October 6, 2016

Geotechnical Engineering Report

Quantico Middle/High School
Quantico Marine Corps Base
Quantico, Virginia

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Mr. Dan Meza, AIA, LEED AP
EwingCole
Federal Reserve Bank Building
100 N. 6th Street
Philadelphia, PA 19106-1590

Subject: **Geotechnical Engineering Report, Quantico Middle/High School, Quantico Marine Corps Base, Quantico, Virginia (GeoConcepts Project No. 13066)**

Dear Mr. Meza,

GeoConcepts Engineering, Inc. (GeoConcepts) is pleased to present the following geotechnical engineering report prepared for Quantico Middle/High School located on the east side of the Quantico Marine Corps Base in Virginia.

We appreciate the opportunity to serve as your geotechnical consultant on this project. Please do not hesitate to contact me if you have any questions or want to meet to discuss the findings and recommendations contained in the report.

Sincerely,

GEOCONCEPTS ENGINEERING, INC.

Rebecca L. Smith-Zakowicz, PG
Associate
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GeoConcepts Engineering, Inc.

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1.0 Scope of Services

This geotechnical engineering report presents the results of the field investigation, soil laboratory testing, and engineering analysis of the geotechnical data. This report specifically addresses the following:

- An evaluation of subsurface conditions within the area of the proposed site development, including a seismic site classification per the International Building Code, and metal corrosion and concrete attack potential of on-site soils.
- Foundation recommendations for support of the proposed building and lower floor slabs on grade.
- Lateral earth pressures and subdrainage for use in design of loading dock walls, basement walls, and site retaining walls, including recommended backfill requirements.
- An assessment of subgrade conditions for support of flexible and rigid pavements, including recommended flexible and rigid pavement sections based on an estimated design California Bearing Ratio (CBR) value and traffic loading information provided to us by others.
- Earthwork recommendations for construction of loadbearing fills, including an assessment of on-site soils to be excavated for re-use as fill.
- Recommendations for stormwater management by infiltration based on field infiltration tests and published correlations with soil classifications.

Services not specifically identified in the contract for this project are not included in the scope of services.

2.0 Site Description and Proposed Construction

The Quantico Middle/High School site is located within Quantico Marine Corps Base, Virginia. Specifically the site is located at 3307 Purvis Road and is currently developed with an existing middle/high school, playgrounds, and parking areas.

Based on information provided to us, the buildings associated with the existing middle/high school will be demolished and a new 2-story, approximately 116,050 SF middle/high school will be constructed in the same general vicinity, including parking areas, mechanical rooms, delivery areas, athletic fields with bleachers, and playgrounds. We have assumed that construction of the new buildings will occur at about

existing grades with no significant cuts and fills to reach the finished floor elevations. The proposed finished floor elevation is at about elevation (EL) 179, the commons and gym level is at about EL 177, and the auditorium will step down from EL 179 to EL 176. The estimated maximum column load is approximately 170 kips.

3.0 Subsurface Conditions

Subsurface conditions were investigated by drilling a total of 24 test borings at the site; 15 test borings in the proposed building areas and nine test borings in the proposed stormwater management (SWM) areas. Test boring logs and a boring location plan are presented in Appendix A of this report.

3.1 Geology

The Quantico Middle/High School site is located within the Coastal Plain Physiographic Province of Virginia. The Coastal Plain consists of a seaward thickening wedge of unconsolidated to semi-consolidated sedimentary deposits from the Cretaceous Geologic Period to the Holocene Geologic Epoch. These deposits represent marginal-marine to marine sediments consisting of interbedded sands and clays. The Coastal Plain is bordered to the east by the Atlantic Ocean and to the west by the Piedmont Physiographic Province. The dividing line between the Coastal Plain and the Piedmont is locally referred to as the "Fall Line". This name comes from the waterfalls that form as a result of the differential erosion that occurs as streams cross the Piedmont/Coastal Plain contact.

Specifically, according to local geologic maps, the site is mapped in the Potomac Formation of the Cretaceous geologic period. This formation consists of pebbly, poorly sorted sand interbedded with layers of sandy clay and silt. Based on our subsurface investigation, the sediments and strata correspond favorably to the geologic publications.

The existing fill soils of Stratum A are believed to be related to previous site grading. The natural soils assigned to Stratum B are believed to be Potomac Group sedimentary deposits. The Potomac Group sediments are the oldest sedimentary deposits in the Washington, DC area. These soils are known to be highly over-consolidated as a result of the weight of a substantial thickness of overlying soils that have since been eroded away. As a result of over-consolidation, Potomac Group soils have been pre-loaded and are capable of supporting substantial loads.

Given our knowledge of the site subsurface conditions, we do not foresee potential geologic and seismic hazards including slope instability, liquefaction, differential settlement, and surface displacement due to faulting or lateral spreading.

3.2 Stratification

The subsurface materials encountered have been stratified for purposes of our discussions herein. These stratum designations do not imply that the materials encountered are continuous across the site. Stratum designations have been established to characterize similar subsurface conditions based on material gradations and parent geology. The subsurface materials encountered in the test borings completed at the site have been assigned to the following strata:

Stratum A (Existing Fill)	generally firm, sandy lean clay, sandy silt, silty sand, and clayey sand, FILL, with gravel, dry to moist, brown
Stratum B1 (Potomac Group)	generally stiff, FAT CLAY (CH) with sand, sandy ELASTIC SILT (MH), and sandy SILT (ML), moist, orange, brown, gray, dark blue
Stratum B2 (Potomac Group)	firm to compact, silty SAND (SM) and clayey SAND (SC), moist to wet, brown, orange, white, gray, tan, tan-brown

The two letter designations included in the strata descriptions presented above and on the test boring logs represent the Unified Soil Classification System (USCS) group symbol and group name for the samples based on laboratory testing per ASTM D-2487 and visual classifications per ASTM D-2488. It should be noted that visual classifications per ASTM D-2488 may not match classifications determined by laboratory testing per ASTM D-2487.

3.3 Groundwater

Groundwater level observations were made in the field during drilling and up to one day after the completion of the test borings. Longer-term groundwater level readings were obtained in temporary observation standpipes installed in test borings TB-1 and TB-7. Groundwater was encountered at depths of about 28 to 35 feet below the existing ground surface. Accordingly, groundwater should be at least 25 feet below the proposed finished floor levels, and permanent dewatering should not be required for this project. A summary of the water level readings rounded off to the nearest 0.5 feet elevation is presented in the table below.

Test Boring No.	Depth to Groundwater (feet)	Groundwater Elevation (feet)
TB-1	31.0	147.0
TB-3	28.0	149.5
TB-4	28.0	148.5
TB-7	33.5	145.0
TB-13	35.0	141.5
TB-15	33.0	141.0

The groundwater observations presented herein are considered to be an indication of the groundwater levels at the dates and times indicated. Accordingly, the groundwater information presented herein should be used with caution. Also, fluctuations in groundwater levels should be expected with seasons of the year, construction activity, changes to surface grades, precipitation, or other similar factors.

3.4 Soil Laboratory Test Results

Selected soil samples obtained from the field investigation were tested for grain size distribution, Atterberg limits, compaction characteristics using standard effort, California Bearing Ratio (CBR), and natural moisture contents. A summary of soil laboratory test results is presented below, and the results of natural moisture content tests are presented on the test boring logs in Appendix A.

Test Boring No.	Depth (ft)	Sample Type	Stratum	Description of Soil Specimen	Sieve Results		Atterberg Limits			Natural Moisture Content (%)	Remarks
					Percent Retained #4 Sieve	Percent Passing #200 Sieve	LL	PL	PI		
TB-1	28.5-30	Jar	B1	FAT CLAY (CH) with sand	0.0	72.2	65	26	39	31.1	--
TB-3	8.5-10	Jar	B1	sandy ELASTIC SILT (MH)	0.7	52.9	58	35	23	26.4	--
TB-3	28.5-30	Jar	B2	silty SAND (SM)	0.0	17.1	NP	NP	NP	24.1	--
TB-6	2.5-4	Jar	A	silty SAND (SM)	0.0	24.9	29	26	3	19.6	--
TB-6	18.5-20	Jar	B2	silty SAND (SM)	0.9	17.5	NP	NP	NP	14.4	--

Test Boring No.	Depth (ft)	Sample Type	Stratum	Description of Soil Specimen	Sieve Results		Atterberg Limits			Natural Moisture Content (%)	Remarks
					Percent Retained #4 Sieve	Percent Passing #200 Sieve	LL	PL	PI		
TB-7	13.5-15	Jar	B2	silty SAND (SM)	8.4	14.1	NP	NP	NP	14.1	--
TB-10	5-6.5	Jar	A	clayey SAND (SC)	0.0	42.1	25	17	8	14.1	--
TB-12	13.5-10	Jar	B2	silty SAND (SM)	1.2	16.2	41	27	14	14.8	--
TB-12	18.5-20	Jar	B1	sandy SILT (ML)	0.0	60.5	49	29	20	36.3	--
TB-13	4-6	Jar	A	clayey SAND (SC)	0.6	30.7	55	24	31	16.4	--
TB-14	8.5-10	Jar	B2	silty SAND (SM)	5.7	15.3	54	35	19	13.1	--
SWM-9	6-8	Jar	A	silty SAND (SM)	4.5	26.7	48	29	19	14.6	--
SWM-11	4-6	Jar	A	sandy LEAN CLAY (CL)	0.0	54.5	34	22	12	22.3	--
CBR-1	0-5	Bulk	A	clayey SAND (SC)	1.1	44.7	26	19	7	12.0	CBR = 19.2
CBR-2	0-5	Bulk	A	clayey SAND (SC)	2.6	41.3	32	19	13	15.8	CBR = 11.4

Notes:
1. Soil tests are in accordance with applicable ASTM standards
2. Soil classification symbols are in accordance with Unified Soil Classification System
3. Visual identification of samples is in accordance with ASTM D-2488
4. Key to abbreviations: LL = liquid limit; PL = plastic limit; PI = plasticity index; NP = nonplastic; N/T = not tested

Chemical laboratory testing was not performed as part of this investigation; however, it should be noted that no visual or olfactory evidence of hazardous materials were observed during our subsurface investigation.

3.5 Seismic Site Classification

Based on the results of the subsurface investigation and our knowledge of local geologic conditions, the site soils have been assigned to a site class D per the International Building Code (IBC).

The site coefficients and adjusted Maximum Considered Earthquake (MCE) spectral response acceleration parameters were obtained from the USGS computer program, and are presented in the table below.

Mapped Spectral Accelerations for Site Class B and 5% Damping (Step 1)	Site Coefficients to Modify Accelerations Based on Site Classification D (Step 2)
Ss = 0.128(g)	Fa = 1.6
S1 = 0.053(g)	Fv = 2.4
MCE Spectral Response Accelerations (Step 3)	**Design Spectral Response Accelerations (Step 4)**
S_{MS} = 0.205(g) (=Ss*Fa)	S_{DS} = 0.137(g) (=2/3*S_{MS})
S_{M1} = 0.127(g) (=S1*Fv)	S_{D1} = 0.085(g) (=2/3*S_{M1})

3.6 Metal Corrosion/Concrete Attack Test Results

In addition to standard geotechnical soil laboratory testing, three samples were submitted to an analytical laboratory for metal corrosion and concrete attack testing. Corrosion testing consisted of analysis for

moisture content (ASTM D-2216), pH (EPA 9045), resistivity (ASTM G57), sulfides (EPA 9030), and reduction-oxidation potential (ASTM D-1498 mod.). The results of these tests are presented below:

Test Boring No.	Sample Depth (feet)	Moisture Content (%)	pH	Resistivity (ohm – cm)	Sulfides (ppm)	Red-ox Potential (mV)	Point Total
TB-1	2.5-6.5	11	5.4	39,000	<1.2	+150	3
TB-4	2.5-6.5	11	6.0	38,000	<1.2	+179	3
TB-15	2.5-6.5	18	4.0	39,000	<1.2	+389	3

For each test presented above, points are assigned based on the range of the test results. If the total points from the five tests completed for a particular sample are 10 or more, the soil is considered to be corrosive. The methods described herein are based on information from the American Water Works Association (AWWA). Using the methods described by AWWA, the point total for the samples tested averaged 3. Accordingly, the site soils are considered non-corrosive.

Sulfate (CA Test 417) tests were performed on selected soil samples to determine the severity of sulfate attack on concrete structures. The results of sulfate testing are presented in the table below.

Test Boring No.	Sample Depth (feet)	Sulfate Concentration (ppm)
TB-1	2.5-6.5	9.2
TB-4	2.5-6.5	5.7
TB-15	2.5-6.5	19

Based on correlations between sulfate concentrations and severity of sulfate attack as presented in American Concrete Institute (ACI) 318, the above sulfate concentrations are considered to pose a negligible threat of sulfate attack on concrete.

4.0 Engineering Analysis

Recommendations regarding foundations, lower floor slabs, lateral earth pressures, pavements, earthwork, and stormwater management by infiltration are presented herein.

4.1 Spread Footings

Based on the finished floor elevations for the proposed building, firm existing fill, natural soils, or new compacted fill should be encountered at normal spread footing depths. Spread footings founded in these materials are considered suitable for support of the proposed building, and may be designed with a net allowable soil bearing pressure of 3,000 psf when using a factor of safety of 2.5. Fill material and compaction requirements are presented in Section 4.5 of this report. Spread footing bearing capacity and settlement calculations are presented in Appendix C.

Exterior footing subgrades should be located at least 2 feet below final exterior grades for frost considerations. Individual column footings and continuous wall footings should be at least 30 inches and 18 inches wide, respectively, for local or punching shear considerations. A maximum slope of one horizontal to one vertical (1H:1V) should be maintained between the bottom edges of adjacent footings, including between existing and proposed footings. Settlement of spread footings should not exceed about 1.0-inch,

and differential settlement between adjacent foundation elements should not exceed about 0.5-inch, including not exceeding an angular distortion of 0.002 inch/inch along continuous wall footings.

In order to achieve the design bearing pressure, lowering or undercutting of specific footings may be required. It is critical that all footing subgrades be observed and approved for the appropriate bearing pressure by the geotechnical engineer, prior to placement of steel reinforcement or concrete. The spread footing bearing pressure should be confirmed by in-situ Dynamic Cone Penetration (DCP) testing per ASTM STP 399. Footings should be excavated and concrete placed the same day in order to avoid disturbance from water or weather. Disturbance of footing subgrades by exposure to water seepage or weather conditions should be avoided. Any existing fill, disturbed, frozen, or soft subgrade soils should be removed prior to placing footing concrete. It may be desirable to place a 3 to 4-inch thick "mud mat" of lean concrete immediately on the approved footing subgrade to avoid softening of the exposed subgrade. Forms may be used if necessary, but less subgrade disturbance is anticipated if excavations are made to the required dimensions and concrete placed against the soil. If footings are formed, the forms shall be removed and the excavation backfilled as soon as possible. Water should not be allowed to pond along the outside of footings for long periods of time.

4.2 Finished Floor Slabs on Grade

Finished floor slabs supported by firm existing fill, natural soils, or new compacted fill are considered feasible at the site. The floor slab may be designed based on a modulus of subgrade reaction K_S of 150 pounds per cubic inch (pci). All debris and soft soils near the final floor slab subgrade as a result of construction operations should be stripped and removed prior to placement of underfloor stone. A 4-inch minimum thickness of washed gravel or crushed stone meeting the requirement of AASHTO No. 57 should be placed below floor slabs on grade to serve as a capillary break. An impermeable plastic membrane should be placed on top of the crushed stone layer to assist as a moisture barrier. Special attention should be given to the surface curing of the slab in order to minimize uneven drying of the slab and associated cracking. Underfloor subdrainage is not recommended since groundwater is expected to be below the finished floor levels.

We recommend mesh (fiber or welded wire fabric) reinforcement be included in the design of the floor slab to minimize the development of any shrinkage cracks near the surface of the slab. If welded wire fabric is used, the mesh should be located in the top half of the slab.

4.3 Lateral Earth Pressures

Below grade walls should be designed to withstand lateral earth pressures. An equivalent fluid pressure of 60H (psf) should be used for design of loading dock and basement walls, and 40H (psf) for design of site retaining walls, where H refers to the height of the wall. The design should account for any surcharge loads within a 45 degree slope from the base of the walls. Retaining walls may be designed to include a passive equivalent fluid pressure of 360D (psf), where D represents the depth of wall embedment below the exposed wall face. The upper 1.5 feet of soil at the base of retaining walls should not be included in the design of passive soil resistance. A coefficient of friction of 0.35 may be used for sliding resistance at the soil/concrete interface. Recommended lateral earth pressure diagrams for use in the design of loading dock walls, basement walls, and site retaining walls are presented as Figures 1 through 3, respectively, at the end of this report.

Hydrostatic pressures are not included in the lateral earth pressure diagrams assuming the use of relatively granular or free draining backfill, and perimeter subdrainage (weepholes) at the base of walls below grade. Recommendations for backfill against walls below grade are presented in Section 4.5 of this report.

4.4 Pavements

Traffic data was estimated by GeoConcepts based on parking spaces and roadway pavement areas. The table below summarizes the estimated design traffic data for the pavement section analyses:

Design Parameter	Value
Year	**2014**
Average Daily Traffic (ADT) – Light Duty	200**
Average Daily Traffic (ADT) – Heavy Duty	3,000**
Average Daily Traffic (ADT) – Fire Lane	100**
Traffic Growth Rate	1.0**
Number of Lanes	2
Design Lane Factor	1.0*
Directional Split	50/50**
Percent Single Unit Trucks – Light Duty	15**
Percent Heavy Trucks – Heavy Duty	1**
Percent Heavy Trucks – Fire Lane	20**
18-Kip Equivalency Factor – Trailer Trucks (Flexible Pavement)	1.05*
18-Kip Equivalency Factor – Trailer Trucks (Rigid Pavement)	1.59*

* Values from Pavement Design Standards
** Assumption for Analysis Purposes

The design ESAL's presented in the table below were developed from the traffic data for the design lane with a 25-year service life for flexible pavement and 30-year service life for rigid pavement:

Pavement Design Situation	Design ESAL's
Cumulative Equivalent 18-Kip Trucks for Light Duty Flexible Pavement (Year 2014)	71,355
Cumulative Equivalent 18-Kip Trucks for Heavy Duty Flexible Pavement (Year 2014)	805,873
Cumulative Equivalent 18-Kip Trucks for Fire Lane Rigid Pavement (Year 2014)	368,194

Pavement sections were designed based on the 1993 AASHTO Guide for Design of Pavement Structures. For the rigid pavement design, the PCC elastic modulus value was assumed using a typical value from Virginia - Section 604.03 Rigid Pavement Design Chapter VI – VDOT Pavement Evaluation and Design Manual of Instruction. Pavement recommendations for the new flexible and rigid pavements were developed based on a roadbed soil resilient modulus of 15,000 psi.

Three pavement designs were analyzed and are recommended for the proposed development: 1) Light Duty Flexible Pavement, 2) Heavy Duty Flexible Pavement, and 3) Fire Lane Rigid Pavement. The following design parameters were used in the AASHTO Design Equation for the flexible and rigid pavements:

Design Parameter	Design Value – Flexible Pavements	Design Value – Rigid Pavements
Initial Serviceability	4.0	4.5
Terminal Serviceability	2.0	2.8
Standard Deviation	0.49	0.39
Reliability	85%	90%

Based on the estimated design CBR/resilient modulus value and traffic loading, the following flexible and rigid pavement sections are recommended at this site. Pavement design calculations are presented in Appendix C of this report.

Light Duty Flexible Pavement Section

Flexible Pavement Layers	Thickness (inches)
SM-9.5A for Surface	1.5
BM-25.0A for Base	2.5
Graded Aggregate Subbase	6.0

Heavy Duty Flexible Pavement Section

Flexible Pavement Layers	Thickness (inches)
SM-9.5A for Surface	1.5
BM-25.0A for Base	3.0
Graded Aggregate Subbase	6.0

Fire Lane Rigid Concrete Section

Continuously Reinforced Concrete Pavement (CRCP)*	
Concrete Design Strength (psi)	4,000
Concrete Thickness, T (inches)	6.0
Minimum Percent Steel Reinforcement Required	0.1 (WWF placed at mid-depth of the slab)
Dowel Requirements at Transverse Construction Joints	3/4 inch diameter smooth bars, 18 inches long at 12-inches center to center spacing
Graded Aggregate Subbase (inches)	8.0

* A maximum 25 feet transverse joint spacing is recommended, with sawcut depths at T/3 (2.33-inch).

Construction traffic activity on partially constructed pavement sections may result in subgrade and pavement failures due to the reduced support qualities of a partially constructed pavement section and the relatively heavy loads associated with construction traffic. Accordingly, consideration should be given to the construction of designated haul roads where the thickness of the granular subbase and/or asphalt base course has been increased to account for the heavier-loaded construction traffic. We suggest that placement of the asphalt surface course not occur until all the major construction has been completed for

pavement areas subjected to construction traffic. To minimize damage to light duty pavement areas during and after construction, consideration should be given to restricting access by construction and any future commercial (non-passenger vehicle) traffic onto the light duty pavement areas, where possible.

The overall grading design should include suitable storm inlets and diversion structures for collecting surface runoff and to limit excessive ponding on paved surfaces. Specific surface drainage recommendations are beyond the scope of our services.

4.5 Earthwork

Fill will be required for site grading in building and pavement areas, and possibly backfill against walls below grade. Unsuitable existing fill, soft or loose natural soils, organic material, and rubble should be stripped to approved subgrades as determined by the geotechnical engineer. Topsoil depths presented on the boring logs should not be considered as stripping depths, as topsoil depths may vary widely across the site. Stripping depths will probably extend to greater depths than the topsoil depths indicated herein due to the presence of minor amounts of organics, roots, and other surficial materials that will require removal as a part of the stripping operations. In addition, seasonal soil moisture variations can affect stripping depths. In general, less stripping may occur during summer months when drier weather conditions can be expected. The depth of required stripping should be determined prior to construction by the excavation contractor using test pits, probes, or other means that the contractor wishes to employ, and this determination should be the responsibility of the excavation contractor. All subgrades should be proofrolled with a minimum 20 ton, loaded dump truck or suitable rubber tire construction equipment approved by the geotechnical engineer, prior to the placement of new fill.

The excavations may be constructed by laying back the earth with temporary slopes. Temporary excavations that may occur will generally extend through sandy soils. Based on the on-site soils, an OSHA type C soil classification should be used for design of earth slopes, which requires a maximum allowable slope of 1.5H:1V. Any benching of excavations should be performed in accordance with OSHA requirements.

For building areas, the new fill should extend at least 10 feet outside building lines. For parking areas, the new fill should extend at least 5 feet outside pavement edges. These recommendations are illustrated by Figure 4 at the end of this report.

Fill placed along slopes steeper than 5H:1V should be benched into the existing slope. Benches should consist of minimum 8 feet wide level cut, and at least one such bench should be used for each 3 feet of vertical rise of fill placed.

Fill material should be placed in lifts not exceeding 8 inches loose thickness, with fill materials compacted by hand operated tampers or light compaction equipment placed in maximum 4-inch thick loose lifts. Fill should be compacted at +/- 2% of the optimum moisture content to at least 95 percent of the maximum dry density per ASTM D-698.

Materials used for compacted fill for support of footings, floor slabs, and pavements should consist of soils classifying SC, SM, SP, SW, GC, GM, GP, or GW per ASTM D-2487, with a maximum dry density greater than 105 pcf. Materials used for backfill against walls below grade should consist of soils classifying SM, SP, SW, GM, GP, or GW, with a liquid limit and plasticity index less than 40 and 15 respectively. It is expected that the majority of soils excavated at the site will be suitable for re-use as fill based on classification. However, the Stratum A existing fill may not be suitable for re-use as new compacted fill due to deleterious man-made materials in the fill. In addition, drying of excavated soils by spreading and aerating may be necessary to obtain proper compaction. This may not be practical during the wet period of the year. Accordingly, earthwork operations should be planned for early Spring through late Fall, when drier weather conditions can be expected. Drying of fill materials by the use of lime may also be considered. However, in the event that lime is used, more specific details regarding the percentage of lime used and

installation techniques should be provided. Individual borrow areas, both from on-site and off-site sources, should be sampled and tested to verify classification of materials prior to their use as fill.

Fill materials should not be placed on frozen or frost-heaved soils, and/or soils that have been recently subjected to precipitation. All frozen or frost-heaved soils should be removed prior to continuation of fill operations. Borrow fill materials should not contain frozen materials at the time of placement.

Compaction equipment that is compatible with the soil type used for fill should be selected. Theoretically, any equipment type can be used as long as the required density is achieved; however, sheepsfoot roller equipment are best suited for fine-grained soils and vibratory smooth drum rollers are best suited for granular soils. Ideally, a smooth drum roller should be used for sealing the surface soils at the end of the day or prior to upcoming rain events. In addition, compaction equipment used adjacent to walls below grade should be selected so as to not impose undesirable surcharge on walls. All areas receiving fill should be graded to facilitate positive drainage of any water associated with precipitation and surface run-off.

For utility excavation backfill, we recommend that open graded stone be used to backfill the pipe trench to the spring line of the pipe. Backfill should be compacted in lifts not exceeding 6 inches loose thickness, to at least 95 percent of the maximum dry density per ASTM D-698. Hand operated compaction equipment should be used until the backfill has reached a level 1 foot above the top of the pipe to prevent damaging the pipe. Also, backfill material within 2 feet of the top of the pipe should not contain rock fragments or gravel greater than 1-inch in diameter.

After completion of compacted fill operations in building or pavement areas, construction of building elements or asphalt should begin immediately, or the finished subgrade should be protected from exposure to inclement weather conditions. Exposure to precipitation and freeze/thaw cycles will cause the finished subgrade to soften and become excessively disturbed. If development plans require that finished subgrades remain exposed to weather conditions after completion of fill operations, additional fill should be placed above finished grades to protect the newly placed fill. Alternatively, a budget should be established for reworking of the upper 1 to 2 feet of previously placed compacted fill.

4.6 Infiltration Analysis

Two methods were used to estimate infiltration capabilities on the subject site: in-situ infiltration testing and published correlations with soil classifications. Details regarding the in-situ infiltration and classification test techniques, the estimated infiltration rates from the individual methods, and the recommended design infiltration rate for the site soils are presented herein.

4.6.1 Infiltration Test Results

In-situ infiltration tests are performed in the field to observe the rate at which water will permeate the soil under saturated conditions. Nine test borings were drilled in the area of planned infiltration. Test borings were initially drilled to depths of at least 4 feet below the planned infiltration invert elevations, and allowed to remain open for a period of approximately 24 hours to allow any groundwater levels within the boreholes to stabilize. After 24 hours, offset infiltration test holes were drilled at the boring locations to planned infiltration invert elevations. Four-inch diameter PVC casing was set to the bottom of the test holes. The purpose of the casing is to prevent caving of test hole sidewalls. After setting the PVC casing, the borehole was filled with water to saturate the bottom subsoils. The following day, the test hole was refilled with water and the water level in each test hole was recorded every hour for a 4-hour period. Using this procedure, the average change in the water level over the 4-hour period is considered the infiltration rate. Based on the results of the in-situ infiltration tests, estimated infiltration rates have been assigned for the site soils, as presented in the table below:

Test Boring No.	Approximate Test Depth (feet)	Estimated Infiltration Rate (inches/hour)
SWM-1	10	3.9

Test Boring No.	Approximate Test Depth (feet)	Estimated Infiltration Rate (inches/hour)
SWM-3	10	2.0
SWM-5	10	0.6
SWM-7	10	5.3
SWM-8	10	4.5
SWM-9	10	1.9
SWM-11	10	0.0
SWM-13	5	16.3
SWM-16	5	14.5

4.6.2 Classification Test Results

The classification test method is performed with grain-size sieve analyses including hydrometer testing on samples obtained from corresponding proposed infiltration depths, to determine the USDA soil texture classifications. Published correlations between USDA classifications and infiltration rates were used to provide estimated hydraulic conductivity values. Since hydraulic conductivity and infiltration values are essentially equal at no head conditions, using the hydraulic conductivity values to estimate the infiltration rates provides a conservative estimate of infiltration for use in design. Estimated infiltration rates using the USDA soil texture classifications are presented below.

Test Boring No.	Approximate Test Depth (feet)	USDA Soil Texture Classification	Estimated Infiltration Rate (inches/hour)
SWM-1	10-12	Sandy Loam	1.02
SWM-3	8-10	Sandy Loam	1.02
SWM-5	10-12	Loamy Sand	2.41
SWM-7	10-12	Loam	0.52
SWM-8	10-12	Sand	8.27
SWM-9	10-12	Sand	8.27
SWM-11	10-12	Sandy Loam	1.02
SWM-13	6-8	Sandy Loam	1.02
SWM-16	6-8	Loamy Sand	2.41

4.6.3 Recommended Design Infiltration Rate

Based on the results of the in-situ infiltration tests and soil laboratory classification tests, we recommend that a design infiltration rate of 0.52 inches/hour be used for design of infiltration structures. It should be noted that the recommended design infiltration rate presented herein is intended for use in design.

However, during construction, observations of the subgrade conditions should be made to confirm that the subgrade soils are consistent with the soils analyzed in this report.

5.0 General Limitations

Recommendations contained in this report are based upon the data obtained from the relatively limited number of test borings. This report does not reflect conditions that may occur between the points investigated, or between sampling intervals in test borings. The nature and extent of variations between test borings and sampling intervals may not become evident until the course of construction. Therefore, it is essential that on-site observations of subgrade conditions be performed during the construction period to determine if re-evaluation of the recommendations in this report must be made. It is critical to the successful completion of this project that GeoConcepts be retained during construction to observe the implementation of the recommendations provided herein.

This report has been prepared to aid in the evaluation of the site and to assist your office and the design professionals in the design of this project. It is intended for use with regard to the specific project as described herein. Changes in proposed construction, grading plans, structural loads, etc. should be brought to our attention so that we may determine any effect on the recommendations presented herein.

An allowance should be established for additional costs that may be required for foundation and earthwork construction as recommended in this report. Additional costs may be incurred for various reasons including wet fill materials, soft subgrade conditions, unexpected groundwater problems, etc.

This report should be made available to bidders prior to submitting their proposals to supply them with facts relative to the subsurface conditions revealed by our investigation and the results of analyses and studies that have been performed for this project. In addition, this report should be given to the successful contractor and subcontractors for their information only.

We recommend the project specifications contain the following statement: "A geotechnical engineering report has been prepared for this project by GeoConcepts Engineering, Inc. This report is for informational purposes only and should not be considered part of the contract documents. The opinions expressed in this report are those of the geotechnical engineer and represent their interpretation of the subsoil conditions, tests and results of analyses that they performed. Should the data contained in this report not be adequate for the contractor's purposes, the contractor may make their own investigations, tests and analyses prior to bidding."

This report was prepared in accordance with generally accepted geotechnical engineering practices. No warranties, expressed or implied, are made as to the professional services included in this report.

We appreciate the opportunity to be of service for this project. Please contact the undersigned if you require clarification of any aspect of this report.

