance will remain in place on the low side of the retaining wall. Equivalent fluid pressures for passive earth pressure resistance can be computed as  $250D$ , in units of pounds per square foot, where  $D$  is the depth of undisturbed natural soil or engineered fill that will remain in place above the base of the wall footing. Because the frictional and passive earth pressure resistances are based on limit strength conditions, appropriate factors of safety of at least 1.5 should be applied to the designs considering these resistances.

The Geotechnical Engineer can provide additional design guidance regarding these and other aspects of below-grade wall and retaining wall design upon request.

#### **4.4 SEISMIC CLASSIFICATION**

Section 1613.3.2 of the IBC 2012 refers to Chapter 20 of ASCE7 for seismic site classification, which is based on various criteria, one of which is the Standard Penetration Resistance,  $N_{bar}$ , derived from the Standard Penetration Test Procedure (ASTM D-1586). ASCE7 Table 20.3.1 provides correlations for Site Classes C, D, and E with various ranges of  $N_{bar}$  to be calculated for the top 100 feet of the subsurface materials at a site in accordance with procedures described in Section 20.4.2 of ASCE7. In addition, the table presents criteria related to various soil properties for Site Classes E and F. KCI has used Table 20.3.1 of ASCE7 and the procedures outlined in Section 20.4.2 of ASCE7 to evaluate the Site Class for this project site.

Based on our review of the soil test boring results, and from our local experience, it appears that the average  $N_{bar}$  value should be over 50 bpf over a depth of 100 ft. This  $N_{bar}$  places the project site within the Site Classification of C, according to Table 20.3.1 of ASCE7.

#### **4.5 PAVEMENT CONSTRUCTION**

Details regarding traffic conditions anticipated for the site were not provided. However, based on our previous experience, it is KCI's opinion that a medium-duty pavement section should be considered. It is our judgment that traffic conditions associated with medium-duty pavements can be represented by approximately 75,000 18-kip equivalent single-axle loads (ESALs) during an approximately 20-year service life.

It is KCI's opinion that use of medium-duty pavement section most likely will be sufficient for traffic conditions likely to occur at the site. However, traffic loading conditions are an extremely important parameter with regard to pavement design. Therefore, if the traffic condition estimates provided above are considered to be inappropriate for the project, please advise KCI so that revised pavement section designs can be determined for this site. Final decisions regarding pavement sections can be made as project design progresses, when further input regarding likely traffic conditions can be provided by other Design Team members.

Subgrade support conditions are the other major parameter of importance to pavement design and performance. Based on the boring results, it is anticipated that the subgrade soil conditions exposed at final

subgrade levels when the project site is graded prior to pavement construction will generally consist of Silty SAND (SM), Sandy SILT (ML), and either existing or new fill material.

Based upon our previous experience with similar projects and site conditions, it is our judgment that the typical pavement subgrade soils such as the soils encountered at the site could exhibit a minimum California Bearing Ratio (CBR) value of 3 when compacted to at least 95 percent of the maximum dry density, as determined by the Modified Proctor test (ASTM D 1557). Therefore, for pavement design a CBR value of 3 is considered. If material having a CBR value of less than 3 is encountered at pavement subgrades, it is recommended to undercut the top 12 inches of this material at the pavement subgrade and replace it with approved fill material.

The pavement sections provided in this report (for budgeting purposes) have been designed based on methodology from the American Association of State Highway and Transportation Officials' (AASHTO) Guide for Design of Pavement Structures, 1993. Summarized below are the subgrade strength parameters, the traffic conditions, and other design parameters and criteria considered in these analyses.

CBR value:	3
Traffic for Medium-Duty Pavement:	75,000 ESALs
Reliability:	85 percent
Overall Variance:	0.45
Initial Serviceability:	4.2
Terminal Serviceability:	2.0

Using the above-indicated design parameters, we have estimated pavement section designs as shown in the following table.

Pavement Material	Compacted Material Thicknesses (Inches)*
	Medium-Duty (75,000 ESALs)
Surface Course Asphalt	1.5
Base Course Asphalt	3.5
Graded Aggregate Base	6.0
GAB	
<b>Total Pavement Thickness</b>	<b>11.0</b>
* Compaction: Level 1 (50 Gyration)	

Final determinations of pavement sections to be used at the site may not be possible until the time of actual construction, depending on the sequence of grading and availability of materials, when the subgrade soil

conditions become exposed in the various site areas. For planning and pricing considerations, however, it is anticipated that the pavement sections shown for a CBR value of 3 should provide a reasonable estimate of the average pavement sections that will be needed for the site.

It is KCI's opinion that the suggested flexible pavement section would not be suitable for the support of heavy, concentrated wheel loads. Therefore, we recommend that rigid Portland cement concrete pavement sections should be provided for any dumpster storage areas and for any unloading zones for deliveries. The Portland cement concrete pavement section should be at least 6 inches thick and should consist of air-entrained Portland cement concrete having a minimum 28-day compressive strength of 4,000 pounds per square inch (psi). A minimum of 4 inches of compacted dense-graded aggregate subbase should be placed beneath all rigid concrete pavements. For any dumpster storage areas, the Portland cement concrete slab area should be large enough to support the dumpster and at least the front wheels of the truck used to unload the dumpster.

All pavement materials and construction should be in accordance with the most current version of the Standard Specifications for Construction and Materials of the Maryland Department of Transportation, State Highway Administration (SHA) and any applicable Baltimore City standards.

The pavement section provided in the table above was developed for the anticipated in-service traffic conditions only and does not provide an allowance for construction traffic conditions. Therefore, if pavement will be constructed early during site work to accommodate construction traffic, consideration must be given to the construction of heavier pavement sections, capable of accommodating the much heavier loads normally associated with construction traffic, as well as the future in-service traffic.

#### 4.6 STORMWATER MANAGEMENT

Based on the provided information, we understand that management of stormwater will be necessary for the project and that infiltration is desirable for the planned storm water management (SWM) facilities. Field infiltration tests were performed adjacent to two borings for each planned facility at a depth of about 4 ft below the existing ground surface. Based on the soil test boring results, the soil at the level of the infiltration tests predominantly consists of Sandy LEAN CLAY (CL) and ELASTIC SILT (MH). In addition to the field infiltration test, gradation analysis by hydrometer was performed on samples recovered at a depth of approximately 4 to 6.5 feet from each boring. Based on the gradation analyses hydrologic soil properties were assigned using the USDA soil classification. A summary of infiltration test results are shown in the following table.

Infiltration Test Results for SWM facilities			
Boring No.	Anticipated Soil per USCS/USDA (4' to 5' below existing grade)	Min. Infiltration Rate (in/hr )	
		Field	Soil Lab per USDA.
I-1	CL/Silty Clay Loam	0.0	0.06
I-2	MH/Clay	3.6	0.02

Soil borings indicate presence of relatively poorly draining Clays and Silts at the planned SWM locations; therefore, infiltration is not considered feasible.

#### **4.7 SOIL CORROSIVITY**

The soil corrosivity laboratory testing has not been completed to date. However, based on our prior experience with projects in general vicinity with similar geology and soil types and comparing to requirements provided by the American Concrete Institute (ACI 318) there are no specific requirements for cement type selection based on the predicted sulfate and chloride content in soil at the site. The laboratory test results will be provided at later date when become available and our recommendation will be revised if necessary.

### **5.0 CONSTRUCTION RECOMMENDATIONS**

The following paragraphs detail our recommendations regarding subgrade preparation and compaction requirements.

#### **5.1 SUBGRADE PREPARATION**

Subgrade preparation should generally include the stripping of any unsuitable surface materials from the planned structure areas. It is recommended that the stripping of unsuitable surficial materials should extend to a minimum of 5 feet beyond the structure area limits, where feasible.

Subsequent to stripping operations, the exposed subgrade soils should be examined by a qualified representative of the Geotechnical Engineer. The exposed soils should be thoroughly proofrolled by a vehicle having an axle weight of at least 10 tons, such as a loaded tandem-axle dump truck. This procedure is intended to assist in identifying any localized loose or yielding materials. In the event that any yielding materials are encountered during the proofrolling operations, those subgrade soils should either be thoroughly densified in-place, or undercut to firm ground and replaced with controlled, compacted fill to final subgrade elevations. Any existing soft or loose fill should be undercut at least 24 inches below the planned subgrade elevation and replaced with new approved compacted fill.

Construction of access road may encounter hard excavation, especially between R-1 and R-2 boring locations. Contractor should be prepared to excavate very stiff and very hard soils and weathered rock boulders.

#### **5.2 FILL SELECTION, PLACEMENT AND COMPACTION**

Prior to placement of compacted fill, representative bulk samples (about 50 pounds) should be taken of the proposed fill soils and laboratory tests should be conducted to determine Atterberg limits, natural moisture content, grain-size distribution, and moisture-density relationships for compaction. These test results will be necessary for proper control of construction for new engineered fill.

Upon achieving competent subgrade conditions, the Contractor can place and compact engineered fill to reach final subgrade levels. In general, any materials to be used as structural fill should consist of soil types classified as SM or more granular, in accordance with ASTM D 2487, and should have a Liquid Limit less

than 30 and a Plasticity Index less than 15 and should have no more than 30 percent by weight of soil particles finer than the No. 200 sieve. On-site soils are generally not suitable as structural fill or backfill and import of borrow material should be anticipated for this project.

Finer-grained, more plastic, and organic soil types, if encountered at the site, may be used as fill materials in landscape areas. Any such materials encountered during grading operations should be either stockpiled for later use in landscape fills, or should be placed in approved disposal areas either on-site or off-site.

Prior to the utilization of any on-site or off-site borrow materials, the Geotechnical Engineer should be provided with representative samples in order to determine the suitability of the materials for use as a controlled compacted fill and to develop moisture-density relationships. In order to expedite the earthwork operations, it is recommended that any off-site borrow materials generally should be comprised of SM or more granular soil types.

All structural fill should be placed in loose lifts, which do not exceed 8 inches in thickness, and should be compacted to at least 95 percent of the maximum dry density, as determined by the Modified Proctor Compaction Test (ASTM D 1557). Generally, the moisture content of the fill material should be maintained within 2 percentage points of the optimum moisture content for the fill material, as determined by ASTM D 1557. Fill materials in the upper 1 foot of slab subgrades should be compacted to at least 98 percent of the Modified Proctor maximum dry density. Fill placed in non-structural areas should be compacted to at least 90 percent of the Modified Proctor maximum dry density in order to avoid significant subsidence.

Compaction equipment suitable for the soil types being used as fill should be selected to compact the fill. Theoretically, any equipment type can be used, so long as the required density is achieved. Ideally, a steel drum roller generally will be the most efficient for compaction of granular soil types and for sealing the surface soils, while a sheepfoot roller or pneumatic-tire roller generally will be most efficient for compaction of cohesive soil types.

If any problems are encountered during the earthwork operations, or if site conditions deviate from those indicated by the borings, the Geotechnical Engineer should be notified immediately.

### **5.3 CONSTRUCTION WATER CONTROLS**

As noted in the Groundwater Level Observations section of this report, groundwater was encountered only in boring below 16 feet. Therefore groundwater is not anticipated to have a significant effect on construction. Any groundwater encountered during the construction of should be the results of perched water and should be readily managed by interceptor trenches and localized systems of sumps and pumps.

All foundation excavations must be protected to prevent the disturbance of the subgrade materials and to minimize any potential loss of support capacity. Foundation concrete generally should be placed for foundations during the same day that the foundation excavations are made and approved. Should excavating and placing the foundation concrete the same day not be practical, we recommend that a concrete mud mat, 2 to 3 inches thick, be placed to protect the subgrade soils from moisture changes and disturbance. If protection of the soils is not provided, then undercutting of softened or loosened soils may be necessary prior to the placement of reinforcing steel and foundation concrete.



Prior to the placement of any foundation concrete or mud mat, the subgrade soils must be carefully examined and tested by a qualified representative of the Geotechnical Engineer to confirm the availability of the design soil bearing capacity. To minimize disturbance to the subgrade soils during excavation, we recommend that a bucket without scarifying teeth, in addition to hand excavation methods, be used during the final phases of the excavation for the foundations.

Any cuts or excavations associated with this construction may require forming or bracing, slope flattening, or other physical measures to control sloughing and/or to prevent slope failures. An examination of the applicable OSHA codes and requirements should be made by the appropriate Contractor to ensure that adequate protection of the excavations and trench walls is provided.

The surface soils contain some clays and silt and are considered erodible. The Contractor should provide and maintain good site drainage during earthwork operations to help to maintain the integrity of the surface soils. All erosion and sedimentation shall be controlled in accordance with sound engineering practice and current local requirements. Surface water should be directed away from the construction area, and the site should be sloped to reduce the potential for ponding water.

## **6.0 GEOTECHNICAL LIMITATIONS**

### **General**

1. This report has been prepared to aid in the evaluation for the proposed construction described in this report. Adequate recommendations have been provided to serve as a basis for design and preparation of plans and specifications. The opinions, conclusions, and recommendations contained in this report are based upon our professional judgment and generally accepted principles of geotechnical engineering. Inherent to these are the assumptions that the earthwork construction should be monitored and tested under the guidance of a geotechnical engineer licensed in the State of Maryland or his representative.

