

Geotechnical Engineering Report

South Florida National Cemetery
6501 State Road 7
Lake Worth, Palm Beach County, Florida

January 19, 2018

Terracon Project No. HD165118



Prepared for:

Mabbett & Associates, Inc.
Providence, Rhode Island

Prepared by:

Terracon Consultants, Inc.
West Palm Beach, Florida

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January 19, 2018



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Re: Geotechnical Engineering Report
South Florida National Cemetery Expansion
6501 State Road 7
Lake Worth, Palm Beach County, Florida
Terracon Project Number: HD165118

Terracon Consultants, Inc. (Terracon) has completed the geotechnical engineering study for the above referenced project. This study was performed in general accordance with the Subcontract Agreement dated October 21, 2016.

This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report, or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.
Certificate of Authorization Number 8830

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Geotechnical



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EXECUTIVE SUMMARY

A geotechnical exploration study has been performed for the proposed South Florida National Cemetery Expansion that is located in Lake Worth, Palm Beach County, Florida. Fifteen SPT borings, designated B-1 through B-15 were drilled to 15 feet below the existing ground surface and fifteen permeability tests were executed in the surficial soils (i.e. upper 2 feet below the existing ground surface) in the proposed expansion area.

Based on the information obtained from our geotechnical exploration, it appears that the site can be developed for the proposed project. The following geotechnical considerations were identified:

- n The generalized subsurface profile consists of granular soils (i.e. sands) over a formation of weakly to moderately well cemented shellrock.
- n Groundwater was found to be relatively shallow at the site, and some areas of ponding above the ground surface were observed. It is recommended that careful consideration be given to high groundwater levels when preparing the grading plan.
- n The proposed columbariums may be supported on conventional shallow foundations bearing on compacted native soil or on newly placed engineered fill following the earthwork operations outlined in Section 4.2.
- n It is anticipated that excavations for the proposed construction can be accomplished with conventional earthmoving equipment. However, excavations within the shellrock formation may be difficult and slow due to the hardness of the rock in some areas. Although the borings drilled at the site indicate that the rock is weakly to moderately well cemented, our regional experience suggests that the shellrock may be very hard in some areas.
- n Close monitoring of the construction operations discussed herein will be critical in achieving the design subgrade support. We therefore recommend that Terracon be retained to monitor this portion of the work.

This summary should be used in conjunction with the entire report for design purposes. It should be recognized that details were not included or fully developed in this section, and the report must be read in its entirety for a comprehensive understanding of the items contained herein. The section titled **GENERAL COMMENTS** should be read for an understanding of the report limitations.

GEOTECHNICAL ENGINEERING REPORT
PROPOSED FLORIDA NATIONAL CEMETERY EXPANSION
6501 State Road 7
Lake Worth, Palm Beach, Florida
Terracon Project No. HD165118
January 19, 2018

1.0 INTRODUCTION

A geotechnical engineering study has been prepared for the proposed expansion of the South Florida National Cemetery in Lake Worth, Palm Beach County, Florida. Fifteen SPT borings, designated B-1 through B-15, were drilled to about 15 feet below the existing ground surface in the proposed expansion areas. Fifteen permeability tests were conducted adjacent to selected boring locations. A Site Location Map and Exploration Plan are included in Appendix A as Exhibits A-1 and A-4, respectively. Logs of the test borings are also included in Appendix A.

The purpose of these services was to provide information and geotechnical engineering recommendations relative to:

- n subsurface soil conditions
- n earthwork considerations
- n settlement estimates
- n groundwater conditions
- n foundation design parameters
- n related construction considerations

2.0 PROJECT INFORMATION

2.1 Project Description

Item	Description
Boring layout	See Appendix A, Exhibit A-4: Exploration Plan.
Proposed Construction	The expansion will include the construction of columbariums and the development of additional gravesites to the north of the existing cemetery.
Building construction	Masonry load bearing walls.
Maximum loads (assumed)	Load bearing walls: 1 - 2 kips per lineal foot vertical load
Grading	Significant thickness of earth fill will be placed to elevate the site to proposed grades.
Stormwater Management	Not noted in this expansion.

Should any of the above information or assumptions be inconsistent with the planned construction, please let us know so that we may make any necessary modifications to this report.

2.2 Site Location and Description

Item	Description
Location	The Florida National Cemetery is located at 6501 State Road 7 in Lake Worth, Palm Beach County, Florida. The proposed expansion area is located to the north of the existing cemetery. The approximate center of the expansion area has the following coordinates: Latitude: 26°35'2.82"N Longitude: 80°12'38.92"W
Existing improvements	The expansion area is currently undeveloped.
Current ground cover	The expansion area is thickly vegetated by trees with underbrush.
Existing topography	The existing topography appears to be relatively flat, with some slightly rolling and depressional areas scattered throughout.

3.0 SUBSURFACE CONDITIONS

3.1 Soil Survey

The Soil Survey of Palm Beach County, Florida, issued 1978, as prepared by the United States Department of Agriculture (USDA), Soil Conservation Service (now renamed the Natural Resource Conservation Service - NRCS) was reviewed for the project area. The maps indicate that the site is underlain by Boca fine sand, with the exception of a few small pockets which are underlain by Riviera fine sand, depressional.

Boca fine sand is described as a nearly level, poorly drained soil that has a sandy subsurface that is underlain by a loamy subsoil from about 29 to 36 inches deep. Fractured limestone follows the loamy subsoil. The water table is within 10 inches of the natural ground surface for 2 to 4 months of the year.

Riviera fine sand, depressional is a nearly level, poorly drained soil with a thin sandy layer that is typically 3 inches thick. A loamy subsoil follows and is underlain by sand with shell fragments. For more than 6 months in a year the soil is ponded with up to 2 feet of water.

It should be noted that the Soil Survey is not intended as a substitute for site-specific geotechnical exploration; rather it is a useful tool in planning a project scope in that it provides information on soil types likely to be found. Boundaries between adjacent soil types on the Soil Survey map are approximate and are shown in Appendix A as Exhibit A-2. Descriptions of the mapped soil unit is included in Appendix A as Exhibit A-3.

3.2 Typical Profile

Based on the results of the borings, subsurface conditions at the expansion area can be generalized as follows:

Stratum	Approximate Depth to Bottom of Stratum	Material Description	Density/ Cementation
1	2 to 8 feet	Fine SAND, sometimes with silt or clay, sometimes with shell fragments (SP, SP-SM, SP-SC)	Loose to Medium Dense
2	4 to 7 feet	Clayey SAND (SC)	Medium Dense to Dense
3	8 to 15 feet	Sandy SHELLROCK	Weakly to Moderately Well Cemented
4	15 feet	SAND with silt, with varying amounts of shell fragments, sometimes with cemented sand fragments (SP-SM)	Loose to Dense

Conditions found at each boring location are indicated on the individual boring logs, which can be found on Exhibits A-6-1 through A-6-15 in Appendix A. Stratification boundaries on the boring logs represent the approximate location of changes in soil types; in-situ, the transition between materials may be gradual. Descriptions of our field exploration methods are included as Exhibit A-5 in Appendix A.

3.3 Groundwater

The boreholes were observed during drilling (December 14 through 20, 2017) for the presence and level of groundwater. Groundwater depths recorded during drilling ranged between 2 and 3 feet below the existing ground surface. Stabilized groundwater readings were collected at the locations of B-1, B-4, B-11 and B-13 on January 5, 2017 and ranged between 0.8 and 1.9 feet below surface grades. Additionally, some areas of the site were ponded above the ground surface during our field exploration. The following photograph shows an area of the site that was ponded.



Photograph 1 – View of ponded area

It should also be noted that these borings were accomplished approximately one to two months after the end of the “wet season” when rainfall and recharge of the surficial aquifer is relatively high. Therefore, we would anticipate that the groundwater levels measured for this study would be slightly below the seasonal high levels.

It should be recognized that fluctuations of the groundwater table will occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were drilled. In addition, perched water can develop within higher permeability soils overlying less permeable soils. Therefore, groundwater levels during construction or at other times in the future may be higher or lower than the levels indicated on the boring logs.

We estimate the seasonal high water to range between one foot below the existing ground surface to at or above the existing ground surface, depending on topography. Our estimates of the seasonal groundwater conditions are based on the soil types found in the borings, recent weather conditions, and the water levels observed during our fieldwork. To obtain a better estimate of the seasonal high groundwater table, it would be necessary to install monitor wells and to take reading during the rainy season that generally runs from May to October.

These seasonal groundwater table estimates do not represent the temporary rise in groundwater table that occurs immediately during a significant storm event, including adjacent to other stormwater management facilities. This is different from static groundwater levels in wet ponds and/or drainage canals which can affect the design water levels of new, nearby ponds. The seasonal high groundwater table may vary from normal when affected by extreme weather changes, localized or regional flooding, future grading, drainage improvements, or other construction that may occur on our around the site following the date of this report.

3.4 Percolation Tests

Percolation tests were conducted adjacent to each boring location. All of the tests were conducted at a depth of 2 feet. The tests were to be completed by excavating a 15 gallon (2 cubic foot) hole and introducing water into the hole and measuring the drawdown. However, the near surface soils were fine sands and thus the sides of the holes would not remain stable, especially with the high groundwater levels. As a result, the test was conducted using a 2-foot length of 4-inch diameter screened PVC pipe, filling the pipe with water, and measuring the water level drop (i.e. head drop) with time within the pipe. These results are presented in the following table, including depth to groundwater measured in the pipe, head drop and the permeability rates:

Permeability Test Results (Total Test)

Boring Number	Depth to groundwater (inches)	Head Drop (inches)	Time (minutes)	Permeability (cm/sec)	Permeability (inches/minute)	Soil Types
B-1	>24	21.0	30	5.6×10^{-4}	0.013	Fine sand
B-2	>24	17.2	13	7.8×10^{-4}	0.018	Fine sand with clay
B-3	>24	19.8	30	4.7×10^{-4}	0.011	Fine sand
B-4	>24	21.2	30	5.8×10^{-4}	0.014	Fine sand with silt
B-5	>24	21.0	30	5.6×10^{-4}	0.013	Fine sand
B-6	>24	22.9	30	8.3×10^{-4}	0.020	Fine sand
B-7	>24	19.2	30	4.3×10^{-4}	0.010	Fine sand with silt
B-8	>24	23.3	12	2.4×10^{-3}	0.056	Fine sand with silt
B-9	19	12.2	30	1.9×10^{-4}	4.5×10^{-3}	Fine sand
B-10	>24	21.7	30	6.3×10^{-4}	0.015	Fine sand
B-11	23	1.8	30	2.1×10^{-5}	5.0×10^{-4}	Fine sand with silt
B-12	10	7.7	30	1.0×10^{-4}	2.4×10^{-3}	Fine sand
B-13	23	17.4	30	3.5×10^{-4}	8.2×10^{-3}	Fine sand
B-14	>24	5.5	30	7.0×10^{-5}	1.7×10^{-3}	Fine sand
B-15	>24	20.4	20	7.7×10^{-4}	0.018	Topsoil (6") over fine sand (24")

The initial drawdown during the tests was typically faster than the overall drawdown. The following table shows the permeability rates after the first five minutes of the tests.