Sincerely,

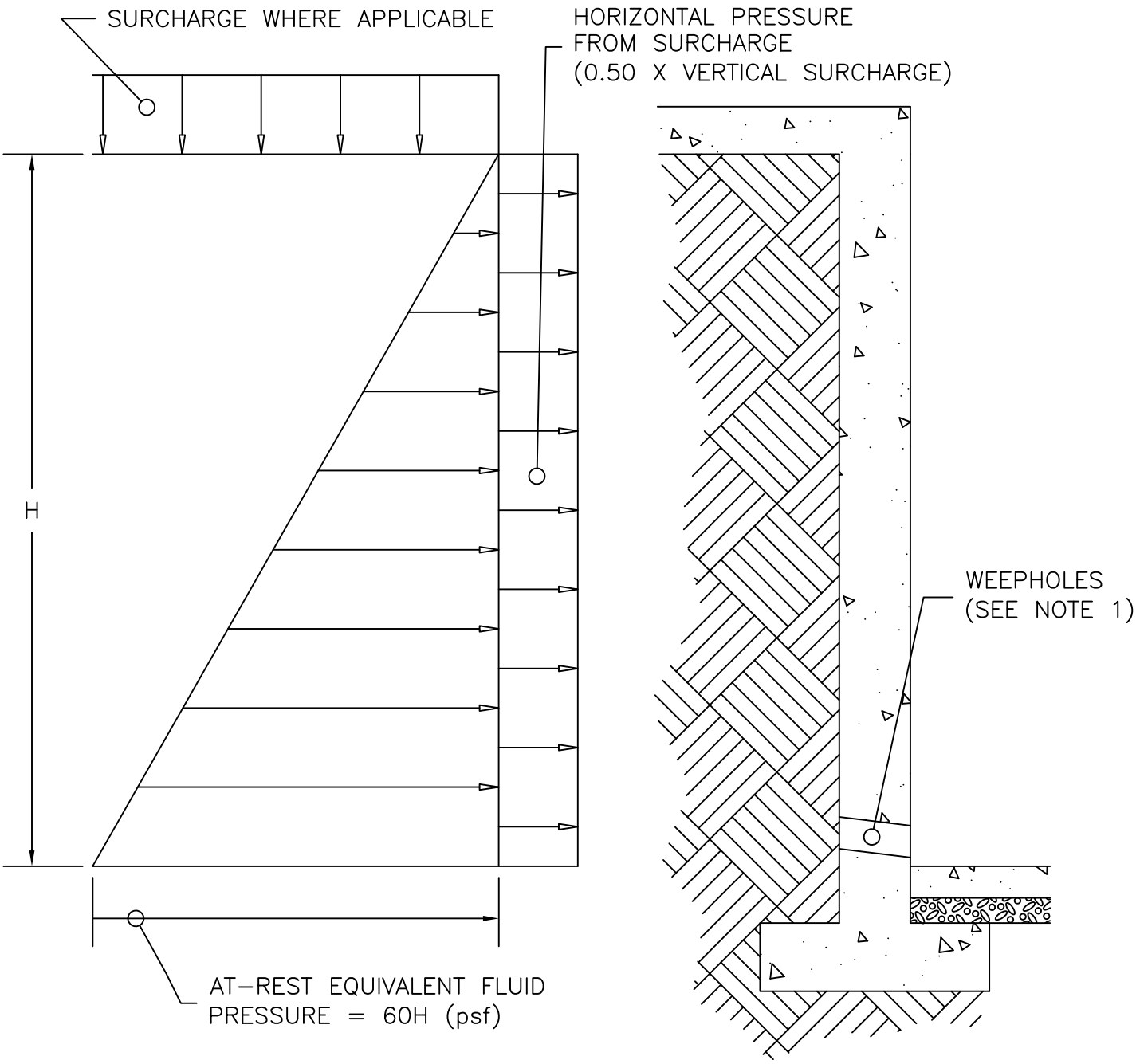
GEOCONCEPTS ENGINEERING, INC.

Rebecca L. Smith-Zakowicz, PG
Associate

COMMONWEALTH OF VIRGINIA
PAUL E. BURKART
Lic. No. 021556
PROFESSIONAL ENGINEER

Paul E. Burkart, PE
Principal

DS/RSZ/PEB/shm
N:\PROJECTS\Active 13 Projects\13066, Quantico Marine Corps Base, Middle-High School\Final\Final Geotechnical Report.docx



NOTES:

1) WEEPHOLES SHOULD CONSIST OF 3-INCH DIA. PVC PIPE AT 10 FEET INTERVALS.
2) PRESSURE DIAGRAM SHOWN ASSUMES HORIZONTAL GROUND BEHIND WALL AND FULL DRAINAGE OF HYDROSTATIC PRESSURES.
3) BACKFILL SHOULD CONSIST OF MATERIAL CLASSIFIED AS SM, SP, SW, GM, GP, OR GW PER ASTM D-2487. THE LIQUID LIMIT AND PLASTICITY INDEX OF BACKFILL MATERIAL SHOULD NOT EXCEED 40 AND 15, RESPECTIVELY.

F:\CAD\ENG DETAILS\LAT PRESS\EARTH PRESSURE LOADING DOCK WALL.DWG

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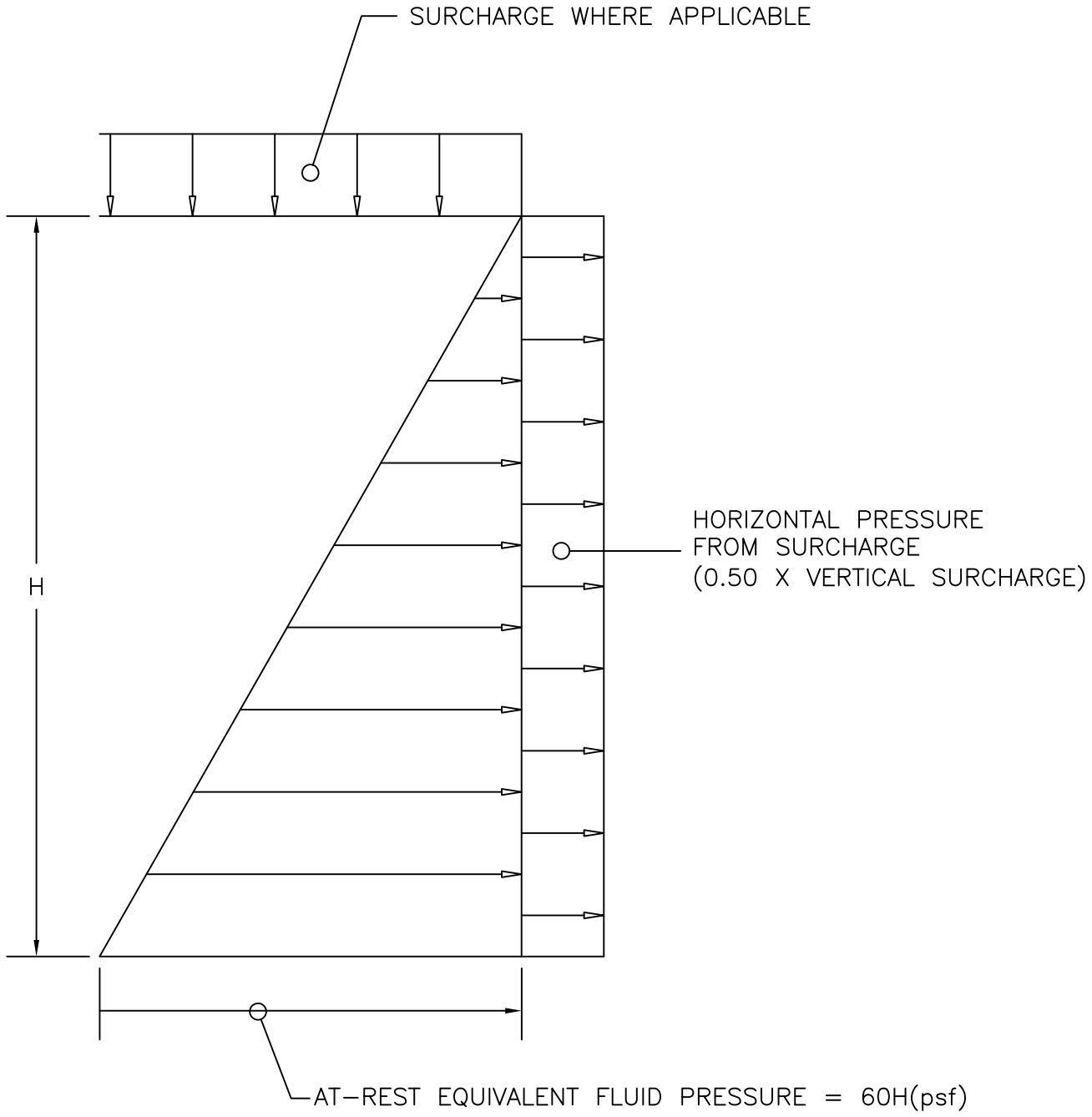
QUANTICO MIDDLE/HIGH SCHOOL
QUANTICO MARINE CORPS BASE, VIRGINIA

DESIGN EARTH PRESSURES FOR LOADING DOCK WALLS		Scale: N.T.S.	Fig. 1
Date: August 2014	Checked By: P.E.B.	Project No.: 13066	



NOTES:

1) PRESSURE DIAGRAM SHOWN ASSUMES HORIZONTAL GROUND BEHIND WALL AND FULL DRAINAGE OF HYDROSTATIC PRESSURES.

2) BACKFILL SHOULD CONSIST OF MATERIAL CLASSIFIED AS SM, SP, SW, GM, GP, OR GW PER ASTM D-2487. THE LIQUID LIMIT AND PLASTICITY INDEX OF BACKFILL MATERIAL SHOULD NOT EXCEED 40 AND 15, RESPECTIVELY.

N:\CAD\ENG DETAILS\LAT PRESS\EARTH PRESSURE BASEMENT WALLS Ffx Cty edits.DWG

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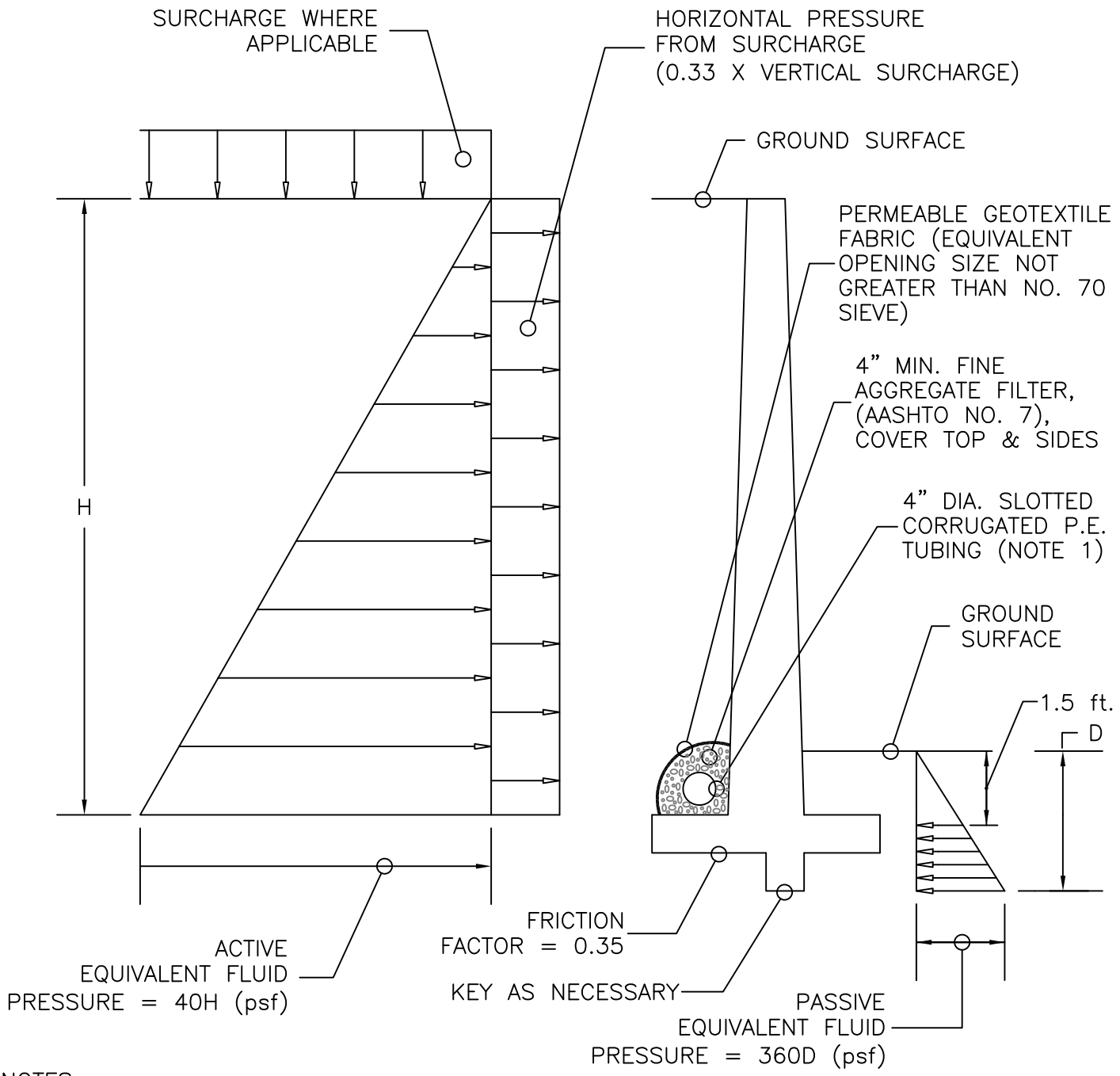
QUANTICO MARINE CORPS BASE, VIRGINIA

DESIGN EARTH PRESSURES FOR BASEMENT WALLS		Scale: N.T.S.	Fig. 2
Date: August 2014	Checked By: P.E.B.	Project No.: 13066	



NOTES:

1) WEEPHOLES CONSISTING OF 3-INCH DIA. PVC PIPE AT 10 FEET INTERVALS CAN BE SUBSTITUTED FOR SUBDRAINAGE PIPE.
2) PRESSURE DIAGRAM SHOWN ASSUMES HORIZONTAL GROUND BEHIND WALL AND FULL DRAINAGE OF HYDROSTATIC PRESSURES.
3) BACKFILL SHOULD CONSIST OF MATERIAL CLASSIFIED AS SM, SP, SW, GM, GP, OR GW PER ASTM D-2487. THE LIQUID LIMIT AND PLASTICITY INDEX OF BACKFILL MATERIAL SHOULD NOT EXCEED 40 AND 15, RESPECTIVELY.

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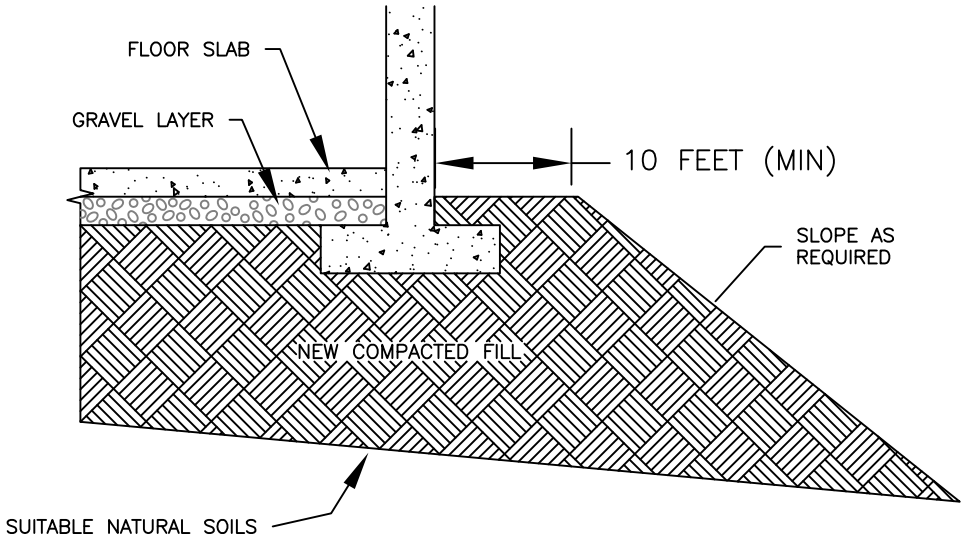
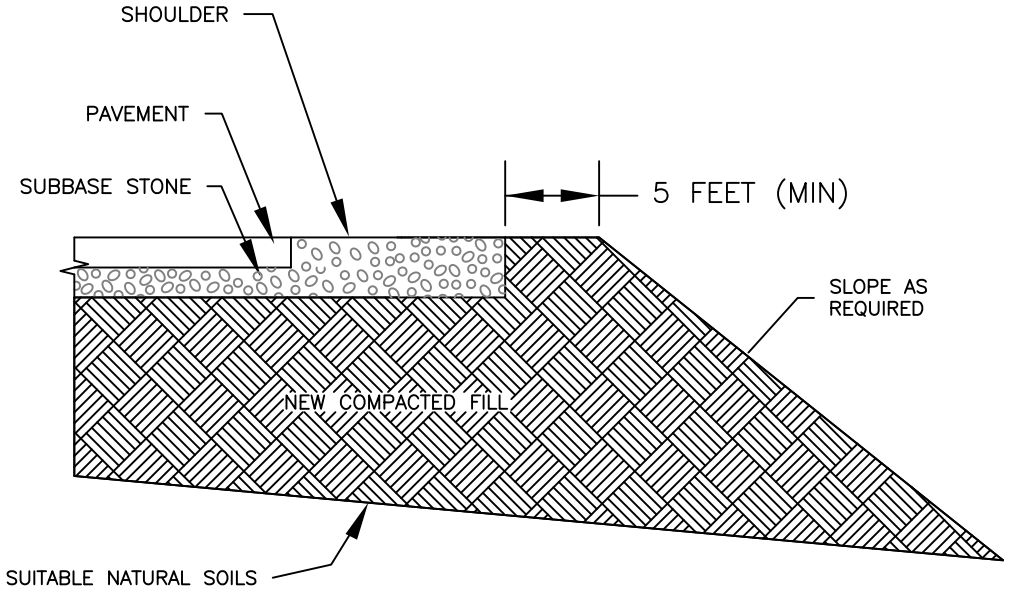
QUANTICO MIDDLE/HIGH SCHOOL
QUANTICO MARINE CORPS BASE VIRGINIA

DESIGN EARTH PRESSURES FOR SITE RETAINING WALLS		Scale: N.T.S.	Fig. 3
Date: August 2014	Checked By: P.E.B.	Project No.: 13066	

FOR BUILDINGS:



FOR PAVEMENTS:



N:\CAD\ENG DETAILS\FILL RECS\CSF DIAGRAM (BUILDING & PAVEMENT).DWG

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Ashburn, Virginia 20147 (703) 726-8032 fax

QUANTICO MIDDLE/HIGH SCHOOL
QUANTICO MARINE CORPS BASE, VIRGINIA

COMPACTED STRUCTURAL FILL DIAGRAM		Scale: N.T.S.	Fig. 4
Date: August 2014	Checked By: P.E.B.	Project No.: 13066	

Appendix A
Subsurface Investigation

Subsurface Investigation Procedures (1 page)

Identification of Soil (1 page)

Test Boring Notes (1 page)

Test Boring Logs (24 pages)

Boring Location Plan, Figure 5 (1 page)

Subsurface Diagram A-A', Figure 6 (1 page)

Subsurface Investigation Procedures

1. Test Borings – Hollow Stem Augers

The borings are advanced by turning an auger with a center opening of 2-¼ inches. A plug device blocks off the center opening while augers are advanced. Cuttings are brought to the surface by the auger flights. Sampling is performed through the center opening in the hollow stem auger, by standard methods, after removal of the plug. Usually, no water is introduced into the boring using this procedure.

2. Standard Penetration Tests

Standard penetration tests are performed by driving a 2 inch O.D., 1-⅜ inch I.D. sampling spoon with a 140-pound hammer falling 30 inches, according to ASTM D-1586. After an initial 6 inches penetration to assure the sampling spoon is in undisturbed material, the number of blows required to drive the sampler an additional 12 inches is generally taken as the N value. In the event 30 or more blows are required to drive the sampling spoon the initial 6 inch interval, the sampling spoon is driven to a total penetration resistance of 100 blows or 18 inches, whichever occurs first. The sampling operation is terminated after a total of 100 hammer blows and the depth of penetration is recorded.

3. Temporary Groundwater Observation Standpipes

Temporary ground water observation standpipes were installed in test borings TB-1 and TB-7 to observe groundwater levels. The standpipes were installed by inserting a 1-¼ inch diameter plastic pipe through the 2-¼ inch center opening of the auger. Groundwater level observations were made as shown on the test boring logs. The standpipes were removed from the borings after completion of the final water level readings.

4. Test Boring Stakeout

The test boring stakeout was provided by the project civil engineer.

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Identification of Soil

I. DEFINITION OF SOIL GROUP NAMES

		ASTM D-2487	Symbol	Group Name
Coarse-Grained Soils More than 50% retained on No. 200 sieve	**Gravels** More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines	***GW***	WELL GRADED GRAVEL
			GP	POORLY GRADED GRAVEL
		Gravels with Fines More than 12% fines	***GM***	silty GRAVEL
			GC	clayey GRAVEL
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines	***SW***	WELL GRADED SAND
			SP	POORLY GRADED SAND
		Sands with fines More than 12% fines	***SM***	silty SAND
			SC	clayey SAND
Fine-Grained Soils 50% or more passes the No. 200 sieve	**Silts and Clays** Liquid Limit less than 50	Inorganic	***CL***	LEAN CLAY
			ML	SILT
		Organic	***OL***	ORGANIC CLAY
				ORGANIC SILT
	Silts and Clays Liquid Limit 50 or more	Inorganic	***CH***	FAT CLAY
			MH	ELASTIC SILT
		Organic	***OH***	ORGANIC CLAY
				ORGANIC SILT
Highly Organic Soils	Primarily organic matter, dark in color, and organic odor		***PT***	PEAT

II. DEFINITION OF MINOR COMPONENT PROPORTIONS

Minor Component	Approximate Percentage of Fraction by Weight
Gravelly, Sandy (adjective)	30% or more coarse grained
Sand, Gravel (with)	15% to 29% coarse grained
Silt, Clay (with)	5% to 12% fine grained

III. GLOSSARY OF MISCELLANEOUS TERMS

SYMBOLS	Unified Soil Classification Symbols are shown above as group symbols. Use "A" Line Chart for laboratory identification. Dual symbols are used for borderline classification.
BOULDERS & COBBLES	Boulders are considered pieces of rock larger than 12 inches, while cobbles range from 3 to 12 inches.
DISINTEGRATED ROCK	Residual rock material with a standard penetration test (SPT) resistance between 60 blows per foot and refusal.
ROCK	Rock material with a standard penetration test (SPT) resistance of 100 blows for 2 inches or 50 blows for 0 inches, or less penetration
DECOMPOSED ROCK	Residual rock material exhibiting rock-like properties that can be excavated by backhoe equipment. Similar to Disintegrated Rock, but cannot be classified as such because SPT N-Values were not obtained.
ROCK FRAGMENTS	Angular pieces of rock, distinguished from rounded transported gravel, which have separated from original vein or strata and are present in a soil matrix.
QUARTZ	A hard silicate mineral often found in residual soils. Only used when describing residual soils.
CEMENTED SAND	Usually localized rock-like deposits within a soil stratum composed of sand grains cemented by calcium carbonate, iron oxide, or other minerals. Commonly encountered in Coastal Plain sediments, primarily in the Potomac Group sands (Kps).
MICA	A plate-like phyllosilicate mineral found in many rocks, and in residual or transported soil derived there from.
ORGANIC MATERIALS (Excluding Peat)	Topsoil - Surface soils that support plant life and contain organic matter. Lignite - Hard, brittle decomposed organic matter with low fixed carbon content (a low grade of coal).
FILL	Man made deposit containing soil, rock, and other foreign matter.
PROBABLE FILL	Soils which contain no visually detected foreign matter but which are suspect with regard to origin.
LAYERS	½ to 12 inch seam of minor soil component.
COLOR	Two most predominant colors present should be described.
MOISTURE CONDITIONS	Wet, moist, or dry to indicate visual appearance of specimen.

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Test Boring Notes

1. Classification of soil is by visual inspection and is in accordance with the Unified Soil Classification System.

2. Estimated groundwater levels are indicated on the logs. These are only estimates from available data and may vary with precipitation, porosity of soil, site topography, etc.

3. Sampling data presents standard penetrations for 6-inch intervals or as indicated with graphic representations adjacent to the sampling data.

4. The logs and related information 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 the test locations. Also, the passage of time may result in a change in the subsurface conditions at the test locations.

5. The stratification lines represent the approximate boundary between soil types as determined in the sampling operation. Some variation may be expected vertically between samples taken. The soil profile, groundwater level observations and penetration resistances presented on the logs have been made with reasonable care and accuracy and must be considered only an approximate representation of subsurface conditions to be encountered at the particular location.

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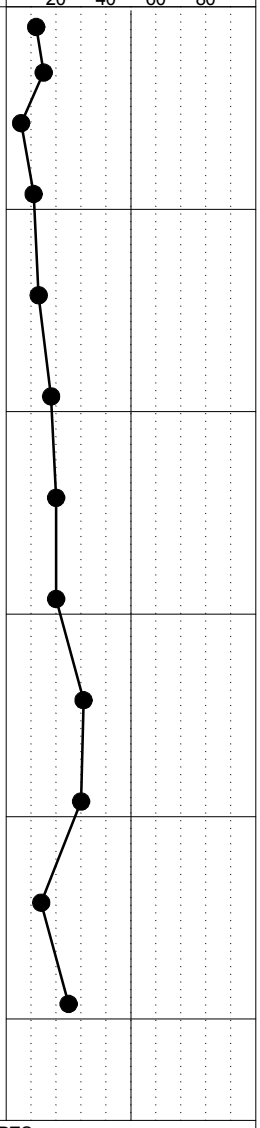
PROJECT:	LOGGED BY:	BORING NUMBER:
Quantico Middle/High School	D. Stein	TB-1
LOCATION:	DRILLING CONTRACTOR:	SHEET 1 OF 1
Quantico Marine Corps Base, Virginia	Connelly and Associates, Inc.	
OWNER/CLIENT:	DRILLER:	DATE STARTED:
EwingCole	Z. Cumberland	5/19/14
PROJECT NUMBER: / GROUND SURFACE ELEVATION (ft):	DRILLING METHOD:	DATE COMPLETED:
13066 / 178.0	2.25" I.D. HSA	5/19/14

ELEV. (ft)	DEPTH (ft)	STRATUM	MATERIAL DESCRIPTION	N_{60}	MC (%)	SAMPLE TYPE	SPT BLOW COUNTS	RECOVERY (in)
177.7			Topsoil = 3 inches					
		A	silty sand FILL with gravel, moist, brown	16		Split Spoon	3+5+7+10	24
				20		Split Spoon	2+7+8	18
173.0								
		B2	silty SAND (SM), moist, brown and white	8		Split Spoon	3+3+3	18
	10			15		Split Spoon	4+5+6	18
				17		Split Spoon	4+6+7	18
	20			24		Split Spoon	6+9+9	18
154.5								
		B1	FAT CLAY (CH) with sand, moist, orange, brown and gray	27		Split Spoon	5+9+11	18
	30			27	31.1	Split Spoon	7+10+10	18
				41		Split Spoon	12+14+17	18
	40			40		Split Spoon	14+15+15	18
134.5								
		B2	silty SAND (SM), wet, brown and orange	19		Split Spoon	4+6+8	18
128.0	50			33		Split Spoon	7+12+13	18
			Bottom of Boring at 50.0 ft					

STANDARD PENETRATION TEST RESISTANCE (BLOWS/FOOT)



GROUND WATER LEVELS:

ENCOUNTERED: 32.0 ft ELEV. 146.0

5/20/2014 30.8 ft ELEV. 147.2

SAMPLE TYPES:

Split Spoon

REMARKS: Coordinates: 38°32'06.69" N 77°20'12.96" W
Installed temporary standpipe.
Offset boring 15 ft. southeast due to overhead powerlines.

THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES. THE TRANSITION MAY BE GRADUAL.

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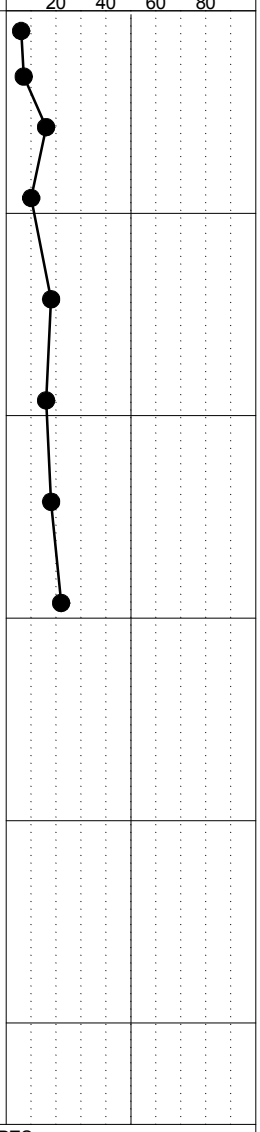
PROJECT:	LOGGED BY:	BORING NUMBER:
Quantico Middle/High School	D. Stein	TB-2
LOCATION:	DRILLING CONTRACTOR:	
Quantico Marine Corps Base, Virginia	Connelly and Associates, Inc.	SHEET 1 OF 1
OWNER/CLIENT:	DRILLER:	DATE STARTED:
EwingCole	Z. Cumberland	5/19/14
PROJECT NUMBER: / GROUND SURFACE ELEVATION (ft):	DRILLING METHOD:	DATE COMPLETED:
13066 / 178.1	2.25" I.D. HSA	5/19/14

ELEV. (ft)	DEPTH (ft)	STRATUM	MATERIAL DESCRIPTION	N_{60}	MC (%)	SAMPLE TYPE	SPT BLOW COUNTS	RECOVERY (in)
178.0			Topsoil = 2 inches					
		A	sandy silt FILL, moist, brown	8		Split Spoon	3+3+3+3	24
174.1				9		Split Spoon	2+3+4	18
		B1	sandy ELASTIC SILT (MH), moist, brown	21		Split Spoon	6+7+9	18
	10			13		Split Spoon	5+5+5	18
164.6		B2	silty SAND (SM), moist, brown	24		Split Spoon	8+8+10	18
	20			21		Split Spoon	6+7+9	18
				24		Split Spoon	7+8+10	18
148.1	30		Bottom of Boring at 30.0 ft	29		Split Spoon	9+11+11	18
	40							
	50							

STANDARD PENETRATION TEST RESISTANCE (BLOWS/FOOT)



GROUND WATER LEVELS:

ENCOUNTERED: None

UPON COMPLETION: Dry

CAVED: 14.7 ft ELEV. 163.4

SAMPLE TYPES:

Split Spoon

REMARKS: Coordinates: 38°32'06.15" N, 77°20'12.38" W

THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES. THE TRANSITION MAY BE GRADUAL.

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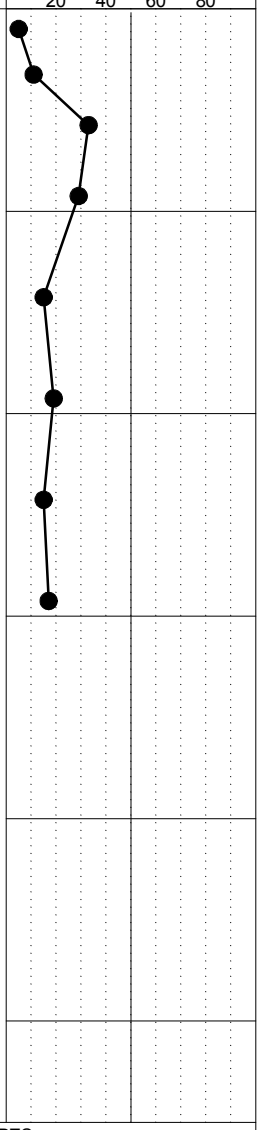
PROJECT:	LOGGED BY:	BORING NUMBER:
Quantico Middle/High School	D. Stein	TB-3
LOCATION:	DRILLING CONTRACTOR:	
Quantico Marine Corps Base, Virginia	Connelly and Associates, Inc.	SHEET 1 OF 1
OWNER/CLIENT:	DRILLER:	DATE STARTED:
EwingCole	Z. Cumberland	5/14/14
PROJECT NUMBER: / GROUND SURFACE ELEVATION (ft):	DRILLING METHOD:	DATE COMPLETED:
13066 / 177.3	2.25" I.D. HSA	5/14/14

ELEV. (ft)	DEPTH (ft)	STRATUM	MATERIAL DESCRIPTION	N_{60}	MC (%)	SAMPLE TYPE	SPT BLOW COUNTS	RECOVERY (in)
177.0			Topsoil = 3 inches					
		A	silty sand FILL with gravel, moist, brown	7		Split Spoon	1+2+3+5	24
				15		Split Spoon	3+5+6	18
172.3								
		B2	silty SAND (SM), moist, white and brown	44		Split Spoon	5+19+14	18
168.8								
	10	B1	sandy ELASTIC SILT (MH), moist, white and gray	39	26.4	Split Spoon	9+12+17	18
163.8								
		B2	silty SAND (SM), moist, white and brown	20		Split Spoon	4+5+10	18
	20			25		Split Spoon	3+9+10	18
				20		Split Spoon	4+6+9	18
147.3	30			23	24.1	Split Spoon	5+7+10	18
			Bottom of Boring at 30.0 ft					
	40							
	50							

STANDARD PENETRATION TEST RESISTANCE (BLOWS/FOOT)



GROUND WATER LEVELS:

ENCOUNTERED: 28.0 ft ELEV. 149.3

UPON COMPLETION: Dry CAVED: 25.0 ft ELEV. 152.3

SAMPLE TYPES:

Split Spoon

REMARKS: Coordinates: 38°32'05.54" N, 77°20'12.77" W

THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES. THE TRANSITION MAY BE GRADUAL.