### **Explorations**

2. The analyses and recommendations provided are, of necessity, based on project information available at the time of the actual writing of this report, including existing site, surface and subsurface conditions that existed at the time the exploratory borings were drilled. Further assumption has been made that the limited exploratory borings, in relation to both the lateral extent of the site and to depth, are representative of general conditions across the site.

The nature and extent of variations between these explorations may not become evident until further explorations and construction. If variations from anticipated conditions then appear evident, it will be necessary to revise the recommendations in this report.

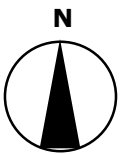
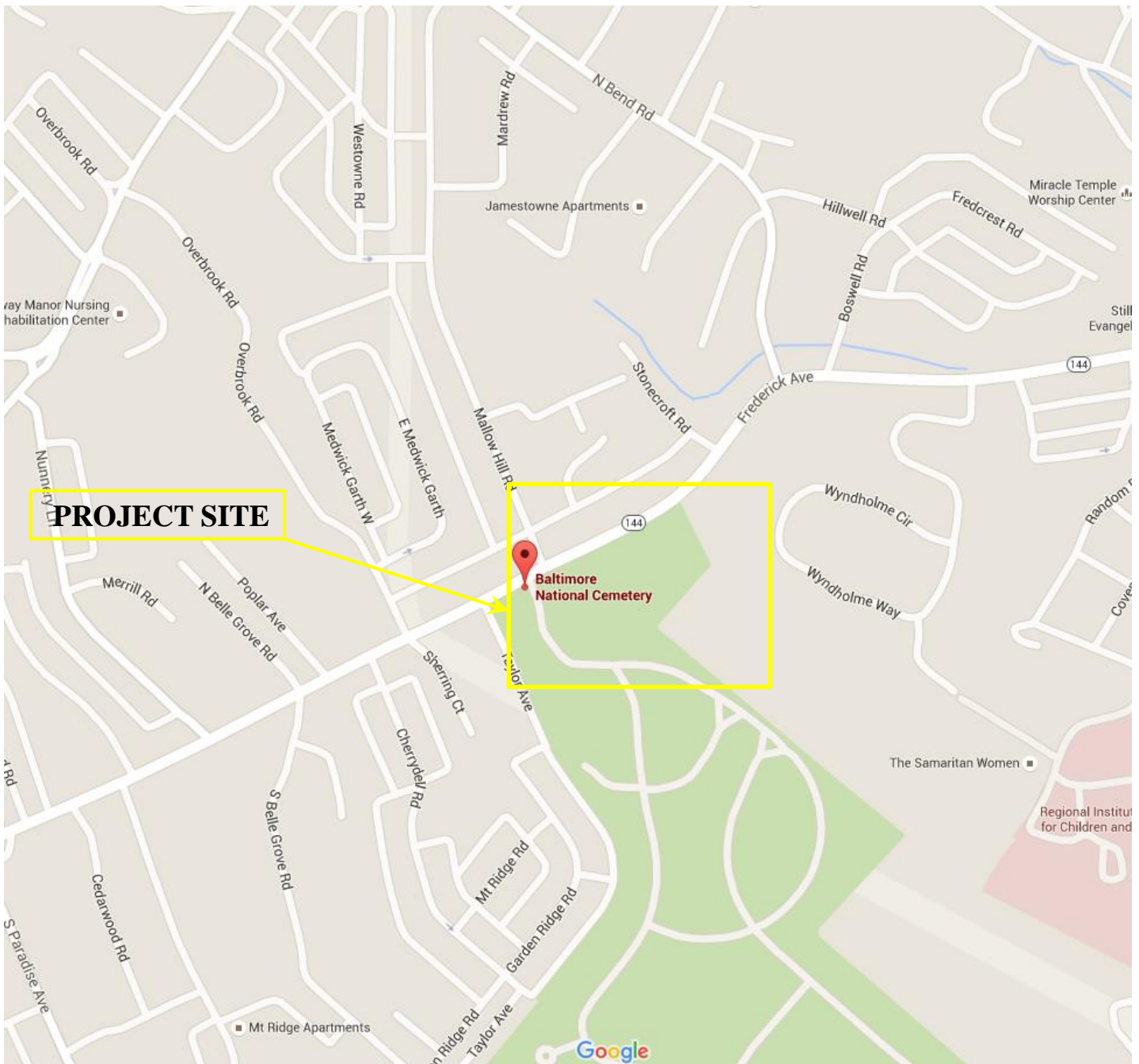
3. The generalized soil profiles described in the text and indicated on the boring logs are intended to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized, and have been developed by interpretations of widely spaced explorations and samples; actual soil transitions are probably more erratic. Refer to boring logs for specific information.
4. Groundwater level readings have been made in the drill hole at times and under conditions stated on the boring profile log. This data has been reviewed and interpretations have been made in this report. Fluctuations in the level of the ground water may occur due to variations in rainfall, temperature, and other factors occurring since the time measurements were made.

**Uses of Report**

5. This report has been prepared for the exclusive use of MTR Landscape Architects, LLC, and other members of the design team for specific application to the proposed **Baltimore National Cemetery Improvements Project**. Our professional services have been performed in accordance with generally accepted geotechnical engineering principles and practices; no other warranty, expressed or implied, is made. KCI assumes no responsibility for interpretations made by others on the work performed by KCI.
6. This report is for design purposes only and is not sufficient to prepare an accurate bid. Contractors wishing a copy of the report may secure it with the understanding that its scope is limited to design considerations only. We recommend that this report be made available in its entirety including attachments and appendices to contractors for informational purposes only. The project plans or specifications should include the following note:

A geotechnical report has been prepared for this project by KCI Technologies, Inc. This report is for informational purposes only and shall not be considered as part of the contract documents. The opinions and conclusions of KCI represent our interpretation of the subsurface conditions and the planned construction at the time of the report preparation. The data in this report may not be adequate for contractors estimating purposes.

## FIGURES



ENGINEERS  
PLANNERS  
SCIENTISTS  
CONSTRUCTION MANAGERS

936 Ridgebrook Rd.  
Sparks, MD 21152  
410-316-7800 | Fax 410-316-7817

## SITE LOCATION MAP

**BALTIMORE NATIONAL CEMETERY  
CATONSVILLE, MARYLAND**

FIGURE NO.

**1**

DRAWN BY  
TL

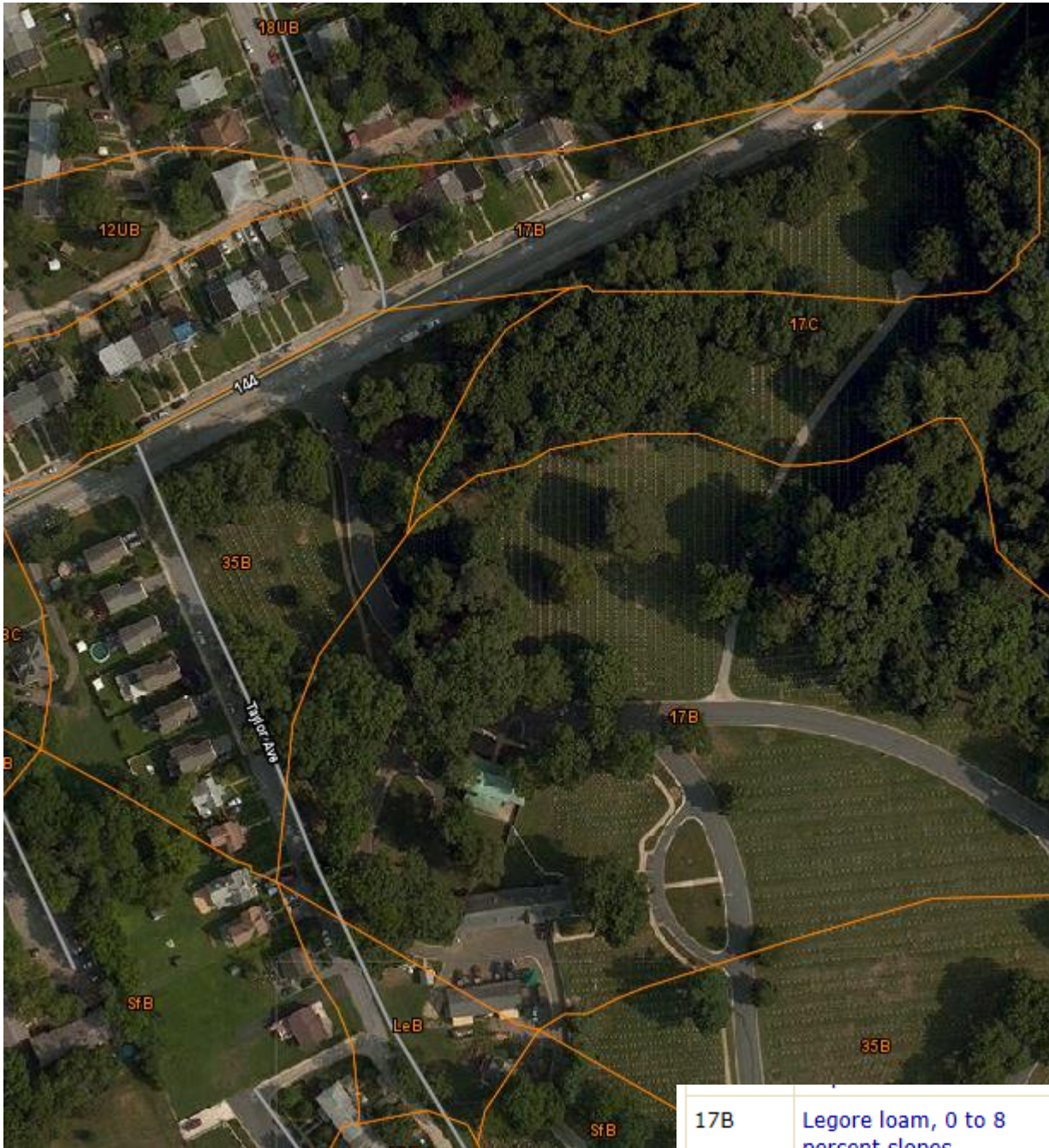
APPROVED BY  
TL

SCALE  
NTS

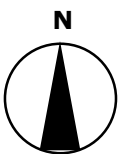
DATE  
NOV 2015

KCI PROJECT NO.  
27133363.14





17B	Legore loam, 0 to 8 percent slopes
17C	Legore loam, 8 to 15 percent slopes
LeB	Legore silt loam, 3 to 8 percent slopes
35B	Sunnyside fine sandy loam, 0 to 8 percent slopes



ENGINEERS  
PLANNERS  
SCIENTISTS  
CONSTRUCTION MANAGERS

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Sparks, MD 21152  
410-316-7800 | Fax 410-316-7817

## USDA – NRCS WEB SOIL SURVEY MAP

**BALTIMORE NATIONAL CEMETERY  
CATONSVILLE, BALTIMORE CITY, MARYLAND**

DRAWN BY  
TL

APPROVED BY  
TL

SCALE  
NTS

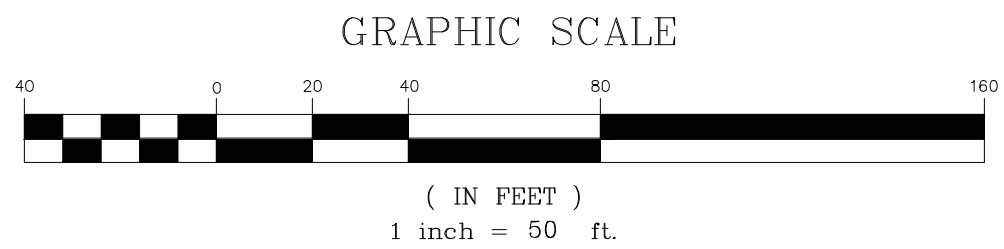
DATE  
NOVEMBER 2015

FIGURE NO.