Permeability Test Results (First 5 Minutes of Test)

Boring Number	Depth to groundwater (inches)	Head Drop (inches)	Time (minutes)	Permeability (cm/sec)	Permeability (inches/minute)	Soil Types
B-1	>24	13.0	5	1.3×10^{-3}	0.030	Fine sand
B-2	>24	11.4	5	1.0×10^{-3}	0.025	Fine sand with clay
B-3	>24	10.4	5	9.2×10^{-3}	0.022	Fine sand
B-4	>24	14.0	5	1.4×10^{-3}	0.034	Fine sand with silt
B-5	>24	13.7	5	1.4×10^{-3}	0.032	Fine sand
B-6	>24	15.6	5	1.7×10^{-3}	0.040	Fine sand
B-7	>24	11.6	5	1.1×10^{-3}	0.025	Fine sand with silt
B-8	>24	18.6	5	2.4×10^{-3}	0.057	Fine sand with silt
B-9	19	7.2	5	5.8×10^{-4}	0.014	Fine sand
B-10	>24	13.0	5	1.3×10^{-3}	0.030	Fine sand
B-11	23	0.5	5	3.3×10^{-5}	7.7×10^{-4}	Fine sand with silt
B-12	10	4.7	5	3.5×10^{-4}	8.3×10^{-3}	Fine sand
B-13	23	11.0	5	9.9×10^{-4}	0.023	Fine sand
B-14	>24	1.7	5	1.2×10^{-4}	2.8×10^{-3}	Fine sand
B-15	>24	11.8	5	1.1×10^{-3}	0.026	Topsoil (6") over fine sand (24")

3.5 Laboratory Test Results

Soil index tests were conducted on selected representative soil samples. Grain size tests indicated that the clayey sands had fines contents between about 13 and 16 percent and that the shellrock was very sandy. The results of the tests are shown on the boring logs in Appendix A, are presented in tabular form in Appendix B (Exhibit B-2), and grain size curves are provided on Exhibits B-4-1 through B-4-5 for those soils where full grain size tests were conducted.

In addition, corrosion series testing including pH, chlorides, sulfates and resistivity were conducted on composite soil samples between the depths of 2 and 8 feet at the locations of Borings B-4 and B-8. The samples were also tested for redox potential. Using the FDOT criteria, the results of these tests indicate that the soils at this site are considered to be slightly aggressive for concrete and slightly to moderately aggressive for steel based on the resistivity values.

4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

4.1 Geotechnical Considerations

The results of the borings showed that the surficial soils are generally loose to medium dense clean to slightly silty/clayey sands. These soils can be used in the proposed construction and will provide adequate bearing, after proper site preparation. Clayey sands were found below the surficial sands in some areas. They should not be used as fill material as they will be very difficult to compact due to a very tight moisture range to obtain the required density. Sandy, weakly to moderately well cemented shellrock was found below the surficial sands, starting at depths between 2 and 8 feet below surface grades. It is anticipated that excavation within the shellrock can be accomplished with conventional earthmoving equipment, however the excavation may be difficult and slow due to the hardness of the rock in some areas. Groundwater was found to be relatively shallow at the site, and some areas of ponding above the ground surface were observed. It is recommended that careful consideration be given to high groundwater levels when preparing the grading plan.

We recommend that the exposed subgrade be thoroughly evaluated after removal of any surficial organics and vegetation prior to the start of site grading fill or structural fill operations. We recommend that Terracon be retained to evaluate the satisfactory preparation of the bearing material for the pavements, foundations, and floor slab subgrade soils. Subsurface conditions, as identified by the field and laboratory testing programs, have been reviewed and evaluated with respect to the proposed building plans known to us at this time.

Design and construction recommendations for foundation systems and other earth connected phases of the project are outlined below.

4.2 Earthwork

Site Preparation

Surface vegetation should be cleared from all areas receiving fill, structures and paving and its root systems grubbed from the soils. Clearing and grubbing should consist of the complete removal and disposal of timber, stumps, roots, asphalt, concrete, rubbish, debris and all other obstructions resting on or protruding through the surface of the existing ground and the surface of excavated areas. All roots greater than one inch in diameter, or high concentrations of smaller diameter roots, exposed by clearing, grubbing and stripping should be removed to a depth of not less than 12 inches. Stripping depths between our boring locations and across the site could vary considerably, and as such we recommend actual stripping depths be evaluated by a representative of Terracon during construction to aid in preventing removal of excess material. Considering groundwater levels measured during this study and the potential for higher groundwater level conditions to occur during the wet season, we recommend that the project schedule be established such that the site preparation work is completed during the dry season, which typically extends from November to April.

After stripping, proof-rolling should be performed with a vibratory roller with a minimum static weight of 20,000 pounds. Considering the shallow groundwater at the site, compaction may be difficult at the stripped grades. Therefore, a 1 to 2-foot thick layer of structural (or site grading) fill may need to be placed on top of the stripped grades prior to compaction. The roller should make a minimum of 10 overlapping passes over all areas of the proposed building and pavement areas and to 5 feet outside of the structural footprints. The latter 5 passes should be at right angle to previous passes. Rolling should continue until the soils are compacted sufficiently to obtain a minimum compaction as defined in Section 4.2.3. A geotechnical engineer or his representative should observe proof-rolling to aid in locating unstable subgrade materials (if any). Unstable soil (pumping) should be removed or moisture conditioned and compacted in place prior to placing fill. The excavated soils can then be used as backfill placed in accordance with the guidelines noted in Section 4.2.3 of this report.

4.2.2 Material Requirements

Engineered fill should meet the following material property requirements:

Fill Type	USCS Classification	Acceptable Location for Placement
General ¹	SP, SP-SM, SP-SC or GP, GP-GM (fines content < 12 percent, maximum particle size < 2 inches, organic content < 2 percent)	All locations and elevations

1. The soils for Stratum 1 should meet these criteria.
2. Stratum 2 soils do not meet this criteria.

4.2.3 Compaction Requirements-Mass Fill Areas

ITEM	DESCRIPTION
Fill Lift Thickness	12 inches or less in loose thickness when heavy vibratory compaction equipment is used. Maximum particle size should not exceed 2 inches in a 12-inch lift. 4 to 6 inches in loose thickness when hand-guided equipment (i.e. jumping jack or plate compactor) is used. Maximum particle size should not exceed 1 inch in a 4- to 6-inch lift.
Minimum Compaction Requirements	Beneath the columbarium footprint and more than one foot below pavement subgrade elevation should be compacted to at least 95 percent of the maximum dry density as determined by the modified Proctor Test (ASTM D-1557). The upper one foot of pavement subgrades should be compacted to at least 98 percent of the maximum dry density as determined by the modified Proctor Test (ASTM D-1557). In the area of gravesites, the density requirement can be reduced to 90 percent of the maximum dry density as determined by the modified Proctor Test (ASTM D-1557).
Moisture Content ¹	Within ±3 percent of optimum moisture content as determined by the modified Proctor test, at the time of placement and compaction.

Minimum Testing Frequency	One field density test per 2,500 square feet of building footprint (or fraction thereof) per lift and one test per 5,000 square feet of parking/drive area.
1 We recommend that engineered fill be tested for moisture content and compaction during placement. Should the results of the in-place density tests indicate compaction limits have not been met, the area represented by the test should be reworked and retested as required until the compaction requirements are achieved.	

4.2.4 Utility Trench Backfill

All trench excavations should be made with sufficient working space to permit construction including backfill placement and compaction. The density of the backfill material should be checked and comply with the criteria noted in Section 4.2.3.

4.2.5 Grading and Drainage

Final surrounding grades should be sloped away from the structures on all sides to prevent ponding of water. Gutters, downspouts, or other appropriate methods that direct water a minimum of 10 feet beyond the footprint of the proposed structures are recommended. Site grades should be set considering the estimated seasonal high groundwater presented in Section 3.4.

4.2.6 Earthwork Construction Considerations

It is anticipated that excavations for the proposed construction can be accomplished with conventional earthmoving equipment. However, excavations within the shellrock formation may be difficult and slow due to the hardness of the rock in some areas. Although the borings drilled at the site indicate that the rock is weakly to moderately well cemented, our regional experience suggests that the shellrock may be very hard in some areas.

After initial proof-rolling and compaction, unstable subgrade conditions could develop during general construction operations, particularly if the soils are wetted and/or subjected to repetitive construction traffic. Upon completion of filling and grading, care should be taken to maintain the subgrade moisture content prior to construction of structures and pavements. Construction traffic over the completed subgrade should be avoided to the extent practical. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. If the subgrade should become saturated, or disturbed, the affected material should be removed or these materials should be moisture conditioned and re-compacted prior to slab and pavement construction.

Trees or other vegetation whose root systems have the ability to remove excessive moisture from the subgrade and foundation soils should not be planted next to the structures. Trees and shrubbery should be kept away from the exterior edges of the foundation element a distance at least equal to 1.5 times their expected mature height.

As a minimum, all temporary excavations should be sloped or braced as required by Occupational Health and Safety Administration (OSHA) regulations to provide stability and safe working conditions. Temporary excavations will probably be required during grading operations. The grading contractor, by his contract, is usually responsible for designing and constructing stable, temporary excavations and should shore, slope or bench the sides of the excavations as required, to maintain stability of both the excavation sides and bottom. All excavations should comply with applicable local, state and federal safety regulations, including the current OSHA Excavation and Trench Safety Standards.

Terracon should be retained during the construction phase of the project to observe earthwork and to perform necessary tests and observations during subgrade preparation, proof-rolling, placement and compaction of controlled compacted fills, backfilling of excavations into the completed subgrade, and just prior to construction of building floor slabs.

4.3 Foundations

In our opinion, the proposed columbariums can be supported by a shallow foundation system bearing on compacted existing ground or newly placed fill extending to native soil after earthwork operations as described in Section 4.2 of this report have been performed. Design recommendations for shallow foundations for the proposed structure are presented in the following sections.

4.3.1 Foundation Design Recommendations

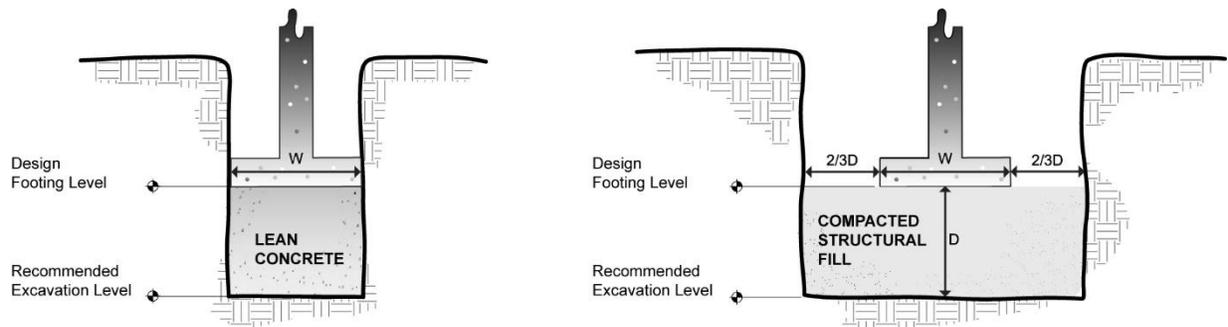
Description	Column Footing	Wall Footing	Monolithic Slab Foundation ⁵
Net allowable bearing pressure ¹	2,500 psf	2,500 psf	2,500 psf
Minimum width	30 inches	18 inches	12 inches
Minimum embedment below finished grade ²	18 inches	18 inches	12 inches
Minimum compaction requirements	95 percent of the materials' maximum modified Proctor dry density for a depth of 12 inches below footing.		
Minimum Testing Frequency	One field density test per footing for a minimum depth of 1 foot below the footing subgrade.	One field density test per 50 lineal feet for a minimum depth of 1 foot below the footing subgrade.	One field density test per 50 lineal feet for a minimum depth of 1 foot below the footing subgrade. ⁵
Approximate total settlement ³	<1/2 inch	<1/2 inch	<1/2 inch
Estimated differential settlement ³	<1/2 inch between columns	<1/2 inch over 40 feet	<1/2 inch over 40 feet
Ultimate coefficient of sliding friction ⁴	0.35	0.35	0.35

Description	Column Footing	Wall Footing	Monolithic Slab Foundation ⁵
<ol style="list-style-type: none"> 1. The recommended net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. Assumes any unsuitable fill or soft soils, if encountered, will be undercut and replaced with engineered fill. 2. For erosion protection and to reduce effects of seasonal moisture variations in subgrade soils. 3. The foundation settlement will depend upon the variations within the subsurface soil profile, the structural loading conditions, the embedment depth of the footings, the thickness of compacted fill, and the quality of the earthwork operations. The above settlement estimates have assumed that the maximum footing width is 4 feet for column footings and 1.5 feet for continuous wall footings. In addition, the bearing materials are sands where the settlement occurs essentially as the load is applied so that when construction is complete, so is the settlement. 4. Sliding friction along the base of the footings will not develop where net uplift conditions exist. 5. Turn-down slab testing; For slab requirements see Section 4.5.1. 			