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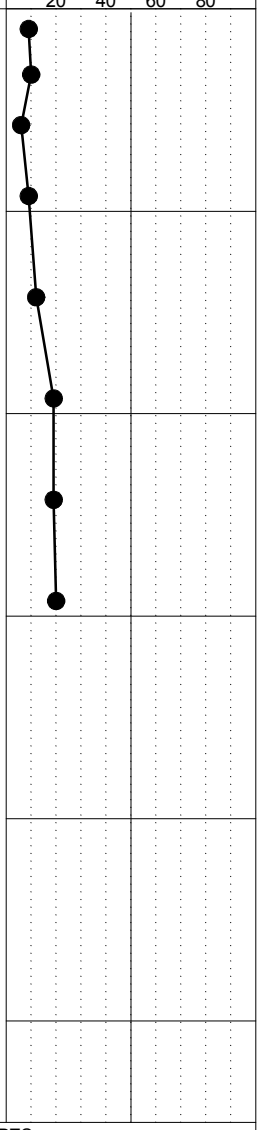
PROJECT:	LOGGED BY:	BORING NUMBER:
Quantico Middle/High School	D. Stein	TB-4
LOCATION:	DRILLING CONTRACTOR:	
Quantico Marine Corps Base, Virginia	Connelly and Associates, Inc.	SHEET 1 OF 1
OWNER/CLIENT:	DRILLER:	DATE STARTED:
EwingCole	Z. Cumberland	5/14/14
PROJECT NUMBER: / GROUND SURFACE ELEVATION (ft):	DRILLING METHOD:	DATE COMPLETED:
13066 / 176.3	2.25" I.D. HSA	5/14/14

ELEV. (ft)	DEPTH (ft)	STRATUM	MATERIAL DESCRIPTION	N_{60}	MC (%)	SAMPLE TYPE	SPT BLOW COUNTS	RECOVERY (in)
176.0			Topsoil = 3 inches					
		A	silty sand FILL with gravel, moist, brown	12		Split Spoon	1+4+5+5	24
				13		Split Spoon	4+4+6+7	18
171.3								
		B2	silty SAND (SM), moist, tan and brown	8		Split Spoon	4+3+3	18
	10			12		Split Spoon	2+4+5	18
162.8								
		B1	sandy ELASTIC SILT (MH), moist, white, gray, and orange	16		Split Spoon	2+3+9	18
157.8								
	20	B2	silty SAND (SM) with gravel, moist, orange, brown, and white	25		Split Spoon	4+8+11	18
				25		Split Spoon	5+9+10	18
146.3	30			27		Split Spoon	4+10+10	18
			Bottom of Boring at 30.0 ft					
	40							
	50							

STANDARD PENETRATION TEST RESISTANCE (BLOWS/FOOT)



GROUND WATER LEVELS:

ENCOUNTERED: 28.0 ft ELEV. 148.3

UPON COMPLETION: Dry CAVED: 20.0 ft ELEV. 156.3

SAMPLE TYPES:

Split Spoon

REMARKS: Coordinates: 38°32'05.01" N, 77°20'12.78" W

THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES. THE TRANSITION MAY BE GRADUAL.

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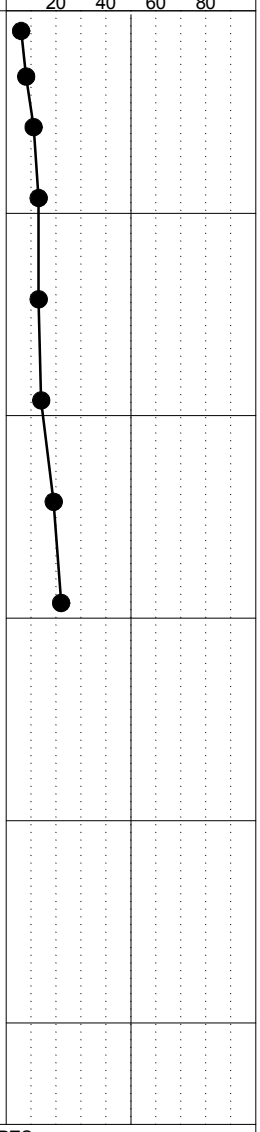
PROJECT:	LOGGED BY:	BORING NUMBER:
Quantico Middle/High School	D. Stein	TB-5
LOCATION:	DRILLING CONTRACTOR:	
Quantico Marine Corps Base, Virginia	Connelly and Associates, Inc.	SHEET 1 OF 1
OWNER/CLIENT:	DRILLER:	DATE STARTED:
EwingCole	Z. Cumberland	5/14/14
PROJECT NUMBER: / GROUND SURFACE ELEVATION (ft):	DRILLING METHOD:	DATE COMPLETED:
13066 / 178.5	2.25" I.D. HSA	5/14/14

ELEV. (ft)	DEPTH (ft)	STRATUM	MATERIAL DESCRIPTION	N_{60}	MC (%)	SAMPLE TYPE	SPT BLOW COUNTS	RECOVERY (in)
178.3		A	Topsoil = 2 inches	8		Split Spoon	2+3+3+5	24
			sandy silt FILL with gravel, moist, brown	11		Split Spoon	3+3+5	18
173.5		B2	silty SAND (SM), moist, white and brown	15		Split Spoon	8+6+5	18
	10			17		Split Spoon	4+6+7	18
				17		Split Spoon	4+5+8	18
	20			19		Split Spoon	5+7+7	18
				25		Split Spoon	5+10+9	18
148.5	30		Bottom of Boring at 30.0 ft	29		Split Spoon	5+10+12	18
	40							
	50							

STANDARD PENETRATION TEST RESISTANCE (BLOWS/FOOT)



GROUND WATER LEVELS:

ENCOUNTERED: Dry

UPON COMPLETION: Dry

CAVED: 26.0 ft ELEV. 152.5

SAMPLE TYPES:

Split Spoon

REMARKS: Coordinates: 38°32'05.41" N, 77°20'11.48" W

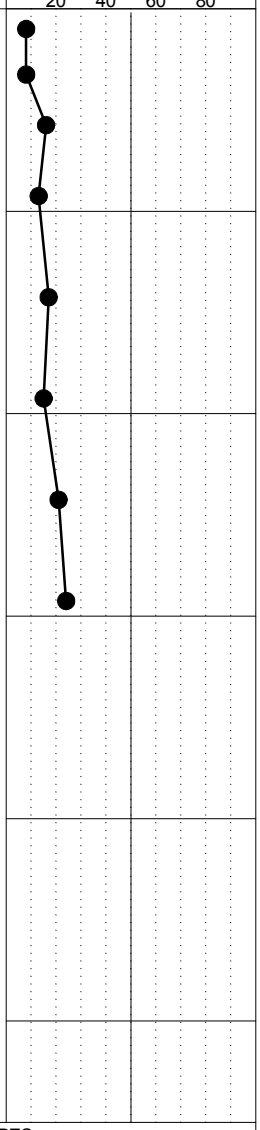
THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES. THE TRANSITION MAY BE GRADUAL.

GeoConcepts Engineering, Inc.
19955 Highland Vista Dr., #170
Ashburn, Virginia 20147
703-726-8030
703-726-8032 fax

PROJECT:	LOGGED BY:	BORING NUMBER:
Quantico Middle/High School	D. Stein	TB-6
LOCATION:	DRILLING CONTRACTOR:	
Quantico Marine Corps Base, Virginia	Connelly and Associates, Inc.	SHEET 1 OF 1
OWNER/CLIENT:	DRILLER:	DATE STARTED:
EwingCole	Z. Cumberland	5/19/14
PROJECT NUMBER: / GROUND SURFACE ELEVATION (ft):	DRILLING METHOD:	DATE COMPLETED:
13066 / 178.4	2.25" I.D. HSA	5/19/14

ELEV. (ft)	DEPTH (ft)	STRATUM	MATERIAL DESCRIPTION	N_{60}	MC (%)	SAMPLE TYPE	SPT BLOW COUNTS	RECOVERY (in)
178.2			Topsoil = 3 inches					
		A	silty sand FILL, moist, brown	11		☒	1+3+5+6	18
173.4				11	19.6	☒	3+3+5	18
		B2	clayey SAND (SC), moist, white	21		☒	7+8+8	18
	10			17		☒	4+6+7	18
164.9								
			silty SAND (SM), moist, brown and orange	23		☒	7+8+9	18
	20			20	14.4	☒	8+7+8	18
				28		☒	8+10+11	18
148.4	30			32		☒	10+10+14	18
			Bottom of Boring at 30.0 ft					
	40							
	50							

STANDARD PENETRATION TEST RESISTANCE (BLOWS/FOOT)



GROUND WATER LEVELS:

ENCOUNTERED: None

UPON COMPLETION: Dry

CAVED: 14.5 ft ELEV. 163.9

SAMPLE TYPES:

☒ Split Spoon

REMARKS: Coordinates: 38°32'04.80" N, 77°20'11.62" W

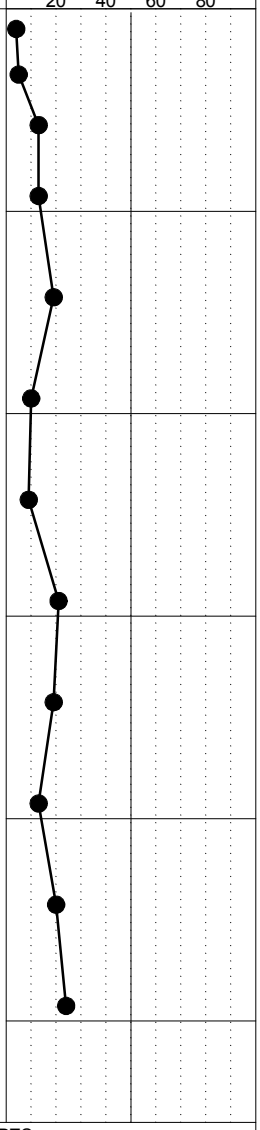
THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES. THE TRANSITION MAY BE GRADUAL.

GeoConcepts Engineering, Inc.
19955 Highland Vista Dr., #170
Ashburn, Virginia 20147
703-726-8030
703-726-8032 fax

PROJECT:	LOGGED BY:	BORING NUMBER:
Quantico Middle/High School	D. Stein	TB-7
LOCATION:	DRILLING CONTRACTOR:	
Quantico Marine Corps Base, Virginia	Connelly and Associates, Inc.	SHEET 1 OF 1
OWNER/CLIENT:	DRILLER:	DATE STARTED:
EwingCole	Z. Cumberland	5/19/14
PROJECT NUMBER: / GROUND SURFACE ELEVATION (ft):	DRILLING METHOD:	DATE COMPLETED:
13066 / 178.5	2.25" I.D. HSA	5/19/14

ELEV. (ft)	DEPTH (ft)	STRATUM	MATERIAL DESCRIPTION	N_{60}	MC (%)	SAMPLE TYPE	SPT BLOW COUNTS	RECOVERY (in)
178.2			Topsoil = 3 inches	5		Split Spoon	3+2+2+2	24
		A	silty sand FILL, moist, brown	7		Split Spoon	1+2+3	18
173.5		B2	silty SAND (SM), moist, white and orange	17		Split Spoon	5+6+7	18
	10			17		Split Spoon	3+6+7	18
				25	14.1	Split Spoon	7+9+10	18
	20			13		Split Spoon	2+4+6	18
				12		Split Spoon	3+4+5	18
150.0			clayey SAND (SC), moist, white and orange	28		Split Spoon	3+9+12	18
	30			25		Split Spoon	6+7+12	18
	40			17		Split Spoon	3+5+8	18
135.0			silty SAND (SM), wet, gray	27		Split Spoon	5+8+12	18
128.5	50			32		Split Spoon	7+10+14	18
			Bottom of Boring at 50.0 ft					

STANDARD PENETRATION TEST RESISTANCE (BLOWS/FOOT)



GROUND WATER LEVELS:

ENCOUNTERED: 35.0 ft ELEV. 143.5

5/20/2014 33.3 ft ELEV. 145.2

SAMPLE TYPES:

Split Spoon

REMARKS: Coordinates: 38°32'04.60 N, 77°20'10.58" W
Installed temporary standpipe.

THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES. THE TRANSITION MAY BE GRADUAL.

GeoConcepts Engineering, Inc.
19955 Highland Vista Dr., #170
Ashburn, Virginia 20147
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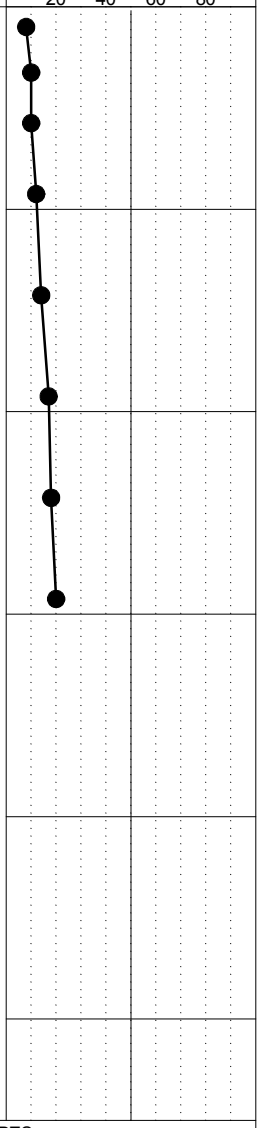
703-726-8032 fax

PROJECT:	LOGGED BY:	BORING NUMBER:
Quantico Middle/High School	D. Stein	TB-8
LOCATION:	DRILLING CONTRACTOR:	
Quantico Marine Corps Base, Virginia	Connelly and Associates, Inc.	SHEET 1 OF 1
OWNER/CLIENT:	DRILLER:	DATE STARTED:
EwingCole	Z. Cumberland	5/13/14
PROJECT NUMBER: / GROUND SURFACE ELEVATION (ft):	DRILLING METHOD:	DATE COMPLETED:
13066 / 178.8	2.25" I.D. HSA	5/13/14

ELEV. (ft)	DEPTH (ft)	STRATUM	MATERIAL DESCRIPTION	N_{60}	MC (%)	SAMPLE TYPE	SPT BLOW COUNTS	RECOVERY (in)
178.5			Topsoil = 3 inches					
		A	silty sand FILL with gravel, moist, brown	11		Split Spoon	2+4+4+5	18
				13		Split Spoon	2+4+6	18
				13		Split Spoon	3+5+5	18
170.3								
	10	B2	silty SAND (SM), moist, brown and white	16		Split Spoon	4+5+7	18
				19		Split Spoon	6+7+7	18
	20			23		Split Spoon	4+10+7	12
				24		Split Spoon	7+9+9	18
148.8	30			27		Split Spoon	8+9+11	18
			Bottom of Boring at 30.0 ft					
	40							
	50							



GROUND WATER LEVELS:

ENCOUNTERED: None

UPON COMPLETION: Dry

CAVED: 16.2 ft ELEV. 162.6

SAMPLE TYPES:

Split Spoon

REMARKS: Coordinates: 38°32'05.66" N, 77°20'09.45" W

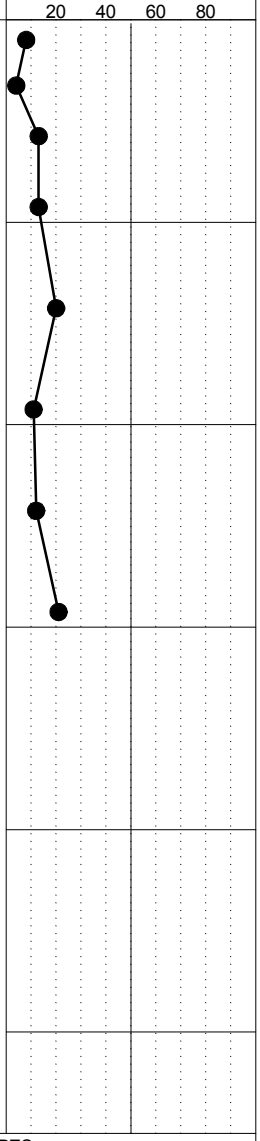
THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES. THE TRANSITION MAY BE GRADUAL.

GeoConcepts Engineering, Inc.
19955 Highland Vista Dr., #170
Ashburn, Virginia 20147
703-726-8030
703-726-8032 fax

PROJECT:	LOGGED BY:	BORING NUMBER:
Quantico Middle/High School	D. Stein	TB-9
LOCATION:	DRILLING CONTRACTOR:	
Quantico Marine Corps Base, Virginia	Connelly and Associates, Inc.	SHEET 1 OF 1
OWNER/CLIENT:	DRILLER:	DATE STARTED:
EwingCole	Z. Cumberland	5/19/14
PROJECT NUMBER: / GROUND SURFACE ELEVATION (ft):	DRILLING METHOD:	DATE COMPLETED:
13066 / 177.9	2.25" I.D. HSA	5/19/14

ELEV. (ft)	DEPTH (ft)	STRATUM	MATERIAL DESCRIPTION	N_{60}	MC (%)	SAMPLE TYPE	SPT BLOW COUNTS	RECOVERY (in)
177.8		A	Topsoil = 2 inches	11		Split Spoon	2+3+5+5	0
			silty sand FILL, moist, brown	5		Split Spoon	2+2+2	18
172.9		B2	silty SAND (SM), moist, brown and white	17		Split Spoon	6+7+6	18
	10			17		Split Spoon	5+5+8	18
				27		Split Spoon	8+9+11	18
	20			15		Split Spoon	4+5+6	18
				16		Split Spoon	5+6+6	18
147.9	30		Bottom of Boring at 30.0 ft	28		Split Spoon	4+8+13	18
	40							
	50							

STANDARD PENETRATION TEST RESISTANCE (BLOWS/FOOT)



GROUND WATER LEVELS:

ENCOUNTERED: None

UPON COMPLETION: Dry

CAVED: 16.7 ft ELEV. 161.2

SAMPLE TYPES:

Split Spoon

REMARKS: Coordinates: 38°32'04.81" N, 77°20'09.64" W

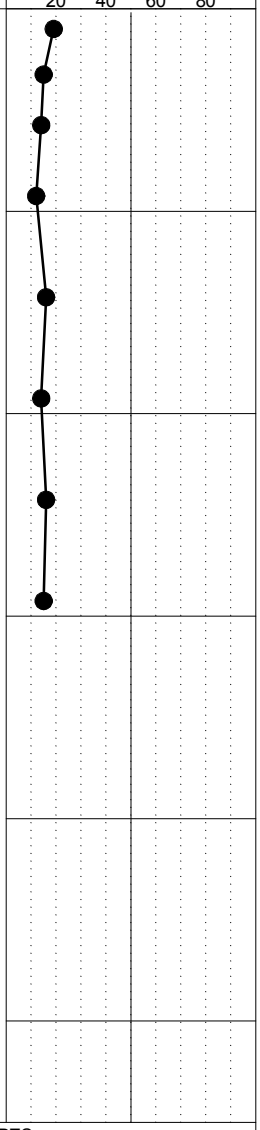
THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES. THE TRANSITION MAY BE GRADUAL.

GeoConcepts Engineering, Inc.
19955 Highland Vista Dr., #170
Ashburn, Virginia 20147
703-726-8030
703-726-8032 fax

PROJECT:	LOGGED BY:	BORING NUMBER:
Quantico Middle/High School	D. Stein	TB-10
LOCATION: Quantico Marine Corps Base, Virginia	DRILLING CONTRACTOR: Connelly and Associates, Inc.	SHEET 1 OF 1
OWNER/CLIENT: EwingCole	DRILLER: Z. Cumberland	DATE STARTED: 5/13/14
PROJECT NUMBER: 13066 / GROUND SURFACE ELEVATION (ft): 177.7	DRILLING METHOD: 2.25" I.D. HSA	DATE COMPLETED: 5/13/14

ELEV. (ft)	DEPTH (ft)	STRATUM	MATERIAL DESCRIPTION	N_{60}	MC (%)	SAMPLE TYPE	SPT BLOW COUNTS	RECOVERY (in)
177.6			Topsoil = 2 inches					
		A	clayey sand FILL, moist, brown	25		Split Spoon	7+9+10+12	6
				20		Split Spoon	5+7+8	18
				19	14.1	Split Spoon	6+6+8	18
168.7								
	10	B2	silty SAND (SM), moist, brown and white	16		Split Spoon	4+6+6	18
				21		Split Spoon	5+8+8	18
	20			19		Split Spoon	2+5+9	18
				21		Split Spoon	5+7+9	18
147.7	30			20		Split Spoon	4+7+8	18
			Bottom of Boring at 30.0 ft					
	40							
	50							

STANDARD PENETRATION TEST RESISTANCE (BLOWS/FOOT)



GROUND WATER LEVELS:

ENCOUNTERED: None

UPON COMPLETION: Dry

CAVED: 15.0 ft ELEV. 162.7

SAMPLE TYPES:

Split Spoon

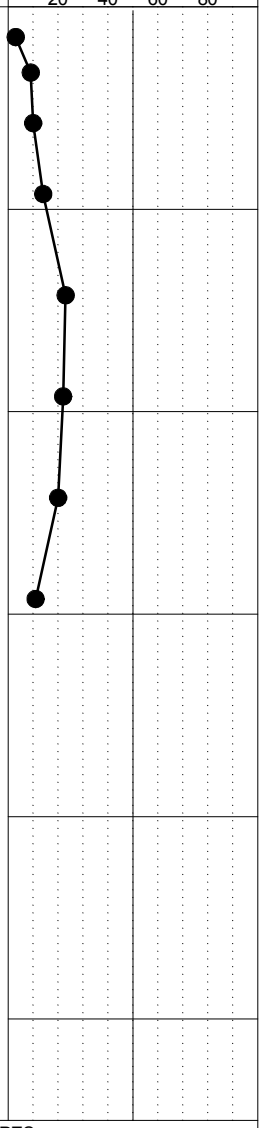
REMARKS: Coordinates: 38°32'05.74" N, 77°20'08.50" W

THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES. THE TRANSITION MAY BE GRADUAL.

GeoConcepts Engineering, Inc.
19955 Highland Vista Dr., #170
Ashburn, Virginia 20147
703-726-8030
703-726-8032 fax

PROJECT:	LOGGED BY:	BORING NUMBER:
Quantico Middle/High School	D. Stein	TB-11
LOCATION:	DRILLING CONTRACTOR:	
Quantico Marine Corps Base, Virginia	Connelly and Associates, Inc.	SHEET 1 OF 1
OWNER/CLIENT:	DRILLER:	DATE STARTED:
EwingCole	Z. Cumberland	5/14/14
PROJECT NUMBER: / GROUND SURFACE ELEVATION (ft):	DRILLING METHOD:	DATE COMPLETED:
13066 / 178.0	2.25" I.D. HSA	5/14/14

ELEV. (ft)	DEPTH (ft)	STRATUM	MATERIAL DESCRIPTION	N_{60}	MC (%)	SAMPLE TYPE	SPT BLOW COUNTS	RECOVERY (in)
177.8 / 177.0			Asphalt = 3 inches					
		A	Gravel Base = 9 inches					
173.0			silty sand FILL with gravel, moist, brown	12		Split Spoon	2+4+5	16
		B2	silty SAND (SM), moist, white and brown	13		Split Spoon	3+5+5	18
	10			19		Split Spoon	8+6+8	18
				31		Split Spoon	5+11+12	18
	20			29		Split Spoon	5+9+13	18
				27		Split Spoon	7+8+12	18
148.0	30			15		Split Spoon	5+5+6	18
			Bottom of Boring at 30.0 ft					
	40							
	50							



GROUND WATER LEVELS:

ENCOUNTERED: None

UPON COMPLETION: Dry

CAVED: 17.2 ft ELEV. 160.8

SAMPLE TYPES:

Split Spoon

REMARKS: Coordinates: 38°32'05.05" N, 77°20'08.57" W

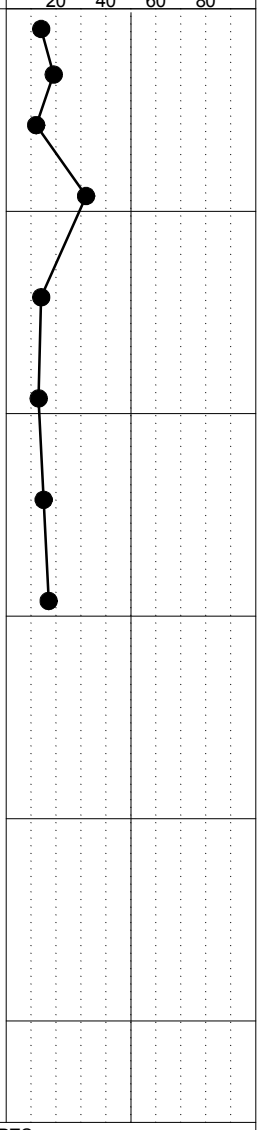
THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES. THE TRANSITION MAY BE GRADUAL.

GeoConcepts Engineering, Inc.
19955 Highland Vista Dr., #170
Ashburn, Virginia 20147
703-726-8030
703-726-8032 fax

PROJECT:	LOGGED BY:	BORING NUMBER:
Quantico Middle/High School	D. Stein	TB-12
LOCATION: Quantico Marine Corps Base, Virginia	DRILLING CONTRACTOR: Connelly and Associates, Inc.	SHEET 1 OF 1
OWNER/CLIENT: EwingCole	DRILLER: Z. Cumberland	DATE STARTED: 5/14/14
PROJECT NUMBER: 13066 / GROUND SURFACE ELEVATION (ft): 174.4	DRILLING METHOD: 2.25" I.D. HSA	DATE COMPLETED: 5/14/14

ELEV. (ft)	DEPTH (ft)	STRATUM	MATERIAL DESCRIPTION	N_{60}	MC (%)	SAMPLE TYPE	SPT BLOW COUNTS	RECOVERY (in)
171.9		A	silty sand FILL, moist, brown	19		☒	2+6+8+8	20
		B2	silty SAND (SM), moist, white, orange, and brown	25		☒	3+9+10	18
				16		☒	3+5+7	18
	10			43		☒	11+16+16	4
				19	14.8	☒	5+6+8	18
155.9								
	20	B1	sandy SILT (ML), moist, white and gray	17	36.3	☒	3+5+8	18
150.9		B2	silty SAND (SM), moist, white and orange	20		☒	5+8+7	18
144.4	30			23		☒	3+7+10	18
			Bottom of Boring at 30.0 ft					
	40							
	50							

STANDARD PENETRATION TEST RESISTANCE (BLOWS/FOOT)



GROUND WATER LEVELS:

ENCOUNTERED: None

UPON COMPLETION: Dry

CAVED: 23.5 ft ELEV. 150.9

SAMPLE TYPES:

☒ Split Spoon

REMARKS: Coordinates: 38°32'04.25" N, 77°20'08.85" W

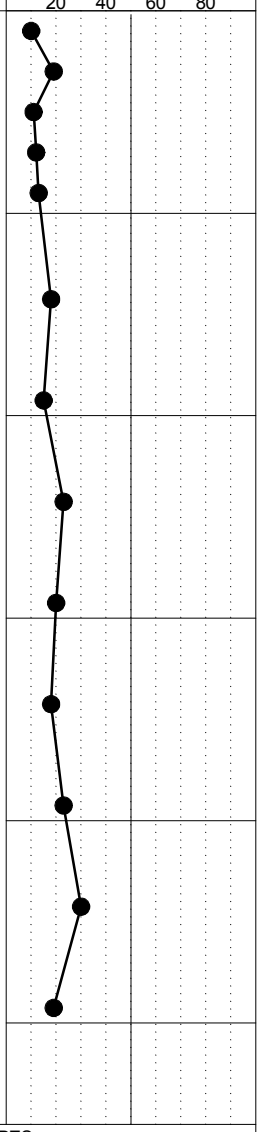
THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES. THE TRANSITION MAY BE GRADUAL.

GeoConcepts Engineering, Inc.
19955 Highland Vista Dr., #170
Ashburn, Virginia 20147
703-726-8030
703-726-8032 fax

PROJECT:	LOGGED BY:	BORING NUMBER:
Quantico Middle/High School	D. Stein	TB-13
LOCATION: Quantico Marine Corps Base, Virginia	DRILLING CONTRACTOR: Connelly and Associates, Inc.	SHEET 1 OF 1
OWNER/CLIENT: EwingCole	DRILLER: Z. Cumberland	DATE STARTED: 5/13/14
PROJECT NUMBER: 13066 / GROUND SURFACE ELEVATION (ft): 176.5	DRILLING METHOD: 2.25" I.D. HSA	DATE COMPLETED: 5/13/14

ELEV. (ft)	DEPTH (ft)	STRATUM	MATERIAL DESCRIPTION	N_{60}	MC (%)	SAMPLE TYPE	SPT BLOW COUNTS	RECOVERY (in)
		A	clayey sand FILL, moist, brown	13		Split Spoon	5+6+4+6	24
				25		Split Spoon	4+6+13+11	24
170.5				15	16.4	Split Spoon	3+6+5+6	24
		B2	silty SAND (SM), moist, tan, brown, and white	16		Split Spoon	4+5+7+8	24
	10			17		Split Spoon	5+6+7+8	24
163.0			clayey SAND (SC), wet, tan and brown	24		Split Spoon	8+9+9	18
	20			20		Split Spoon	5+8+7	18
				31		Split Spoon	7+9+14	18
	30			27		Split Spoon	6+9+11	18
▽				24		Split Spoon	7+8+10	18
	40			31		Split Spoon	10+12+11	18
133.0		B1	FAT CLAY (CH) with sand, moist, dark blue	40		Split Spoon	7+13+17	18
128.0								
126.5	50	B2	clayey SAND (SC), wet, tan-brown	25		Split Spoon	6+7+12	18
			Bottom of Boring at 50.0 ft					

STANDARD PENETRATION TEST RESISTANCE (BLOWS/FOOT)



GROUND WATER LEVELS:

▽ ENCOUNTERED: 35.0 ft ELEV. 141.5

UPON COMPLETION: Dry CAVED: 16.5 ft ELEV. 160.0

SAMPLE TYPES:

Split Spoon

REMARKS: Coordinates: 38°32'05.54" N, 77°20'07.55" W

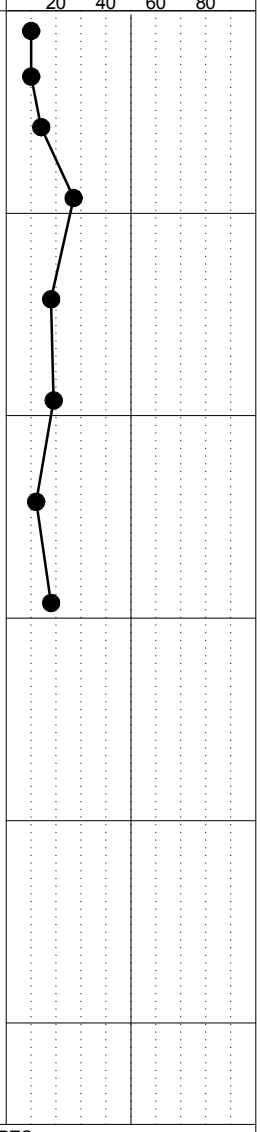
THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES. THE TRANSITION MAY BE GRADUAL.

GeoConcepts Engineering, Inc.
19955 Highland Vista Dr., #170
Ashburn, Virginia 20147
703-726-8030
703-726-8032 fax

PROJECT:	LOGGED BY:	BORING NUMBER:
Quantico Middle/High School	D. Stein	TB-14
LOCATION: Quantico Marine Corps Base, Virginia	DRILLING CONTRACTOR: Connelly and Associates, Inc.	SHEET 1 OF 1
OWNER/CLIENT: EwingCole	DRILLER: Z. Cumberland	DATE STARTED: 5/13/14
PROJECT NUMBER: 13066 / GROUND SURFACE ELEVATION (ft): 176.2	DRILLING METHOD: 2.25" I.D. HSA	DATE COMPLETED: 5/13/14

ELEV. (ft)	DEPTH (ft)	STRATUM	MATERIAL DESCRIPTION	N_{60}	MC (%)	SAMPLE TYPE	SPT BLOW COUNTS	RECOVERY (in)
		A	sandy silt FILL with gravel, dry to moist, brown	13		Split Spoon	4+5+5+5	18
				13		Split Spoon	2+5+5	18
171.2		B2	silty SAND (SM), moist, tan and brown	19		Split Spoon	4+5+9	18
	10			36	13.1	Split Spoon	5+11+16	18
162.7			clayey SAND (SC), moist, white and brown	24		Split Spoon	5+8+10	18
	20			25		Split Spoon	5+8+11	18
				16		Split Spoon	4+5+7	18
146.2	30		Bottom of Boring at 30.0 ft	24		Split Spoon	5+9+9	18
	40							
	50							

STANDARD PENETRATION TEST RESISTANCE (BLOWS/FOOT)



GROUND WATER LEVELS:

ENCOUNTERED: None

UPON COMPLETION: Dry

CAVED: 15.0 ft ELEV. 161.2

SAMPLE TYPES:

Split Spoon

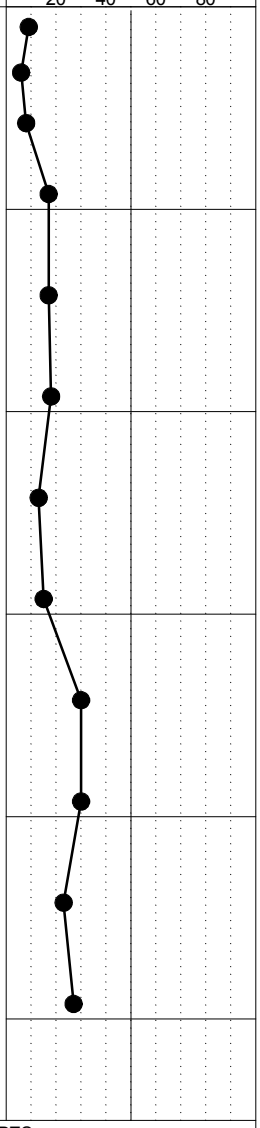
REMARKS: Coordinates: 38°32'04.56" N, 77°20'07.52" W

THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES. THE TRANSITION MAY BE GRADUAL.