**2**

KCI PROJECT NO.  
27133363.14





- LEGEND
- C- COLUMBARIUM / CREMAIN BORING LOCATION
  - R- ROADWAY AND PARKING BORING LOCATION
  - I- INFILTRATION BORING LOCATION
  - S- SANITARY MANHOLE
  - SD- STORM DRAIN MANHOLE
  - E- ELECTRIC MANHOLE
  - TE- TELEPHONE MANHOLE
  - L- LIGHT POLE
  - W- WATER METER
  - SG- SIGN
  - UP- UTILITY POLE
  - H- HEDGEROW
  - DT- DECIDUOUS TREE
  - B- BUSH
  - GV- GAS VALVE
  - GW- GUY WIRE
  - WV- WATER VALVE
  - FH- FIRE HYDRANT
  - EH- ELECTRIC HANDBOX
  - PA- PLANTING AREA
  - WS- WATER SPRINKLER
  - UWEL- UNDERGROUND ELECTRIC LINE
  - UWL- UNDERGROUND WATER LINE
  - USW- UNDERGROUND SANITARY SEWER
  - USD- UNDERGROUND STORM DRAIN
  - FL- FENCE LINE

FIGURE NO 3

KCI # 28133363.14

	<b>KCI TECHNOLOGIES INC.</b> ENGINEERS, SURVEYORS AND PLANNERS	
	1352 MARROWS ROAD SUITE 100 NEWARK, DE 19711 PHONE (302) 731-9176 • FAX (302) 731-7807	
	<b>BORING PLAN</b> BALTIMORE NATIONAL CEMETERY 5501 FREDERICK AVE CATONSVILLE, MD 21228 BALTIMORE COUNTY	
	DATE: 08/05/2015	SCALE: 1" = 50'



## **TEST BORING LOGS**



PROJECT **Baltimore National Cemetery**

PROJECT NO. **27133363.14**

Surface Elevation **296 (ft)**

# TEST BORING LOG

## C-1

SHEET **1** OF **1**

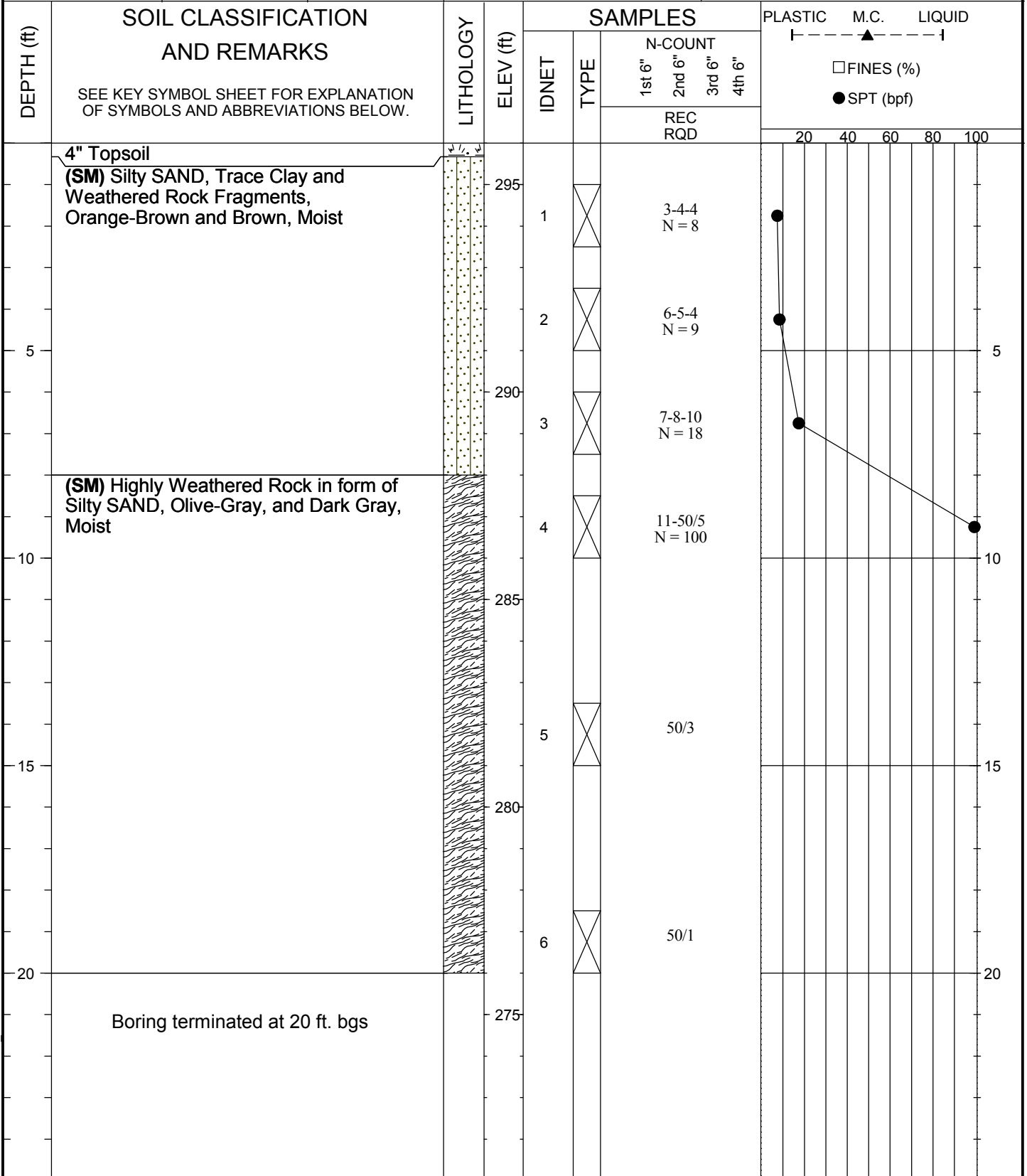
Driller: **Shane/D&S** Method: **HSA** Casing Length: **18.5 ft** Date Begun: **11/17/2015**

KCI Representative: **TL** Hammer Type: **Automatic** Casing Diameter: Date Completed: **11/17/2015**

### Groundwater Levels (feet)

0 hour:   Dry  

24 hours:   NA  







PROJECT **Baltimore National Cemetery**

PROJECT NO. **27133363.14**

Surface Elevation **295 (ft)**

# TEST BORING LOG

## C-2

SHEET **1** OF **1**

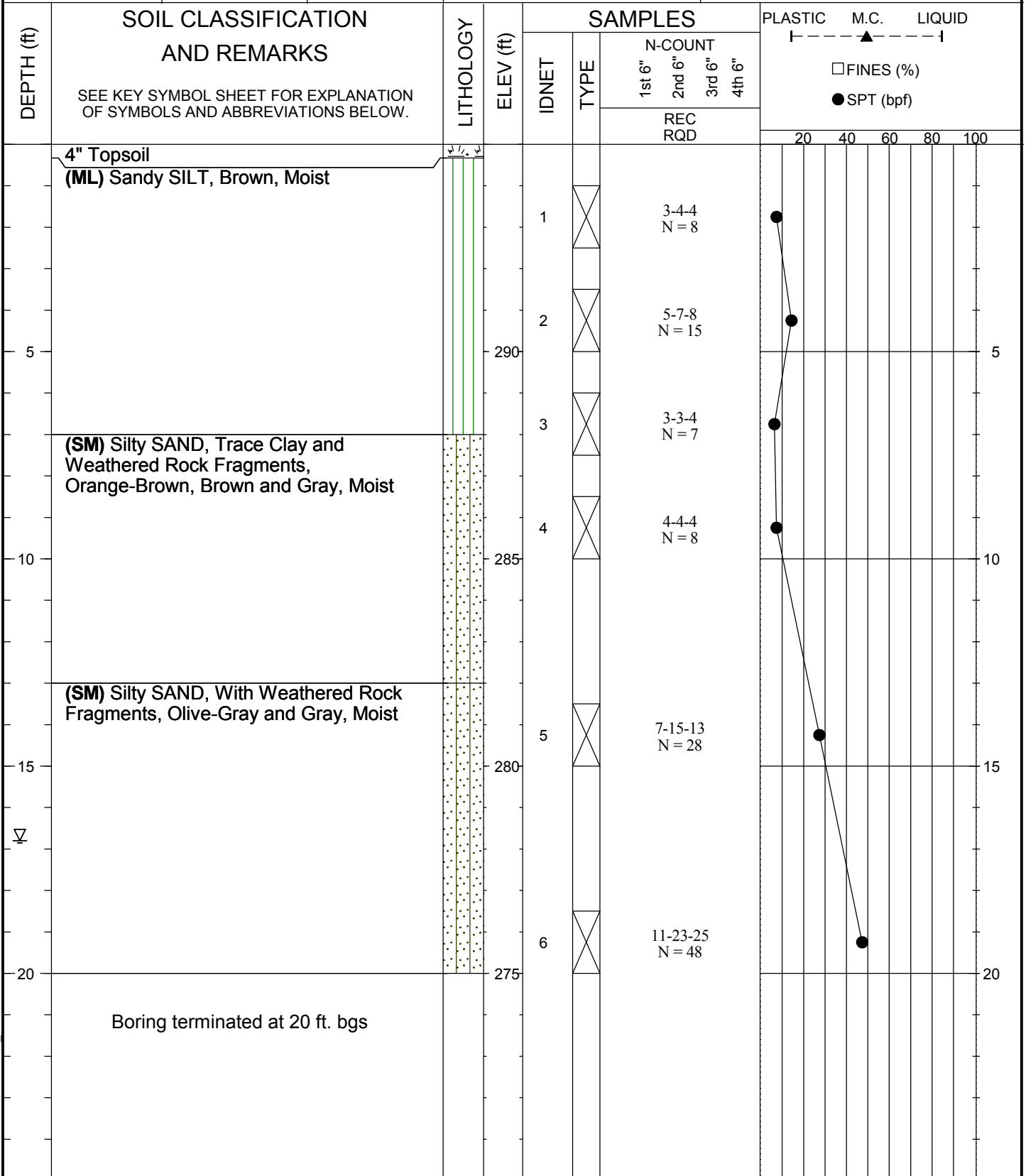
Driller: **Shane/D&S** Method: **HSA** Casing Length: **18.5 ft** Date Begun: **11/17/2015**

KCI Representative: **TL** Hammer Type: **Automatic** Casing Diameter: Date Completed: **11/17/2015**

### Groundwater Levels (feet)

0 hour: 16.8 ▽

24 hours: NA





PROJECT **Baltimore National Cemetery**

PROJECT NO. **27133363.14**

Surface Elevation **293 (ft)**

# TEST BORING LOG

## C-3

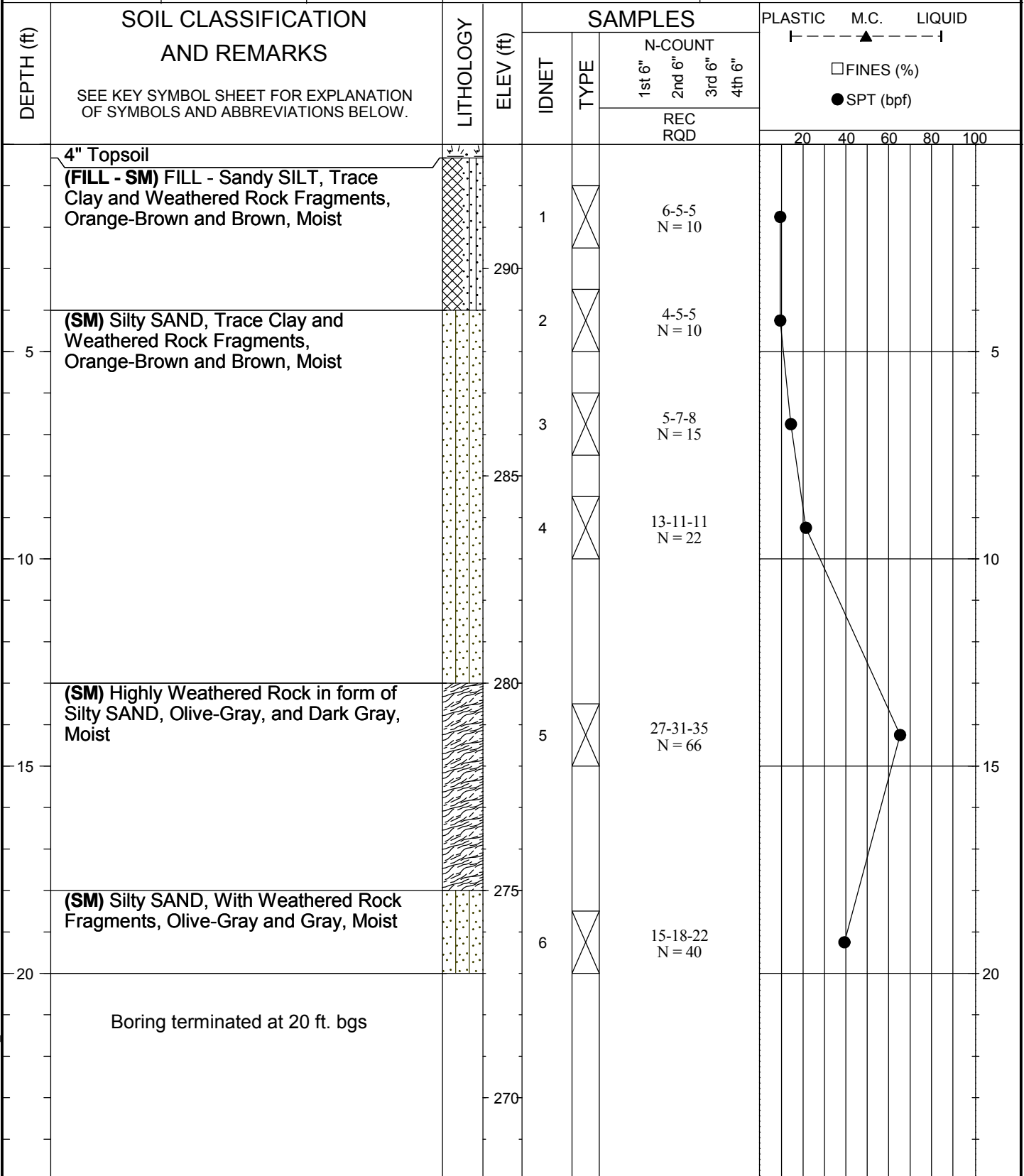
SHEET **1** OF **1**

Driller: **Shane/D&S** Method: **HSA** Casing Length: **18.5 ft** Date Begun: **11/17/2015**

KCI Representative: **TL** Hammer Type: **Automatic** Casing Diameter: Date Completed: **11/17/2015**