4.3.2 Foundation Construction Considerations

The base of all foundation excavations should be free of water and loose soil and debris prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Should the soils at bearing level become excessively dry, disturbed or saturated, the affected soil should be removed or moisture conditioned and re-compacted prior to placing concrete. Place a lean concrete mud-mat over the bearing soils if the excavations must remain open over night or for an extended period of time. It is recommended that the geotechnical engineer be retained to observe and test the soil foundation bearing materials.

If unsuitable bearing soils are encountered in footing excavations or should the bearing soils become loosened from exposure to weather conditions, the excavations should be extended deeper to suitable soils and the footings could bear directly on these soils at the lower level or on lean concrete backfill placed in the excavations. The footings could also bear on properly compacted backfill extending down to the suitable soils. Over-excavation for compacted backfill placement below footings should extend laterally beyond all edges of the footings at least 8 inches per foot of over-excavation depth below footing base elevation. The over-excavation should then be backfilled up to the footing base elevation with granular material placed in lifts of 6 inches or less in loose thickness and compacted to at least 95 percent of the material's modified effort maximum dry density (ASTM D-1557). The over-excavation and backfill procedures are described in the figures below. Compaction tests should be performed at a frequency of 1 test per footing per 1-foot lift for square footings, and 1 test per 50 lineal feet per 1-foot lift for wall or continuous footings.



Lean Concrete Backfill

Overexcavation / Backfill

NOTE: Excavations in sketches shown vertical for convenience. Excavations should be sloped as necessary for safety.

4.4 Seismic Considerations

Florida is generally regarded to be in a zone of low seismic risk. While the Florida Building Code mentions seismic design, the preface of the document notes that these sections should be disregarded. Therefore we do not consider seismic effects to be a concern at this site.

4.5 Floor Slabs

4.5.1 Floor Slab Design Recommendations

Item	Description
Floor slab support	Free draining granular material meeting the general fill specification. ¹
Modulus of subgrade reaction	150 pounds per square inch per inch (psi/in) for point loading conditions.
Aggregate base course/capillary break²	6 inches of free draining granular material.
Compaction requirements	95 percent of the materials maximum modified Proctor dry density.
Minimum Testing Frequency	One field density test per 2,500 square feet or fraction thereof for a depth of 12 inches. ³

1. We recommend subgrades be maintained in a relatively moist condition until floor slabs are constructed. If the subgrade should become disturbed prior to construction of floor slabs, the affected material should be removed or the materials moistened and recompact. Upon completion of grading operations in the building areas, care should be taken to maintain the recommended subgrade moisture content and density prior to construction of the building floor slabs.
2. The floor slab design should include a capillary break, comprised of free-draining, compacted, granular material, at least 6 inches thick. Free-draining granular material should have less than 5 percent fines (material passing the #200 sieve).
3. Density in pipe trenches should be re-checked after utility construction.

Where appropriate, saw-cut control joints should be placed in the slab to help control the location and extent of cracking. For additional recommendations refer to the ACI Design Manual.

The use of a vapor retarder should be considered beneath concrete slabs-on-grade that will be covered with wood, tile, carpet or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer and slab contractor should refer to ACI and Florida Building Code (FBC) regarding moisture and radon for procedures and cautions regarding the use and placement of a vapor retarder. We note that FBC requires a minimum of 6-mil polyethylene, which is typically used in Florida.

4.5.2 Floor Slab Construction Considerations

On most project sites, the site grading is generally accomplished early in the construction phase. We recommend the area underlying the floor slab be rough graded and then thoroughly proofrolled prior to final grading. However, as construction proceeds, the subgrade may be disturbed due to utility excavations, construction traffic, rainfall, etc. As a result, the floor slab subgrade may not be suitable for placement of concrete and corrective action will be required.

Particular attention should be paid to high traffic areas that were rutted and disturbed earlier and to areas where backfilled trenches are located. Areas where unsuitable conditions are located should be repaired by removing and replacing the affected material with properly compacted fill. All floor slab subgrade areas should be moisture conditioned and properly compacted to the recommendations in this report immediately prior to placement of concrete.

4.6 Pavements

4.6.1 Subgrade Preparation

Terracon recommends that the moisture content and density of the top 12 inches of the subgrade be evaluated and the pavement subgrades be proof-rolled and tested. Compaction tests should be performed at a frequency of 1 test per 5,000 square feet or fraction thereof. Areas not in compliance with the required ranges of moisture or density should be moisture conditioned and recompacted. Particular attention should be paid to high traffic areas that were rutted and disturbed earlier and to areas where backfilled trenches are located. Areas where unsuitable conditions are found should be repaired by removing and replacing the materials with properly compacted fills.

If a significant precipitation event occurs after the evaluation or if the surface becomes disturbed, the subgrade should be reviewed by qualified personnel immediately prior to paving. The subgrade should be in its finished form at the time of the final review.

4.6.2 Design Considerations

Traffic patterns and anticipated loading conditions were not provided at the time that this report was prepared. However, we anticipate that traffic loads will be produced primarily by automobile traffic and occasional delivery and maintenance trucks. The thickness of pavements subjected to heavy truck traffic should be determined using expected traffic volumes, vehicle types, and vehicle loads and should be in accordance with local, city, or county ordinances.

Pavement thickness can be determined using AASHTO, Asphalt Institute, PCA, and/or other methods if specific wheel loads, axle configurations, frequencies, and desired pavement life are provided. Terracon can provide thickness recommendations for pavements subjected to loads other than personal vehicle and occasional delivery and maintenance truck traffic if this information is provided. However, absent that data, we recommend the following minimum typical sections.

4.6.3 Estimates of Minimum Pavement Thickness

Typical Pavement Section (inches)				
Traffic Area	Alternative	Asphalt Concrete Surface Course	Limerock, or Crushed Concrete Base Course	Stabilized Subbase Course ^{1, 2}
Car Parking	AC	1.5	6.0	12.0
Truck and Drive Areas	AC	2.5	8.0	12.0

1. Often referred to as Stabilized Subgrade.

2. Use coarse granular materials such as recycled crushed concrete, shell, or gravel when seasonal high groundwater is within 4 feet of the profile grade.

4.6.4 Asphaltic Concrete Design Recommendations

The following items are applicable to asphaltic concrete pavement sections.

- n Terracon recommends a minimum separation of 12 inches between the bottom of the base course and the seasonal high groundwater table if crushed concrete is used and 24 inches if limerock is used as a base. Based on our understanding of the project, it appears that either type of base material may be used. Natural or fill subgrade soils to a depth of 18 inches below the base should be clean, free draining sands.
- n Stabilized subgrade soils (also identified as stabilized subbase) should be stabilized to a minimum Limerock Bearing Ratio (LBR; Florida Method of Test Designation FM 5-515) value of 40 if they do not already meet this criterion, or modified/replaced with new compacted fill that meets the minimum LBR value. Although LBR testing has not been performed, our experience with similar soils indicates that the near surface sands found in the soil borings are unlikely to meet this requirement.

- n The stabilized subgrade course should be compacted to at least 98 percent of the modified Proctor maximum dry density (AASHTO T-180 or ASTM D-1557). Any underlying, newly-placed subgrade fill need only be compacted to a minimum of 95 percent of the modified Proctor maximum dry density. Compaction tests should be performed at a frequency of 1 test per 5,000 square feet or fraction thereof.
- n Limerock base courses from an approved FDOT source should have a minimum LBR value of 100, and be compacted to a minimum of 98 percent of the maximum dry density as determined by the modified Proctor test. Limerock should be placed in uniform lifts not to exceed 6 inches loose thickness. Recycled Limerock is not a suitable substitute for virgin Limerock for base courses but may be used as a granular stabilizing admixture.
- n Crushed (recycled) concrete base should meet the current FDOT specification 911 for recycled materials.
- n Asphalt should be compacted to a minimum of 95 percent of the design mix density. Asphalt surface courses should be Type SP, Type S, or other suitable mix design according to FDOT and local requirements.
- n To verify thicknesses, after placement and compaction of the pavement courses, core the wearing surface to evaluate material thickness and composition at a minimum frequency of 5,000 square feet or two locations per day's production.
- n All curbing should be full depth. Use of extruded curb sections which lie on top of asphalt surface courses can allow migration of water between the surface and base courses, leading to rippling and pavement deterioration.

4.6.5 Pavement Drainage

Pavements should be sloped to provide rapid drainage of surface water. Water allowed to pond on or adjacent to the pavements could saturate the subgrade and contribute to premature pavement deterioration. In addition, the pavement subgrade should be graded to provide positive drainage within the granular base section. The subgrade and the pavement surface should have a minimum $\frac{1}{4}$ inch per foot slope to promote drainage. Appropriate sub-drainage or connection to a suitable daylight outlet should be provided to remove water from the base layer.

4.6.6 Pavement Maintenance

The pavement sections provided in this report represent minimum recommended thicknesses and, as such, periodic maintenance should be anticipated. Therefore, preventive maintenance should be planned and provided for through an on-going pavement management program. Maintenance activities are intended to slow the rate of pavement deterioration, and to preserve the pavement investment. Maintenance consists of both localized maintenance (e.g. crack and joint sealing and patching) and global maintenance (e.g. surface sealing). Preventive maintenance is usually the first priority when implementing a pavement maintenance program. Additional engineering observation is recommended to determine the type and extent of a cost effective program. Even with periodic maintenance, some movements and related cracking may still occur and repairs may be required.

4.7 Temporary Dewatering

Temporary dewatering will likely be needed for below grade excavations. The necessity for dewatering will be dependent on the depth of excavation below existing grade and the groundwater levels at the time of construction. Actual dewatering means and methods should be left up to a contractor experienced in installation and operation of dewatering systems. The contractor should provide a dewatering plan for review and approval by the engineer prior to the installation of the dewatering systems.