GeoConcepts Engineering, Inc.
19955 Highland Vista Dr., #170
Ashburn, Virginia 20147
703-726-8030
703-726-8032 fax

PROJECT:	LOGGED BY:	BORING NUMBER:
Quantico Middle/High School	D. Stein	TB-15
LOCATION: Quantico Marine Corps Base, Virginia	DRILLING CONTRACTOR: Connelly and Associates, Inc.	SHEET 1 OF 1
OWNER/CLIENT: EwingCole	DRILLER: Z. Cumberland	DATE STARTED: 5/14/14
PROJECT NUMBER: 13066 / GROUND SURFACE ELEVATION (ft): 173.9	DRILLING METHOD: 2.25" I.D. HSA	DATE COMPLETED: 5/14/14

ELEV. (ft)	DEPTH (ft)	STRATUM	MATERIAL DESCRIPTION	N_{60}	MC (%)	SAMPLE TYPE	SPT BLOW COUNTS	RECOVERY (in)
173.8		A	Topsoil = 2 inches	12		Split Spoon	3+5+4+5	24
			silty sand FILL with gravel, moist, brown	8		Split Spoon	3+3+3	18
				11		Split Spoon	2+3+5	18
165.9		B2	silty SAND (SM), moist, white and brown	23		Split Spoon	1+6+11	18
	10			23		Split Spoon	8+9+8	18
	20			24		Split Spoon	6+9+9	18
				17		Split Spoon	5+7+6	18
	30			20		Split Spoon	5+7+8	18
				40		Split Spoon	7+14+16	18
135.4		B1	sandy SILT (ML), moist, gray and brown	40		Split Spoon	8+15+15	18
	40			31		Split Spoon	3+11+12	18
125.4		B2	clayey SAND (SC), wet, white and orange	36		Split Spoon	11+11+16	18
123.9	50		Bottom of Boring at 50.0 ft					



GROUND WATER LEVELS:

ENCOUNTERED: 33.0 ft ELEV. 140.9

UPON COMPLETION: Dry CAVED: 3.0 ft ELEV. 170.9

SAMPLE TYPES: Split Spoon

REMARKS: Coordinates: 38°32'03.98" N, 77°20'07.98" W

THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES. THE TRANSITION MAY BE GRADUAL.

GeoConcepts Engineering, Inc.
19955 Highland Vista Dr., #170
Ashburn, Virginia 20147
703-726-8030
703-726-8032 fax

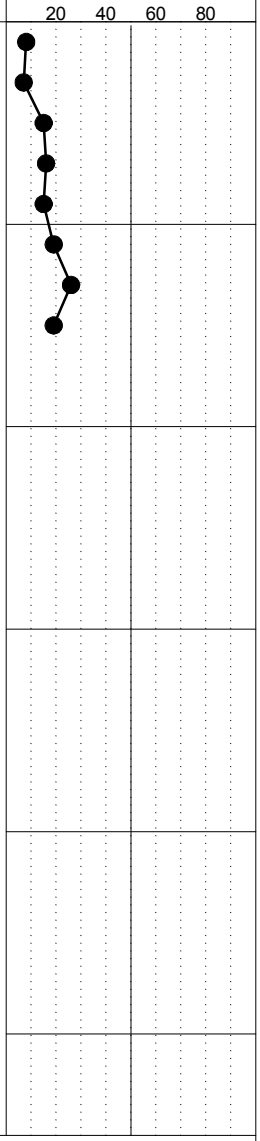
PROJECT:	LOGGED BY:	BORING NUMBER:
Quantico Middle/High School	D. Stein	SWM-1
LOCATION:	DRILLING CONTRACTOR:	SHEET 1 OF 1
Quantico Marine Corps Base, Virginia	Connelly and Associates, Inc.	

OWNER/CLIENT:	DRILLER:	DATE STARTED:
EwingCole	Z. Cumberland	5/16/14

PROJECT NUMBER:	GROUND SURFACE ELEVATION (ft):	DRILLING METHOD:	DATE COMPLETED:
13066	180.8	2.25" I.D. HSA	5/16/14

ELEV. (ft)	DEPTH (ft)	STRATUM	MATERIAL DESCRIPTION	N_{60}	MC (%)	SAMPLE TYPE	SPT BLOW COUNTS	RECOVERY (in)
180.6		A	Topsoil = 2 inches	11		Split Spoon	1+3+5+5	24
			silty sand FILL with gravel, moist, brown	9		Split Spoon	1+3+4+6	24
174.8				20		Split Spoon	6+7+8+10	18
172.8		B2	clayey SAND (SC), moist, tan and brown	21		Split Spoon	6+7+9+10	18
	10		silty SAND (SM), moist, brown and white	20		Split Spoon	4+7+8+8	18
				25		Split Spoon	6+9+10+12	18
				35		Split Spoon	9+12+14+10	24
164.8				25		Split Spoon	9+9+10+13	18
			Bottom of Boring at 16.0 ft					
	20							
	30							
	40							
	50							

STANDARD PENETRATION TEST RESISTANCE (BLOWS/FOOT)



GROUND WATER LEVELS:

ENCOUNTERED: None

UPON COMPLETION: Dry

CAVED: 7.5 ft ELEV. 173.3

SAMPLE TYPES:

Split Spoon

REMARKS: Coordinates: 38°32'09.95" N, 77°20'14.23" W
Offset boring 20 ft. southwest

THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES. THE TRANSITION MAY BE GRADUAL.

GeoConcepts Engineering, Inc.
19955 Highland Vista Dr., #170
Ashburn, Virginia 20147
703-726-8030
703-726-8032 fax

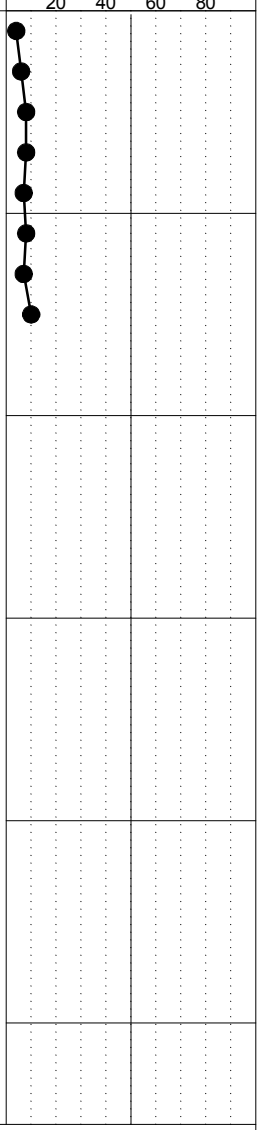
PROJECT:	LOGGED BY:	BORING NUMBER:
Quantico Middle/High School	D. Stein	SWM-3
LOCATION:	DRILLING CONTRACTOR:	SHEET 1 OF 1
Quantico Marine Corps Base, Virginia	Connelly and Associates, Inc.	

OWNER/CLIENT:	DRILLER:	DATE STARTED:
EwingCole	Z. Cumberland	5/16/14

PROJECT NUMBER:	GROUND SURFACE ELEVATION (ft):	DRILLING METHOD:	DATE COMPLETED:
13066	179.1	2.25" I.D. HSA	5/16/14

ELEV. (ft)	DEPTH (ft)	STRATUM	MATERIAL DESCRIPTION	N_{60}	MC (%)	SAMPLE TYPE	SPT BLOW COUNTS	RECOVERY (in)
178.9			Topsoil = 3 inches					
		A	silty sand FILL with gravel, moist, red-brown and orange	5		Split Spoon	1+1+3+5	18
175.1				8		Split Spoon	2+2+4+6	18
		B2	silty SAND (SM), moist, brown and white	11		Split Spoon	3+4+4+3	4
				11		Split Spoon	3+4+4+5	18
				9		Split Spoon	3+4+3+5	24
	10			11		Split Spoon	4+4+4+4	24
				9		Split Spoon	2+3+4+5	24
163.1				13		Split Spoon	5+5+5+6	24
			Bottom of Boring at 16.0 ft					
	20							
	30							
	40							
	50							

STANDARD PENETRATION TEST RESISTANCE (BLOWS/FOOT)



GROUND WATER LEVELS:

ENCOUNTERED: None

UPON COMPLETION: Dry

CAVED: 6.0 ft ELEV. 173.1

SAMPLE TYPES:

Split Spoon

REMARKS: Coordinates: 38°32'07.46" N, 77°20'15.20" W

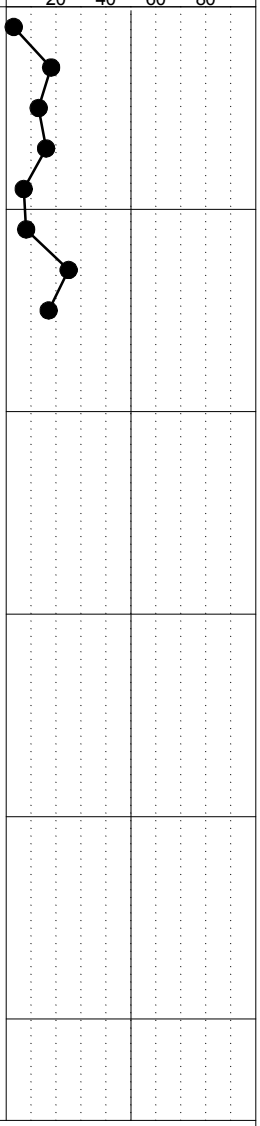
THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES. THE TRANSITION MAY BE GRADUAL.

GeoConcepts Engineering, Inc.
19955 Highland Vista Dr., #170
Ashburn, Virginia 20147
703-726-8030
703-726-8032 fax

PROJECT:	LOGGED BY:	BORING NUMBER:
Quantico Middle/High School	D. Stein	SWM-5
LOCATION:	DRILLING CONTRACTOR:	
Quantico Marine Corps Base, Virginia	Connelly and Associates, Inc.	SHEET 1 OF 1
OWNER/CLIENT:	DRILLER:	DATE STARTED:
EwingCole	Z. Cumberland	5/16/14
PROJECT NUMBER: / GROUND SURFACE ELEVATION (ft):	DRILLING METHOD:	DATE COMPLETED:
13066 / 178.7	2.25" I.D. HSA	5/16/14

ELEV. (ft)	DEPTH (ft)	STRATUM	MATERIAL DESCRIPTION	N_{60}	MC (%)	SAMPLE TYPE	SPT BLOW COUNTS	RECOVERY (in)
178.5			Topsoil = 3 inches					
		A	silty sand FILL with gravel, moist, brown	4		Split Spoon	1+1+2+2	24
				24		Split Spoon	2+5+13+7	24
				17		Split Spoon	5+6+7+10	24
170.7				21		Split Spoon	6+7+9+8	24
		B2	silty SAND (SM), moist, orange, brown, and pink	9		Split Spoon	2+3+4+4	24
	10			11		Split Spoon	3+4+4+5	24
				33		Split Spoon	3+15+10+9	24
162.7				23		Split Spoon	7+8+9+14	24
			Bottom of Boring at 16.0 ft					
	20							
	30							
	40							
	50							

STANDARD PENETRATION TEST RESISTANCE (BLOWS/FOOT)



GROUND WATER LEVELS:

ENCOUNTERED: None

UPON COMPLETION: Dry

CAVED: 8.0 ft ELEV. 170.7

SAMPLE TYPES:

Split Spoon

REMARKS: Coordinates: 38°32'08.39" N, 77°20'10.35" W

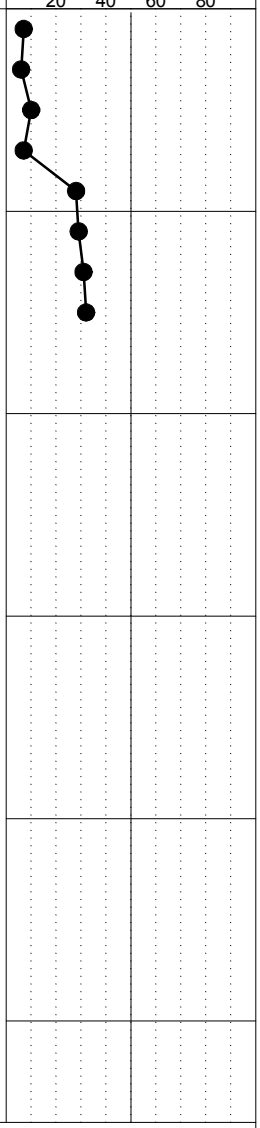
THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES. THE TRANSITION MAY BE GRADUAL.

GeoConcepts Engineering, Inc.
19955 Highland Vista Dr., #170
Ashburn, Virginia 20147
703-726-8030
703-726-8032 fax

PROJECT:	LOGGED BY:	BORING NUMBER:
Quantico Middle/High School	D. Stein	SWM-7
LOCATION: Quantico Marine Corps Base, Virginia	DRILLING CONTRACTOR: Connelly and Associates, Inc.	SHEET 1 OF 1
OWNER/CLIENT: EwingCole	DRILLER: Z. Cumberland	DATE STARTED: 5/15/14
PROJECT NUMBER: 13066 / GROUND SURFACE ELEVATION (ft): 177.7	DRILLING METHOD: 2.25" I.D. HSA	DATE COMPLETED: 5/15/14

ELEV. (ft)	DEPTH (ft)	STRATUM	MATERIAL DESCRIPTION	N_{60}	MC (%)	SAMPLE TYPE	SPT BLOW COUNTS	RECOVERY (in)
177.3			Topsoil = 4 inches					
		A	silty sand FILL, moist, brown	9		Split Spoon	2+3+4+5	24
				8		Split Spoon	3+3+3+5	24
				13		Split Spoon	3+4+6+7	24
				9		Split Spoon	3+3+4+5	24
167.7	10			37		Split Spoon	9+14+14+21	24
		B2	silty SAND (SM), moist, white and brown	39		Split Spoon	15+14+15+16	24
				41		Split Spoon	16+17+14+16	24
161.7				43		Split Spoon	14+18+14+15	24
			Bottom of Boring at 16.0 ft					
	20							
	30							
	40							
	50							

STANDARD PENETRATION TEST RESISTANCE (BLOWS/FOOT)



GROUND WATER LEVELS:

ENCOUNTERED: None

UPON COMPLETION: Dry

CAVED: 6.8 ft ELEV. 170.9

SAMPLE TYPES:

Split Spoon

REMARKS: Coordinates: 38°32'06.61" N, 77°20'03.89" W

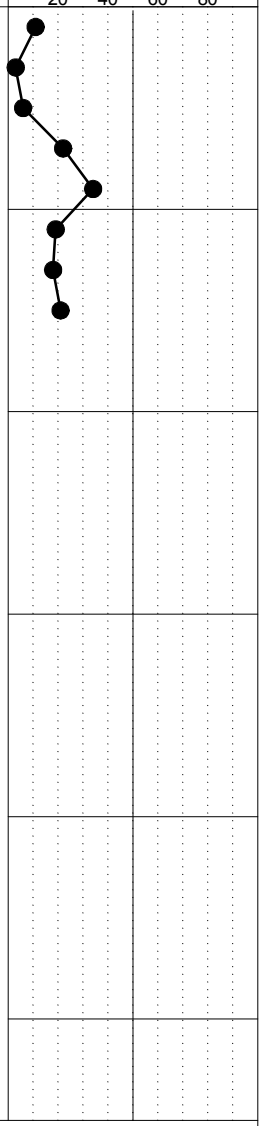
THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES. THE TRANSITION MAY BE GRADUAL.

GeoConcepts Engineering, Inc.
19955 Highland Vista Dr., #170
Ashburn, Virginia 20147
703-726-8030
703-726-8032 fax

PROJECT:	LOGGED BY:	BORING NUMBER:
Quantico Middle/High School	D. Stein	SWM-8
LOCATION: Quantico Marine Corps Base, Virginia	DRILLING CONTRACTOR: Connelly and Associates, Inc.	SHEET 1 OF 1
OWNER/CLIENT: EwingCole	DRILLER: Z. Cumberland	DATE STARTED: 5/19/14
PROJECT NUMBER: 13066 / GROUND SURFACE ELEVATION (ft): 174.0 ±	DRILLING METHOD: 2.25" I.D. HSA	DATE COMPLETED: 5/19/14

ELEV. (ft)	DEPTH (ft)	STRATUM	MATERIAL DESCRIPTION	N_{60}	MC (%)	SAMPLE TYPE	SPT BLOW COUNTS	RECOVERY (in)
173.8			Topsoil = 2 inches	15		Split Spoon	4+5+6+6	24
		A	silty sand FILL with gravel, moist, brown	4		Split Spoon	2+2+1+2	24
170.0								
			clayey sand FILL, moist, brown	8		Split Spoon	2+2+4+7	24
				29		Split Spoon	8+10+12+14	24
166.0								
		B2	silty SAND (SM), moist, brown and white	45		Split Spoon	8+17+17+17	24
	10			25		Split Spoon	6+9+10+11	18
				24		Split Spoon	8+8+10+12	18
158.0				28		Split Spoon	9+10+11+14	24
			Bottom of Boring at 16.0 ft					
	20							
	30							
	40							
	50							

STANDARD PENETRATION TEST RESISTANCE (BLOWS/FOOT)



GROUND WATER LEVELS:

ENCOUNTERED: None

UPON COMPLETION: Dry

CAVED: 6.9 ft ELEV. 167.1

SAMPLE TYPES:

Split Spoon

REMARKS: Coordinates: 38°32'04.36" N, 77°20'01.10" W

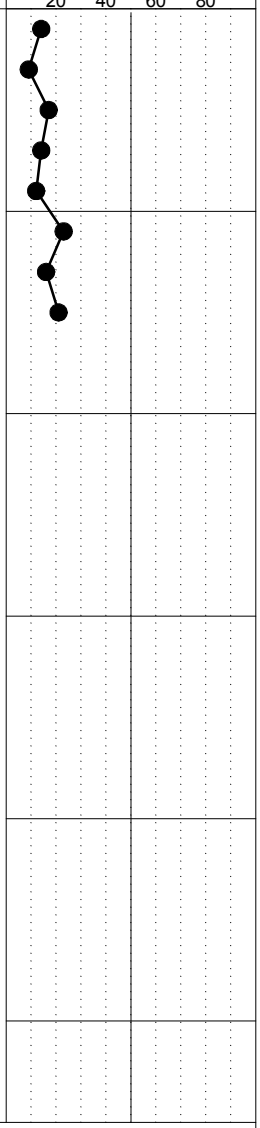
THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES. THE TRANSITION MAY BE GRADUAL.

GeoConcepts Engineering, Inc.
19955 Highland Vista Dr., #170
Ashburn, Virginia 20147
703-726-8030
703-726-8032 fax

PROJECT:	LOGGED BY:	BORING NUMBER:
Quantico Middle/High School	D. Stein	SWM-9
LOCATION:	DRILLING CONTRACTOR:	
Quantico Marine Corps Base, Virginia	Connelly and Associates, Inc.	SHEET 1 OF 1
OWNER/CLIENT:	DRILLER:	DATE STARTED:
EwingCole	Z. Cumberland	5/15/14
PROJECT NUMBER: / GROUND SURFACE ELEVATION (ft):	DRILLING METHOD:	DATE COMPLETED:
13066 / 176.0 ±	2.25" I.D. HSA	5/15/14

ELEV. (ft)	DEPTH (ft)	STRATUM	MATERIAL DESCRIPTION	N_{60}	MC (%)	SAMPLE TYPE	SPT BLOW COUNTS	RECOVERY (in)
174.0		A	sandy silt FILL, moist, brown	19		Split Spoon	4+7+7+8	24
			silty sand FILL, moist, red-brown	12		Split Spoon	3+4+5+8	24
				23		Split Spoon	4+8+9+10	24
168.0				19	14.6	Split Spoon	5+6+8+12	18
	10	B2	silty SAND (SM), moist, white and brown	16		Split Spoon	4+5+7+8	18
				31		Split Spoon	10+12+11+11	24
				21		Split Spoon	7+8+8+8	18
160.0				28		Split Spoon	8+9+12+12	24
			Bottom of Boring at 16.0 ft					
	20							
	30							
	40							
	50							

STANDARD PENETRATION TEST RESISTANCE (BLOWS/FOOT)



GROUND WATER LEVELS:

ENCOUNTERED: None

UPON COMPLETION: Dry

CAVED: 7.0 ft ELEV. 169.0

SAMPLE TYPES:

Split Spoon

REMARKS: Coordinates: 38°32'04.62" N, 77°20'06.61" W

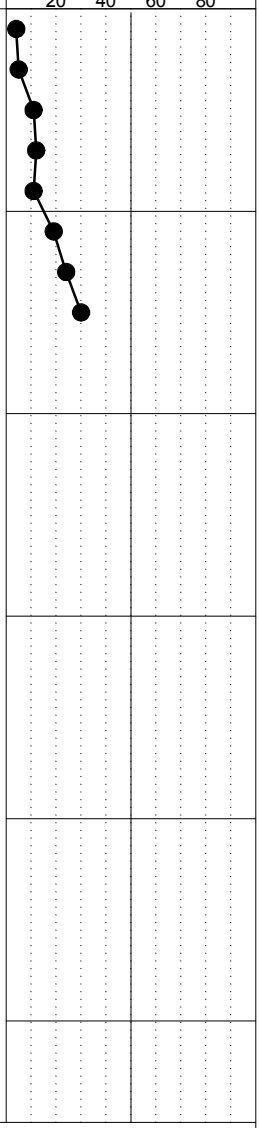
THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES. THE TRANSITION MAY BE GRADUAL.

GeoConcepts Engineering, Inc.
19955 Highland Vista Dr., #170
Ashburn, Virginia 20147
703-726-8030
703-726-8032 fax

PROJECT:	LOGGED BY:	BORING NUMBER:
Quantico Middle/High School	D. Stein	SWM-11
LOCATION: Quantico Marine Corps Base, Virginia	DRILLING CONTRACTOR: Connelly and Associates, Inc.	SHEET 1 OF 1
OWNER/CLIENT: EwingCole	DRILLER: Z. Cumberland	DATE STARTED: 5/15/14
PROJECT NUMBER: 13066 / GROUND SURFACE ELEVATION (ft): 153.5	DRILLING METHOD: 2.25" I.D. HSA	DATE COMPLETED: 5/15/14

ELEV. (ft)	DEPTH (ft)	STRATUM	MATERIAL DESCRIPTION	N_{60}	MC (%)	SAMPLE TYPE	SPT BLOW COUNTS	RECOVERY (in)
		A	sandy lean clay FILL, moist, brown	5		Split Spoon	1+2+2+3	8
				7		Split Spoon	2+2+3+3	24
147.5				15	22.3	Split Spoon	3+5+6+7	24
		B2	clayey SAND (SC), wet, brown and tan	16		Split Spoon	4+6+6+8	24
				15		Split Spoon	3+5+6+7	24
	10			25		Split Spoon	6+8+11+13	24
139.5				32		Split Spoon	7+10+14+16	18
137.5			silty SAND (SM), wet, white and brown	40		Split Spoon	6+14+16+14	24
			Bottom of Boring at 16.0 ft					
	20							
	30							
	40							
	50							

STANDARD PENETRATION TEST RESISTANCE (BLOWS/FOOT)



GROUND WATER LEVELS:

ENCOUNTERED: 2.0 ft ELEV. 151.5

UPON COMPLETION: Dry CAVED: 8.0 ft ELEV. 145.5

SAMPLE TYPES:

Split Spoon

REMARKS: Coordinates: 38°32'01.56" N, 77°20'06.03" W

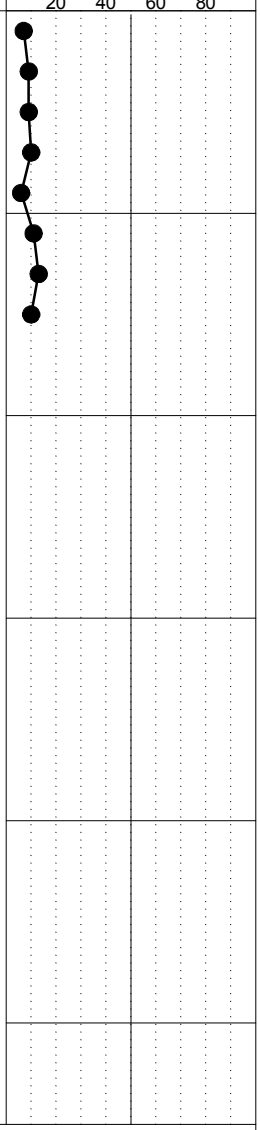
THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES. THE TRANSITION MAY BE GRADUAL.

GeoConcepts Engineering, Inc.
19955 Highland Vista Dr., #170
Ashburn, Virginia 20147
703-726-8030
703-726-8032 fax

PROJECT:	LOGGED BY:	BORING NUMBER:
Quantico Middle/High School	D. Stein	SWM-13
LOCATION: Quantico Marine Corps Base, Virginia	DRILLING CONTRACTOR: Connelly and Associates, Inc.	SHEET 1 OF 1
OWNER/CLIENT: EwingCole	DRILLER: Z. Cumberland	DATE STARTED: 5/15/14
PROJECT NUMBER: 13066 / GROUND SURFACE ELEVATION (ft): 171.3	DRILLING METHOD: 2.25" I.D. HSA	DATE COMPLETED: 5/15/14

ELEV. (ft)	DEPTH (ft)	STRATUM	MATERIAL DESCRIPTION	N_{60}	MC (%)	SAMPLE TYPE	SPT BLOW COUNTS	RECOVERY (in)
171.1			Topsoil = 3 inches					
		A	sandy lean clay FILL, moist, brown	9		Split Spoon	3+3+4+4	24
				12		Split Spoon	3+4+5+5	24
165.3				12		Split Spoon	4+5+4+6	24
		B2	silty SAND (SM), moist, brown and white	13		Split Spoon	3+4+6+7	24
	10			8		Split Spoon	3+2+4+5	24
				15		Split Spoon	5+5+6+6	24
				17		Split Spoon	5+6+7+6	24
155.3				13		Split Spoon	4+5+5+7	18
			Bottom of Boring at 16.0 ft					
	20							
	30							
	40							
	50							

STANDARD PENETRATION TEST RESISTANCE (BLOWS/FOOT)



GROUND WATER LEVELS:

ENCOUNTERED: None

UPON COMPLETION: Dry

CAVED: 7.3 ft ELEV. 164.0

SAMPLE TYPES:

Split Spoon

REMARKS: Coordinates: 38°32'02.01" N, 77°20'08.81" W

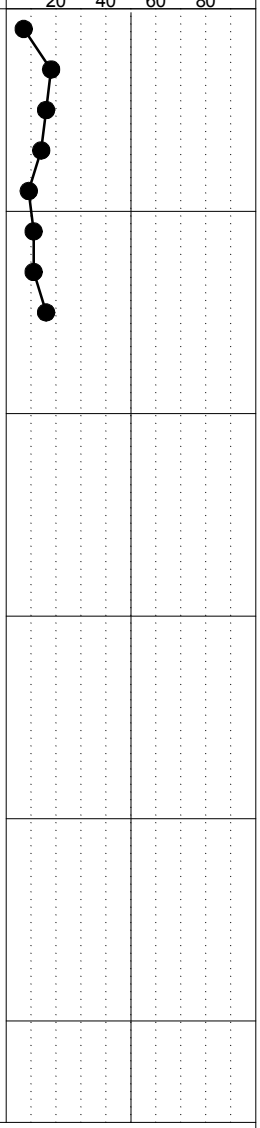
THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES. THE TRANSITION MAY BE GRADUAL.

GeoConcepts Engineering, Inc.
19955 Highland Vista Dr., #170
Ashburn, Virginia 20147
703-726-8030
703-726-8032 fax

PROJECT:	LOGGED BY:	BORING NUMBER:
Quantico Middle/High School	D. Stein	SWM-16
LOCATION: Quantico Marine Corps Base, Virginia	DRILLING CONTRACTOR: Connelly and Associates, Inc.	SHEET 1 OF 1
OWNER/CLIENT: EwingCole	DRILLER: Z. Cumberland	DATE STARTED: 5/15/14
PROJECT NUMBER: 13066 / GROUND SURFACE ELEVATION (ft): 180.8	DRILLING METHOD: 2.25" I.D. HSA	DATE COMPLETED: 5/15/14

ELEV. (ft)	DEPTH (ft)	STRATUM	MATERIAL DESCRIPTION	N_{60}	MC (%)	SAMPLE TYPE	SPT BLOW COUNTS	RECOVERY (in)
180.6/ 178.8		A	Topsoil = 3 inches	9		Split Spoon	1+4+3+5	24
			silty sand FILL, moist, brown	24		Split Spoon	4+8+10+10	24
		B2	silty SAND (SM), moist, white, brown, and orange	21		Split Spoon	5+7+9+11	24
				19		Split Spoon	5+6+8+9	24
	10			12		Split Spoon	5+5+4+4	24
				15		Split Spoon	5+5+6+7	24
				15		Split Spoon	4+5+6+6	18
164.8				21		Split Spoon	6+8+8+10	24
			Bottom of Boring at 16.0 ft					
	20							
	30							
	40							
	50							

STANDARD PENETRATION TEST RESISTANCE (BLOWS/FOOT)



GROUND WATER LEVELS:

ENCOUNTERED: None

UPON COMPLETION: Dry

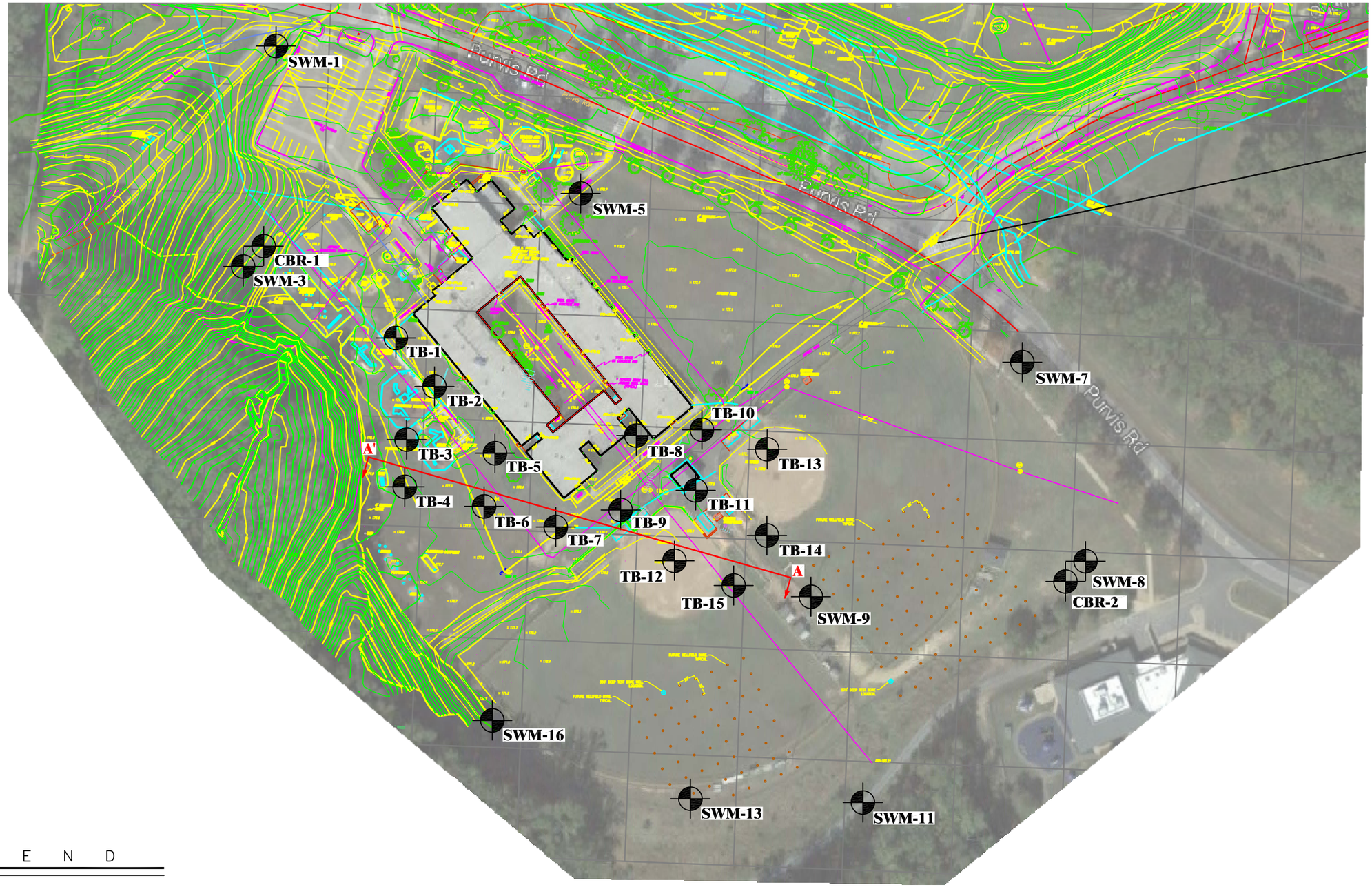
CAVED: 7.0 ft ELEV. 173.8

SAMPLE TYPES:

Split Spoon

REMARKS: Coordinates: 38°32'02.17" N, 77°20'11.83" W

THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES. THE TRANSITION MAY BE GRADUAL.