### Groundwater Levels (feet)

0 hour:   Dry    
24 hours:   NA  





PROJECT **Baltimore National Cemetery**

PROJECT NO. **27133363.14**

Surface Elevation **313 (ft)**

# TEST BORING LOG

## R-1

SHEET **1** OF **1**

Driller: **Shane/D&S** Method: **HSA** Casing Length: **8.5 ft** Date Begun: **11/16/2015**

KCI Representative: **TL** Hammer Type: **Automatic** Casing Diameter: Date Completed: **11/16/2015**

### Groundwater Levels (feet)

0 hour: Dry  
24 hours: NA

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS  SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LITHOLOGY	ELEV (ft)	SAMPLES				PLASTIC M.C. LIQUID						
				IDNET	TYPE	N-COUNT				I-----▲-----I				
						1st 6"	2nd 6"	3rd 6"	4th 6"	□ FINES (%) ● SPT (bpf)				
						REC	RQD							
	5" Topsoil							20	40	60	80	100		
	(ML) Sandy SILT, Trace Clay, Orange-Brown and Brown, Moist			1		4-5-10 N = 15								
			310											
5				2		7-8-10 N = 18								
													5	
	(SM) Silty SAND, Trace Weathered Rock Fragments, Orange-Brown, Olive-Gray, and Dark Gray, Moist			3		5-7-7 N = 14								
			305											
10				4		9-12-9 N = 21								
													10	
	Boring terminated at 10 ft. bgs													
			300											
15													15	
			295											
20													20	
			290											



PROJECT **Baltimore National Cemetery**

PROJECT NO. **27133363.14**

Surface Elevation **301 (ft)**

# TEST BORING LOG

## R-2

SHEET **1** OF **1**

Driller: **Shane/D&S** Method: **HSA** Casing Length: **8.5 ft** Date Begun: **11/16/2015**

KCI Representative: **TL** Hammer Type: **Automatic** Casing Diameter: Date Completed: **11/16/2015**

### Groundwater Levels (feet)

0 hour: Dry

24 hours: NA

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS  SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LITHOLOGY	ELEV (ft)	SAMPLES				PLASTIC M.C. LIQUID						
				IDNET	TYPE	N-COUNT				I-----I				
						1st 6"	2nd 6"	3rd 6"	4th 6"	▲				
						REC RQD				□ FINES (%) ● SPT (bpf)				
	5" Topsoil							20	40	60	80	100		
	(SM) Silty SAND, Trace Weathered Rock Fragments, Orange-Brown and Brown, Moist		300	1		7-9-15 N = 24			●					
	(SM) Highly Weathered Rock in form of Silty SAND, Olive-Gray, and Dark Gray, Moist			2		50/4								
5													5	
			295	3		50/3								
				4		50/1								
10													10	
	Boring terminated at 10 ft. bgs		290											
15			285										15	
20			280										20	



PROJECT **Baltimore National Cemetery**

PROJECT NO. **27133363.14**

Surface Elevation **297 (ft)**

# TEST BORING LOG

## R-3

SHEET **1** OF **1**

Driller: **Shane/D&S** Method: **HSA** Casing Length: **8.5 ft** Date Begun: **11/16/2015**

KCI Representative: **TL** Hammer Type: **Automatic** Casing Diameter: Date Completed: **11/16/2015**

### Groundwater Levels (feet)

0 hour: Dry

24 hours: NA

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS  SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LITHOLOGY	ELEV (ft)	SAMPLES				PLASTIC      M.C.      LIQUID ┌-----▲-----┐  □ FINES (%) ● SPT (bpf)						
				IDNET	TYPE	N-COUNT				20	40	60	80	100
						1st 6"	2nd 6"	3rd 6"	4th 6"					
						REC	RQD							
	5" Topsoil													
	(ML) Sandy SILT, Trace Clay and Weathered Rock Fragments, Orange-Brown and Brown, Moist		295	1				2-3-4 N = 7						
5				2				7-13-9 N = 22						5
	(SM) Silty SAND, Trace Weathered Rock Fragments, Orange-Brown, Olive-Gray, and Dark Gray, Moist		290	3				4-5-6 N = 11						
10				4				11-16-22 N = 38						10
	Boring terminated at 10 ft. bgs		285											
15			280											15
20			275											20



PROJECT **Baltimore National Cemetery**

PROJECT NO. **27133363.14**

Surface Elevation **293 (ft)**

# TEST BORING LOG

## R-4

SHEET **1** OF **1**

Driller: **Shane/D&S** Method: **HSA** Casing Length: **8.5 ft** Date Begun: **11/17/2015**

KCI Representative: **TL** Hammer Type: **Automatic** Casing Diameter: Date Completed: **11/17/2015**

### Groundwater Levels (feet)

0 hour: Dry

24 hours: NA

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS  SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LITHOLOGY	ELEV (ft)	SAMPLES				PLASTIC M.C. LIQUID				
				IDNET	TYPE	N-COUNT				□ FINES (%)	● SPT (bpf)	
						1st 6"	2nd 6"	3rd 6"	4th 6"			
						REC	RQD					
	4" Topsoil											
	(FILL - SM) FILL - Sandy SILT, Trace Clay and Weathered Rock Fragments, Orange-Brown and Brown, Moist			1		2-1-2						
			290									
5	(ML) Sandy SILT, Trace Weathered Rock Fragments, Brown, Moist			2		1-7-10						5
						N = 17						
				3		6-5-7						
						N = 12						
			285									
10	(SM) Silty SAND, Trace Weathered Rock Fragments, Orange-Brown, Moist			4		6-6-8						10
						N = 14						
	Boring terminated at 10 ft. bgs											
			280									
15												15
			275									
20												20
			270									



PROJECT **Baltimore National Cemetery**

PROJECT NO. **27133363.14**

Surface Elevation **343 (ft)**

# TEST BORING LOG

## I-1

SHEET **1** OF **1**

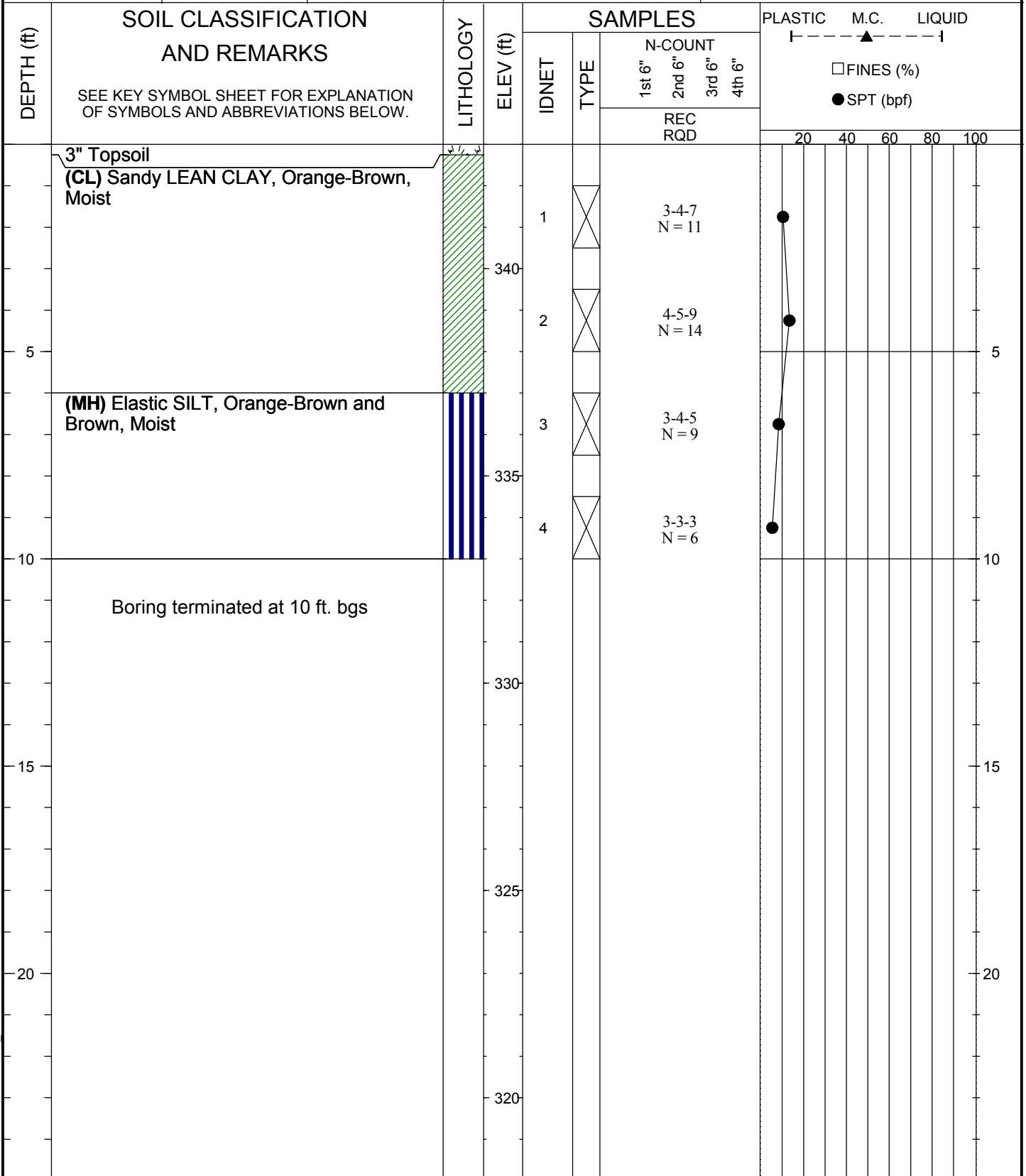
Driller: **Shane/D&S** Method: **HSA** Casing Length: **8.5 ft** Date Begun: **11/16/2015**

KCI Representative: **TL** Hammer Type: **Automatic** Casing Diameter: Date Completed: **11/16/2015**

### Groundwater Levels (feet)

0 hour: Dry

24 hours: NA





PROJECT **Baltimore National Cemetery**

PROJECT NO. **27133363.14**

Surface Elevation **333 (ft)**

# TEST BORING LOG

## I-2

SHEET **1** OF **1**

Driller: **Shane/D&S** Method: **HSA** Casing Length: **8.5 ft** Date Begun: **11/16/2015**

KCI Representative: **TL** Hammer Type: **Automatic** Casing Diameter: Date Completed: **11/16/2015**

### Groundwater Levels (feet)

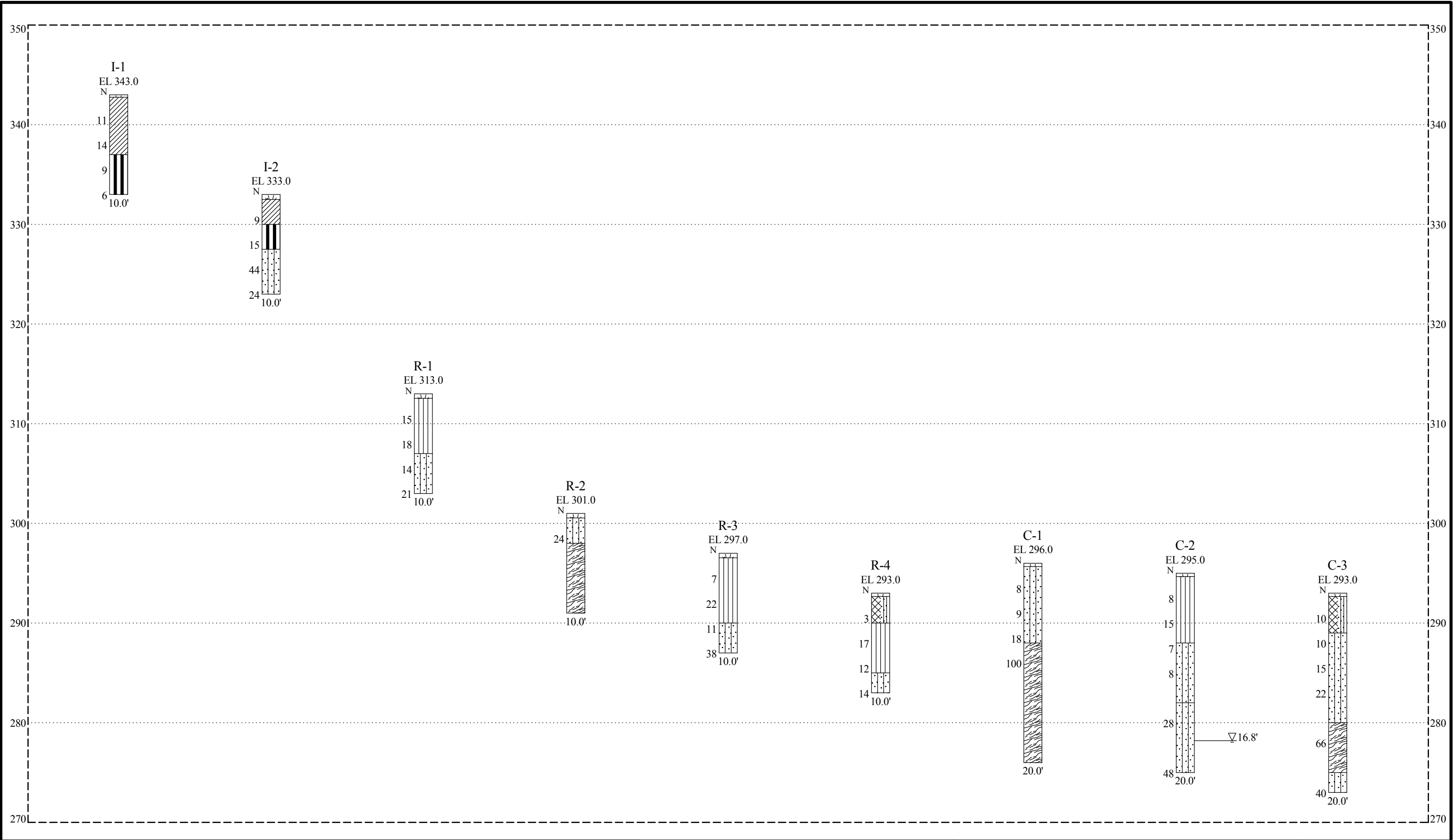
0 hour: Dry

24 hours: NA

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS  SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LITHOLOGY	ELEV (ft)	SAMPLES				PLASTIC M.C. LIQUID				
				IDNET	TYPE	N-COUNT				□ FINES (%)	● SPT (bpf)	
						1st 6"	2nd 6"	3rd 6"	4th 6"			
						REC	RQD					
	6" Topsoil											
	(CL) Sandy LEAN CLAY, Orange-Brown, Moist			1		3-4-5						
						N = 9						
			330									
5	(MH) Elastic SILT, Orange-Brown and Brown, Moist			2		5-6-9						
						N = 15						
												5
	(SM) Silty SAND, Trace Weathered Rock Fragments, Orange-Brown and Dark Gray, Moist			3		40-32-12						
			325			N = 44						
				4		12-11-13						
10						N = 24						10
	Boring terminated at 10 ft. bgs											
			320									
15												15
			315									
20												20
			310									