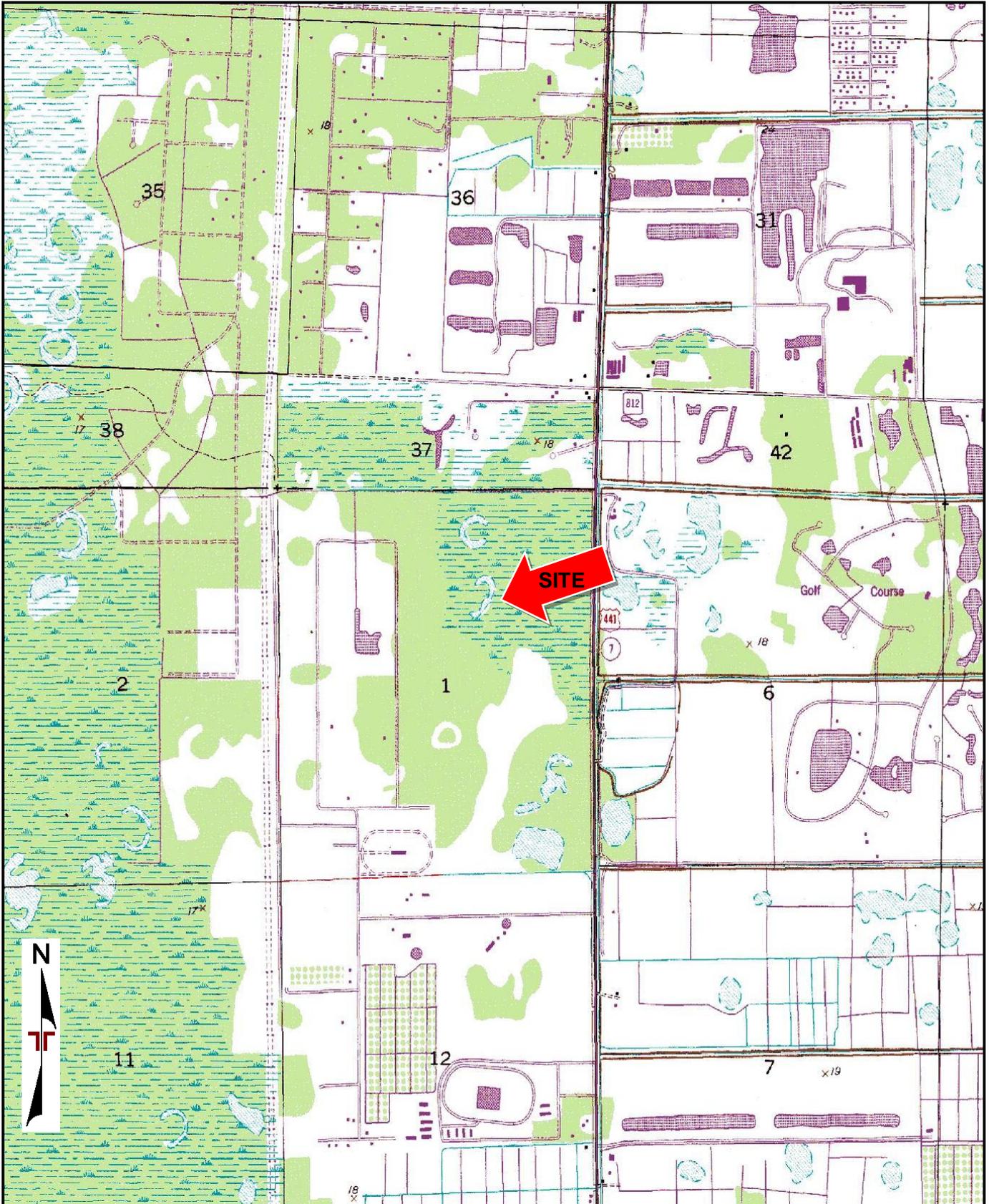
5.0 GENERAL COMMENTS

The analysis and recommendations presented in this report are based upon the data obtained from the borings drilled at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

The scope of services for this project does not include either specifically or by implication any environmental or biological (e.g. mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.

APPENDIX A
FIELD EXPLORATION



TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY
 QUADRANGLES INCLUDE: GREENACRES CITY, FL (1/1/1983).

Project Manager:	DM
Drawn by:	DM
Checked by:	DM
Approved by:	KA

Project No.	HD165118
Scale:	1"=2,000'
File Name:	HD165118
Date:	HD165118

Terracon
 1225 Omar Rd
 West Palm Beach, FL 33405-1046

SITE LOCATION
 South Florida National Cemetery
 6501 S State Road 7
 Lake Worth, FL

Exhibit	A-1
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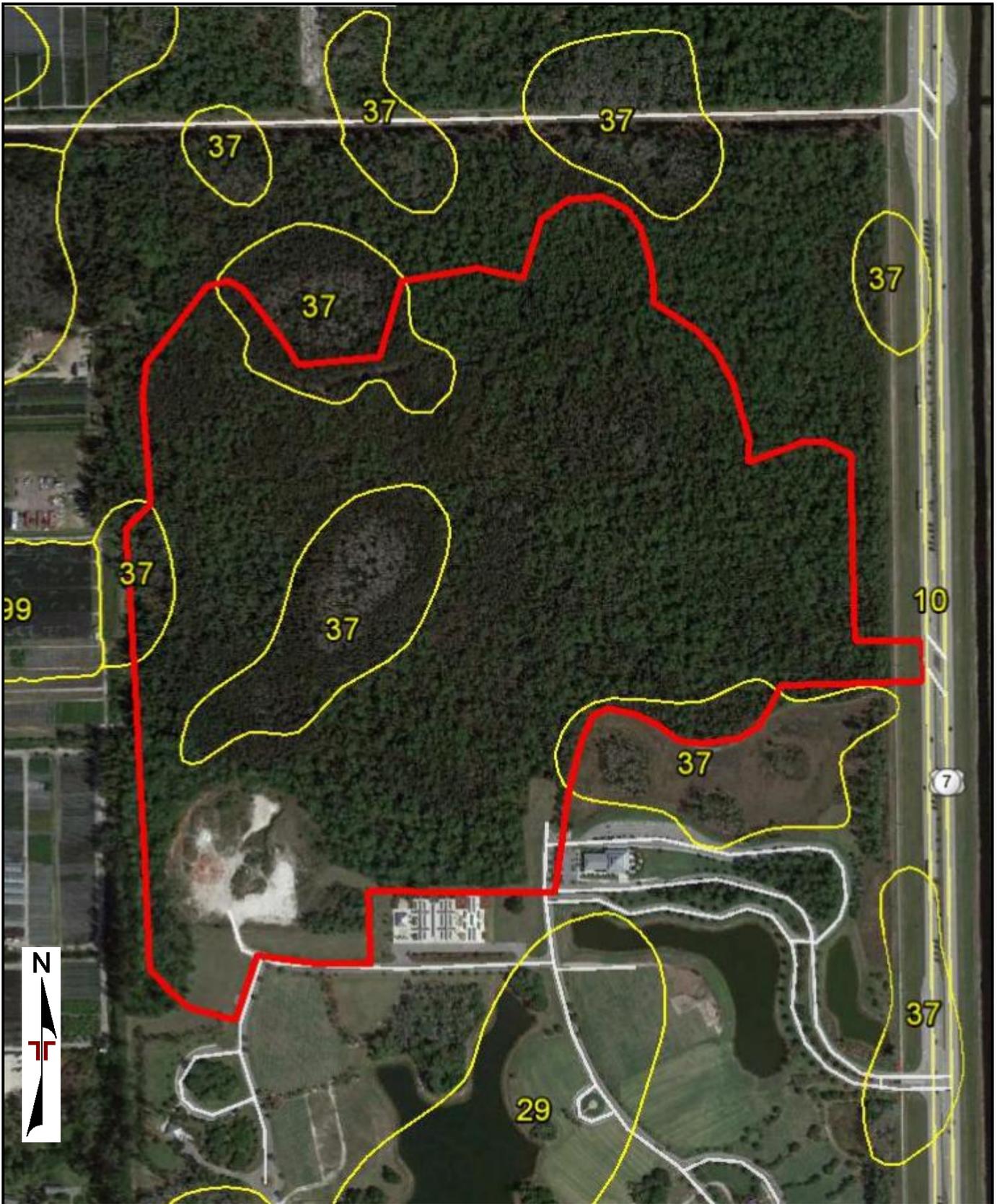


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

USDA SOIL SURVEY FOR PALM BEACH COUNTY (issued 1978)

Project Manager:	DM	Project No.	HD165118
Drawn by:	DM	Scale:	AS SHOWN
Checked by:	DM	File Name:	HD165118
Approved by:	KA	Date:	HD165118

Terracon
 1225 Omar Rd
 West Palm Beach, FL 33405-1046

SOIL SURVEY

South Florida National Cemetery
 6501 S State Road 7
 Lake Worth, FL

Exhibit
A-2

Soil Survey Descriptions

10 – Boca fine sand

Boca fine sand is described as a nearly level, poorly drained soil that has a sandy subsurface that is underlain by a loamy subsoil from about 29 to 36 inches deep. Fractured limestone follows the loamy subsoil. The water table is within 10 inches of the natural ground surface for 2 to 4 months of the year.

37 – Riviera fine sand, depressional

Riviera fine sand, depressional is a nearly level, poorly drained soil with a thin sandy surface layer that is typically 3 inches thick. A loamy subsoil follows and is underlain by sand with shell fragments. For more than 6 months in a year the soil is ponded with up to 2 feet of water.

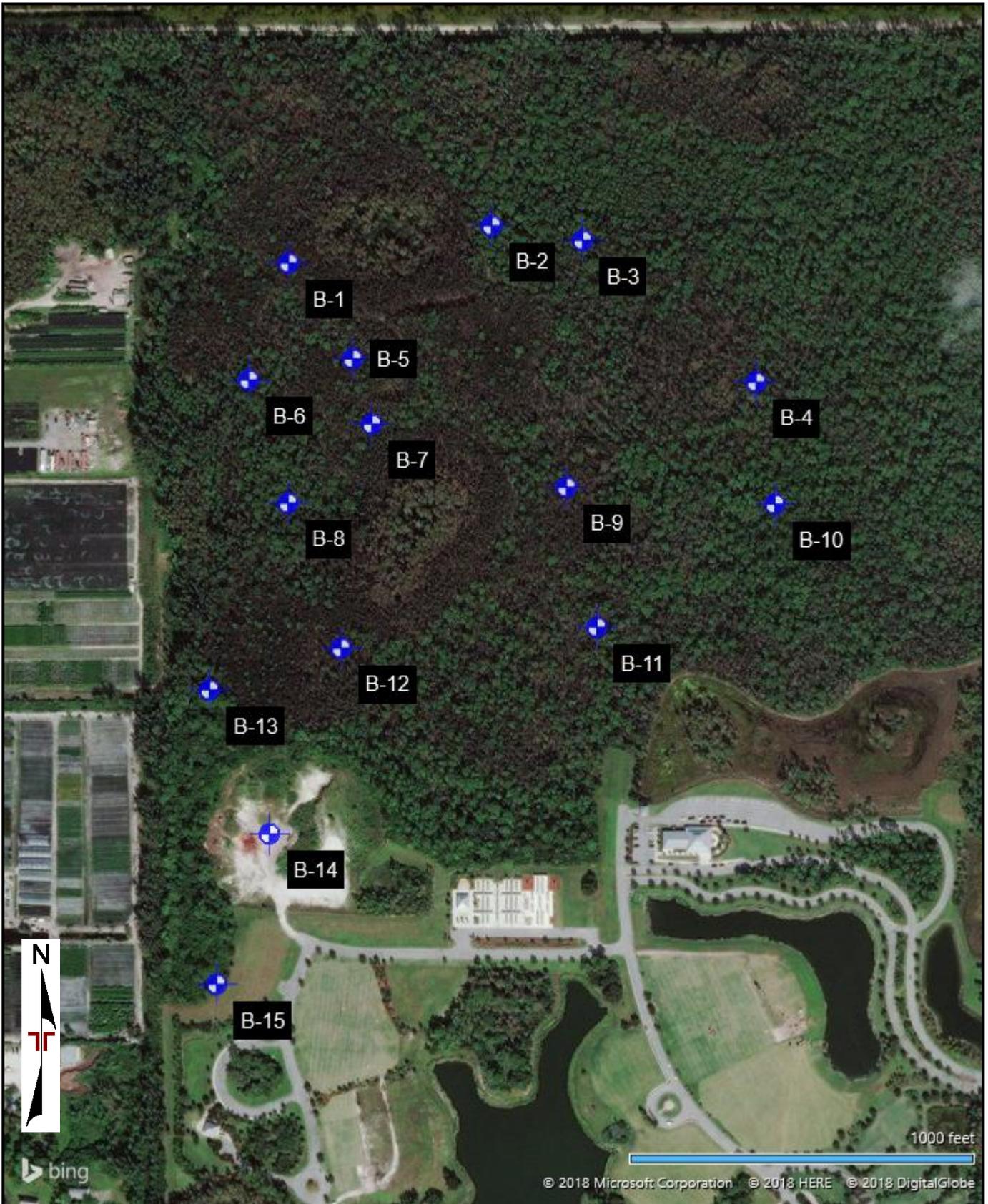


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

Project Manager:	DM
Drawn by:	DM
Checked by:	DM
Approved by:	KA
Project No.:	HD165118
Scale:	AS SHOWN
File Name:	HD165118
Date:	HD165118