N

L E G E N D

TEST BORING LOCATION
TB-1, SWM-1, CBR-1

SUBSURFACE DIAGRAM CROSS SECTION
A A'

GRAPHICAL SCALE
120' 0 120' 240'

NOTE: BASE PLAN PROVIDED BY EWINGCOLE DATED APRIL 2014.

N:\PROJECTS\Active 13 Projects\13066, Quantico Marine Corps Base, Middle-High School\CAD\BLP - using ACAD-QMS13.dwg

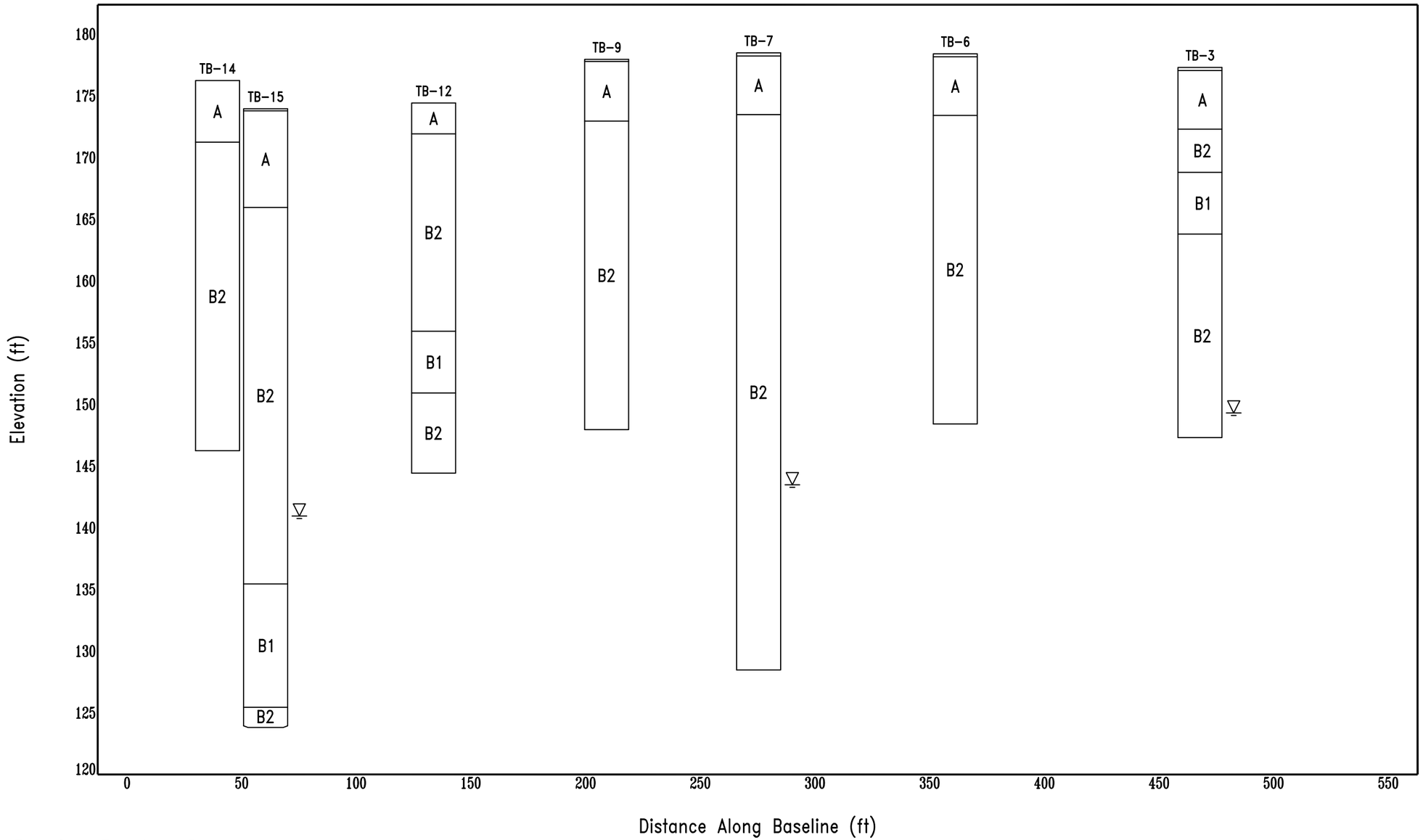
GeoConcepts Engineering, Inc.
19955 Highland Vista Dr., Suite 170 (703) 726-8030
Ashburn, Virginia 20147 (703) 726-8032 fax

QUANTICO MIDDLE/HIGH SCHOOL
QUANTICO MARINE CORPS BASE, VIRGINIA

BORING LOCATION PLAN

Scale:	Fig.
AS SHOWN	5

Date:	Checked By:	Project No.:
OCT. 2016	P.E.B.	13066



L E G E N D

A	EXISTING FILL
B1	POTOMAC GROUP – FINE GRAINED
B2	POTOMAC GROUP – COARSE GRAINED
∇	GROUNDWATER LEVEL ENCOUNTERED DURING DRILLING

GeoConcepts Engineering, Inc.
19955 Highland Vista Dr., Suite 170 (703) 726-8030
Ashburn, Virginia 20147 (703) 726-8032 fax

QUANTICO MIDDLE/HIGH SCHOOL
QUANTICO MARINE CORPS BASE, QUANTICO, VIRGINIA

SUBSURFACE DIAGRAM A–A'

Date:	Drawn By:	Checked By:	Scale:	Fig.
OCT. 2016	K.N.F.	P.E.B.	AS SHOWN	6
			Project No.: 13066	

subsurface diagram a–a'.dwg

Appendix B
Soil Laboratory Test Results

Liquid Limit and Plastic Limit, and Grain Size Analysis Test Data (30 pages)

Moisture Density Relationship Test Data (2 pages)

CBR Test Data (2 pages)

Soil Corrosion Potential Profiles (3 pages)

A&L Texture Analysis (1 page)

GeoConcepts Engineering, Inc.

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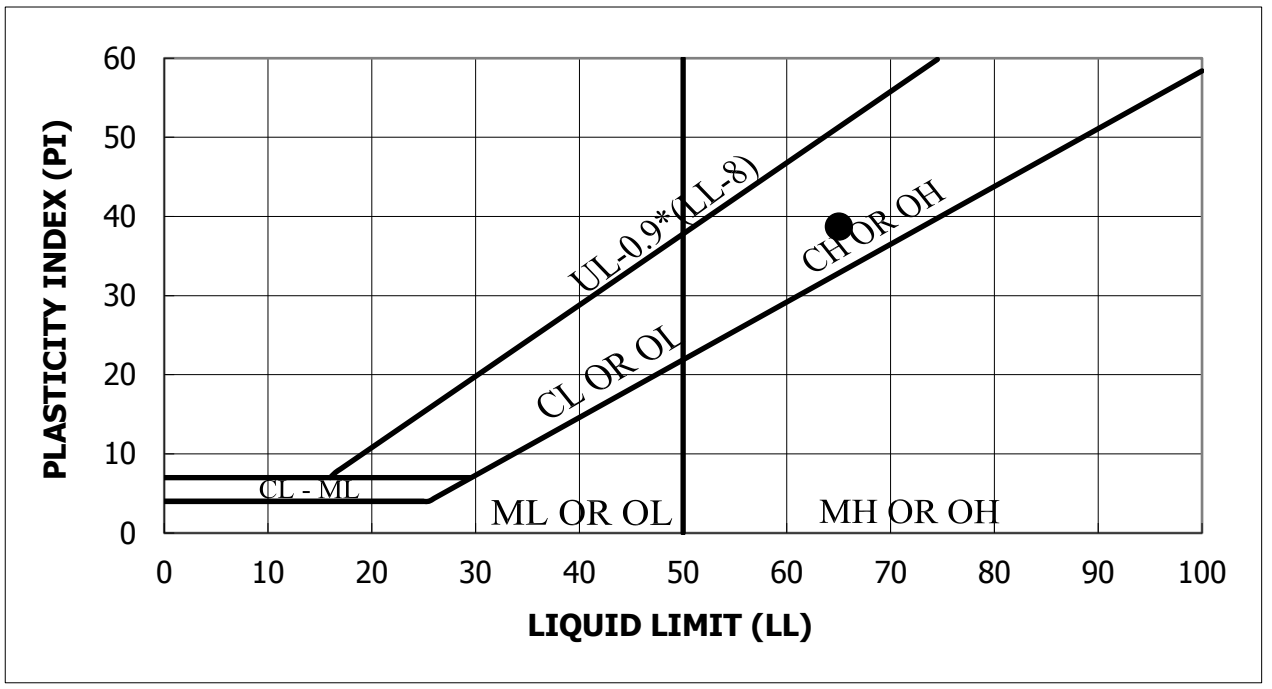
Ashburn, Virginia 20147
(703) 726-8030
www.geoconcepts-eng.com

LIQUID AND PLASTIC LIMIT - ASTM D4318

Project No.	13066	**Project Name**	Quantico MB
Test Boring No.	TB-1	**Depth (Feet)**	28.5'-30.0'
Lab Order No.	3279-1	**Date**	6/11/2014



Material Description	LL	PL	PI	% Passing #4	% Passing #200	USCS	w (%)
Fat Clay with sand	65	26	39	100.0	72.2	CH	31.1
Color	Brownish Gray		AASHTO Classification			A-7-6	

Test Method: ASTM D 4318
Soil Classification by ASTM D2487 and AASHTO M 145

Tested by _____

Reviewed by _____

GeoConcepts Engineering, Inc.

19955 Highland Vista Dr., Suite 170
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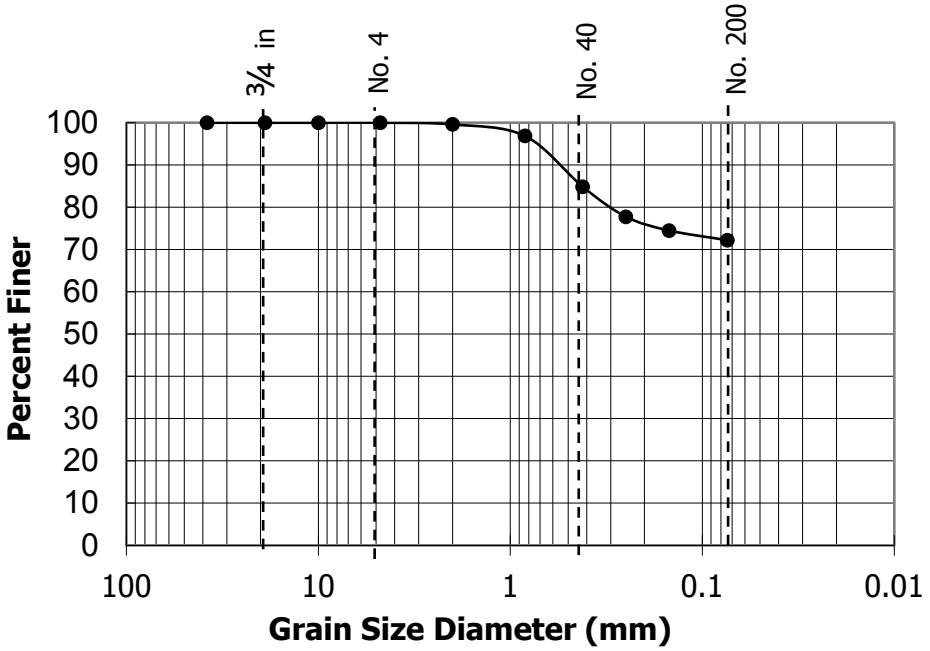
GRAIN SIZE ANALYSIS - ASTM D422

Project No.	13066	**Project Name**	Quantico MB
Test Boring No.	TB-1	**Depth (Feet)**	28.5'-30.0'
Lab Order No.	3279-1	**Date**	6/11/2014



SIEVE	% Passing
1 ½ "	**100**
3/4"	**100**
3/8"	**100**
#4	**100**
#10	**100**
#20	**97**
#40	**85**
#60	**78**
#100	**74**
#200	**72**
Pan	**--**

USCS Group Symbol	**CH**
USCS Group Name	**Fat Clay with sand**
Cu	**---**
Cc	**---**
LL	**65**
PI	**39**
Gravel	**0.0**
Sand	**27.8**
Fines	**72.2**
AASHTO Classification	**A-7-6**
Color	**Brownish Gray**

Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Tested by:_____

Reviewed by: Shawn Harris

GeoConcepts Engineering, Inc.

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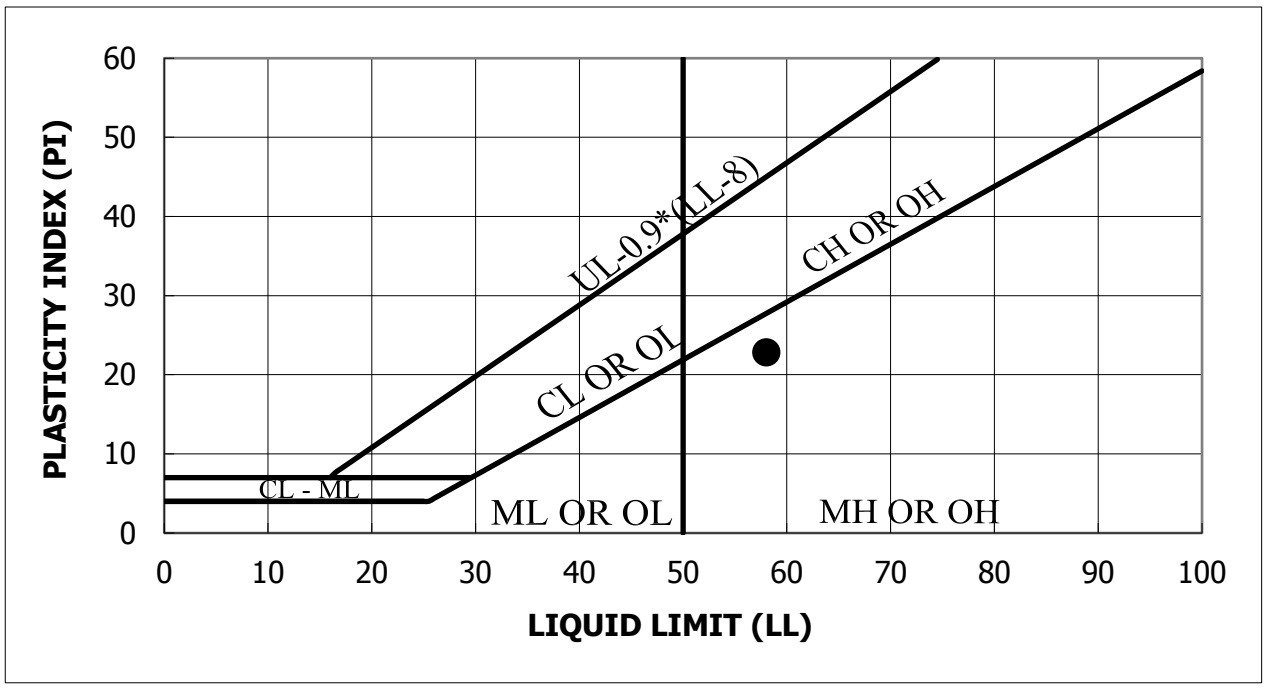
LIQUID AND PLASTIC LIMIT - ASTM D4318

Project No.	13066	**Project Name**	Quantico MB
Test Boring No.	TB-3	**Depth (Feet)**	8.5'-10.0'
Lab Order No.	3279-2	**Date**	6/11/2014



Material Description	LL	PL	PI	% Passing		USCS	w (%)
				#4	#200		
sandy Elastic Silt	58	35	23	99.3	52.9	MH	26.4
Color	Gray		AASHTO Classification			A-7-5	

Test Method: ASTM D 4318
Soil Classification by ASTM D2487 and AASHTO M 145

Tested by _____

Reviewed by _____

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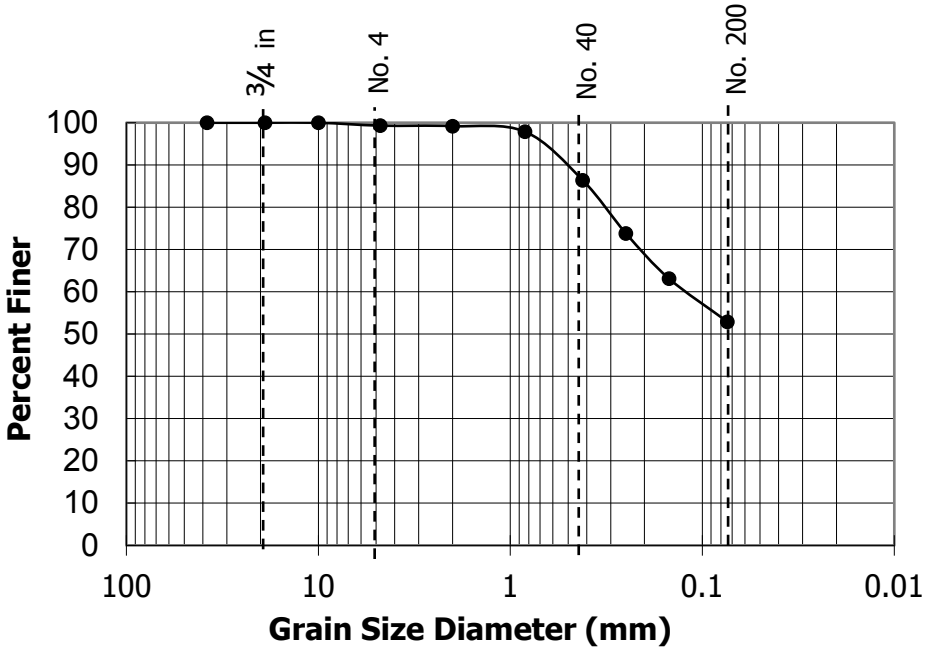
GRAIN SIZE ANALYSIS - ASTM D422			
Project No.	13066	**Project Name**	Quantico MB
Test Boring No.	TB-3	**Depth (Feet)**	8.5'-10.0'
Lab Order No.	3279-2	**Date**	6/11/2014



SIEVE	% Passing
1 ½ "	**100**
3/4"	**100**
3/8"	**100**
#4	**99**
#10	**99**
#20	**98**
#40	**86**
#60	**74**
#100	**63**
#200	**53**
Pan	**--**

USCS Group Symbol	**MH**
USCS Group Name	**sandy Elastic Silt**
Cu	**---**
Cc	**---**
LL	**58**
PI	**23**
Gravel	**0.7**
Sand	**46.4**
Fines	**52.9**
AASHTO Classification	**A-7-5**
Color	**Gray**

Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Tested by:_____

Reviewed by: Shawn Harris

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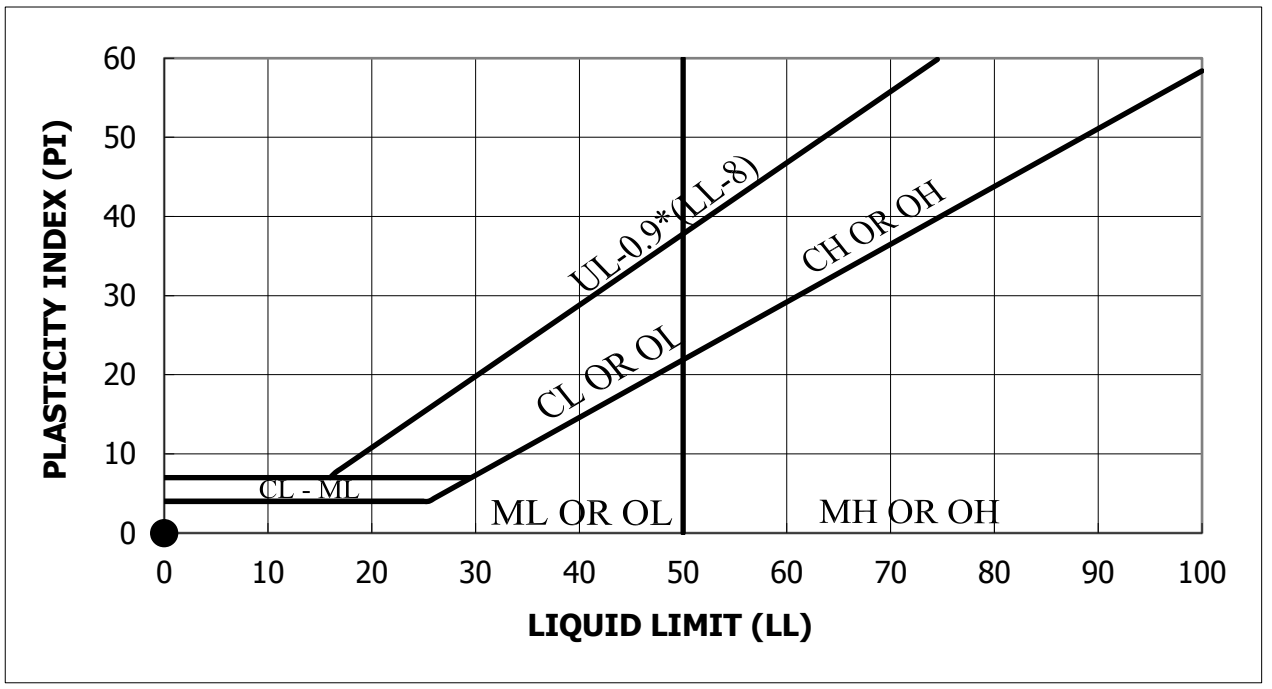
LIQUID AND PLASTIC LIMIT - ASTM D4318			
Project No.	13066	**Project Name**	Quantico MB
Test Boring No.	TB-3	**Depth (Feet)**	28.5'-30.0'
Lab Order No.	3279-3	**Date**	6/11/2014



Material Description	LL	PL	PI	% Passing		USCS	w (%)
				#4	#200		
SILTY SAND	NP	NP	NP	100.0	17.1	SM	24.1
Color	Yellowish Brown		AASHTO Classification			A-1-b	

Test Method: ASTM D 4318
Soil Classification by ASTM D2487 and AASHTO M 145

Tested by _____

Reviewed by _____

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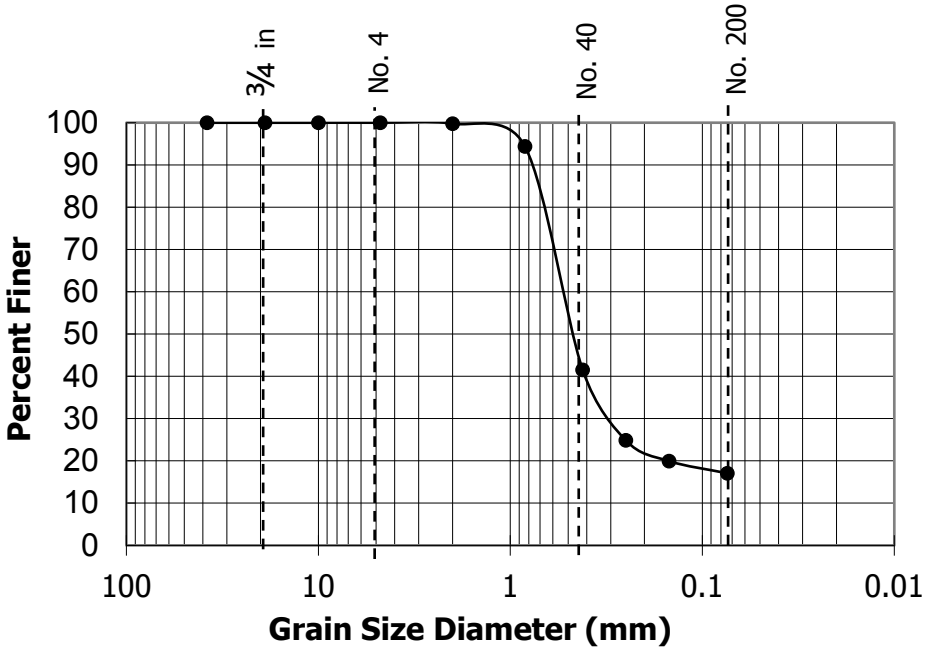
GRAIN SIZE ANALYSIS - ASTM D422			
Project No.	13066	**Project Name**	Quantico MB
Test Boring No.	TB-3	**Depth (Feet)**	28.5'-30.0'
Lab Order No.	3279-3	**Date**	6/11/2014



SIEVE	% Passing
1 ½ "	**100**
3/4"	**100**
3/8"	**100**
#4	**100**
#10	**100**
#20	**94**
#40	**42**
#60	**25**
#100	**20**
#200	**17**
Pan	**--**

USCS Group Symbol	**SM**
USCS Group Name	**SILTY SAND**
Cu	**---**
Cc	**---**
LL	**NP**
PI	**NP**
Gravel	**0.0**
Sand	**82.9**
Fines	**17.1**
AASHTO Classification	**A-1-b**
Color	**Yellowish Brown**

Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Tested by:_____

Reviewed by: Shawn Harris

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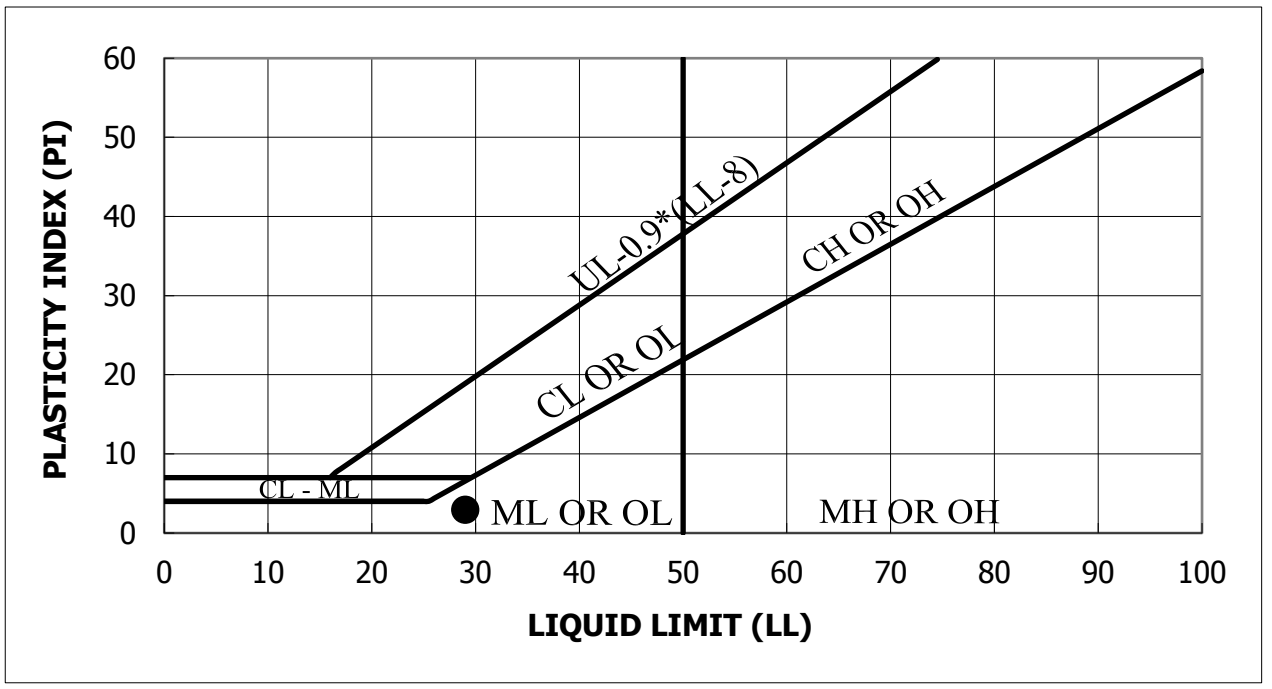
LIQUID AND PLASTIC LIMIT - ASTM D4318

Project No.	13066	**Project Name**	Quantico MB
Test Boring No.	TB-6	**Depth (Feet)**	2.5'-4.0'
Lab Order No.	3279-4	**Date**	6/11/2014



Material Description	LL	PL	PI	% Passing		USCS	w (%)
				#4	#200		
SILTY SAND	29	26	3	100.0	24.9	SM	19.6
Color	Brownish Gray		AASHTO Classification			A-2-4	

Test Method: ASTM D 4318
Soil Classification by ASTM D2487 and AASHTO M 145

Tested by _____ Reviewed by _____

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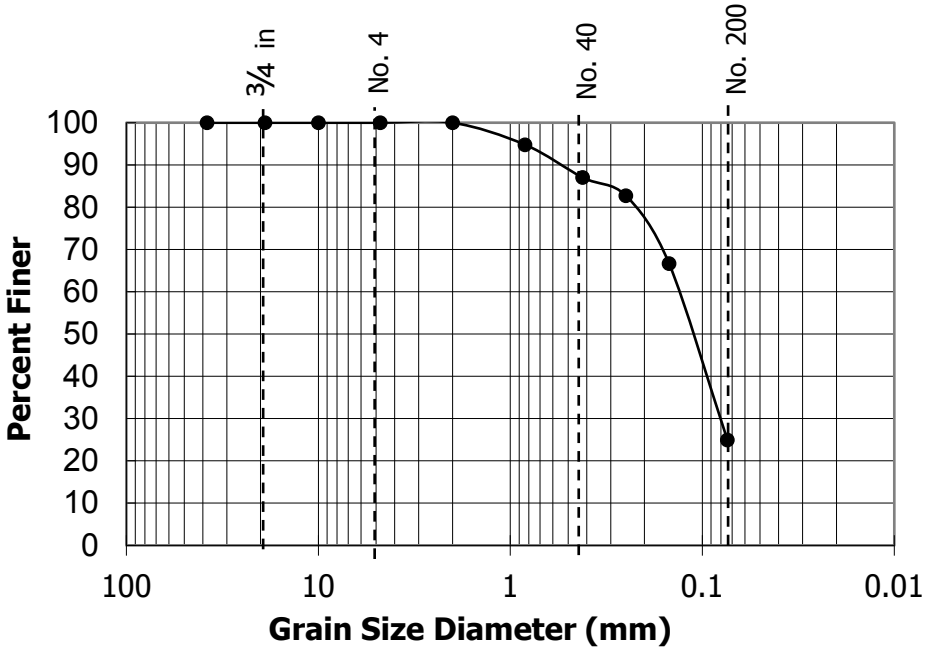
GRAIN SIZE ANALYSIS - ASTM D422			
Project No.	13066	**Project Name**	Quantico MB
Test Boring No.	TB-6	**Depth (Feet)**	2.5'-4.0'
Lab Order No.	3279-4	**Date**	6/11/2014