KCI 11X17 W/LOGO2 PLOG 27133363\_14 BALTIMORE NAT CEM.GPJ MD SHA REVISED TEMPLATE.GDT 11/30/15



USCS SOIL KEY		GW		SW		ML		OL
		GP		SP		MH		OH
		GM		SM		CL		FILL
		GC		SC		CH		CWR



ENGINEERS AND PLANNERS  
936 Ridgebrook Road  
Sparks, MD 21152-9390  
(410) 316-7800

Title: Baltimore National Cemetery			Figure No.
Soil Profile			4
Drawn: DPC	Approved: TL	Date: 11/30/15	KCI Job No. 27133363.14

The general field procedures employed by KCI are summarized in ASTM specification D 420 entitled “Investigating and Sampling Soils and Rocks for Engineering Purposes”. This recommended practice lists recognized methods for determining soil and rock distribution and ground water conditions. These methods include geophysical and in-situ borings.

Borings are advanced to obtain subsurface samples using one of several techniques depending upon the site and subsurface conditions. These techniques are:

1. Hollow-stem augers;
2. Wash borings using roller cone or drag bits (mud or water);
3. Continuous flight augers (ASTM D 1452);

The standard penetration test (SPT) borings are performed in accordance with ASTM D 1586. The SPT method consisted of advancing a two-inch outside diameter sampling spoon to a depth of 18 inches by driving it with a 140-pound hammer falling 30 inches. The values reported on the boring logs are the blows required to advance three successive six-inch increments. The first six-inch increment is considered as seating. The sum of the number of blows for the second and third increments is the “N” value. The “N” value is used to determine the relative density of the soil. KCI obtained soil samples using the SPT method and sampling was performed at two and half-foot intervals to a depth of ten feet bgs and every five feet thereafter to boring terminations depth. Representative soil samples are obtained during these tests and used to classify the soils encountered. We place the recovered representative soil samples in six-inch glass jars and transport them to the laboratory for testing.

These drilling methods are not capable of penetrating through material designated as “refusal materials.” Refusal may result from hard cemented soil, soft watered rock, coarse gravel or boulders, thin rock seams, or the upper surface of sound continuous rock. Core drilling procedures are required to determine the character and continuity of refusal materials.

The Driller reports the subsurface conditions encountered during drilling on a field test boring record. The record contains information concerning the boring method, samples attempted and recovered, indications of the presence of various materials such as coarse gravel, cobbles, etc., and observation of ground water. It also contains the driller’s interpretation of the soil conditions between samples. Therefore, these boring records contain both factual and interpretive information.

A geotechnical engineer reviews the soils and rock samples plus the field boring records. The engineer classifies the soils in general accordance with the procedures outlined in ASTM Specification D 2488 and prepares the final boring records, which are the basis for all evaluations and recommendations.

The final test boring records represent our interpretation of the contents of the field records based on the results of the engineering examination and tests of the field samples. These records depict subsurface conditions at the specific locations and at the particular time when drilled. Soil conditions at other locations may differ from conditions occurring at these boring locations. Also, the passage of time may result in a change in the subsurface soil and ground water conditions at these boring locations. The lines designating the interface between soil or refusal materials on the records and on profiles represent approximate boundaries. The actual transition between materials may be gradual. The final Test Boring Records are included in Appendix B.

## **LABORATORY TESTING DATA**

**SUMMARY OF LABORATORY TESTING**  
**BALTIMORE NATIONAL CEMENTERY**

<b>PROJECT #:</b>	27133363.14	<b>SAMPLED:</b>	-	<b>JAY KAY TESTING, INC.</b>
<b>SAMPLES:</b>	12	<b>LOCATION:</b>	-	5233 Lehman Road, Suite 110
<b>REPORT:</b>	11/24/15	<b>REMARKS:</b>	-	Spring Grove, PA 17362 Phone: (410) 259-5101

BORING	SAMPLE	DEPTH	MC %	OM %	LL	PL	PI	% FINES	USCS
I-1	S-2	3.5-5.0	43.7	-	-	-	-	-	-
I-1	S-3	6.0-7.5	59.3	-	80	58	22	98.5	MH
I-1	S-4	8.5-10.0	58.2	-	-	-	-	-	-
I-2	S-2	3.5-5.0	20.2	-	57	30	27	89.2	MH
I-2	S-3	6.0-7.5	24.6	-	-	-	-	-	-
I-2	S-4	8.5-10.0	15.6	-	-	-	-	-	-
R-1	Bulk	1.0-5.0	13.2	-	38	25	13	65.9	ML
R-1	S-2	3.5-5.0	20.1	-	-	-	-	-	-
R-1	S-3	6.0-7.5	12.1	-	-	-	-	-	-
R-2	S-1	1.0-2.5	18.9	-	-	-	-	-	-
R-3	S-3	6.0-7.5	18.7	-	-	-	-	-	-
R-3	S-4	8.5-10.0	6.6	-	-	-	-	-	-

Jay Kay Testing, Inc. (AASHTO-Accredited)

BALTIMORE NATIONAL CEMENTERY

Boring: I-1

Sample: S-3

Depth: 6.0-7.5'

Project No.: 27133363.14

Sampled: -

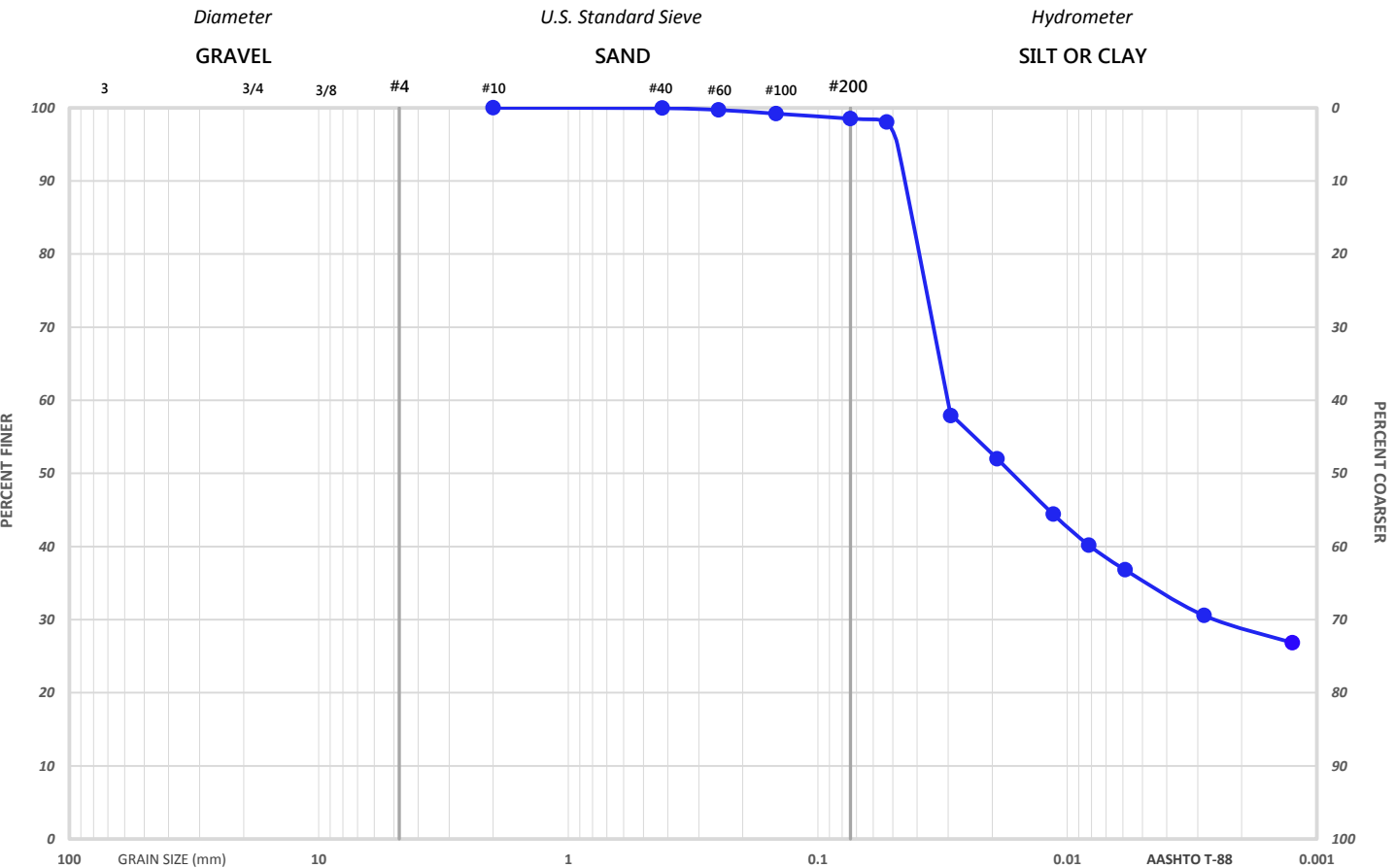
Location: -

JAY KAY TESTING, INC.

5233 Lehman Road, Suite 110

Spring Grove, PA 17362

Phone: (410) 259-5101



GRAIN SIZE ANALYSIS

Diameter	75.0	50.8	37.5	25.4	19.0	12.7	9.51	4.75	2.0	0.42	0.25	0.147	0.074
Sieve Size	3"	2"	1.5"	1"	3/4"	1/2"	3/8"	#4	#10	#40	#60	#100	# 200
% Passing	-	-	-	-	-	-	-	-	100.0	99.9	99.7	99.2	98.5

% GRAVEL	% SAND	Coarse Gravel	Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	CC	CU
-	1.5	-	-	-	0.1	1.4	-	-

Moisture Content

pH

59.3

-

Organic Content

Other

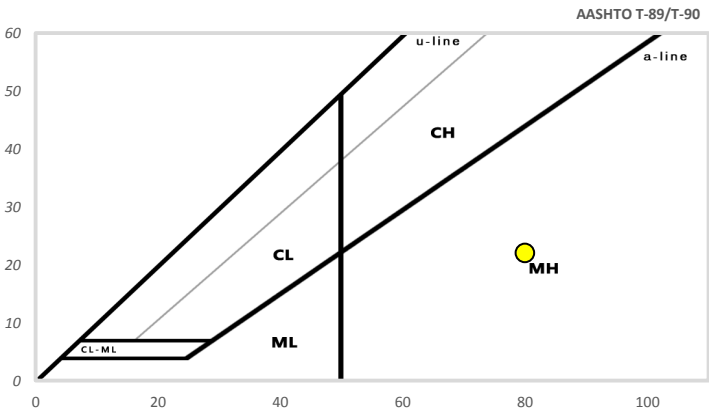
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-

ATTERBERG LIMITS	CLASSIFICATION
Liquid Limit	AASHTO
Plastic Limit	USCS
Plasticity Index	
80	A-7-5
58	MH
22	