Terracon
 1225 Omar Rd
 West Palm Beach, FL 33405-1046

EXPLORATION PLAN

South Florida National Cemetery
 6501 S State Road 7
 Lake Worth, FL

Exhibit
A-4

Field Exploration Description

The boring locations were laid out at the project site by a Terracon technician. The locations indicated on the attached diagram are approximate and were measured utilizing a hand-held GPS unit. The locations were then located by a surveyor. The locations of the borings should be considered accurate only to the degree implied by the means and methods used to define them.

The SPT soil borings were drilled with a ATV-mounted rotary drilling rig, with the exception of Borings B-14 and B-15 which were drilled with a truck-mounted rotary drilling rig. Both drilling rigs were equipped with an automatic hammer. A significantly greater efficiency is achieved with the automatic hammer compared to the conventional safety hammer operated with a cathead and rope. This higher efficiency has an appreciable effect on the SPT-N value. The effect of the automatic hammer's efficiency has been considered in the interpretation and analysis of the subsurface information for this report. The boreholes were advanced with a cutting head and stabilized with the use of bentonite (drillers' mud). Soil samples were obtained by the split spoon sampling procedure in general accordance with the Standard Penetration Test (SPT) procedure. In the split spoon sampling procedure, the number of blows required to advance the sampling spoon the last 12 inches of an 18-inch penetration or the middle 12 inches of a 24-inch penetration by means of a 140-pound hammer with a free fall of 30 inches, is the standard penetration resistance value (N). This value is used to estimate the in-situ relative density of cohesionless soils and the consistency of cohesive soils. The sampling depths and penetration distance, plus the standard penetration resistance values, are shown on the boring logs.

Portions of the samples from the borings were sealed in jars to reduce moisture loss, and then the jars were taken to our laboratory for further observation and classification. Upon completion, the SPT boring boreholes were backfilled with bentonite chips.

Groundwater levels were measured in the boreholes at the time of our field exploration to evaluate the depth to groundwater. These borings were then backfilled with soil cuttings and bentonite hole plug upon completion.

Field logs of each boring were prepared by the drill crew. These logs included visual classifications of the materials found during drilling as well as the driller's interpretation of the subsurface conditions between samples. The boring logs included with this report represent an interpretation of the field logs and include modifications based on laboratory observation of the samples.

Geotechnical Engineering Report

South Florida National Cemetery Expansion ■ Lake Worth, Florida
January 19, 2018 ■ Terracon Project No. H4165118



Permeability tests were conducted by installing a 4 inch diameter screened PVC pipe to a depth of 2 feet. A falling head test was then conducted with the depth of drop of water level versus time measured.

BORING LOG NO. B-1

PROJECT: South Florida National Cemetery

CLIENT: Mabbett & Associates, Inc.
Providence, RI

SITE: 6501 SR7
Lake Worth, FL

GRAPHIC LOG	LOCATION See Exhibit A-4 Latitude: 26.5854° Longitude: -80.2127°	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	PERCENT FINES
DEPTH							
4.0	SAND (SP) , trace shell fragments, fine grained, brown		▽	X	3-4-6-6 N=10		
8.0				X	8-10-10-10 N=20		
12.0	SHELLROCK , sandy, light gray	5		X	8-12-13-15 N=25		
16.0				X	10-13-16-19 N=29	15.3	11.8
20.0				X	15-16-18-19 N=34		
24.0	SAND WITH SILT (SP-SM) , some shell and cemented sand fragments, fine to medium grained, light gray			X	10-11-13 N=24		
28.0	Boring Terminated at 15 Feet	15					

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
SPT

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).

Notes:

Abandonment Method:
Boring backfilled with sand and gravel

See Appendix C for explanation of symbols and abbreviations.

WATER LEVEL OBSERVATIONS

- ▽ 2 feet while drilling
- ▽ 1.9 feet on 1/5/17



Boring Started: 12-19-2017

Boring Completed: 12-19-2017

Drill Rig: D-50

Driller: SH

Project No.: HD165118

Exhibit: A-6-1

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL. HD165118 - SFL VA.GPJ TERRACON_DATATEMPLATE.GDT 1/12/18

BORING LOG NO. B-2

PROJECT: South Florida National Cemetery

CLIENT: Mabbett & Associates, Inc.
Providence, RI

SITE: 6501 SR7
Lake Worth, FL

GRAPHIC LOG	LOCATION See Exhibit A-4 Latitude: 26.5856° Longitude: -80.2109°	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	PERCENT FINES
DEPTH							
0.0 - 2.0	SAND WITH CLAY (SP-SC) , trace shell fragments, fine grained, brown			X	2-3-2-2 N=5		
2.0 - 4.0	CLAYEY SAND (SC) , with some shell fragments, fine grained, brown		▽	X	3-4-8-11 N=12		
4.0 - 5.0	SHELLROCK , sandy, light gray			X	10-12-9-10 N=21		
5.0 - 10.0				X	10-12-10-11 N=22		
10.0 - 15.0				X	13-16-15-16 N=31		
15.0	Boring Terminated at 15 Feet			X	7-10-11 N=21		

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method: SPT	See Exhibit A-5 for description of field procedures See Appendix B for description of laboratory procedures and additional data (if any).	Notes:	
Abandonment Method: Boring backfilled with sand and gravel	See Appendix C for explanation of symbols and abbreviations.		
WATER LEVEL OBSERVATIONS	 1225 Omar Rd West Palm Beach, FL	Boring Started: 12-19-2017	Boring Completed: 12-19-2017
▽ 2.5 feet while drilling		Drill Rig: D-50	Driller: SH
		Project No.: HD165118	Exhibit: A-6-2

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL. HD165118 - SFL VA.GPJ TERRACON_DATATEMPLATE.GDT 1/12/18

BORING LOG NO. B-3

PROJECT: South Florida National Cemetery

CLIENT: Mabbett & Associates, Inc.
Providence, RI

SITE: 6501 SR7
Lake Worth, FL

GRAPHIC LOG	LOCATION See Exhibit A-4 Latitude: 26.5855° Longitude: -80.2101°	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	PERCENT FINES
DEPTH							
2.0	SAND (SP) , fine grained, light brown			X	3-3-3-4 N=6		
6.0	SAND WITH SILT (SP-SM) , trace shell fragments, fine grained, light brown to brown		▽	X	3-5-6-8 N=11	21.0	9.7
6.0	SAND WITH SILT (SP-SM) , with shell fragments, trace cemented sand fragments from 6 to 8 feet, fine to medium grained, light gray			X	8-10-13-15 N=23		
			X	10-16-18-18 N=34			
			X	15-19-22-23 N=41			
15.0	Boring Terminated at 15 Feet			X	10-12-20 N=32		

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
SPT

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

Abandonment Method:
Boring backfilled with sand and gravel

WATER LEVEL OBSERVATIONS

▽ 2.5 feet while drilling



Boring Started: 12-19-2017

Boring Completed: 12-19-2017

Drill Rig: D-50

Driller: SH

Project No.: HD165118

Exhibit: A-6-3

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL. HD165118 - SFL VA.GPJ TERRACON_DATATEMPLATE.GDT 1/12/18

BORING LOG NO. B-4

PROJECT: South Florida National Cemetery

CLIENT: Mabbett & Associates, Inc.
Providence, RI

SITE: 6501 SR7
Lake Worth, FL

GRAPHIC LOG	LOCATION See Exhibit A-4 Latitude: 26.5844° Longitude: -80.2086°	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	PERCENT FINES
	DEPTH						
	2.0	SILTY SAND (SM) , trace shell fragments, fine grained, brown	▽	X	2-3-6-10 N=9	19.3	15.8
	4.0	SAND WITH SILT (SP-SM) , trace shell fragments, fine grained, brown	▽	X	4-6-7-8 N=13		
	5	SAND WITH SILT (SP-SM) , some shell and cemented sand fragments, fine to medium grained, light gray	X	X	6-6-7-9 N=13		
	10		X	X	8-9-9-11 N=18		
15.0	Boring Terminated at 15 Feet	X	X	7-8-10-10 N=18			
		15			9-10-11 N=21		

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
SPT

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).

Notes:

Abandonment Method:
Boring backfilled with sand and gravel

See Appendix C for explanation of symbols and abbreviations.

WATER LEVEL OBSERVATIONS

- ▽ 3 feet while drilling
- ▽ 1.7 feet on 1/5/17



Boring Started: 12-19-2017

Boring Completed: 12-19-2017

Drill Rig: D-50

Driller: SH

Project No.: HD165118

Exhibit: A-6-4

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL. HD165118 - SFL VA.GPJ TERRACON_DATATEMPLATE.GDT 1/12/18

BORING LOG NO. B-5

PROJECT: South Florida National Cemetery

CLIENT: Mabbett & Associates, Inc.
Providence, RI

SITE: 6501 SR7
Lake Worth, FL

GRAPHIC LOG	LOCATION See Exhibit A-4 Latitude: 26.5846° Longitude: -80.2122°	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	PERCENT FINES
DEPTH							
4.0	SAND (SP) , trace small roots in upper 1 foot, fine grained, light gray			X	2-3-4-6 N=7		
4.0			▽	X	7-10-11-11 N=21		
6.0	SAND WITH SILT (SP-SM) , some shell and trace cemented sand fragments, some fibrous roots, fine to medium grained, light gray	5		X	12-11-8-10 N=19		
6.0				X	10-9-10-12 N=19		
6.0	SHELLROCK , sandy, light gray			X	8-10-12-13 N=22		
15.0		10		X			
15.0				X	10-12-12 N=24		
15.0	Boring Terminated at 15 Feet	15					

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method: SPT	See Exhibit A-5 for description of field procedures See Appendix B for description of laboratory procedures and additional data (if any). See Appendix C for explanation of symbols and abbreviations.	Notes:	
Abandonment Method: Boring backfilled with sand and gravel			
WATER LEVEL OBSERVATIONS	Terracon 1225 Omar Rd West Palm Beach, FL	Boring Started: 12-19-2017	Boring Completed: 12-19-2017
▽ 3 feet while drilling		Drill Rig: D-50	Driller: SH
		Project No.: HD165118	Exhibit: A-6-5

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL_HD165118 - SFL_VA.GPJ TERRACON_DATATEMPLATE.GDT 1/12/18

BORING LOG NO. B-6

PROJECT: South Florida National Cemetery

CLIENT: Mabbett & Associates, Inc.
Providence, RI

SITE: 6501 SR7
Lake Worth, FL

GRAPHIC LOG	LOCATION See Exhibit A-4 Latitude: 26.5844° Longitude: -80.2131°	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	PERCENT FINES
DEPTH							
0.0 - 4.0	SAND (SP) , trace small roots in upper 1 foot, fine grained, light gray to light brown	4.0	▽	X	3-4-5-5 N=9		
4.0 - 7.0	CLAYEY SAND (SC) , some shell fragments, fine grained, brown	7.0		X	6-8-12-19 N=20		
7.0 - 15.0	SHELLROCK , sandy, light gray	15.0		X	17-20-21-23 N=41	21.5	13.1
				X	19-20-20-22 N=40		
				X	16-17-15-16 N=32		
				X	9-15-22 N=37		
	Boring Terminated at 15 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
SPT

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).