SIEVE	% Passing
1 ½ "	**100**
3/4"	**100**
3/8"	**100**
#4	**100**
#10	**100**
#20	**95**
#40	**87**
#60	**83**
#100	**67**
#200	**25**
Pan	**--**

USCS Group Symbol	**SM**
USCS Group Name	**SILTY SAND**
Cu	**---**
Cc	**---**
LL	**29**
PI	**3**
Gravel	**0.0**
Sand	**75.1**
Fines	**24.9**
AASHTO Classification	**A-2-4**
Color	**Brownish Gray**

Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Tested by:_____

Reviewed by: _____

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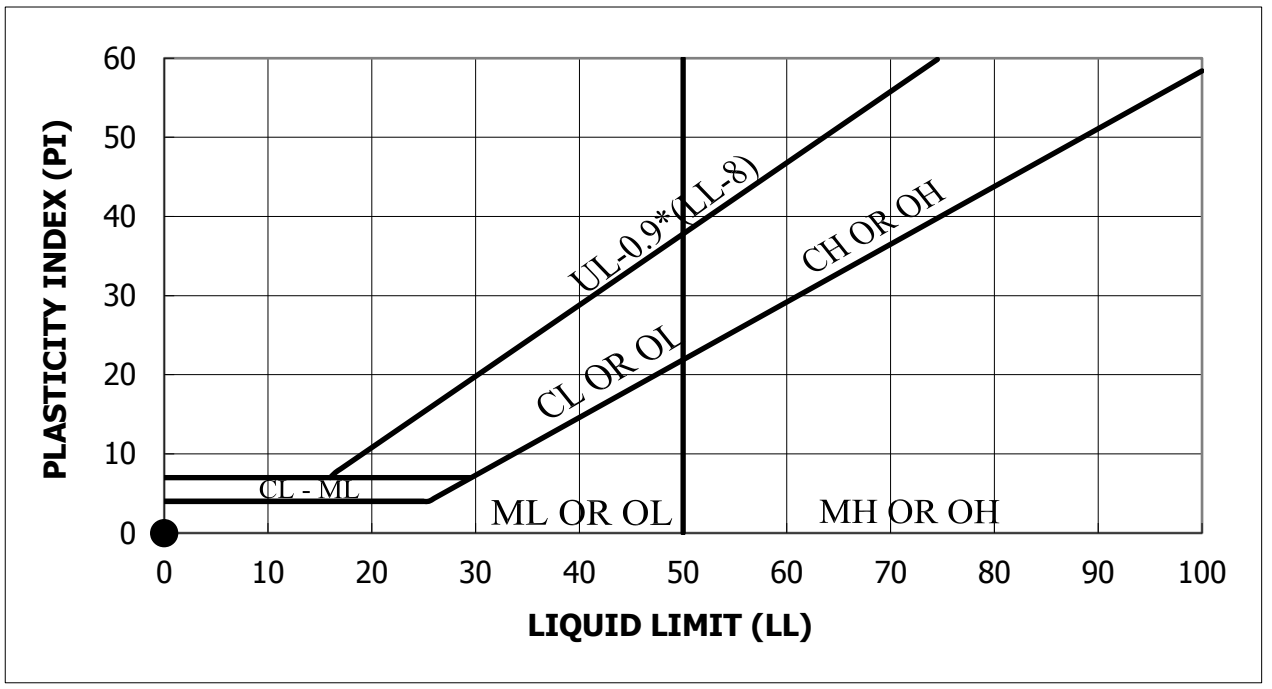
LIQUID AND PLASTIC LIMIT - ASTM D4318

Project No.	13066	**Project Name**	Quantico MB
Test Boring No.	TB-6	**Depth (Feet)**	18.5'-20.0'
Lab Order No.	3279-5	**Date**	6/11/2014



Material Description	LL	PL	PI	% Passing		USCS	w (%)
				#4	#200		
SILTY SAND	NP	NP	NP	99.1	17.5	SM	14.4
Color	Brown		AASHTO Classification			A-1-b	

Test Method: ASTM D 4318
Soil Classification by ASTM D2487 and AASHTO M 145

Tested by _____

Reviewed by _____

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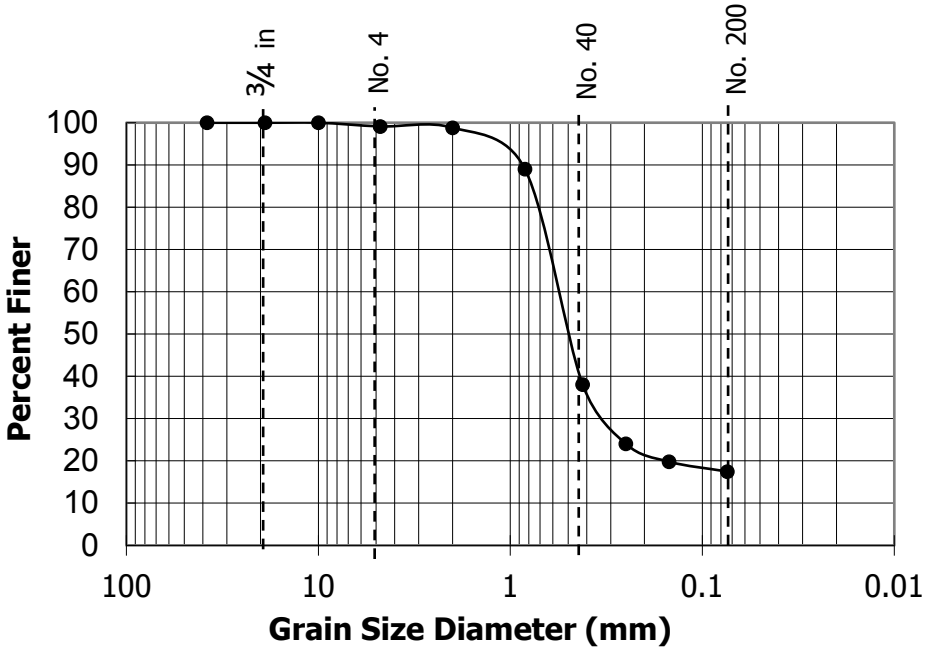
GRAIN SIZE ANALYSIS - ASTM D422			
Project No.	13066	**Project Name**	Quantico MB
Test Boring No.	TB-6	**Depth (Feet)**	18.5'-20.0'
Lab Order No.	3279-5	**Date**	6/11/2014



SIEVE	% Passing
1 ½ "	**100**
3/4"	**100**
3/8"	**100**
#4	**99**
#10	**99**
#20	**89**
#40	**38**
#60	**24**
#100	**20**
#200	**17**
Pan	**--**

USCS Group Symbol	**SM**
USCS Group Name	**SILTY SAND**
Cu	**---**
Cc	**---**
LL	**NP**
PI	**NP**
Gravel	**0.9**
Sand	**81.7**
Fines	**17.5**
AASHTO Classification	**A-1-b**
Color	**Brown**

Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Tested by:_____

Reviewed by: Shawn Harris

GeoConcepts Engineering, Inc.

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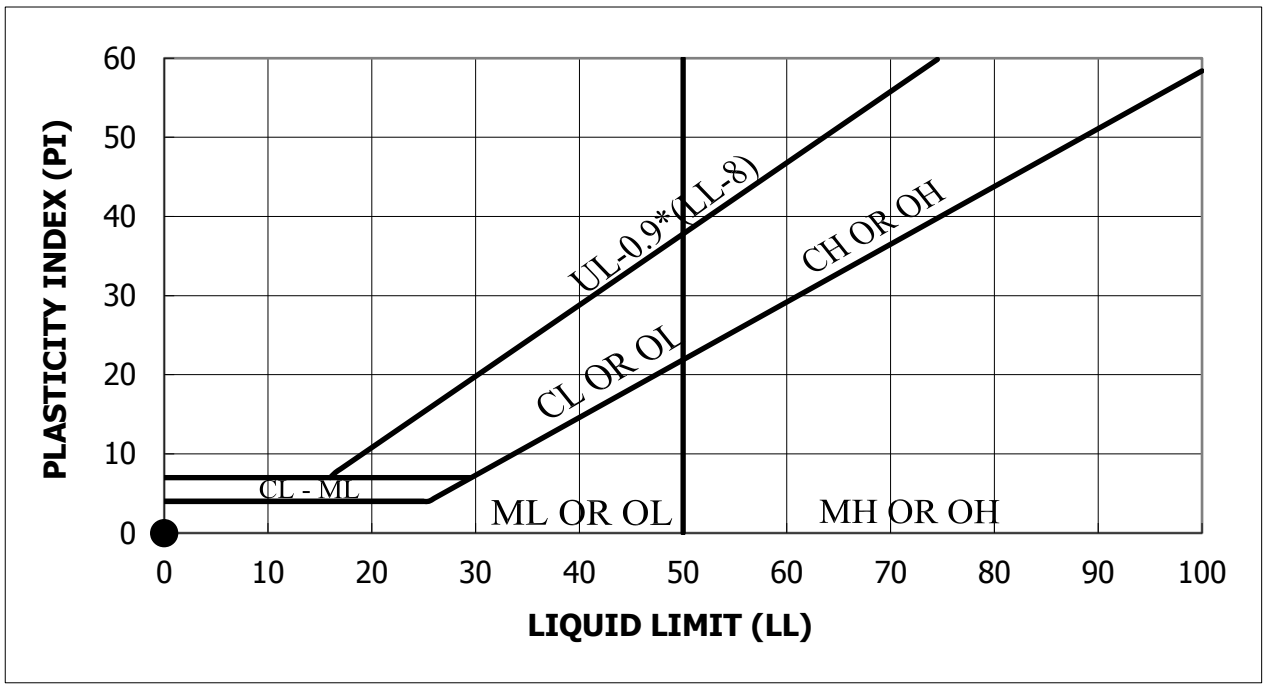
LIQUID AND PLASTIC LIMIT - ASTM D4318

Project No.	13066	**Project Name**	Quantico MB
Test Boring No.	TB-7	**Depth (Feet)**	13.5'-15.0'
Lab Order No.	3279-6	**Date**	6/11/2014



Material Description	LL	PL	PI	% Passing		USCS	w (%)
				#4	#200		
SILTY SAND	NP	NP	NP	91.6	14.1	SM	11.9
Color	Light Gray		AASHTO Classification			A-1-b	

Test Method: ASTM D 4318
Soil Classification by ASTM D2487 and AASHTO M 145

Tested by _____

Reviewed by _____

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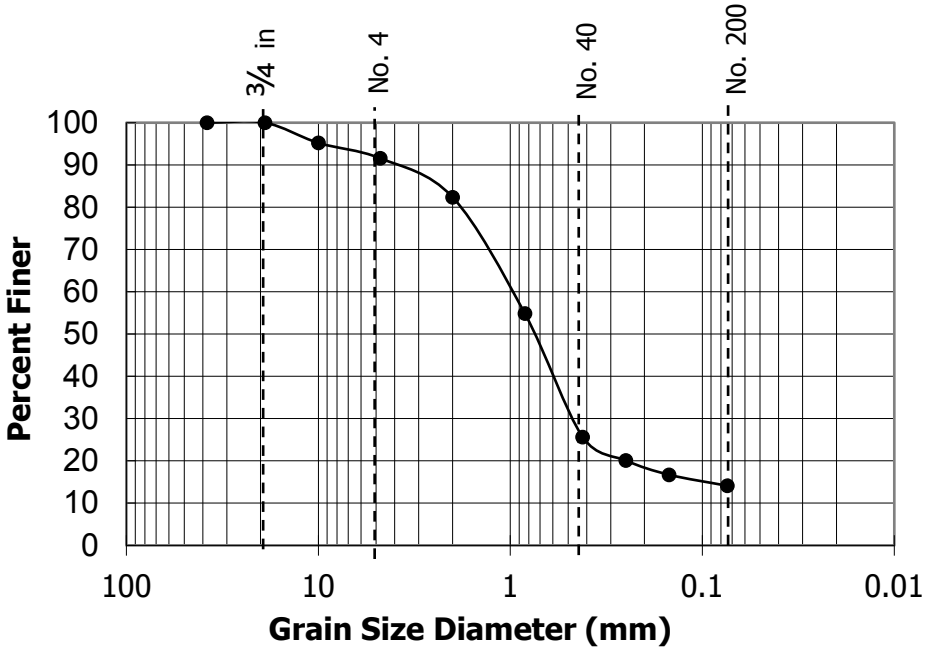
GRAIN SIZE ANALYSIS - ASTM D422			
Project No.	13066	**Project Name**	Quantico MB
Test Boring No.	TB-7	**Depth (Feet)**	13.5'-15.0'
Lab Order No.	3279-6	**Date**	6/11/2014



SIEVE	% Passing
1 ½ "	**100**
3/4"	**100**
3/8"	**95**
#4	**92**
#10	**82**
#20	**55**
#40	**26**
#60	**20**
#100	**17**
#200	**14**
Pan	**--**

USCS Group Symbol	**SM**
USCS Group Name	**SILTY SAND**
Cu	**---**
Cc	**---**
LL	**NP**
PI	**NP**
Gravel	**8.4**
Sand	**77.5**
Fines	**14.1**
AASHTO Classification	**A-1-b**
Color	**Light Gray**

Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Tested by:_____

Reviewed by: Shawn Harris

GeoConcepts Engineering, Inc.

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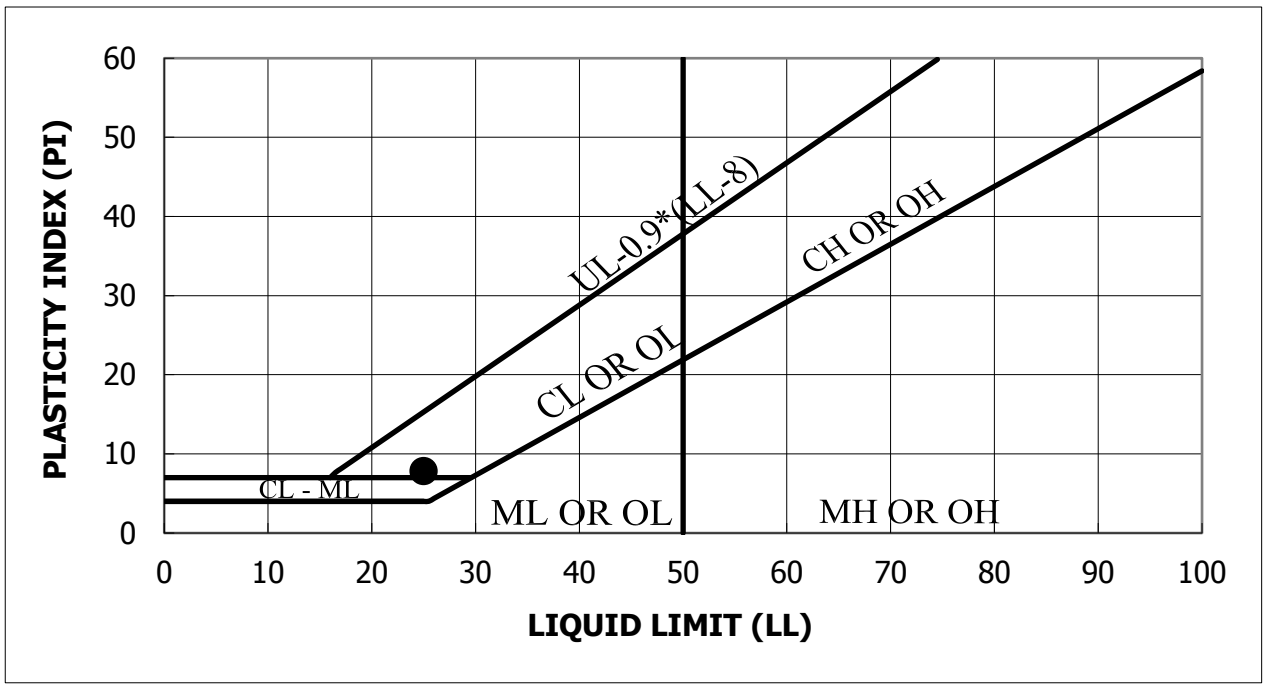
LIQUID AND PLASTIC LIMIT - ASTM D4318			
Project No.	13066	**Project Name**	Quantico MB
Test Boring No.	TB-10	**Depth (Feet)**	5.0'-6.5'
Lab Order No.	3279-7	**Date**	6/11/2014



Material Description	LL	PL	PI	% Passing		USCS	w (%)
				#4	#200		
CLAYEY SAND	25	17	8	100.0	42.1	SC	14.1
Color	Brown		AASHTO Classification			A-4	

Test Method: ASTM D 4318
Soil Classification by ASTM D2487 and AASHTO M 145

Tested by _____

Reviewed by _____

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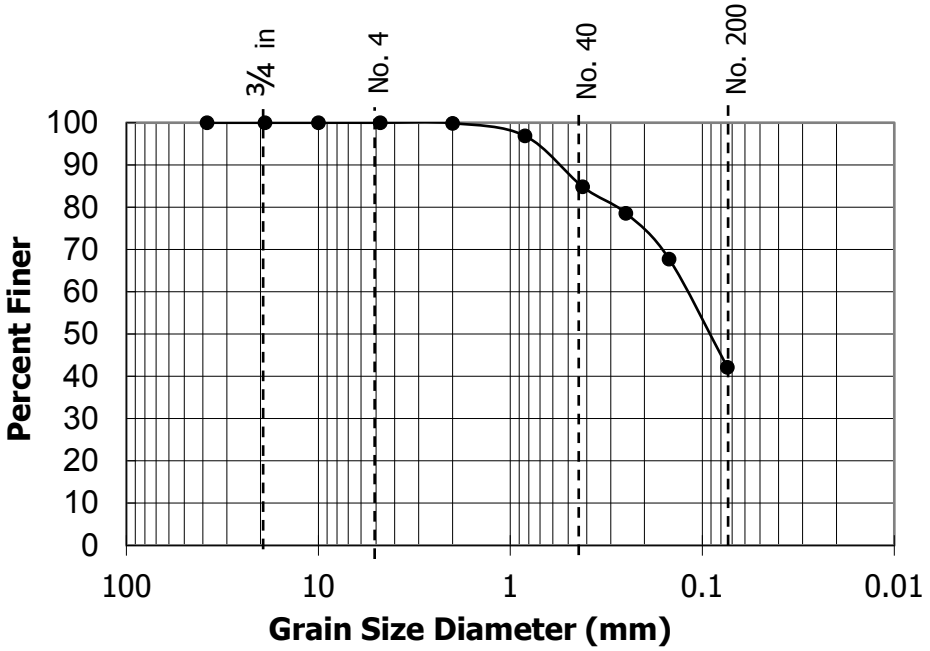
GRAIN SIZE ANALYSIS - ASTM D422			
Project No.	13066	**Project Name**	Quantico MB
Test Boring No.	TB-10	**Depth (Feet)**	5.0'-6.5'
Lab Order No.	3279-7	**Date**	6/11/2014



SIEVE	% Passing
1 ½ "	**100**
3/4"	**100**
3/8"	**100**
#4	**100**
#10	**100**
#20	**97**
#40	**85**
#60	**79**
#100	**68**
#200	**42**
Pan	**--**

USCS Group Symbol	**SC**
USCS Group Name	**CLAYEY SAND**
Cu	**---**
Cc	**---**
LL	**25**
PI	**8**
Gravel	**0.0**
Sand	**57.9**
Fines	**42.1**
AASHTO Classification	**A-4**
Color	**Brown**

Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Tested by:_____

Reviewed by:_ Shawn Harris

GeoConcepts Engineering, Inc.

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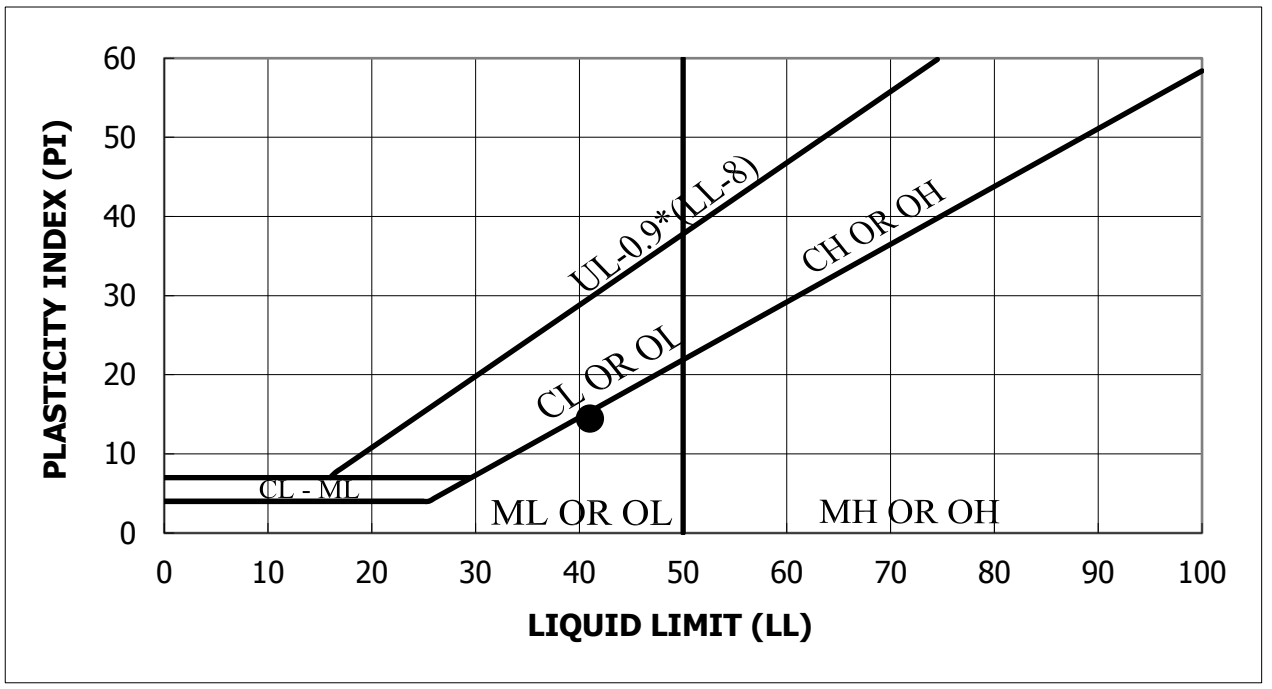
LIQUID AND PLASTIC LIMIT - ASTM D4318

Project No.	13066	**Project Name**	Quantico MB
Test Boring No.	TB-12	**Depth (Feet)**	13.5'-15.0'
Lab Order No.	3279-8	**Date**	6/11/2014



Material Description	LL	PL	PI	% Passing		USCS	w (%)
				#4	#200		
SILTY SAND	41	27	14	98.8	16.2	SM	14.8
Color	Brown		AASHTO Classification			A-2-7	

Test Method: ASTM D 4318
Soil Classification by ASTM D2487 and AASHTO M 145

Tested by _____

Reviewed by _____

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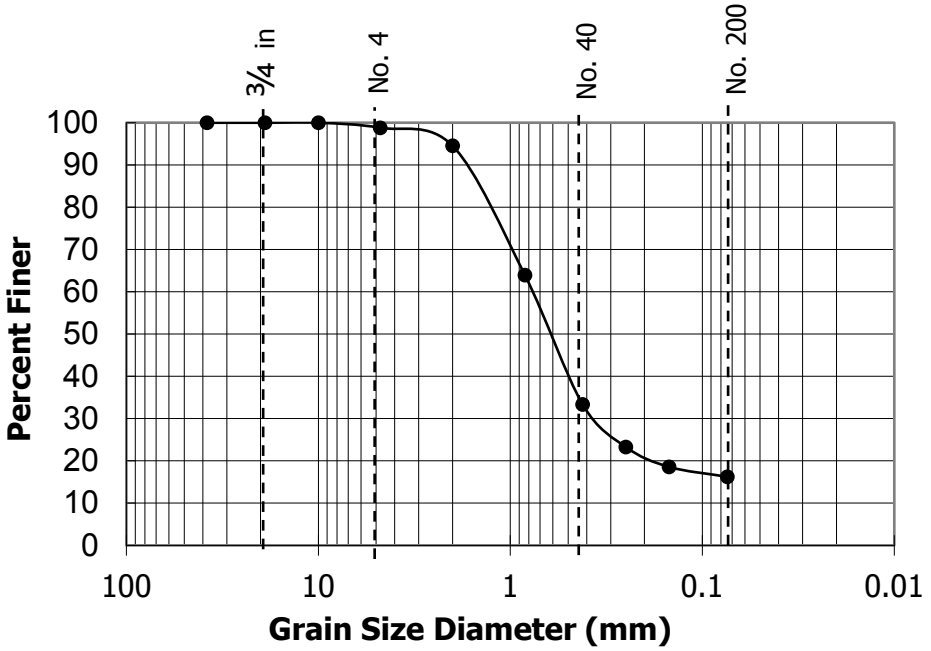
GRAIN SIZE ANALYSIS - ASTM D422			
Project No.	13066	**Project Name**	Quantico MB
Test Boring No.	TB-12	**Depth (Feet)**	13.5'-15.0'
Lab Order No.	3279-8	**Date**	6/11/2014



SIEVE	% Passing
1 ½ "	**100**
3/4"	**100**
3/8"	**100**
#4	**99**
#10	**95**
#20	**64**
#40	**33**
#60	**23**
#100	**19**
#200	**16**
Pan	**--**

USCS Group Symbol	**SM**
USCS Group Name	**SILTY SAND**
Cu	**---**
Cc	**---**
LL	**41**
PI	**14**
Gravel	**1.2**
Sand	**82.6**
Fines	**16.2**
AASHTO Classification	**A-2-7**
Color	**Brown**

Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Tested by:_____

Reviewed by: Shane Harris

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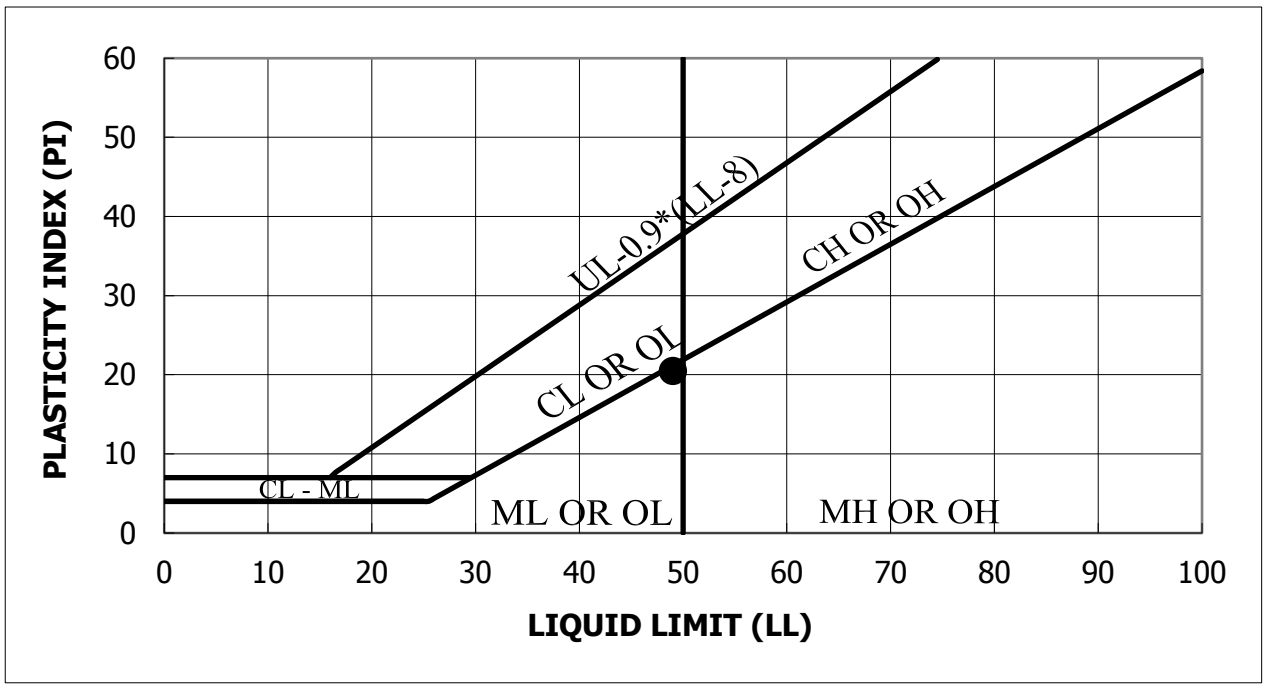
LIQUID AND PLASTIC LIMIT - ASTM D4318

Project No.	13066	**Project Name**	Quantico MB
Test Boring No.	TB-12	**Depth (Feet)**	18.5'-20.0'
Lab Order No.	3279-9	**Date**	6/11/2014



Material Description	LL	PL	PI	% Passing		USCS	w (%)
				#4	#200		
sandy Silt	49	29	20	100.0	60.5	ML	36.3
Color	Brown		AASHTO Classification			A-7-6	

Test Method: ASTM D 4318
Soil Classification by ASTM D2487 and AASHTO M 145

Tested by _____

Reviewed by _____

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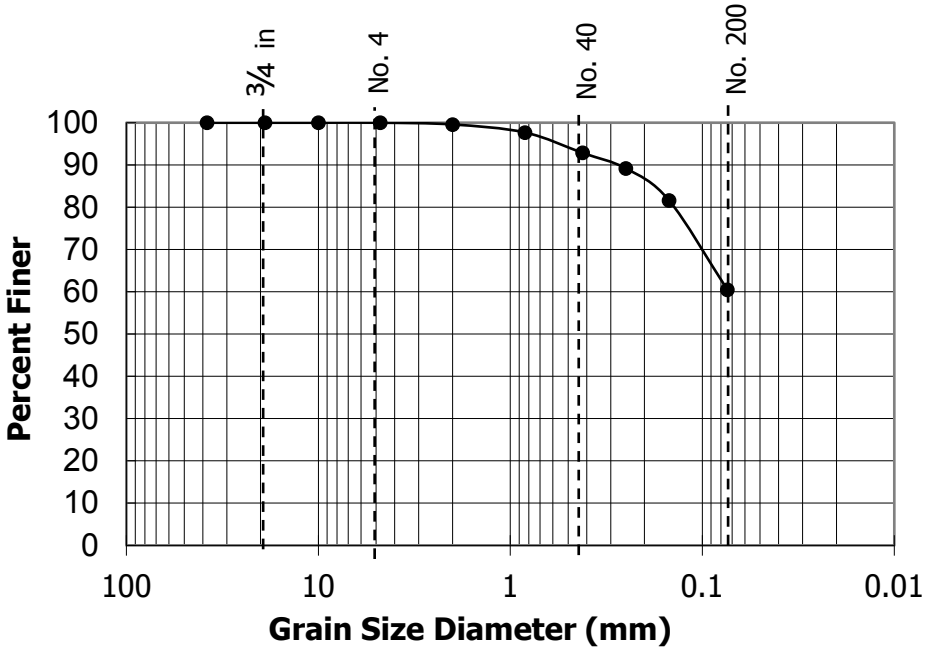
GRAIN SIZE ANALYSIS - ASTM D422			
Project No.	13066	**Project Name**	Quantico MB
Test Boring No.	TB-12	**Depth (Feet)**	18.5'-20.0'
Lab Order No.	3279-9	**Date**	6/11/2014



SIEVE	% Passing
1 ½ "	**100**
3/4"	**100**
3/8"	**100**
#4	**100**
#10	**100**
#20	**98**
#40	**93**
#60	**89**
#100	**82**
#200	**60**
Pan	**--**

USCS Group Symbol	**ML**
USCS Group Name	**sandy Silt**
Cu	**---**
Cc	**---**
LL	**49**
PI	**20**
Gravel	**0.0**
Sand	**39.5**
Fines	**60.5**
AASHTO Classification	**A-7-6**
Color	**Brown**

Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Tested by:_____

Reviewed by: Shawn Harris

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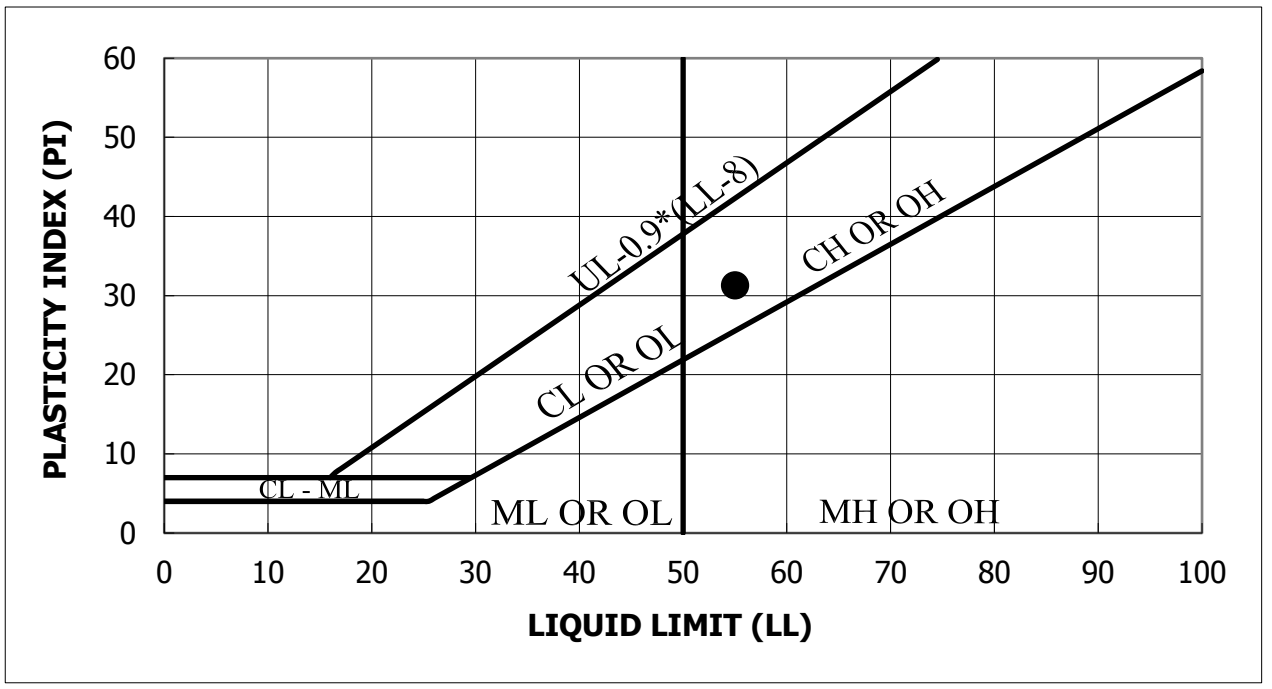
LIQUID AND PLASTIC LIMIT - ASTM D4318

Project No.	13066	**Project Name**	Quantico MB
Test Boring No.	TB-13	**Depth (Feet)**	4.0'-6.0'
Lab Order No.	3279-10	**Date**	6/11/2014



Material Description	LL	PL	PI	% Passing		USCS	w (%)
				#4	#200		
CLAYEY SAND	55	24	31	99.4	30.7	SC	16.4
Color	Brown		AASHTO Classification			A-2-7	

Test Method: ASTM D 4318
Soil Classification by ASTM D2487 and AASHTO M 145

Tested by _____

Reviewed by _____

GeoConcepts Engineering, Inc.