SOIL DESCRIPTION

Orange brown elastic SILT



**JAY KAY TESTING, INC.**  
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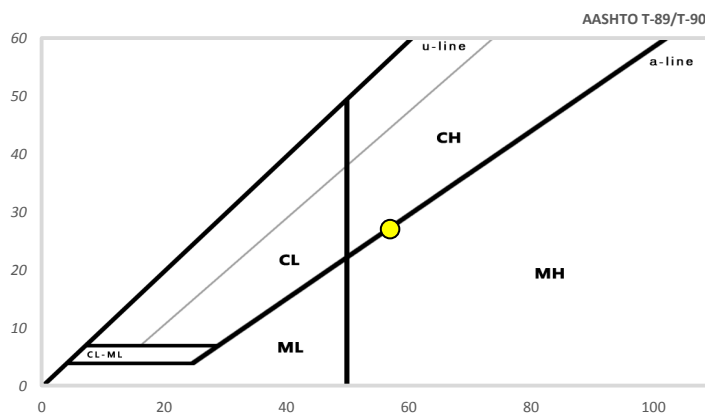
<i>Diameter</i>	75.0	50.8	37.5	25.4	19.0	12.7	9.51	4.75	2.0	0.42	0.25	0.147	0.074
<i>Sieve Size</i>	3"	2"	1.5"	1"	3/4"	1/2"	3/8"	#4	#10	#40	#60	#100	# 200
<i>% Passing</i>	-	-	-	-	-	-	-	-	100.0	99.9	94.4	91.3	89.2

% GRAVEL	% SAND	Coarse Gravel	Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	CC	CU
-	10.8	-	-	-	0.1	10.7	-	-

Moisture Content	20.2	Organic Content	-
pH	-	Other	-

ATTERBERG LIMITS		CLASSIFICATION	
Liquid Limit	57	AASHTO	A-7-5
Plastic Limit	30	USCS	MH
Plasticity Index	27		

Orange brown elastic SILT



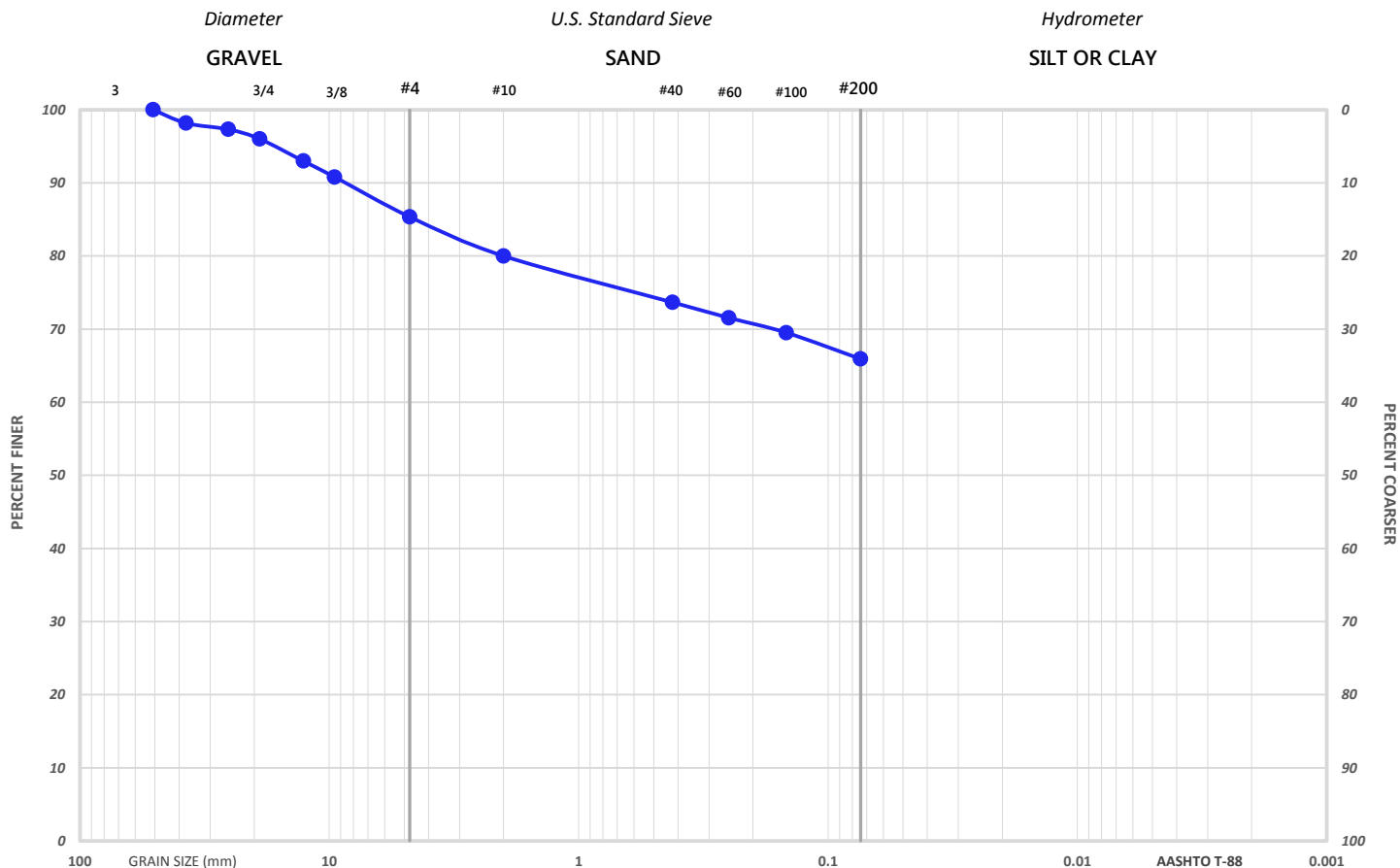


# BALTIMORE NATIONAL CEMENTERY

Boring: **R-1**  
 Sample: **Bulk**  
 Depth: **1.0-5.0'**

Project No.: 27133363.14  
 Sampled: -  
 Location: -

**JAY KAY TESTING, INC.**  
 5233 Lehman Road, Suite 110  
 Spring Grove, PA 17362  
 Phone: (410) 259-5101



GRAIN SIZE ANALYSIS

Diameter	75.0	50.8	37.5	25.4	19.0	12.7	9.51	4.75	2.0	0.42	0.25	0.147	0.074
Sieve Size	3"	2"	1.5"	1"	3/4"	1/2"	3/8"	#4	#10	#40	#60	#100	#200
% Passing	-	100.0	98.2	97.3	96.0	93.0	90.8	85.3	80.0	73.7	71.5	69.5	65.9

% GRAVEL	% SAND	Coarse Gravel	Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	CC	CU
14.7	19.4	4.0	10.7	5.3	6.3	7.8	-	-

Moisture Content 13.2  
 pH -

Organic Content -  
 Other -

## ATTERBERG LIMITS

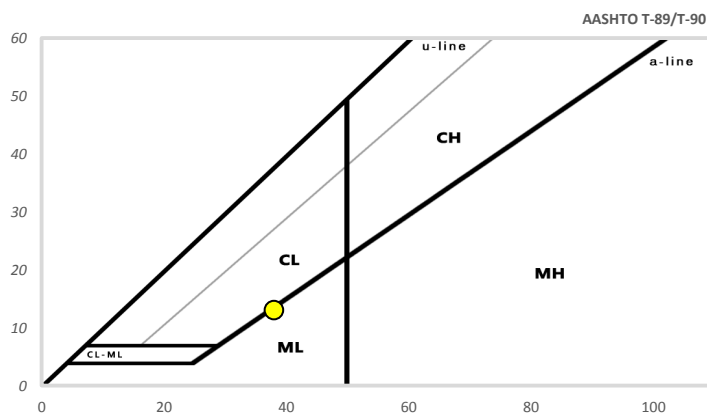
Liquid Limit 38  
 Plastic Limit 25  
 Plasticity Index 13

## CLASSIFICATION

AASHTO A-6  
 USCS ML

## SOIL DESCRIPTION

Orange brown sandy SILT



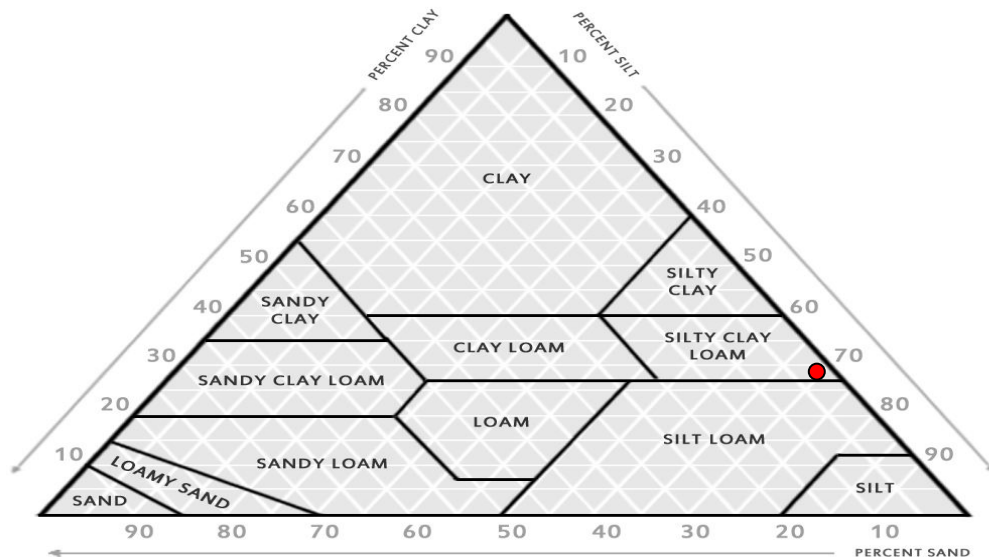
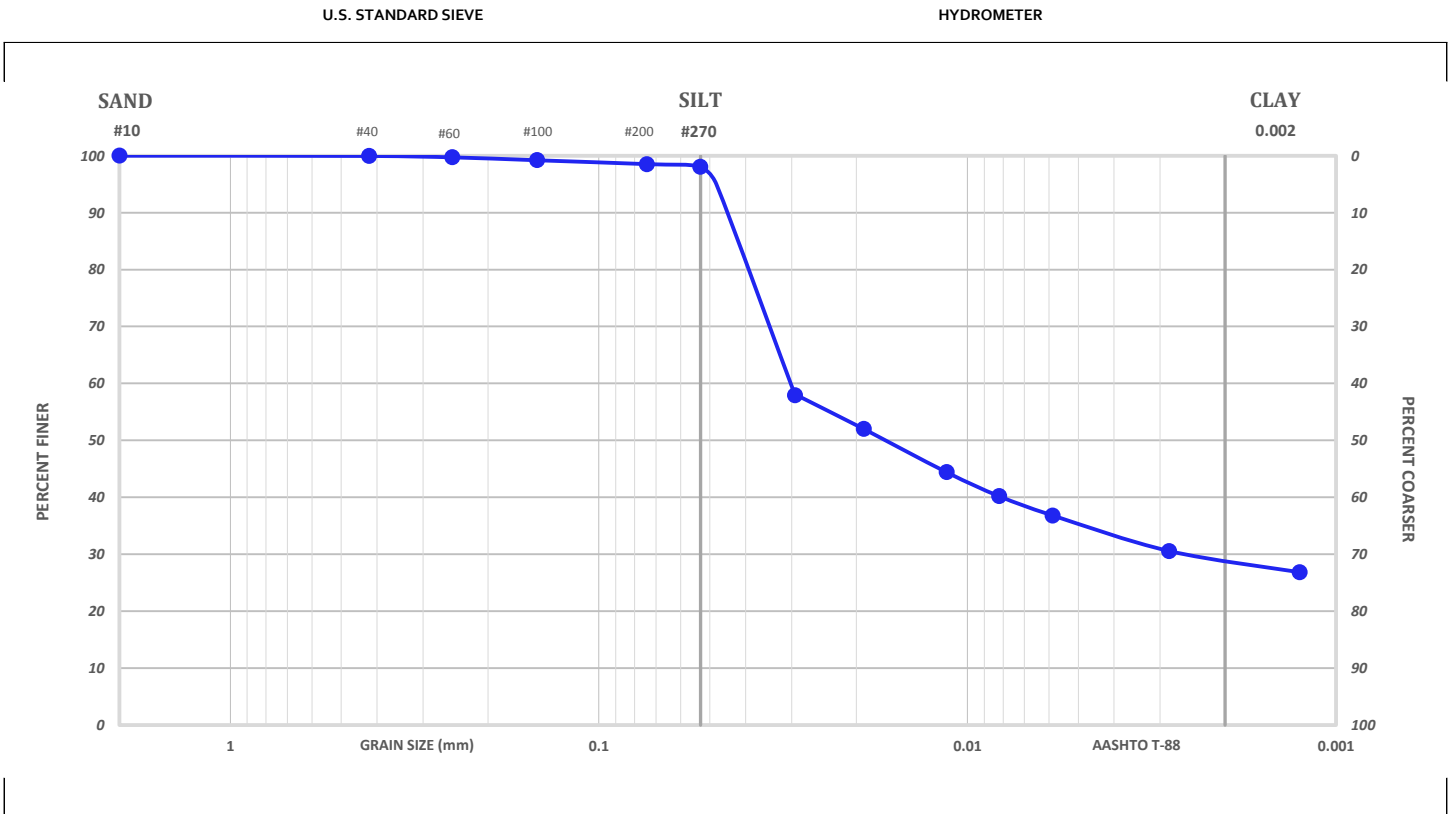
# BALTIMORE NATIONAL CEMENTERY

Boring: I-1  
Sample: S-3  
Depth: 6.0-7.5'