Notes:

Abandonment Method:
Boring backfilled with sand and gravel

See Appendix C for explanation of symbols and abbreviations.

WATER LEVEL OBSERVATIONS

▽ 3 feet while drilling



Boring Started: 12-19-2017

Boring Completed: 12-19-2017

Drill Rig: D-50

Driller: SH

Project No.: HD165118

Exhibit: A-6-6

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL. HD165118 - SFL VA.GPJ TERRACON_DATATEMPLATE.GDT 1/12/18

BORING LOG NO. B-7

PROJECT: South Florida National Cemetery

CLIENT: Mabbett & Associates, Inc.
Providence, RI

SITE: 6501 SR7
Lake Worth, FL

GRAPHIC LOG	LOCATION See Exhibit A-4 Latitude: 26.5841° Longitude: -80.212°	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	PERCENT FINES
DEPTH							
0.0	SAND WITH SILT (SP-SM) , trace shell fragments, fine grained, gray to brown			X	3-3-4-3 N=7		
2.0	SAND (SP) , with shell fragments, fine grained, light brown to light gray		▽	X	3-4-4-5 N=8		
4.0	SHELLROCK , sandy, light gray			X			
		5		X	6-8-10-12 N=18		
				X	10-10-10-11 N=20		
				X	10-12-13-14 N=25		
		10		X			
				X	12-15-14 N=29		
		15					
	Boring Terminated at 15 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
SPT

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).

Notes:

Abandonment Method:
Boring backfilled with sand and gravel

See Appendix C for explanation of symbols and abbreviations.

WATER LEVEL OBSERVATIONS
▽ 3 feet while drilling



Boring Started: 12-18-2017	Boring Completed: 12-18-2017
Drill Rig: D-50	Driller: SH
Project No.: HD165118	Exhibit: A-6-7

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL_HD165118 - SFL VA.GPJ TERRACON_DATATEMPLATE.GDT 1/12/18

BORING LOG NO. B-8

PROJECT: South Florida National Cemetery

CLIENT: Mabbett & Associates, Inc.
Providence, RI

SITE: 6501 SR7
Lake Worth, FL

GRAPHIC LOG	LOCATION See Exhibit A-4 Latitude: 26.5834° Longitude: -80.2127°	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	PERCENT FINES
DEPTH							
2.0	SAND WITH SILT (SP-SM) , trace shell fragments, fine grained, gray to brown			X	2-2-3-3 N=5		
4.0	SAND (SP) , with shell fragments, fine grained, light brown to light gray		▽	X	8-10-15-16 N=25		
	SHELLROCK , sandy, light gray	5		X	11-13-15-16 N=28		
				X	14-15-17-18 N=32		
				X	10-13-14-14 N=27		
				X	9-12-16 N=28		
15.0	Boring Terminated at 15 Feet	15					

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
SPT

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).

Notes:

Abandonment Method:
Boring backfilled with sand and gravel

See Appendix C for explanation of symbols and abbreviations.

WATER LEVEL OBSERVATIONS

▽ 3 feet while drilling



Boring Started: 12-18-2017

Boring Completed: 12-18-2017

Drill Rig: D-50

Driller: SH

Project No.: HD165118

Exhibit: A-6-8

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL. HD165118 - SFL VA.GPJ TERRACON_DATATEMPLATE.GDT 1/12/18

BORING LOG NO. B-9

PROJECT: South Florida National Cemetery

CLIENT: Mabbett & Associates, Inc.
Providence, RI

SITE: 6501 SR7
Lake Worth, FL

GRAPHIC LOG	LOCATION See Exhibit A-4 Latitude: 26.5836° Longitude: -80.2102°	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	PERCENT FINES
DEPTH							
3.0	SAND (SP) , fine grained, light brown			X	3-4-5-5 N=9		
4.0	SAND (SP) , with shell fragments, fine grained, brown		▽	X	4-6-6-8 N=12		
8.0	SHELLROCK , sandy, light gray	5		X	8-8-10-11 N=18	16.3	15.7
8.0				X	8-10-12-13 N=22		
15.0	SAND (SP) , fine grained, light gray			X	9-10-12-15 N=22		
	Boring Terminated at 15 Feet	15		X	10-15-16 N=31		

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method: SPT	See Exhibit A-5 for description of field procedures See Appendix B for description of laboratory procedures and additional data (if any). See Appendix C for explanation of symbols and abbreviations.	Notes:
Abandonment Method: Boring backfilled with sand and gravel		
WATER LEVEL OBSERVATIONS		Boring Started: 12-20-2017 Drill Rig: D-50 Project No.: HD165118
▽ 3 feet while drilling	1225 Omar Rd West Palm Beach, FL	Boring Completed: 12-20-2017 Driller: SH Exhibit: A-6-9

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL_HD165118 - SFL VA GPJ TERRACON DATATEMPLATE.GDT 1/12/18

BORING LOG NO. B-10

PROJECT: South Florida National Cemetery

CLIENT: Mabbett & Associates, Inc.
Providence, RI

SITE: 6501 SR7
Lake Worth, FL

GRAPHIC LOG	LOCATION See Exhibit A-4 Latitude: 26.5834° Longitude: -80.2084°	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	PERCENT FINES
DEPTH							
4.0	SAND (SP) , trace small roots in upper 1 foot, fine grained, brown to gray			X	3-4-6-6 N=10		
4.5	SILTY SAND (SM) , with fibrous roots, fine grained, brown		▽	X	5-5-7-8 N=12		
4.5	SHELLROCK , sandy, light gray			X	6-6-7-9 N=13		
9.0				X	9-10-12-12 N=22		
13.5				X	9-10-15-16 N=25		
15.0	Boring Terminated at 15 Feet			X	8-12-11 N=23		

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method: SPT	See Exhibit A-5 for description of field procedures See Appendix B for description of laboratory procedures and additional data (if any).	Notes:	
Abandonment Method: Boring backfilled with sand and gravel	See Appendix C for explanation of symbols and abbreviations.		
WATER LEVEL OBSERVATIONS ▽ 3 feet while drilling		1225 Omar Rd West Palm Beach, FL	
		Boring Started: 12-19-2017	Boring Completed: 12-19-2017
		Drill Rig: D-50	Driller: SH
		Project No.: HD165118	Exhibit: A-6-10

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL. HD165118 - SFL VA.GPJ TERRACON_DATATEMPLATE.GDT 1/12/18

BORING LOG NO. B-11

PROJECT: South Florida National Cemetery

CLIENT: Mabbett & Associates, Inc.
Providence, RI

SITE: 6501 SR7
Lake Worth, FL

GRAPHIC LOG	LOCATION See Exhibit A-4 Latitude: 26.5825° Longitude: -80.21°	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	PERCENT FINES
DEPTH							
4.0	SAND WITH SILT (SP-SM) , fine grained, brown		▽	X	2-2-3-2 N=5		
6.0	SAND WITH CLAY (SP-SC) , fine grained, gray to brown	5	▽	X	3-3-3-3 N=6		
8.0	SAND WITH SILT (SP-SM) , some shell fragments, fine grained, brown			X	4-6-7-8 N=13		
	SHELLROCK , sandy, light gray			X	8-8-8-9 N=16	27.8	11.0
15.0	Boring Terminated at 15 Feet	10		X	8-10-11-11 N=21		
		15		X	11-13-13 N=26		

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
SPT

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).

Notes:

Abandonment Method:
Boring backfilled with sand and gravel

See Appendix C for explanation of symbols and abbreviations.

WATER LEVEL OBSERVATIONS

- ▽ 3 feet while drilling
- ▽ 0.8 feet on 1/5/17



Boring Started: 12-20-2017

Boring Completed: 12-20-2017

Drill Rig: D-50

Driller: SH

Project No.: HD165118

Exhibit: A-6-11

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL_HD165118 - SFL VA.GPJ TERRACON_DATATEMPLATE.GDT 1/12/18

BORING LOG NO. B-12

PROJECT: South Florida National Cemetery

CLIENT: Mabbett & Associates, Inc.
Providence, RI

SITE: 6501 SR7
Lake Worth, FL

GRAPHIC LOG	LOCATION See Exhibit A-4 Latitude: 26.5823° Longitude: -80.2123°	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	PERCENT FINES
DEPTH							
2.0	SAND (SP) , fine grained, light brown to brown			X	2-3-4-5 N=7		
2.0	SHELLROCK , sandy, light gray		▽	X	4-8-12-13 N=20		
5.0		5		X	8-15-19-21 N=34		
10.0				X	14-20-21-22 N=41		
10.0				X	18-16-15-15 N=31		
15.0				X	12-15-17 N=32		
15.0	Boring Terminated at 15 Feet	15					

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
SPT

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).

Notes:

Abandonment Method:
Boring backfilled with sand and gravel

See Appendix C for explanation of symbols and abbreviations.