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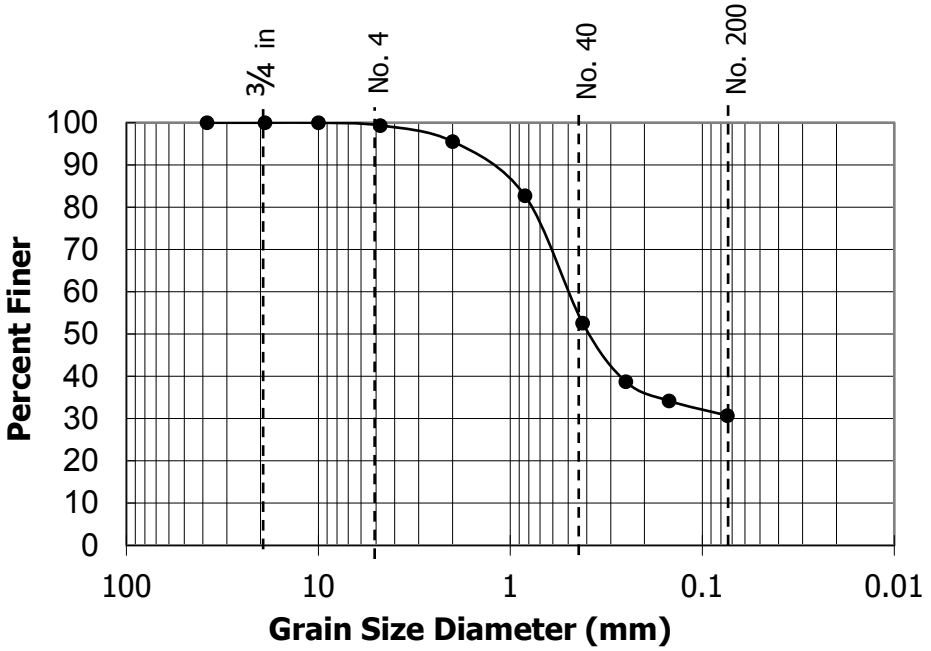
GRAIN SIZE ANALYSIS - ASTM D422			
Project No.	13066	**Project Name**	Quantico MB
Test Boring No.	TB-13	**Depth (Feet)**	4.0'-6.0'
Lab Order No.	3279-10	**Date**	6/11/2014



SIEVE	% Passing
1 ½ "	**100**
3/4"	**100**
3/8"	**100**
#4	**99**
#10	**96**
#20	**83**
#40	**53**
#60	**39**
#100	**34**
#200	**31**
Pan	**--**

USCS Group Symbol	**SC**
USCS Group Name	**CLAYEY SAND**
Cu	**---**
Cc	**---**
LL	**55**
PI	**31**
Gravel	**0.6**
Sand	**68.6**
Fines	**30.7**
AASHTO Classification	**A-2-7**
Color	**Brown**

Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Tested by:_____

Reviewed by:

GeoConcepts Engineering, Inc.

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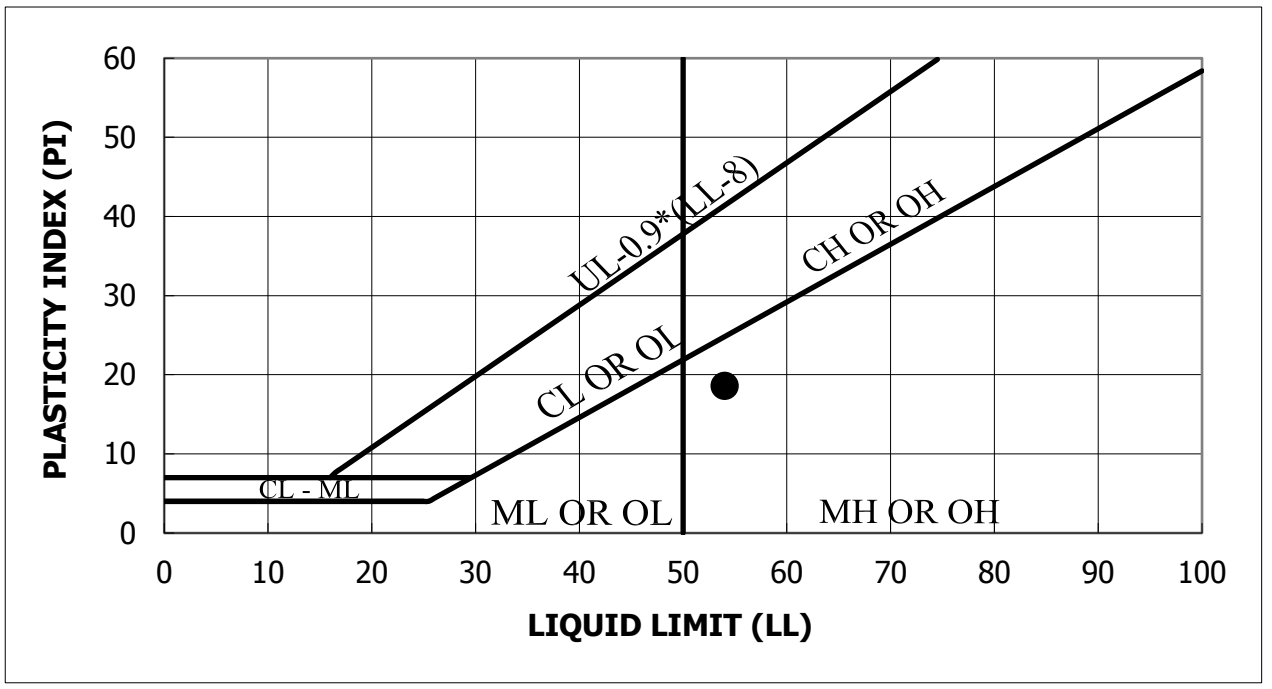
LIQUID AND PLASTIC LIMIT - ASTM D4318

Project No.	13066	**Project Name**	Quantico MB
Test Boring No.	TB-14	**Depth (Feet)**	8.5'-10.0'
Lab Order No.	3279-11	**Date**	6/11/2014



Material Description	LL	PL	PI	% Passing		USCS	w (%)
				#4	#200		
SILTY SAND	54	35	19	94.3	15.3	SM	13.1
Color	Light Brown		AASHTO Classification			A-2-7	

Test Method: ASTM D 4318
Soil Classification by ASTM D2487 and AASHTO M 145

Tested by _____

Reviewed by _____

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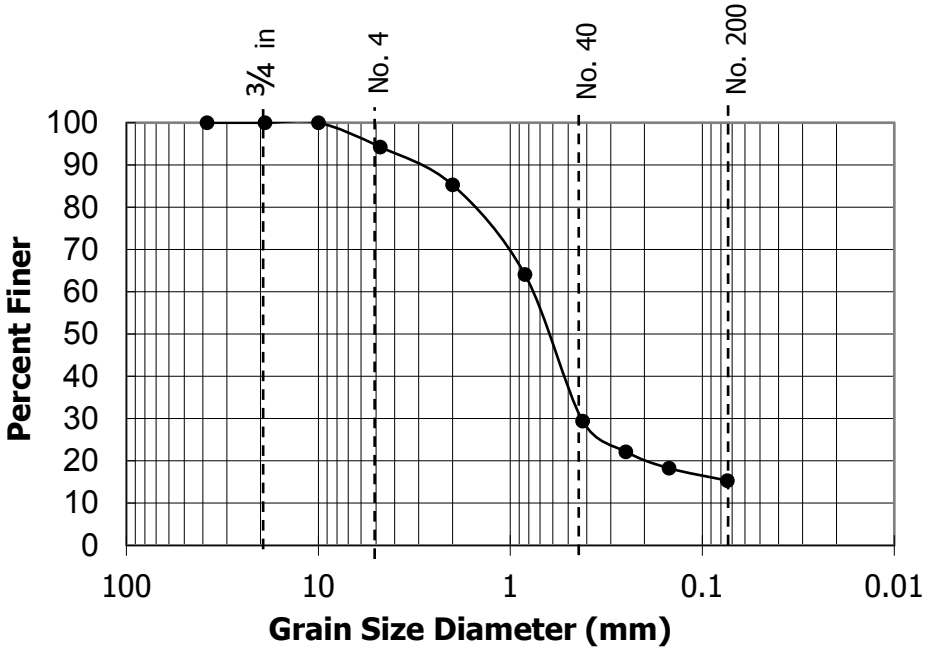
GRAIN SIZE ANALYSIS - ASTM D422			
Project No.	13066	**Project Name**	Quantico MB
Test Boring No.	TB-14	**Depth (Feet)**	8.5'-10.0'
Lab Order No.	3279-11	**Date**	6/11/2014



SIEVE	% Passing
1 ½ "	**100**
3/4"	**100**
3/8"	**100**
#4	**94**
#10	**85**
#20	**64**
#40	**29**
#60	**22**
#100	**18**
#200	**15**
Pan	**--**

USCS Group Symbol	**SM**
USCS Group Name	**SILTY SAND**
Cu	**---**
Cc	**---**
LL	**54**
PI	**19**
Gravel	**5.7**
Sand	**78.9**
Fines	**15.3**
AASHTO Classification	**A-2-7**
Color	**Light Brown**

Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Tested by:_____

Reviewed by: Shawn Harris

GeoConcepts Engineering, Inc.

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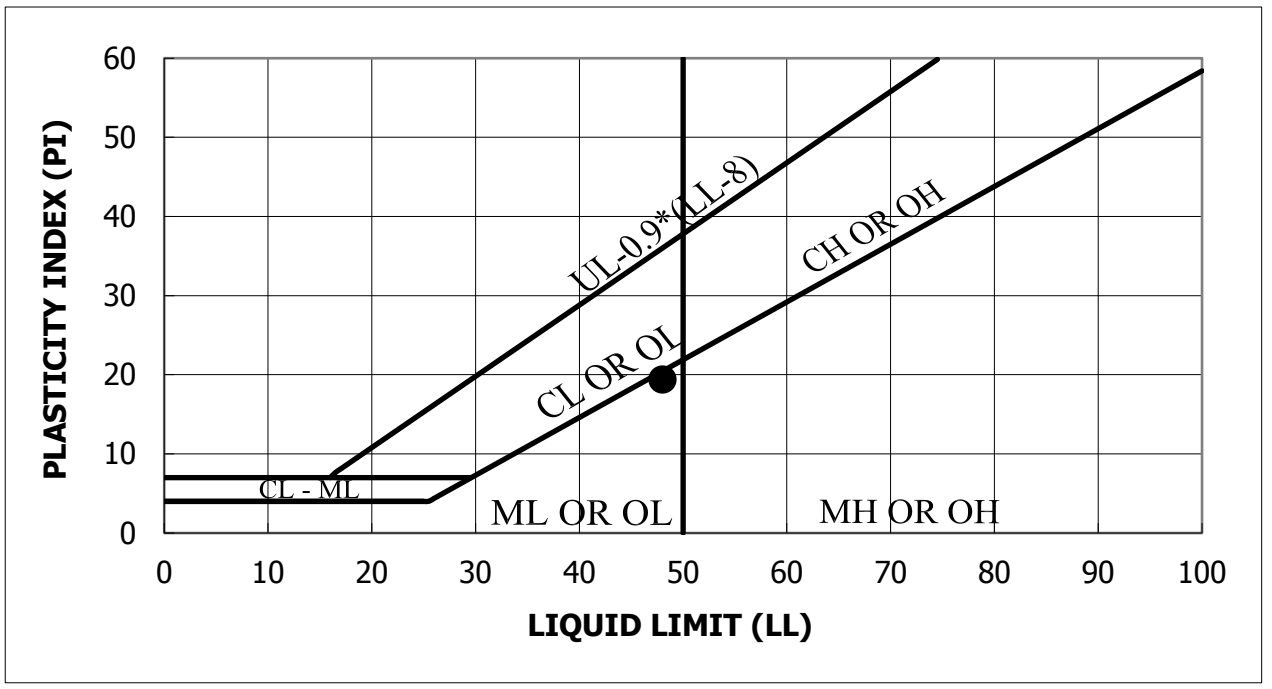
LIQUID AND PLASTIC LIMIT - ASTM D4318			
Project No.	13066	**Project Name**	Quantico MB
Test Boring No.	SWM-9	**Depth (Feet)**	6.0'-8.0'
Lab Order No.	3279-12	**Date**	6/11/2014



Material Description	LL	PL	PI	% Passing		USCS	w (%)
				#4	#200		
SILTY SAND	48	29	19	95.5	26.7	SM	14.6
Color	Reddish Brown		AASHTO Classification			A-2-7	

Test Method: ASTM D 4318
Soil Classification by ASTM D2487 and AASHTO M 145

Tested by _____

Reviewed by _____

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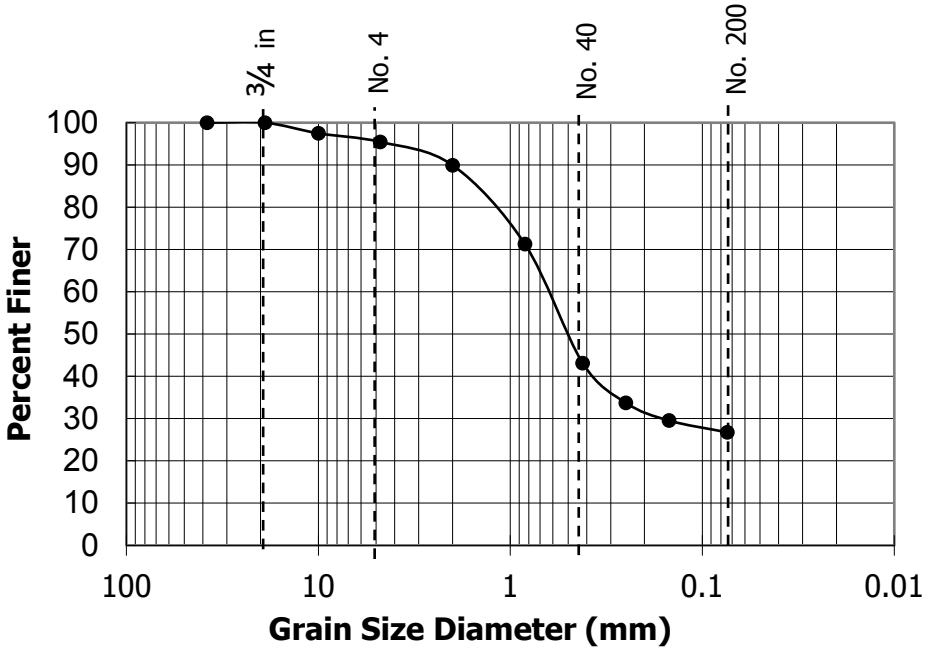
GRAIN SIZE ANALYSIS - ASTM D422			
Project No.	13066	**Project Name**	Quantico MB
Test Boring No.	SWM-9	**Depth (Feet)**	6.0'-8.0'
Lab Order No.	3279-12	**Date**	6/11/2014



SIEVE	% Passing
1 ½ "	**100**
3/4"	**100**
3/8"	**97**
#4	**95**
#10	**90**
#20	**71**
#40	**43**
#60	**34**
#100	**30**
#200	**27**
Pan	**--**

USCS Group Symbol	**SM**
USCS Group Name	**SILTY SAND**
Cu	**---**
Cc	**---**
LL	**48**
PI	**19**
Gravel	**4.5**
Sand	**68.7**
Fines	**26.7**
AASHTO Classification	**A-2-7**
Color	**Reddish Brown**

Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Tested by:_____

Reviewed by: Shawn Harris

GeoConcepts Engineering, Inc.

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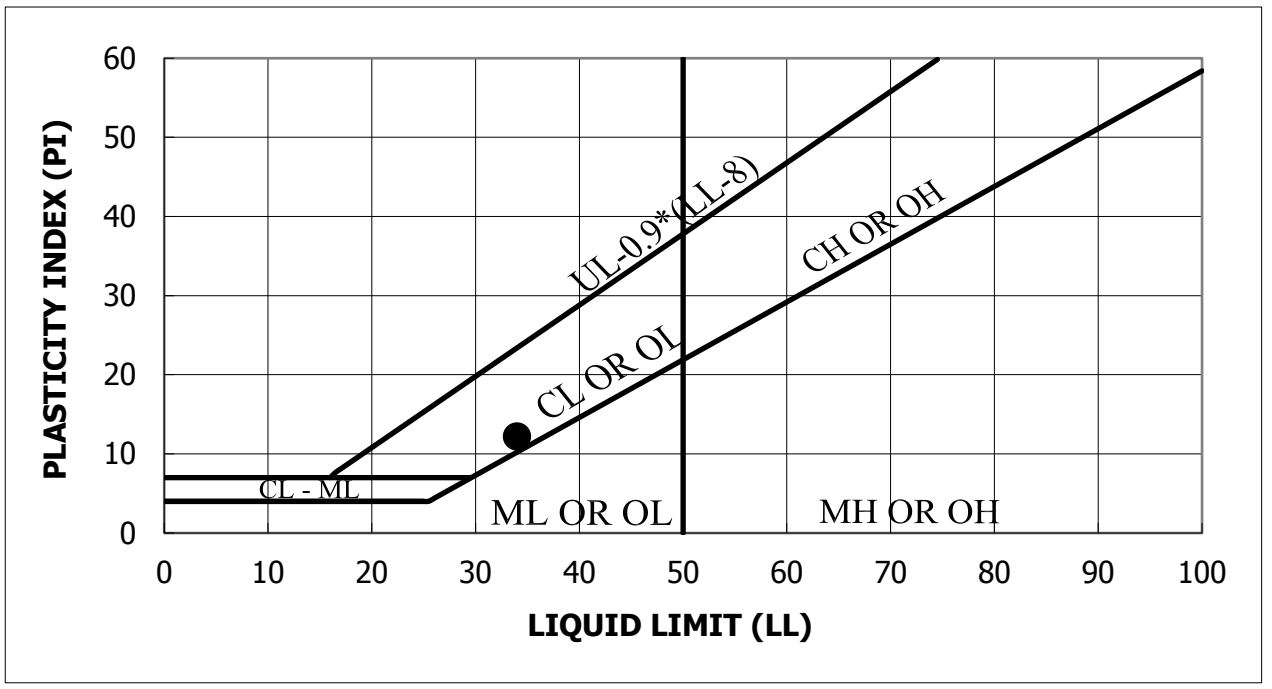
LIQUID AND PLASTIC LIMIT - ASTM D4318

Project No.	13066	**Project Name**	Quantico MB
Test Boring No.	SWM-11	**Depth (Feet)**	4.0'-6.0'
Lab Order No.	3279-13	**Date**	6/11/2014



Material Description	LL	PL	PI	% Passing		USCS	w (%)
				#4	#200		
sandy Lean Clay	34	22	12	100.0	54.5	CL	22.3
Color	Brown		AASHTO Classification			A-6	

Test Method: ASTM D 4318
Soil Classification by ASTM D2487 and AASHTO M 145

Tested by _____

Reviewed by _____

GeoConcepts Engineering, Inc.

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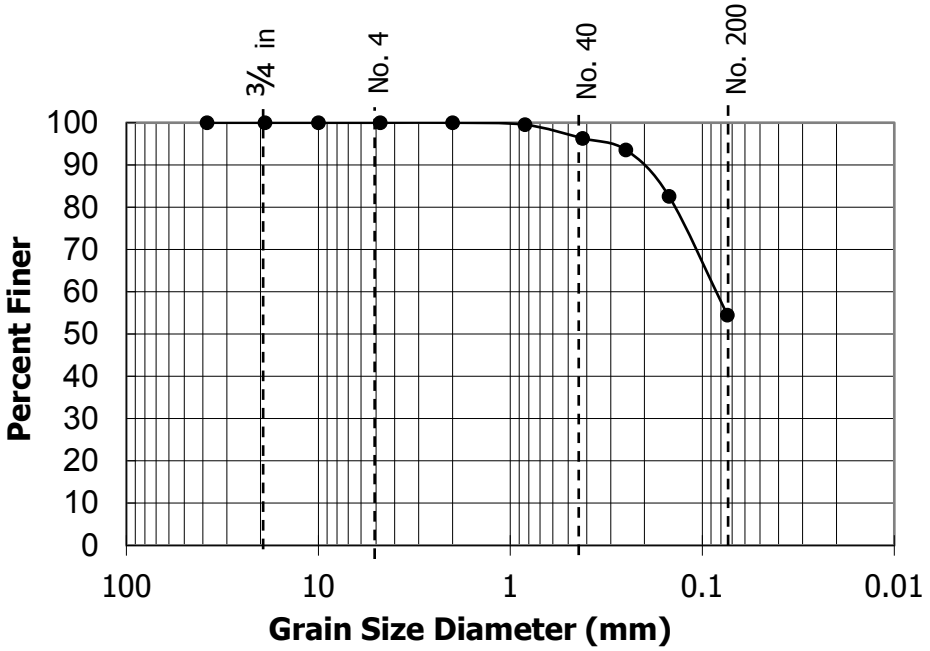
GRAIN SIZE ANALYSIS - ASTM D422			
Project No.	13066	**Project Name**	Quantico MB
Test Boring No.	SWM-11	**Depth (Feet)**	4.0'-6.0'
Lab Order No.	3279-13	**Date**	6/11/2014



SIEVE	% Passing
1 ½ "	**100**
3/4"	**100**
3/8"	**100**
#4	**100**
#10	**100**
#20	**100**
#40	**96**
#60	**94**
#100	**83**
#200	**54**
Pan	**--**

USCS Group Symbol	**CL**
USCS Group Name	**sandy Lean Clay**
Cu	**---**
Cc	**---**
LL	**34**
PI	**12**
Gravel	**0.0**
Sand	**45.5**
Fines	**54.5**
AASHTO Classification	**A-6**
Color	**Brown**

Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Tested by:_____

Reviewed by: Shawn Harris

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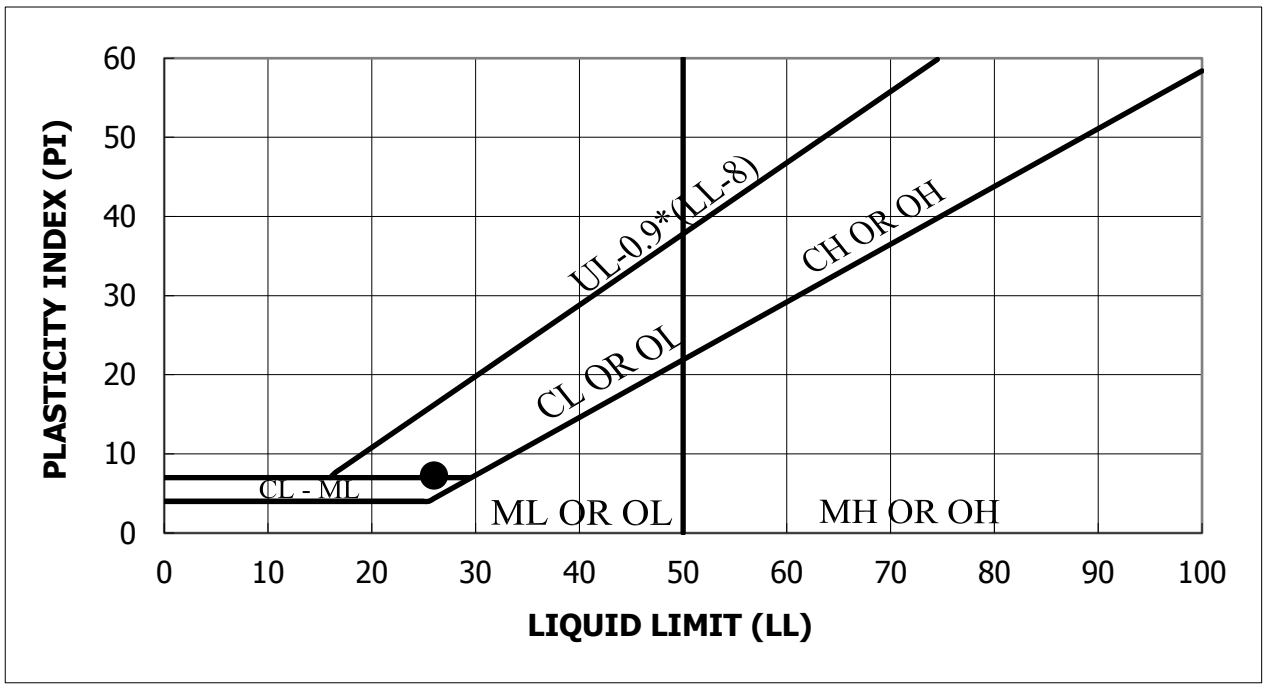
LIQUID AND PLASTIC LIMIT - ASTM D4318

Project No.	13066	**Project Name**	Quantico MB
Test Boring No.	CBR-1	**Depth (Feet)**	Parking Lot
Lab Order No.	3279-14	**Date**	6/11/2014



Material Description	LL	PL	PI	% Passing		USCS	w (%)
				#4	#200		
CLAYEY SAND	26	19	7	98.9	44.7	SC	12.0
Color	Grayish Brown		AASHTO Classification			A-4	

Test Method: ASTM D 4318
Soil Classification by ASTM D2487 and AASHTO M 145

Tested by _____

Reviewed by _____

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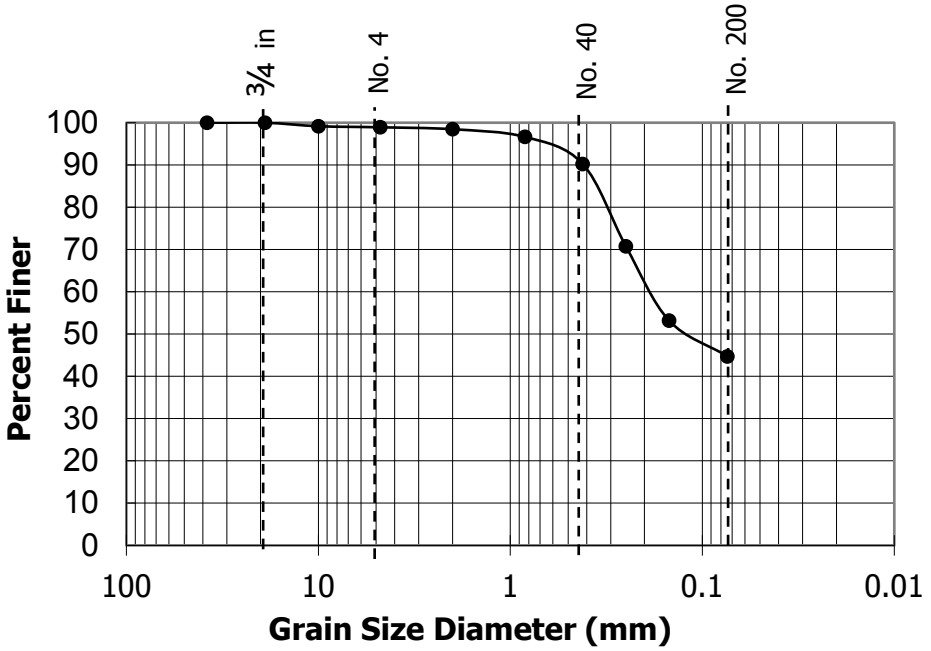
GRAIN SIZE ANALYSIS - ASTM D422			
Project No.	13066	**Project Name**	Quantico MB
Test Boring No.	CBR-1	**Depth (Feet)**	Parking Lot
Lab Order No.	3279-14	**Date**	6/11/2014



SIEVE	% Passing
1 ½ "	**100**
3/4"	**100**
3/8"	**99**
#4	**99**
#10	**98**
#20	**97**
#40	**90**
#60	**71**
#100	**53**
#200	**45**
Pan	**--**

USCS Group Symbol	**SC**
USCS Group Name	**CLAYEY SAND**
Cu	**---**
Cc	**---**
LL	**26**
PI	**7**
Gravel	**1.1**
Sand	**54.2**
Fines	**44.7**
AASHTO Classification	**A-4**
Color	**Grayish Brown**

Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Tested by:_____

Reviewed by:_____

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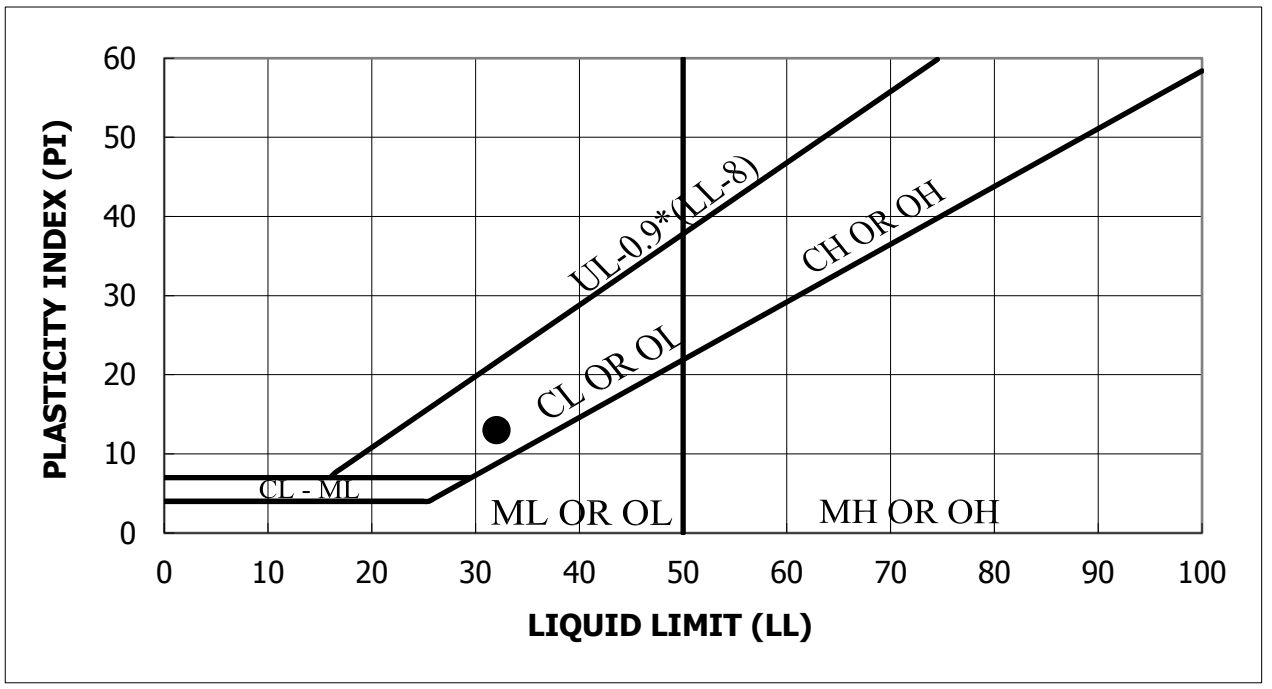
LIQUID AND PLASTIC LIMIT - ASTM D4318			
Project No.	13066	**Project Name**	Quantico MB
Test Boring No.	CBR-2	**Depth (Feet)**	Ball Field
Lab Order No.	3279-15	**Date**	6/11/2014



Material Description	LL	PL	PI	% Passing		USCS	w (%)
				#4	#200		
CLAYEY SAND	32	19	13	97.4	41.3	SC	15.8
Color	Brown		AASHTO Classification			A-6	

Test Method: ASTM D 4318
Soil Classification by ASTM D2487 and AASHTO M 145

Tested by _____

Reviewed by _____

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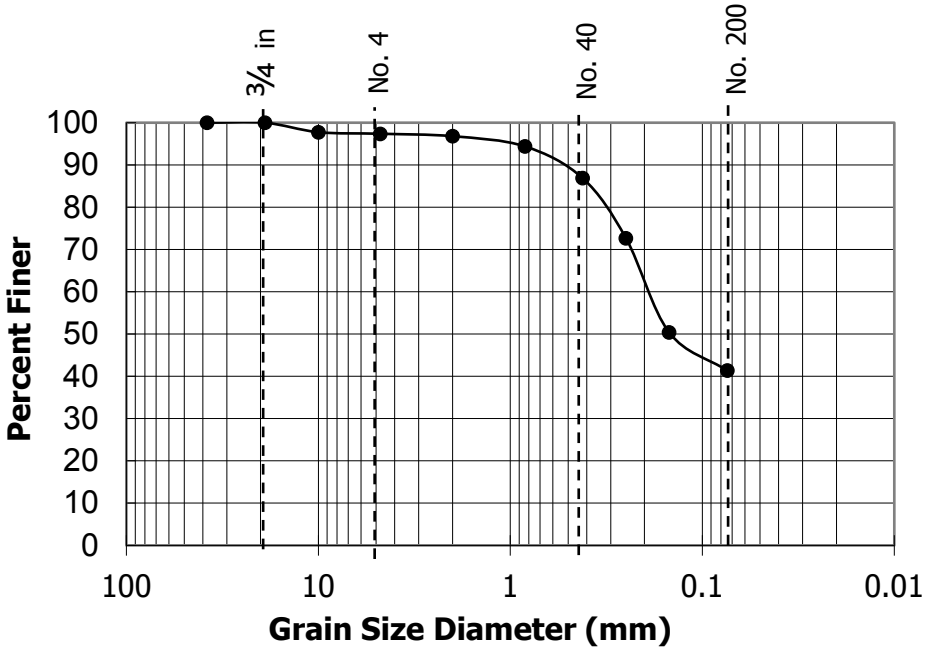
GRAIN SIZE ANALYSIS - ASTM D422			
Project No.	13066	**Project Name**	Quantico MB
Test Boring No.	CBR-2	**Depth (Feet)**	Ball Field
Lab Order No.	3279-15	**Date**	6/11/2014



SIEVE	% Passing
1 ½ "	**100**
3/4"	**100**
3/8"	**98**
#4	**97**
#10	**97**
#20	**94**
#40	**87**
#60	**73**
#100	**50**
#200	**41**
Pan	**--**

USCS Group Symbol	**SC**
USCS Group Name	**CLAYEY SAND**
Cu	**---**
Cc	**---**
LL	**32**
PI	**13**
Gravel	**2.6**
Sand	**56.0**
Fines	**41.3**
AASHTO Classification	**A-6**
Color	**Brown**

Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Tested by:_____

Reviewed by: Shawn Harris

GeoConcepts Engineering, Inc.