Project No.: 27133363.14  
Sampled: -  
Location: -

**JAY KAY TESTING, INC.**  
5233 Lehman Road, Suite 110  
Spring Grove, PA 17362  
Phone: (410) 259-5101

## USDA RESULTS



MC	LL	PL	PI	USCS	AASHTO
59.3	80	58	22	MH	A-7-5

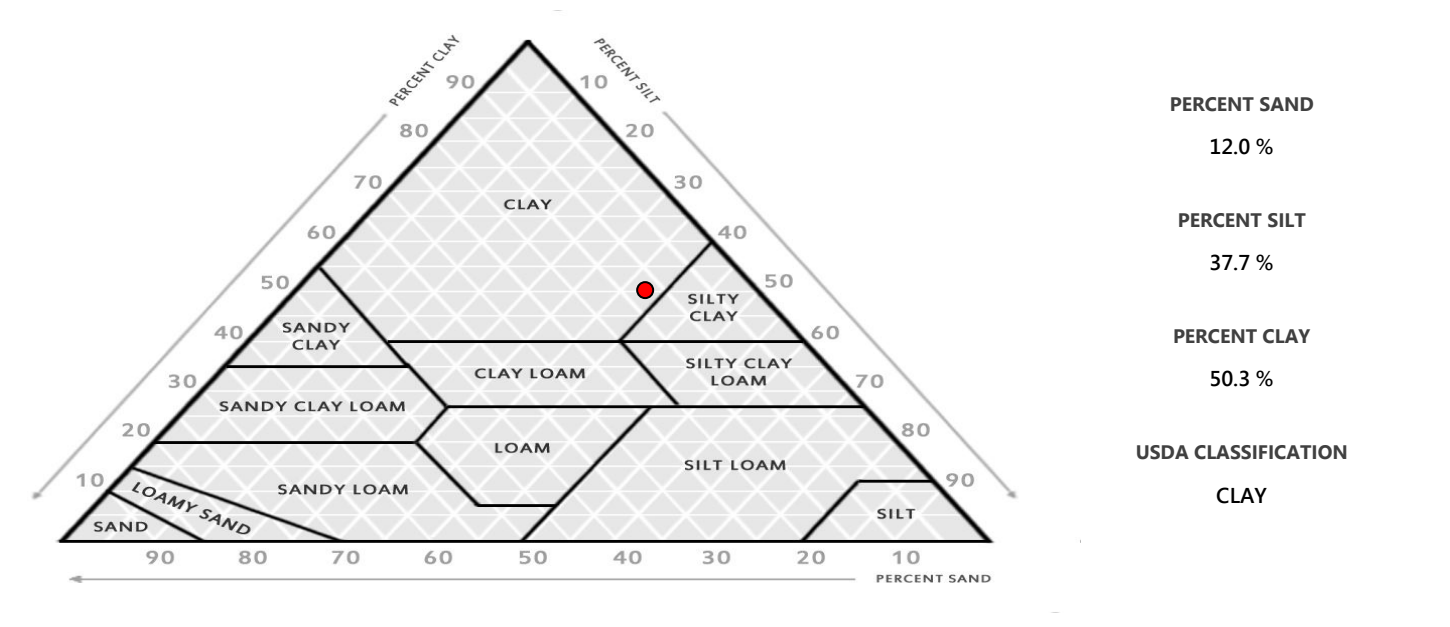
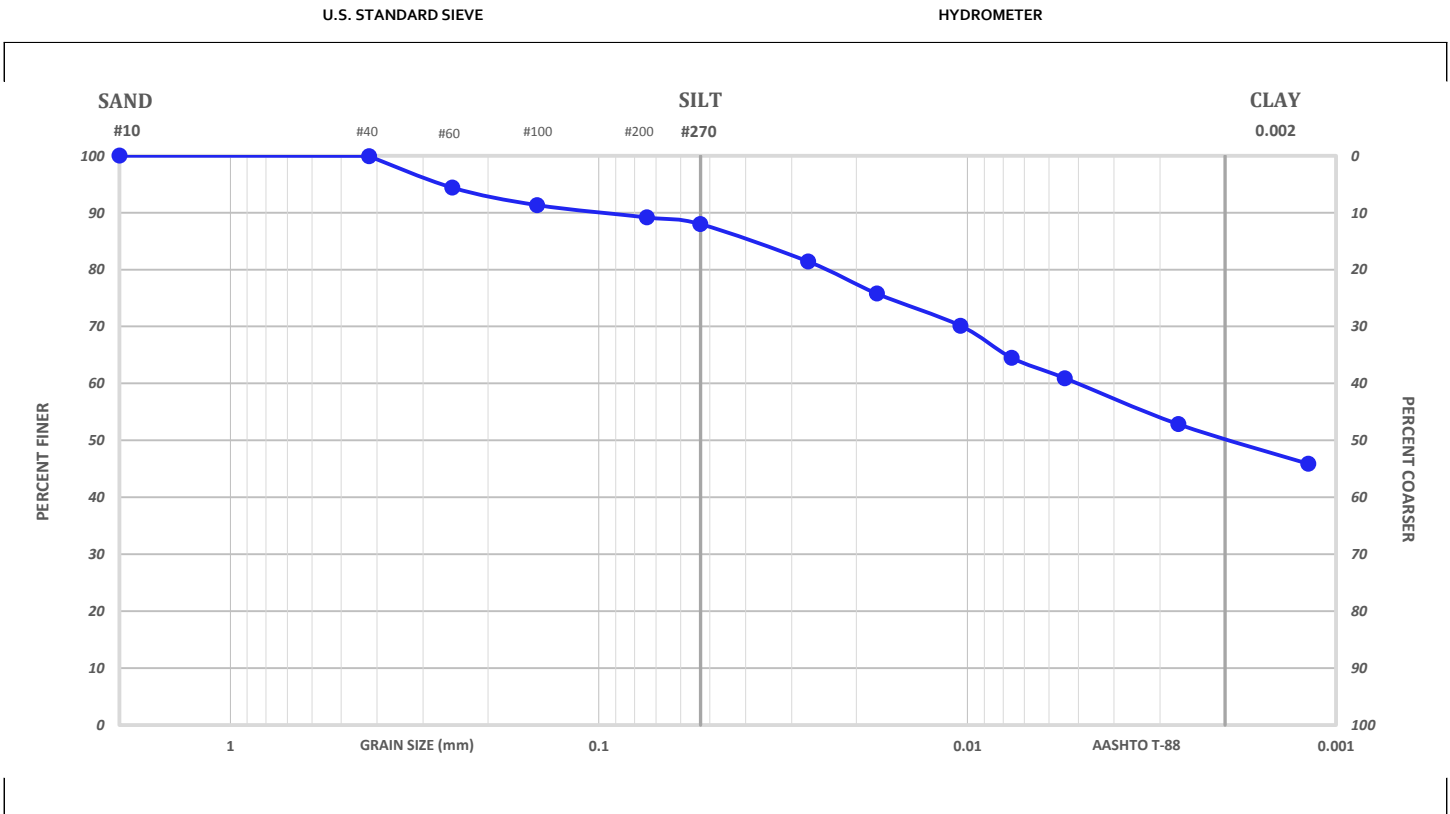
# BALTIMORE NATIONAL CEMENTERY

Boring: I-2  
Sample: S-2  
Depth: 3.5-5.0'

Project No.: 27133363.14  
Sampled: -  
Location: -

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Spring Grove, PA 17362  
Phone: (410) 259-5101

## USDA RESULTS



MC	LL	PL	PI	USCS	AASHTO
20.2	57	30	27	MH	A-7-5

BALTIMORE NATIONAL CEMENTERY

Boring: R-1

Sample: Bulk

Depth: 1.0-5.0'

Project No.: 27133363.14

Sampled: -

Location: -

JAY KAY TESTING, INC.

5233 Lehman Road, Suite 110

Spring Grove, PA 17362

Phone: (410) 259-5101

MODIFIED PROCTOR TEST RESULTS

TEST METHOD: AASHTO T-180 (C)

MAXIMUM DRY UNIT WEIGHT

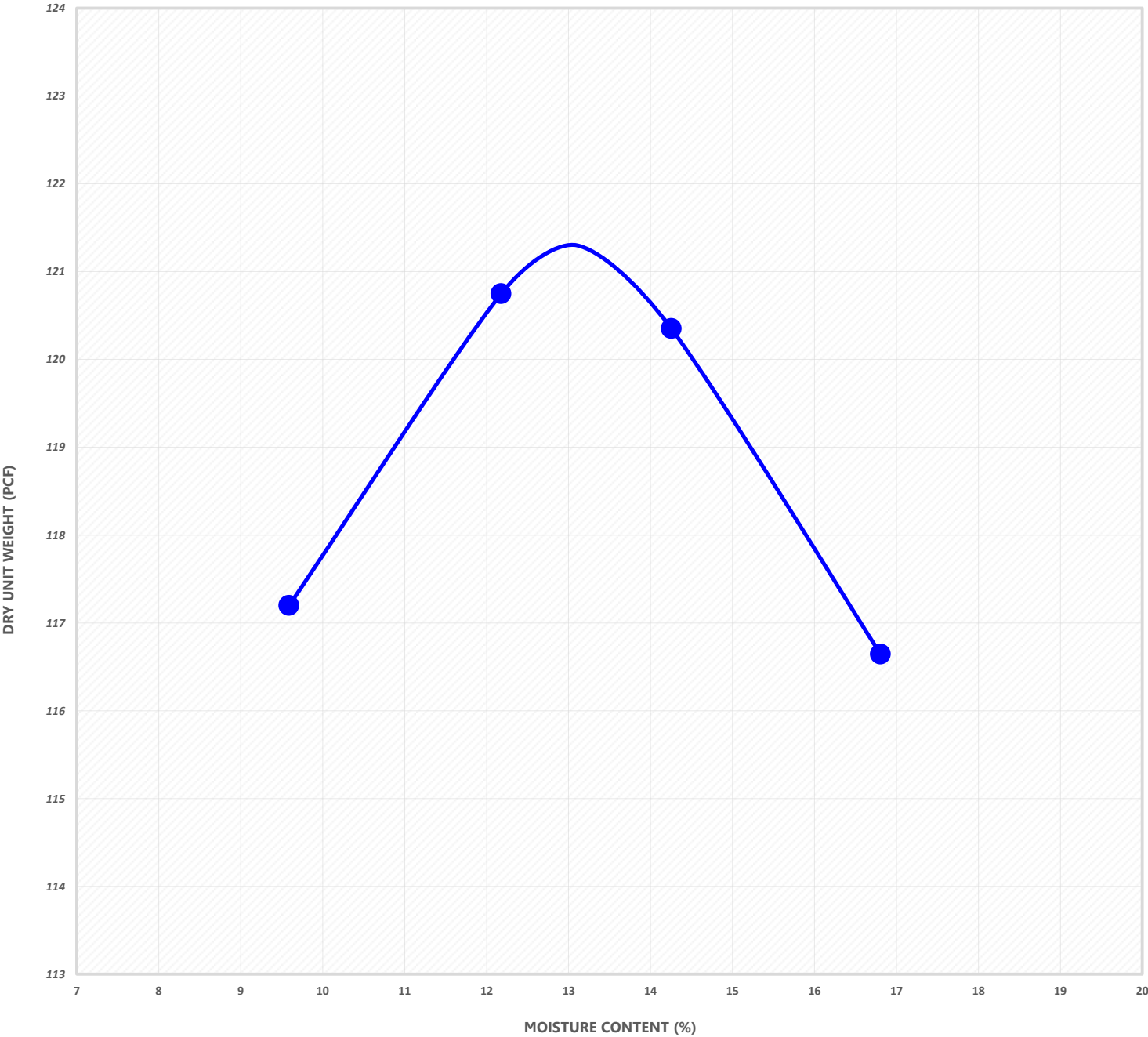
121.3

PCF

OPTIMUM MOISTURE CONTENT

13.1

%



MC	LL	PL	PI	USCS	AASHTO	FINES	SOIL DESCRIPTION
13.2	38	25	13	ML	A-6	65.9	Orange brown sandy SILT