WATER LEVEL OBSERVATIONS
▽ 3 feet while drilling



Boring Started: 12-18-2017	Boring Completed: 12-18-2017
Drill Rig: D-50	Driller: SH
Project No.: HD165118	Exhibit: A-6-12

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL. HD165118 - SFL VA.GPJ TERRACON_DATATEMPLATE.GDT 1/12/18

BORING LOG NO. B-13

PROJECT: South Florida National Cemetery

CLIENT: Mabbett & Associates, Inc.
Providence, RI

SITE: 6501 SR7
Lake Worth, FL

GRAPHIC LOG	LOCATION See Exhibit A-4 Latitude: 26.582° Longitude: -80.2134°	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	PERCENT FINES
DEPTH							
4.0	SAND (SP) , some roots in upper foot, fine grained, light brown		▽	X	3-4-4-3 N=8		
4.0			▽	X	4-8-8-15 N=16		
6.0	SAND WITH SILT (SP-SM) , trace shell fragments, fine grained, light brown	5		X	16-17-19-22 N=36		
6.0				X	18-20-22-22 N=42		
6.0	SHELLROCK , sandy, light gray			X	18-16-12-13 N=28		
15.0		10		X			
15.0				X	8-11-15 N=26		
15.0	Boring Terminated at 15 Feet	15		X			

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method: SPT	See Exhibit A-5 for description of field procedures See Appendix B for description of laboratory procedures and additional data (if any).	Notes:	
Abandonment Method: Boring backfilled with sand and gravel	See Appendix C for explanation of symbols and abbreviations.		
WATER LEVEL OBSERVATIONS		Boring Started: 12-18-2017	Boring Completed: 12-18-2017
▽ 3 feet while drilling		Drill Rig: D-50	Driller: SH
▽ 1.8 feet on 1/5/17		Project No.: HD165118	Exhibit: A-6-13



THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL. HD165118 - SFL VA.GPJ TERRACON_DATATEMPLATE.GDT 1/12/18

BORING LOG NO. B-14

PROJECT: South Florida National Cemetery

CLIENT: Mabbett & Associates, Inc.
Providence, RI

SITE: 6501 SR7
Lake Worth, FL

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL. HD165118 - SFL VA GPJ TERRACON DATATEMPLATE.GDT 1/12/18

GRAPHIC LOG	LOCATION See Exhibit A-4 Latitude: 26.5808° Longitude: -80.2129°	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	PERCENT FINES
DEPTH							
0.0	SAND (SP) , some shell frags, trace to some gravel, fine grained, brown			X	1-6-6-6 N=12		
3.0			▽	X	4-7-13-10 N=20		
4.0	SAND (SP) , fine grained, light brown			X			
4.7	CLAYEY SAND (SC) , fine grained, brown			X			
4.7	SHELLROCK , sandy, light gray			X	7-19-19-10 N=38	14.9	16.1
8.0				X	6-6-7-10 N=13		
8.0	SAND WITH SILT (SP-SM) , some shell and cemented sand fragments, fine to medium grained, light gray to light brown			X	4-6-7-8 N=13		
15.0				X	7-5-4 N=9		
	Boring Terminated at 15 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
SPT

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

Abandonment Method:
Borings backfilled with bentonite chips

WATER LEVEL OBSERVATIONS

▽ 3.1 feet while drilling



Boring Started: 12-14-2017

Boring Completed: 12-14-2017

Drill Rig: CME-45

Driller: BP

Project No.: HD165118

Exhibit: A-6-14

BORING LOG NO. B-15

PROJECT: South Florida National Cemetery

CLIENT: Mabbett & Associates, Inc.
Providence, RI

SITE: 6501 SR7
Lake Worth, FL

GRAPHIC LOG	LOCATION See Exhibit A-4 Latitude: 26.5796° Longitude: -80.2134°	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	PERCENT FINES
	DEPTH						
0.5	TOPSOIL						
	SAND (SP) , trace shell fragments, fine grained, light brown to brown			X	1-2-3-4 N=5	15.8	4.4
2.0	SAND (SP) , fine grained, light brown		▽	X	3-5-3-3 N=8		
4.5				X			
4.8	CLAYEY SAND (SC) , fine grained, brown SHELLROCK , sandy, light gray	5		X	5-6-3-2 N=9		
8.0				X	2-2-9-8 N=11		
	SAND (SP) , trace shell, fine grained, light gray			X	3-5-5-7 N=10		
12.0				X			
	SAND WITH SILT (SP) , fine grained, dark brown			X	2-2-3 N=5		
15.0	Boring Terminated at 15 Feet	15		X			

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
SPT

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

Abandonment Method:
Borings backfilled with bentonite chips

WATER LEVEL OBSERVATIONS

▽ 2.6 feet while drilling



Boring Started: 12-14-2017

Boring Completed: 12-14-2017

Drill Rig: CME-45

Driller: BP

Project No.: HD165118

Exhibit: A-6-15

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL. HD165118 - SFL VA GPJ TERRACON DATATEMPLATE.GDT 1/12/18

APPENDIX B – LABORATORY TESTING

Geotechnical Engineering Report

South Florida National Cemetery Expansion ■ Lake Worth, Florida

January 19, 2018 ■ Terracon Project No. HD165118



Laboratory Testing

During the field exploration, a portion of each recovered sample was sealed in a jar and transported to our laboratory for further visual observation and laboratory testing. The soil samples were classified in general accordance with the appended General Notes and the Unified Soil Classification System based on the material's texture and plasticity. The estimated group symbol for the Unified Soil Classification System is shown on the boring logs and a brief description of the Unified Soil Classification System is included in Appendix C.

Laboratory tests conducted include moisture content, wash 200 sieve, full gradation, corrosion series and redox potential. The tests were conducted in general accordance the appropriate ASTM procedures. The results of the tests have been included on the boring logs and are shown in tabular form as Exhibits B-2 and B-3. Grain size curves are included as Exhibits B-4-1 to B-4-5.



EXHIBIT B-2

SUMMARY OF LABORATORY CLASSIFICATION TESTING
SOUTH FLORIDA NATIONAL CEMETERY
LAKE WORTH, PALM BEACH COUNTY, FLORIDA
TERRACON PROJECT NO. HD165118

Boring Number	Depth (ft)	Moisture Content (%)	Sieve Analysis (% passing)						USCS Symbol	
			3/4"	3/8"	#4	#10	#40	#100		#200
B-1	6.0 – 8.0	15.3	100	86.6	72.9	58.1	43.3	18.8	11.8	Shellrock
B-3	2.0 – 4.0	21.0	-	-	-	-	-	-	9.7	SP-SM
B-4	0 – 2.0	19.3	-	-	-	-	-	-	15.8	SM
B-6	4.0 – 6.0	21.5	100	91.6	80.5	67.2	51.4	20.2	13.1	SC
B-9	4.0 – 6.0	16.3	100	79.3	61.0	49.1	36.5	21.6	15.7	Shellrock
B-11	6.0 – 8.0	27.8	100	97.4	93.5	86.1	72.5	21.9	11.0	SP-SM
B-14	4.0 – 4.7	14.9	-	-	-	-	-	-	16.1	SC
B-15	0.5 – 2.0	15.8	100	100	98.6	97.7	89.8	26.5	4.4	SP

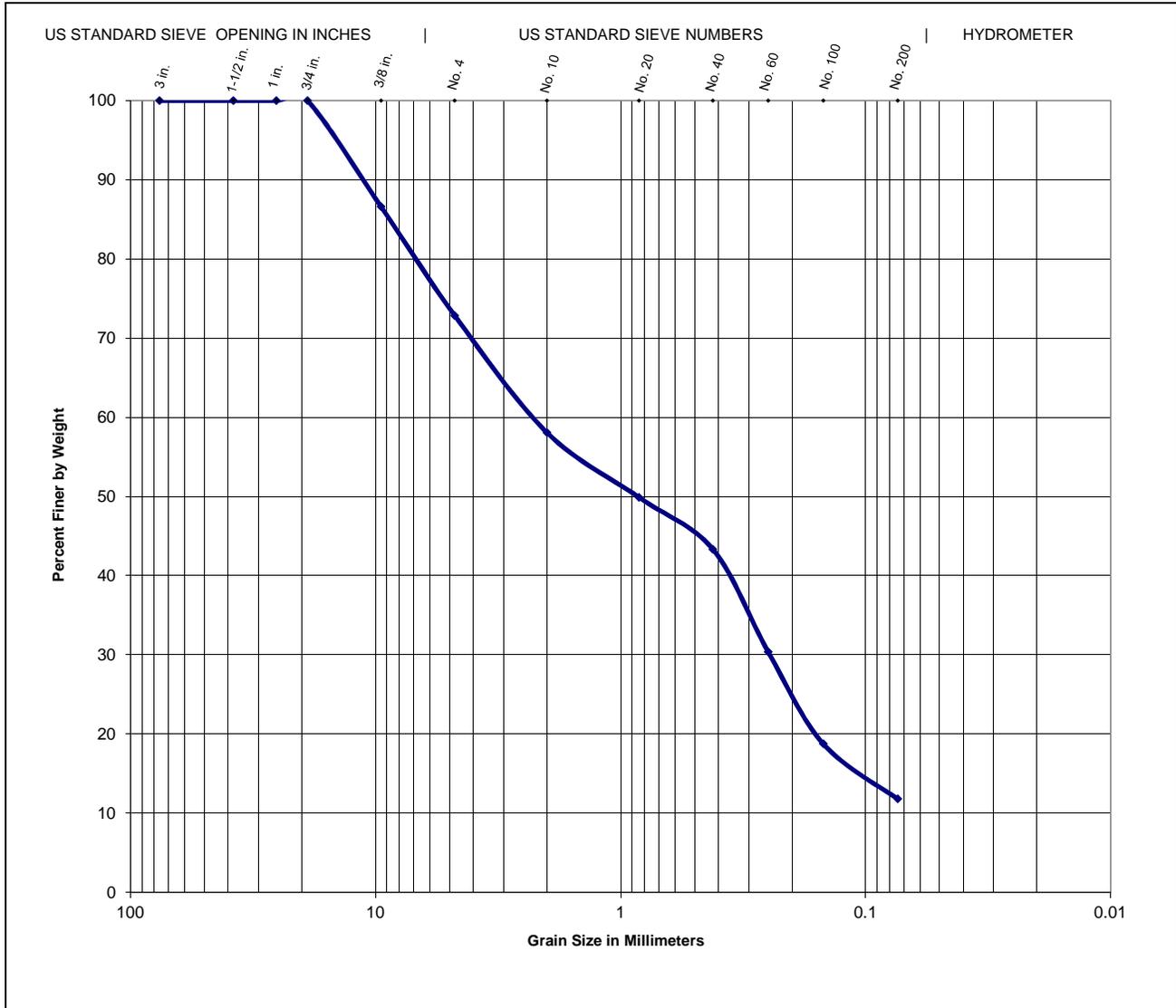


EXHIBIT B-3

CORROSION SERIES TESTING RESULTS
SOUTH FLORIDA NATIONAL CEMETERY
LAKE WORTH, PALM BEACH COUNTY, FLORIDA
TERRACON PROJECT NO. HD165118