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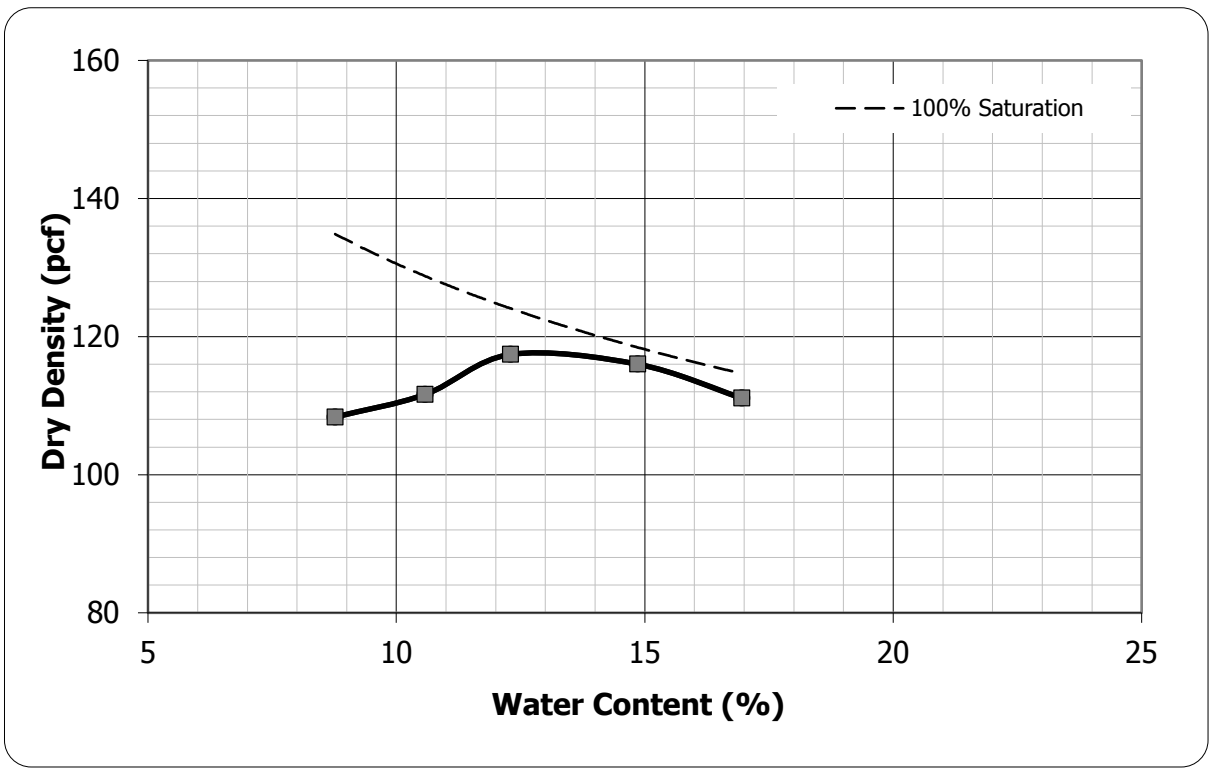
MOISTURE DENSITY RELATIONSHIP - VTM-001			
Project No.	13066	**Project Name**	Quantico MB
Test Boring No.	CBR-1	**Depth (Feet)**	Parking Lot
Lab Order No.	3279-14	**Date**	6/11/2014



TEST RESULTS	Before Correc.		After Correc.					
Maximum Dry Density (pcf)	118		--		Color			
Optimum Moisture Content (%)	13		--		Grayish Brown			
Material	**Classification**		**Nat. Moist. (%)**	**Sp. G. (Assumed)**	**LL**	**PI**	**% > # 4**	**% < #200**
CLAYEY SAND	USCS	AASHTO	12.0	2.65	26	7	1.1	44.7
	SC	A-4						

Tested by _____

Reviewed by _____

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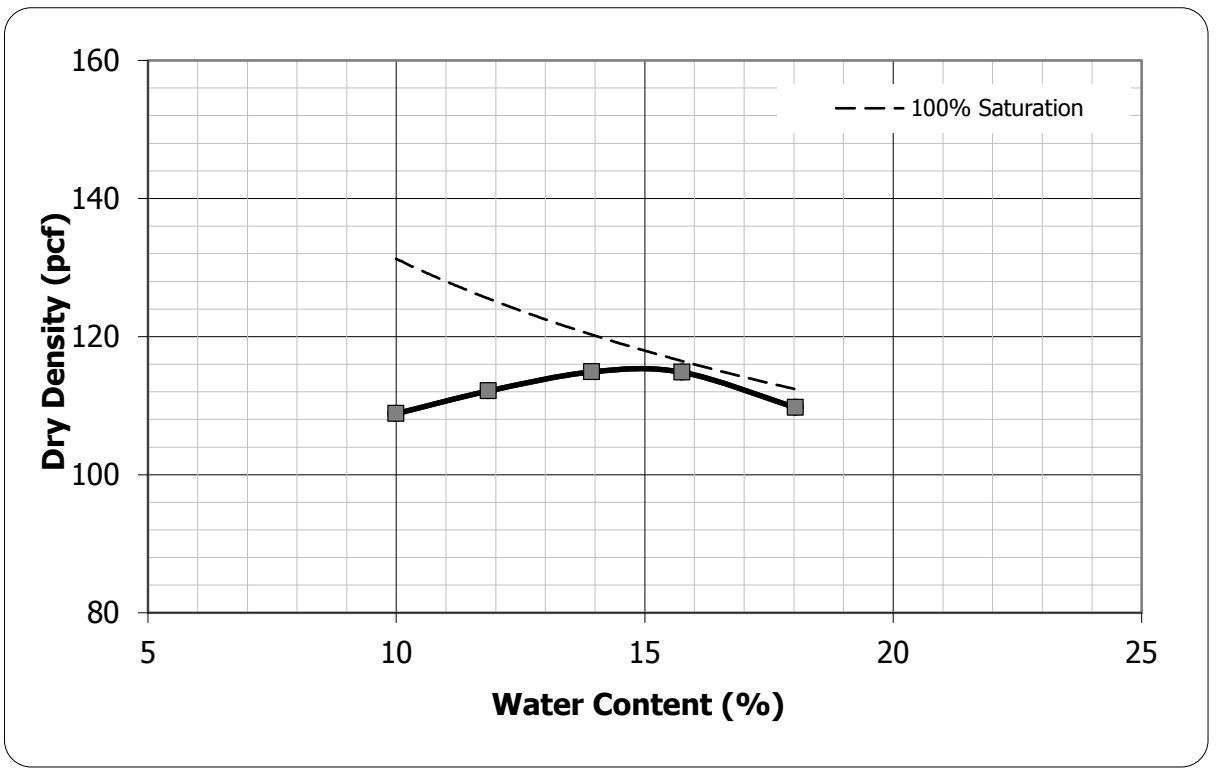
MOISTURE DENSITY RELATIONSHIP - VTM-001			
Project No.	13066	**Project Name**	Quantico MB
Test Boring No.	CBR-2	**Depth (Feet)**	Ball Field
Lab Order No.	3279-15	**Date**	6/11/2014



TEST RESULTS	**Before Correc.**		**After Correc.**					
Maximum Dry Density (pcf)	122		--		**Color**			
Optimum Moisture Content (%)	15		--		Brown			
Material	**Classification**		**Nat. Moist. (%)**	**Sp. G. (Assumed)**	**LL**	**PI**	**% > # 4**	**% < #200**
CLAYEY SAND	USCS	AASHTO	15.8	2.65	32	13	2.6	41.3
	SC	A-6						

Tested by _____

Reviewed by _____

GeoConcepts Engineering, Inc.

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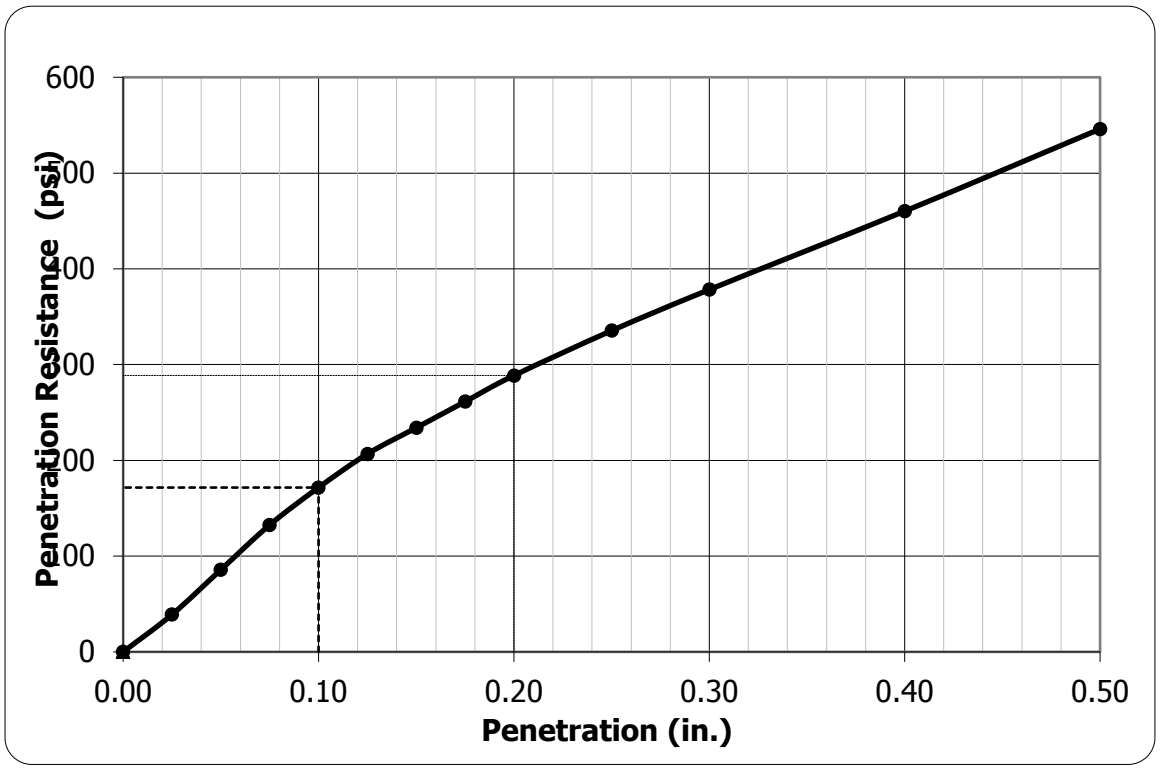
CALIFORNIA BEARING RATIO (CBR) TEST - VTM-008			
Project No.	13066	**Project Name**	Quantico MB
Test Boring No.	CBR-1	**Depth (Feet)**	Parking Lot
Lab Order No.	3279-14	**Date**	6/11/2014



Molded	
Dry Density (pcf)	**118.2**
Moisture (%)	**12.8**
Percent of Max. Density (%)	**100.1**

Soaked	
Dry Density (pcf)	**118.0**
Moisture (%)	**15.2**
Percentage of Max. Density (%)	**100.0**

CBR (%)	
0.1 in.	**17.2**
0.2 in.	**19.2**

Linearity Correction	**0.000**
Surcharge (lbs)	**25**
Max Swell (%)	**0.1**

Material Description	CLAYEY SAND
USCS	**SC**
Max Density	**118**
Optimum Moisture (%)	**13**
LL	**26**
PI	**7**
Color	**Grayish Brown**

Tested by: _____

Reviewed by: _____

GeoConcepts Engineering, Inc.

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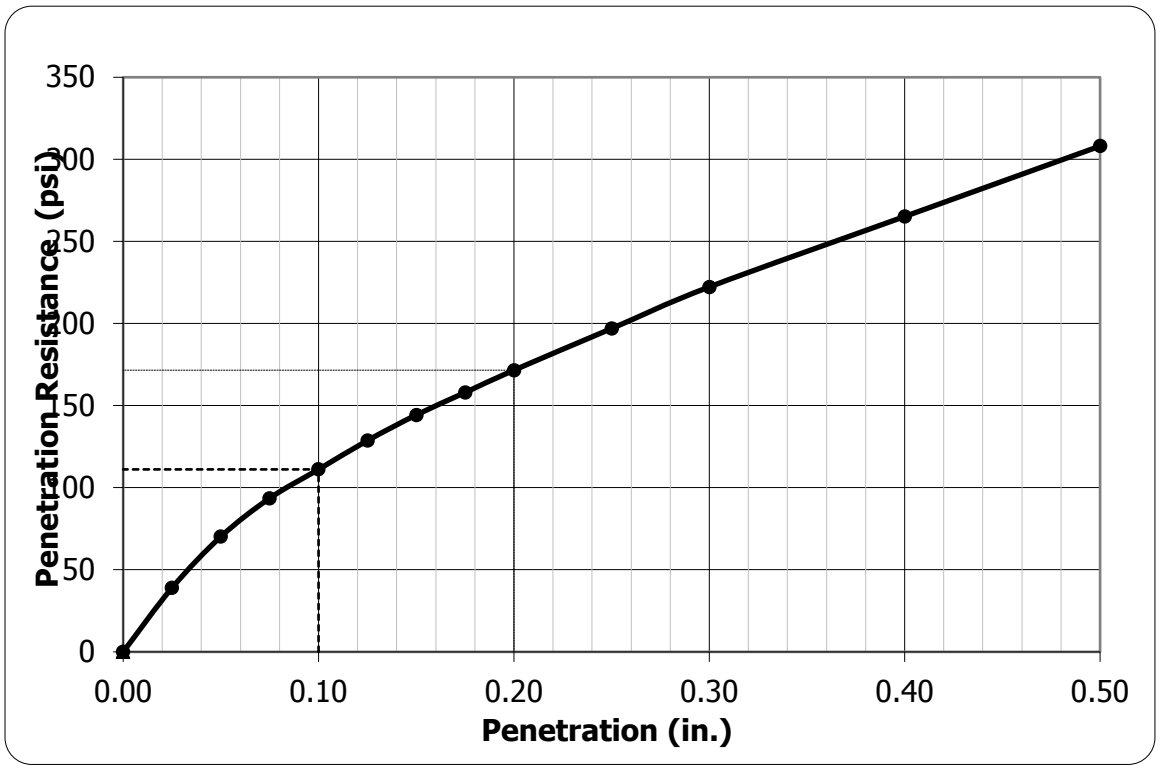
(703) 726-8030
www.geoconcepts-eng.com

CALIFORNIA BEARING RATIO (CBR) TEST - VTM-008			
Project No.	13066	**Project Name**	Quantico MB
Test Boring No.	CBR-2	**Depth (Feet)**	Ball Field
Lab Order No.	3279-15	**Date**	6/11/2014



Molded	
Dry Density (pcf)	**121.5**
Moisture (%)	**15.2**
Percent of Max. Density (%)	**99.6**

Soaked	
Dry Density (pcf)	**121.4**
Moisture (%)	**16.5**
Percentage of Max. Density (%)	**99.5**

CBR (%)	
0.1 in.	**11.1**
0.2 in.	**11.4**

Linearity Correction	**0.000**
Surcharge (lbs)	**25**
Max Swell (%)	**0.1**

Material Description	CLAYEY SAND
USCS	**SC**
Max Density	**122**
Optimum Moisture (%)	**15**
LL	**32**
PI	**13**
Color	**Brown**

Tested by: _____

Reviewed by: _____

HP ENVIRONMENTAL
INCORPORATED

Report Number: **144168**

Certificate of Laboratory Analysis

GeoConcepts Engineering, Inc.
Attn: Rebecca Smith-Zakowicz
19955 Highland Vista Dr.
Suite 170
Ashburn, VA 20147

Date Received: 08/11/14
Date Reported: 08/14/14
Project Location: **QMHS**

---

1. Client Sample No: **TB-1**
Sample Matrix: Soil
Sample Location: 2.5 - 5-6.5'

HPE Sample No.: 144168-01
Date Collected: 05/19/14

Test(s) Requested: **Soil Corrosion Potential Profile**
Analysis Method(s): Various
Date Analyzed: 08/13/14

Analyte	Result	Units	Reporting Limit	Qualifier
Resistivity - ASTM G187	**39000**	ohm-cm	N/A	
Redox Potential - Electrode	+ **150**	mV	N/A	
pH - CA643	**5.4**	pH	N/A	
Chloride (Water Soluble) - CA422	< 2.5	mg/Kg	2.5	U
Sulfate (Water Soluble) - CA417	**9.2**	mg/Kg	5.0	
Sulfide (Water Soluble) EPA 376.2	< 1.2	mg/Kg	1.2	U
Moisture (Percent)	**11**	%	N/A	

2. Client Sample No: **TB-4**
Sample Matrix: Soil
Sample Location: 2.5 - 5-6.5'

HPE Sample No.: 144168-02
Date Collected: 05/14/14

Test(s) Requested: **Soil Corrosion Potential Profile**
Analysis Method(s): Various
Date Analyzed: 08/13/14

Analyte	Result	Units	Reporting Limit	Qualifier
Resistivity - ASTM G187	**38000**	ohm-cm	N/A	
Redox Potential - Electrode	+ **179**	mV	N/A	
pH - CA643	**6.0**	pH	N/A	
Chloride (Water Soluble) - CA422	**3.1**	mg/Kg	2.5	
Sulfate (Water Soluble) - CA417	**5.7**	mg/Kg	5.0	
Sulfide (Water Soluble) EPA 376.2	< 1.2	mg/Kg	1.2	U
Moisture (Percent)	**11**	%	N/A	

Analyte Qualifier Codes

U = Analyte was not detected
J = Analyte detected below reporting limit (estimated value)
D = Analyte reported from a sample dilution
B = Analyte was detected in the corresponding method blank

Report Number: **144168**

HP ENVIRONMENTAL
INCORPORATED

Certificate of Laboratory Analysis

GeoConcepts Engineering, Inc.
Attn: Rebecca Smith-Zakowicz
19955 Highland Vista Dr.
Suite 170
Ashburn, VA 20147

Date Received: 08/11/14
Date Reported: 08/14/14
Project Location: **QMHS**

3. Client Sample No: **TB-15**
Sample Matrix: Soil
Sample Location: 2.5 - 5-6.5'

HPE Sample No.: 144168-03
Date Collected: 05/14/14

Test(s) Requested: **Soil Corrosion Potential Profile**
Analysis Method(s): Various
Date Analyzed: 08/13/14

Analyte	Result	Units	Reporting Limit	Qualifier
Resistivity - ASTM G187	**39000**	ohm-cm	N/A	
Redox Potential - Electrode	+ **389**	mV	N/A	
pH - CA643	**4.0**	pH	N/A	
Chloride (Water Soluble) - CA422	**2.8**	mg/Kg	2.5	
Sulfate (Water Soluble) - CA417	**19**	mg/Kg	5.0	
Sulfide (Water Soluble) EPA 376.2	< 1.2	mg/Kg	1.2	U
Moisture (Percent)	**18**	%	N/A	

JP 08/14/14
Approved by Date

Analyte Qualifier Codes
U = Analyte was not detected
J = Analyte detected below reporting limit (estimated value)
D = Analyte reported from a sample dilution
B = Analyte was detected in the corresponding method blank

HP ENVIRONMENTAL, INC.
104 Elden St, Herndon, VA 20170 (703) 471-4200 Fax (703) 471-0020

Environmental Sample Chain-of-Custody Record

COC Reference Number: 5000

Client: GeoConcepts Engineering, Inc.
Address: 19955 Highland Vista Dr., Suite 170, Ashburn, VA 20147
Contact: Rebecca Smith-Zakowicz, rsmith@geoconcepts-eng.com
Phone: (703) 726-8030
Fax: (703) 726-8032

TURN-AROUND TIME: ***Routine*** Emergency Rush (24-48hr)
P.O./Job Number: 13066
SITE: QMHS
Sampled by: David Stein

	Sample ID	Sample Date	Sample Time	Comp/ Grab	Matrix	Preserv. pH	# Bottles	pH	Chloride	Sulfides	Resistivity	Redox Potential	Natural Moisture Content	Sulfates	Description/Comments
1.	TB-1	5/19/2014	4pm	G	S		2	X	X	X	X	X	X	X	2.5 to 5-6.5'
2.	TB-4	5/14/2014	4pm	G	S		2	X	X	X	X	X	X	X	2.5 to 5-6.5'
3.	TB-15	5/14/2014	4pm	G	S		2	x	x	x	x	x	x	x	2.5 to 5-6.5'
4.															
5.															
6.															
7.															
8.															
9.															
10.															
11.															
12.															
13.															
14.															
15.															

Tests Requested

Received Condition: Ambient	Relinquished By: Cody Stein	Date/Time 8/11/14 11:00AM	Received By:	Date/Time
Mode of Shipment: Client-	Relinquished By: Cody Stein	Date/Time 8/11/14 11:00AM	Received By Laboratory: Brenda	Date/Time 8/11/14-11:01AM
HPE Report Number: 144168				

A&L Eastern Laboratories
7621 Whitepine Road Richmond, Virginia 23237 (804) 743-9401 Fax (804) 271-6446
www.aleastern.com

TEXTURE ANALYSIS

Client :
GEOCONCEPTS ENGINEERING
SUITE 170
19955 HIGHLAND VISTA DR
ASHBURN, VA 20147

Grower :
REBECCA SMITH-ZAKOWICZ

Farm:

Report No : 14-153-0667
Cust No : 74328
Date Printed : 06/04/2014
Page : 1 of 1

Date Received : 06/02/2014

Lab No	Field ID	Sample Identification	Percent Sand	Percent Silt	Percent Clay	Textural Classification
17497		SWM-1	74.0	10.0	16.0	Sandy Loam
17498		SWM-3	72.0	10.0	18.0	Sandy Loam
17499		SWM-5	86.0	8.0	6.0	Loamy Sand
17500		SWM-7	47.7	35.6	16.6	Loam
17501		SWM-8	92.0	4.0	4.0	Sand
17502		SWM-9	90.0	6.0	4.0	Sand
17503		SWM-11	68.1	13.2	18.5	Sandy Loam
17505		SWM-13	76.0	10.0	14.0	Sandy Loam
17506		SWM-16	86.0	8.0	6.0	Loamy Sand

Analysis prepared by: A&L Eastern Laboratories, Inc.

Appendix C
Engineering Calculations

Spread Footing Bearing Capacity Calculation (1 page)

Spread Footing Settlement Calculation (1 page)

Flexible Pavement – Light Duty Section (1 page)

Flexible Pavement – Heavy Duty Section (1 page)

Rigid Pavement (1 page)

GeoConcepts Engineering, Inc.

Bearing Capacity based on Shear Strength
(Classical Bearing Capacity Equation)

Project : QMHS at Quantico MCB
Case spread footing

Unit Weight of Foundation Soils, γ =	125	PCF		
Friction Angle of Foundation Soils, ϕ =	30	Degrees		
Cohesion of Foundation Soils, C =	0	PSF		
Foundation Depth, Df =	2.5	FT		
Foundation Width, B =	**7.5**	FT	90	INCHES
MIN. SAFETY FACTOR, FS =	2.5			

$$Qult = C\,Nc + q\,Nq + 1/2\ B\,\gamma\,N\gamma$$
$$Qall = Qult\ /\ FS$$

Nc = **30.14**
Nq = **18.40**
$N\gamma$ = **22.40**
Qult = 16.25 KSF

Qall = 6.50 KSF

GeoConcepts Engineering, Inc.

Elastic Settlement Calculation - Square Footing

Project Number: 13066	**Project Engineer: RSZ**
Project Name: QMHS	**Principal Engineer: PEB**
Project Location: Quantico MCB	**Date: 6.12.14**

γ	**125**	pcf	(Unit weight)	B (footing width)	7.5
D_f	**2.5**	feet	(Depth of Footing)		
Column Load	**170**	kips		Izp	0.6853
q'	**3000**	psf	(Bearing pressure)		

Layer	Δz (feet)	E_s (tsf)	E_s (psf)	z (ft) to the center of the layer	Iz at the center of the layer	(Iz/Es)*Dz
1	**2.00**	**125**	250000	1	0.255	2.04397E-06
2	**2.00**	**125**	250000	3	0.566	4.53191E-06
3	**2.00**	**150**	300000	5	0.610	4.06832E-06
4	**2.00**	**150**	300000	7	0.489	3.25914E-06
5	**2.00**	**150**	300000	9	0.367	2.44997E-06
6	**2.00**	**150**	300000	11	0.246	1.64079E-06
7	**3.00**	**150**	300000	13.5	0.094	9.43977E-07
						1.89381E-05

Σ 15.00 <= 15.1 **OK**

Time	0.10
C1	0.942
C2	1.00

Settlement	0.0479	ft.
	0.58	inch

Notes:

(1) Schmertman's Method is used to calculate the settlement.

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product
GeoConcepts Engineering

Flexible Structural Design Module

Light Duty Pavement Section

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	71,355
Initial Serviceability	4
Terminal Serviceability	2
Reliability Level	85 %
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	15,000 psi
Stage Construction	1
Calculated Design Structural Number	1.65 in

Rigorous ESAL Calculation

Performance Period (years)	25
Two-Way Traffic (ADT)	200
Number of Lanes in Design Direction	1
Percent of All Trucks in Design Lane	100 %
Percent Trucks in Design Direction	50 %

Vehicle Class	Percent of ADT	Annual % Growth	Average Initial Truck Factor (ESALs/ Truck)	Annual % Growth in Truck Factor	Accumulated 18-kip ESALs over Performance Period
2	85	1	0.0002	0	175
5	15	1	0.46	0	71,179
Total	100	-	-	-	71,355

Growth	Compound
Total Calculated Cumulative ESALs	71,355

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	SM-9.5A for Surface	0.44	1	1.5	-	0.66
2	BM-25.0A for Base	0.4	1	2.5	-	1.00
3	Graded Aggregate Base	0.12	1	6	-	0.72
Total	-	-	-	10.00	-	2.38

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product
GeoConcepts Engineering

Flexible Structural Design Module

Heavy Duty Pavement Section

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	805,873
Initial Serviceability	4
Terminal Serviceability	2
Reliability Level	85 %
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	15,000 psi
Stage Construction	1
Calculated Design Structural Number	2.47 in

Rigorous ESAL Calculation

Performance Period (years)	25
Two-Way Traffic (ADT)	3,000
Number of Lanes in Design Direction	1
Percent of All Trucks in Design Lane	100 %
Percent Trucks in Design Direction	50 %

Vehicle Class	Percent of ADT	Annual % Growth	Average Initial Truck Factor (ESALs/ Truck)	Annual % Growth in Truck Factor	Accumulated 18-kip ESALs over Performance Period
2	90	1	0.0002	0	2,785
5	9	1	0.46	0	640,613
6	-	-	-	0	211,699
9	1	1	1.05	0	162,474
Total	100	-	-	-	805,873

Growth	Compound
Total Calculated Cumulative ESALs	805,873

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	SM-9.5A for Surface	0.44	1	1.5	-	0.66
2	BM-25.0A for Base	0.4	1	3	-	1.20
3	Graded Aggregate Base	0.12	1	6	-	0.72
Total	-	-	-	10.50	-	2.58

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product
GeoConcepts Engineering

Rigid Structural Design Module

Rigid Structural Design

Pavement Type	JRCP
18-kip ESALs Over Initial Performance Period	368,194
Initial Serviceability	4.5
Terminal Serviceability	2.8
28-day Mean PCC Modulus of Rupture	650 psi
28-day Mean Elastic Modulus of Slab	4,000,000 psi
Mean Effective k-value	125 psi/in
Reliability Level	90 %
Overall Standard Deviation	0.39
Load Transfer Coefficient, J	2.8
Overall Drainage Coefficient, Cd	1
Calculated Design Thickness	5.43 in

Rigorous ESAL Calculation

Performance Period (years)	30
Two-Way Traffic (ADT)	100
Number of Lanes in Design Direction	1
Percent of All Trucks in Design Lane	100 %
Percent Trucks in Design Direction	50 %

Vehicle Class	Percent of ADT	Annual % Growth	Average Initial Truck Factor (ESALs/ Truck)	Annual % Growth in Truck Factor	Accumulated 18-kip ESALs over Performance Period
2	20	0	0.0002	0	22
4	60	0	0.59	0	193,948
7	20	0	1.59	0	174,224
Total	100	-	-	-	368,194

Growth	Compound
Total Calculated Cumulative ESALs	368,194

Layer Information

Layer	Material Description	Thickness (in)	One Dir Width (ft)
1	JRCP	5.4265933	-
2	Graded Aggregate Base	8	-
Total	-	13.43	-