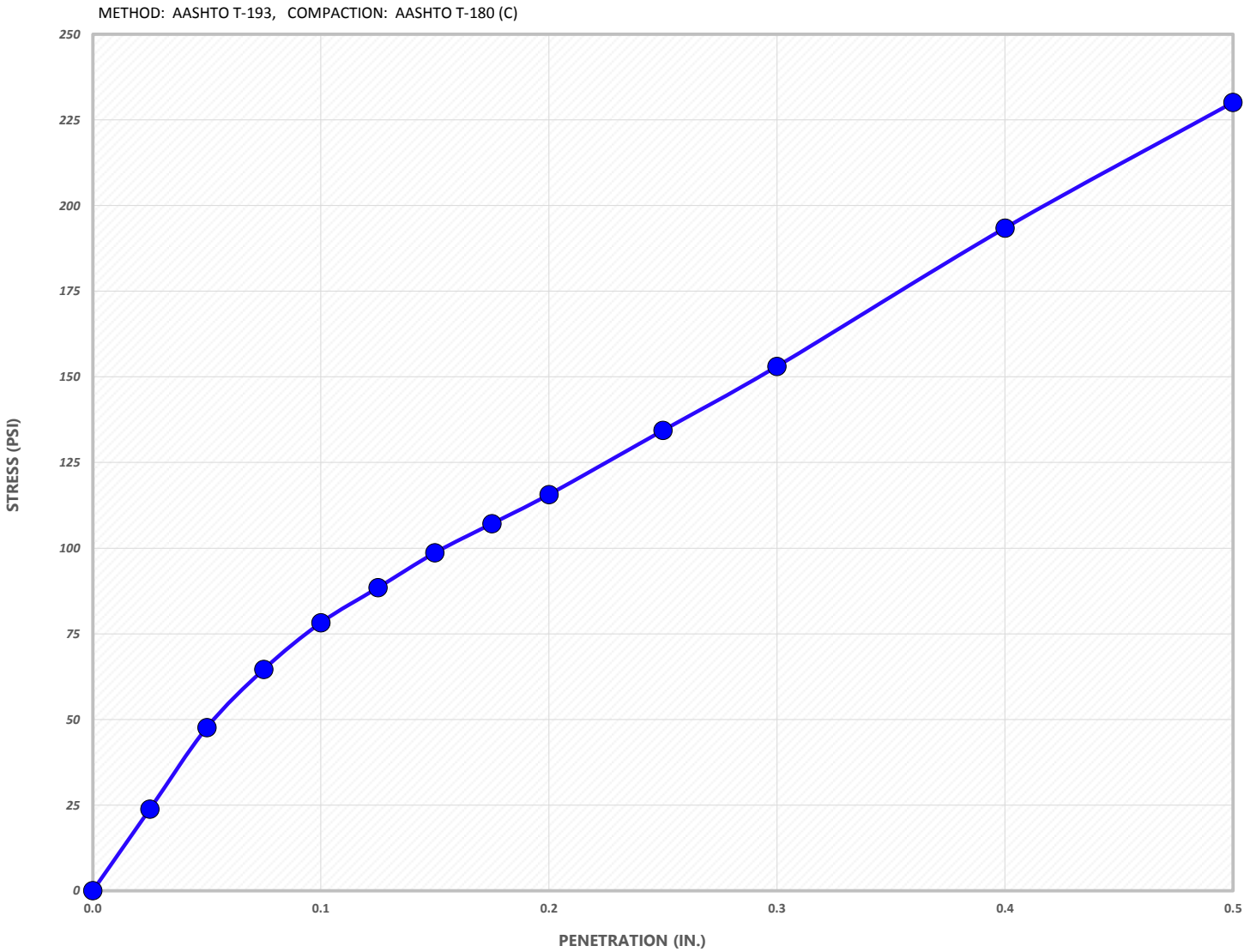
BALTIMORE NATIONAL CEMENTERY

Boring:	R-1	Project No.:	27133363.14	JAY KAY TESTING, INC.
Sample:	Bulk	Sampled:	-	5233 Lehman Road, Suite 110
Depth:	1.0-5.0'	Location:	-	Spring Grove, PA 17362
				Phone: (410) 259-5101

CALIFORNIA BEARING RATIO TEST RESULTS

CBR AT 0.1"	CBR AT 0.2"
7.8	7.7

	Dry Unit Weight	Moisture Content	Compaction	Swell	Surcharge
As Molded	109.5	13.5	90.3	-	75
After Soak	108.2	20.4	89.2	1.44	75
	PCF	%	%	%	PSF



MC	LL	PL	PI	USCS	AASHTO	FINES	SOIL DESCRIPTION
13.2	38	25	13	ML	A-6	65.9	Orange brown sandy SILT

BALTIMORE NATIONAL CEMENTERY

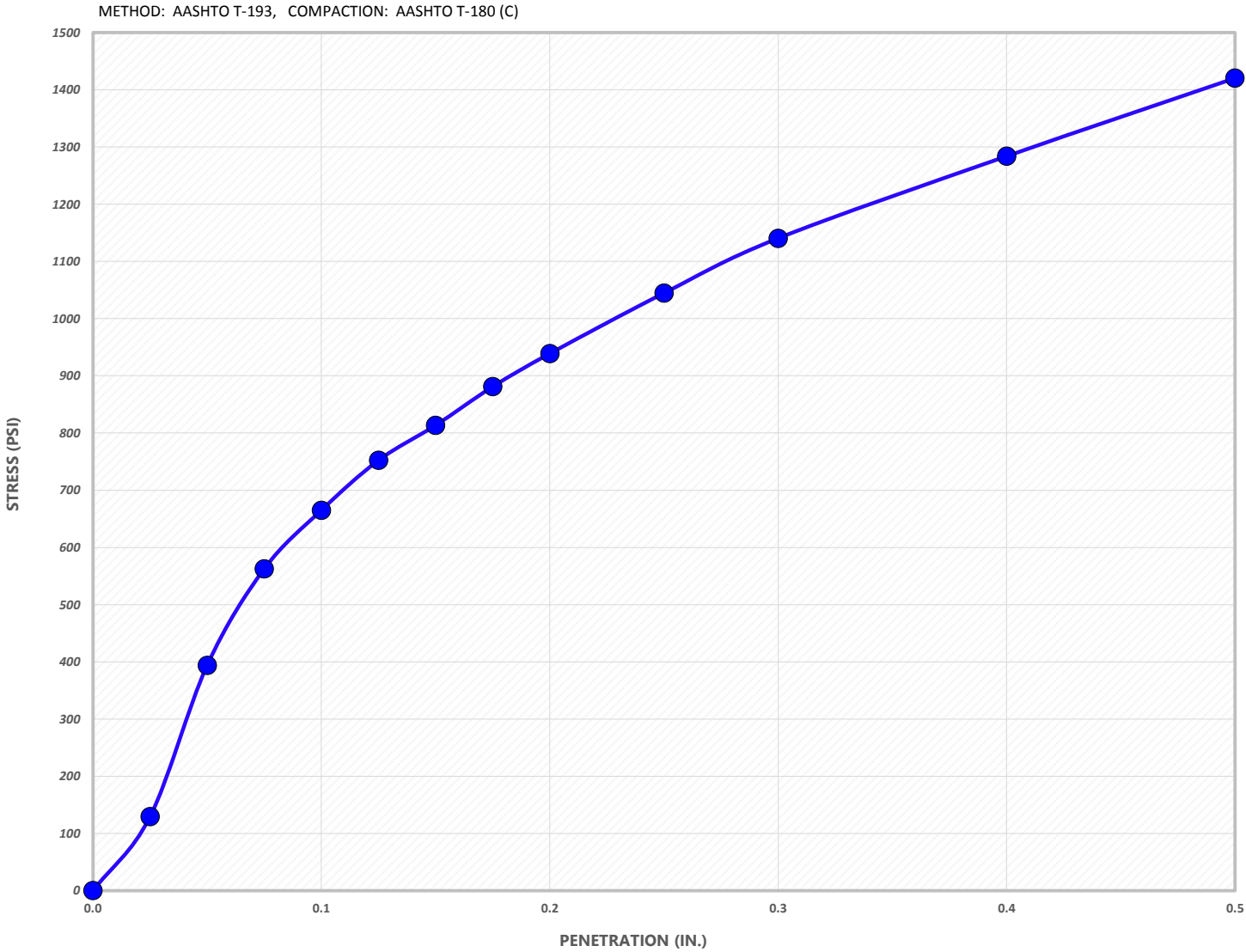
Boring:	R-1	Project No.:	27133363.14	JAY KAY TESTING, INC.
Sample:	Bulk	Sampled:	-	5233 Lehman Road, Suite 110
Depth:	1.0-5.0'	Location:	-	Spring Grove, PA 17362
				Phone: (410) 259-5101

CALIFORNIA BEARING RATIO TEST RESULTS

CBR AT 0.1"  
66.5

CBR AT 0.2"  
62.6

	Dry Unit Weight	Moisture Content	Compaction	Swell	Surcharge
As Molded	119.8	13.4	98.8	-	75
After Soak	118.2	16.9	97.4	0.83	75
	PCF	%	%	%	PSF



MC	LL	PL	PI	USCS	AASHTO	FINES	SOIL DESCRIPTION
13.2	38	25	13	ML	A-6	65.9	Orange brown sandy SILT



# BALTIMORE NATIONAL CEMENTERY

Boring: **R-1**  
 Sample: **Bulk**  
 Depth: **1.0-5.0'**

Project No.: 27133363.14  
 Sampled: -  
 Location: -

**JAY KAY TESTING, INC.**  
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## CALIFORNIA BEARING RATIO TEST RESULTS

	AS MOLDED			AFTER SOAK						
	Compaction	Density	Moisture	Compaction	Density	Moisture	CBR at 0.1"	CBR at 0.2"	Blows	Swell
●	90.3	109.5	13.5	89.2	108.2	20.4	7.8	7.7	15	1.44
▲	98.8	119.8	13.4	97.4	118.2	16.9	66.5	62.6	56	0.83
■	-	-	-	-	-	-	-	-	-	-
	%	PCF	%	%	PCF	%			#	%

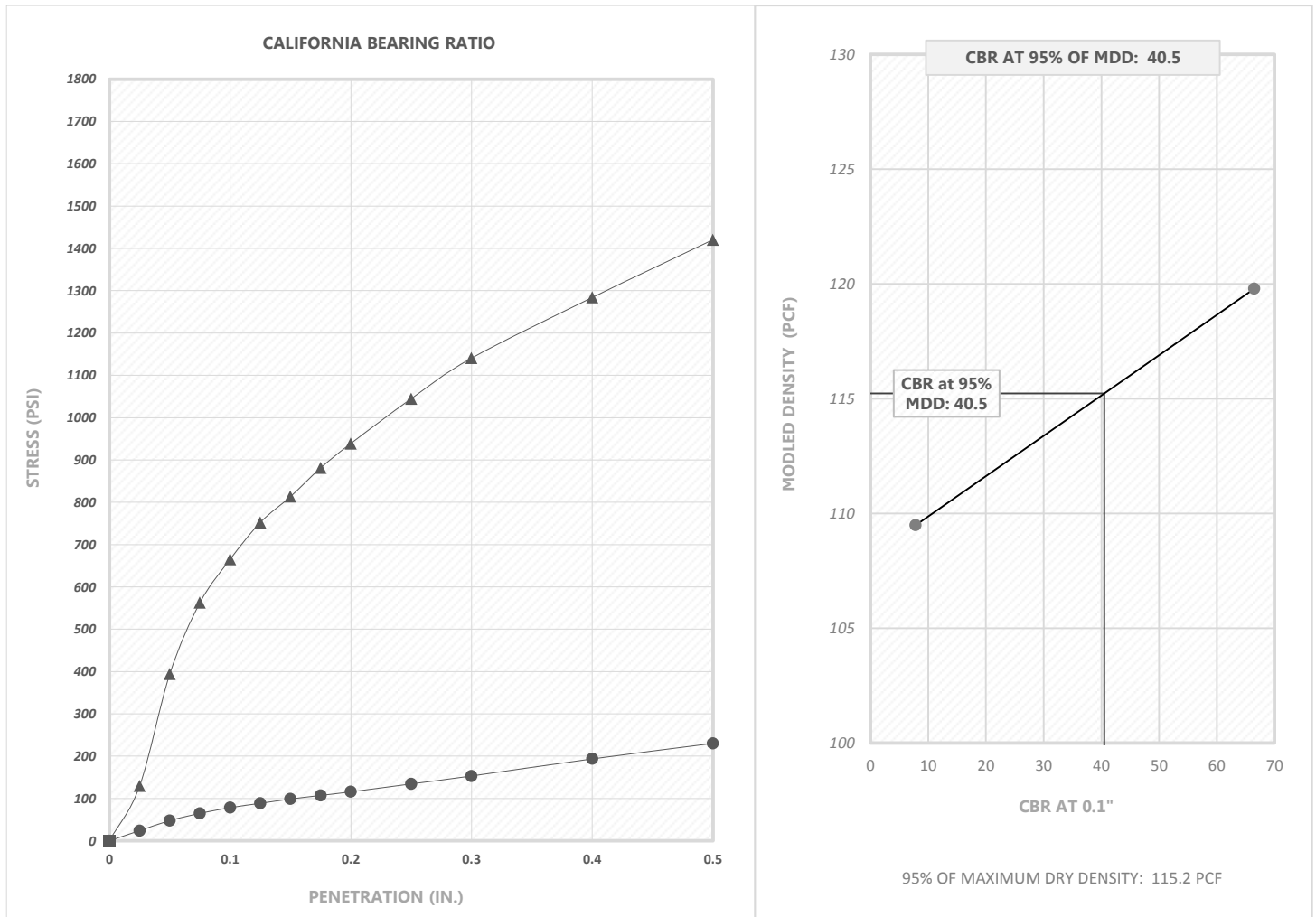
MAXIMUM DRY DENSITY  
121.3 PCF

OPTIMUM MOISTURE CONTENT  
13.1 %

COMPACTION METHOD  
AASHTO T-180 (C)

CBR METHOD  
AASHTO T-193

SURCHARGE  
75 PSF



MC	LL	PL	PI	USCS	AASHTO	FINES	SOIL DESCRIPTION
13.2	38	25	13	ML	A-6	65.9	Orange brown sandy SILT