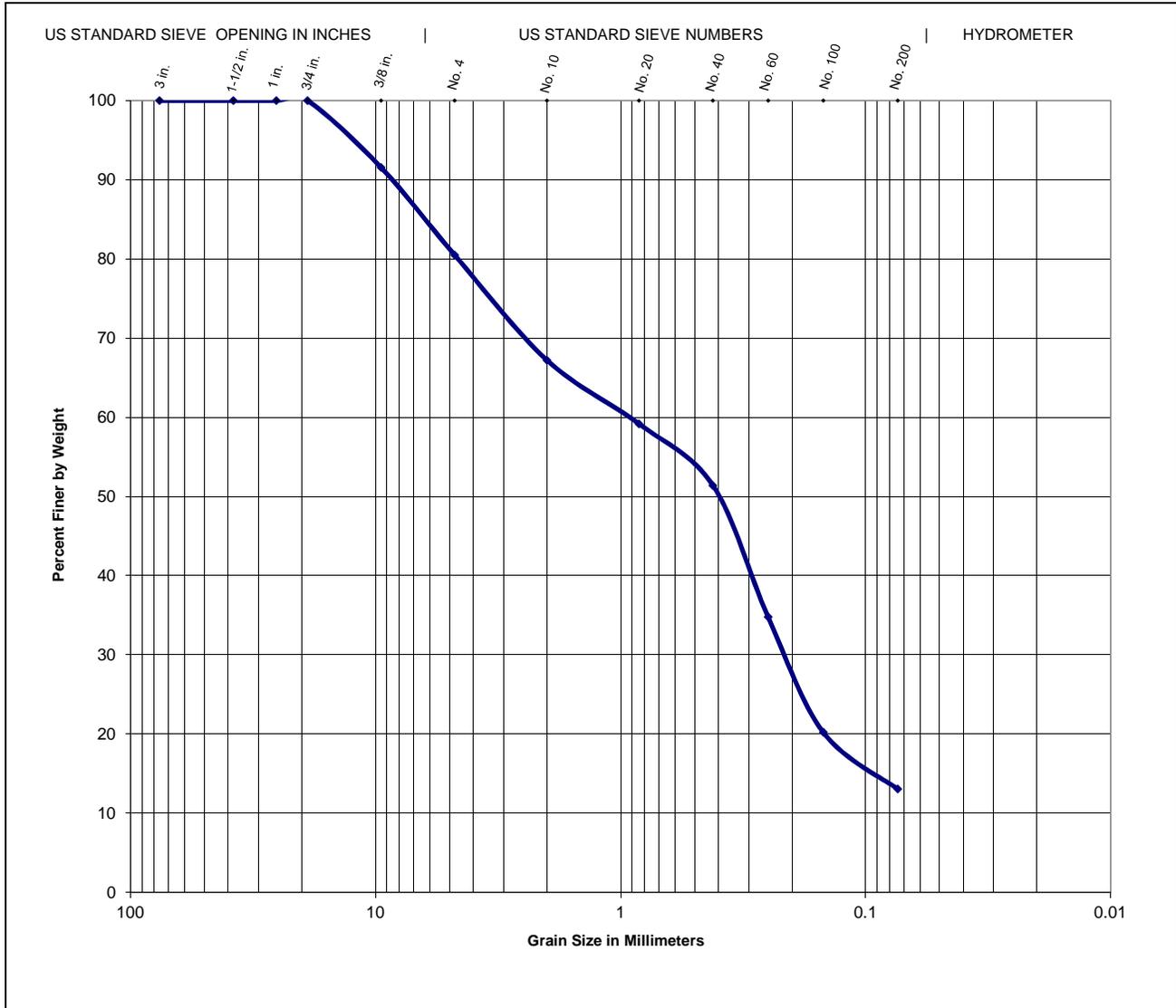
Location	Depth (ft)	pH	Chloride Content (ppm)	Sulfate Content (ppm)	Resistivity (ohm-cm)	Red-Ox (mV)	Substructure Environmental Classification ¹	
							Steel	Concrete
B-4	2.0 – 8.0	8.8	53	72	6,596	+644	Slightly Aggressive	Slightly Aggressive
B-8	2.0 – 8.0	8.3	73	91	3,880	+649	Moderately Aggressive	Slightly Aggressive

¹ According to the criteria described in the Florida Department of Transportation (FDOT) *Structures Manual Volume 1, Section 1.3 (Jan. 2012)*



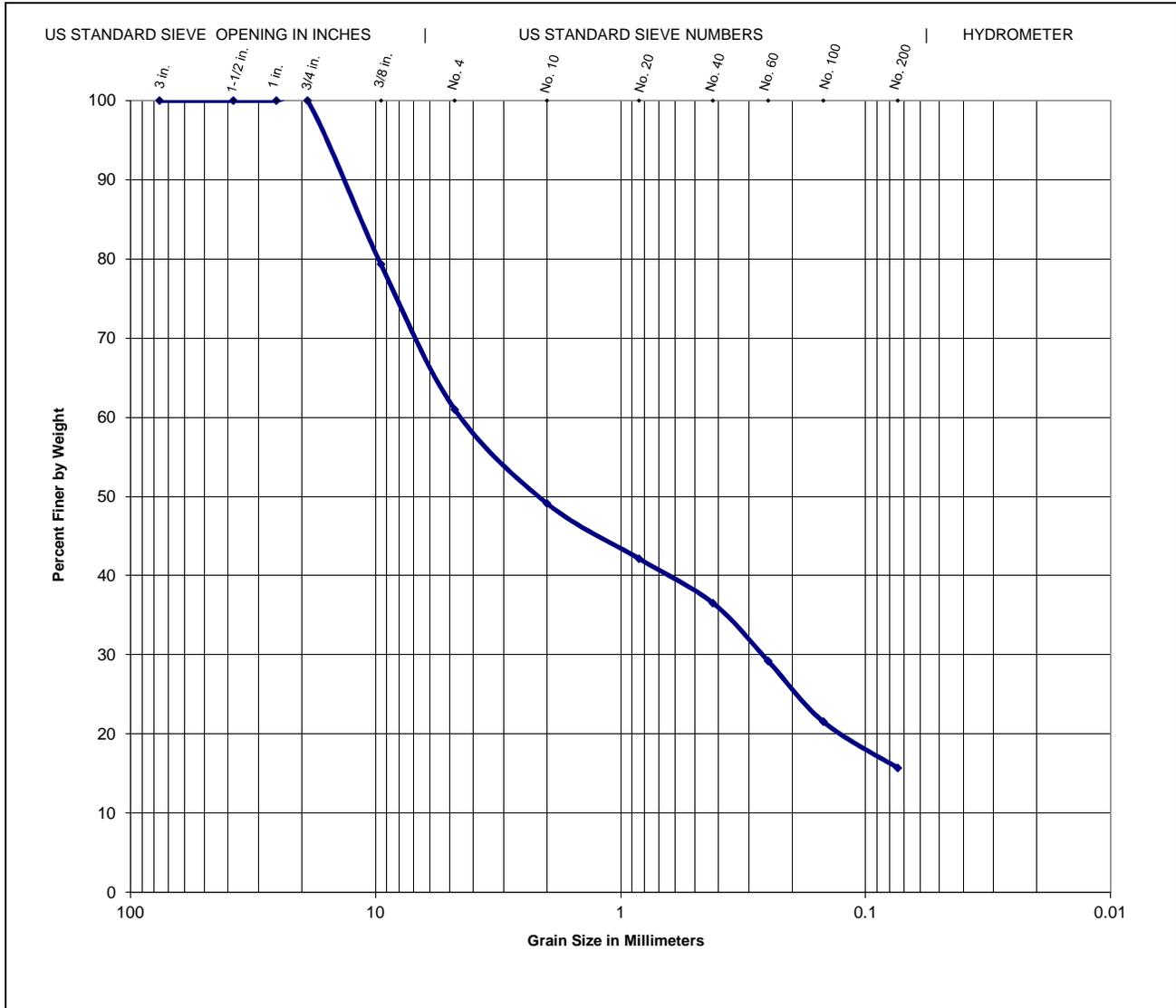
GRAIN SIZE DISTRIBUTION CURVE

Boring Number	Sample Depth	SOIL DESCRIPTION											Moisture Content (%)
B-1	6.0 - 8.0	Light gray sandy SHELLROCK											15.3
U.S. Sieve Number:		3 in.	1-1/2 in.	1 in.	3/4 in.	3/8 in.	No. 4	No. 10	No. 20	No. 40	No. 60	No. 100	No. 200
% Passing:		100	100	100	100	86.6	72.9	58.1	49.9	43.3	30.4	18.8	11.8
Eff. Size (D10) =		N/A		Unif. Coef. (D60/ D10) =		N/A		Mabbett & Associates, Inc. South Florida National Cemetery Lake Worth, Palm Beach County, Florida Project Number : HD165118 Date : 1/12/18					



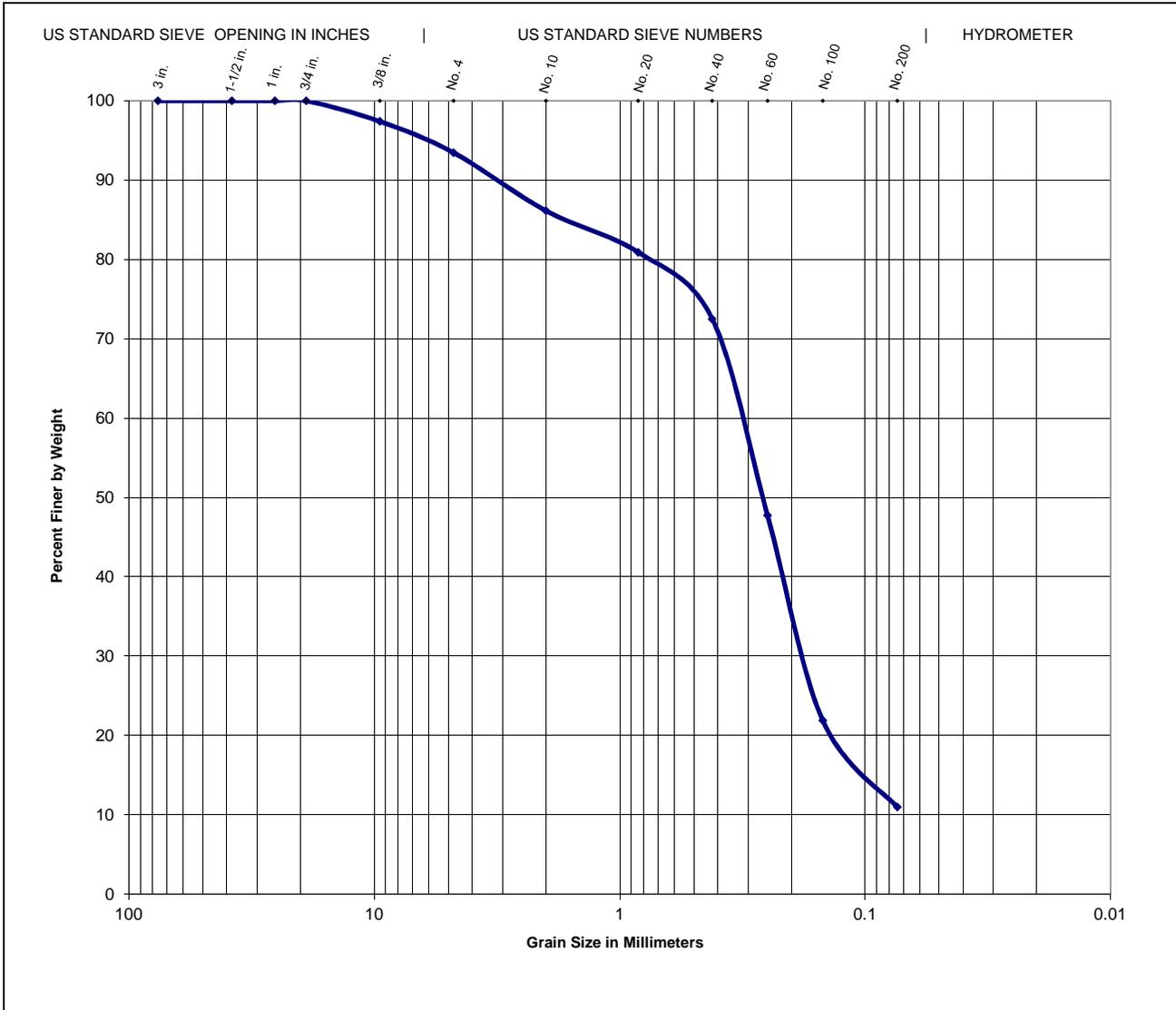
GRAIN SIZE DISTRIBUTION CURVE

Boring Number	Sample Depth	SOIL DESCRIPTION											Moisture Content (%)
B-6	4.0 - 6.0	Light brown clayey SAND, some shell fragments											21.5
U.S. Sieve Number:		3 in.	1-1/2 in.	1 in.	3/4 in.	3/8 in.	No. 4	No. 10	No. 20	No. 40	No. 60	No. 100	No. 200
% Passing:		100	100	100	100	91.6	80.5	67.2	59.2	51.4	34.8	20.2	13.1
Eff. Size (D10) =		N/A		Unif. Coef. (D60/ D10) =		N/A		Mabbett & Associates, Inc. South Florida National Cemetery Lake Worth, Palm Beach County, Florida Project Number : HD165118 Date : 1/12/18					



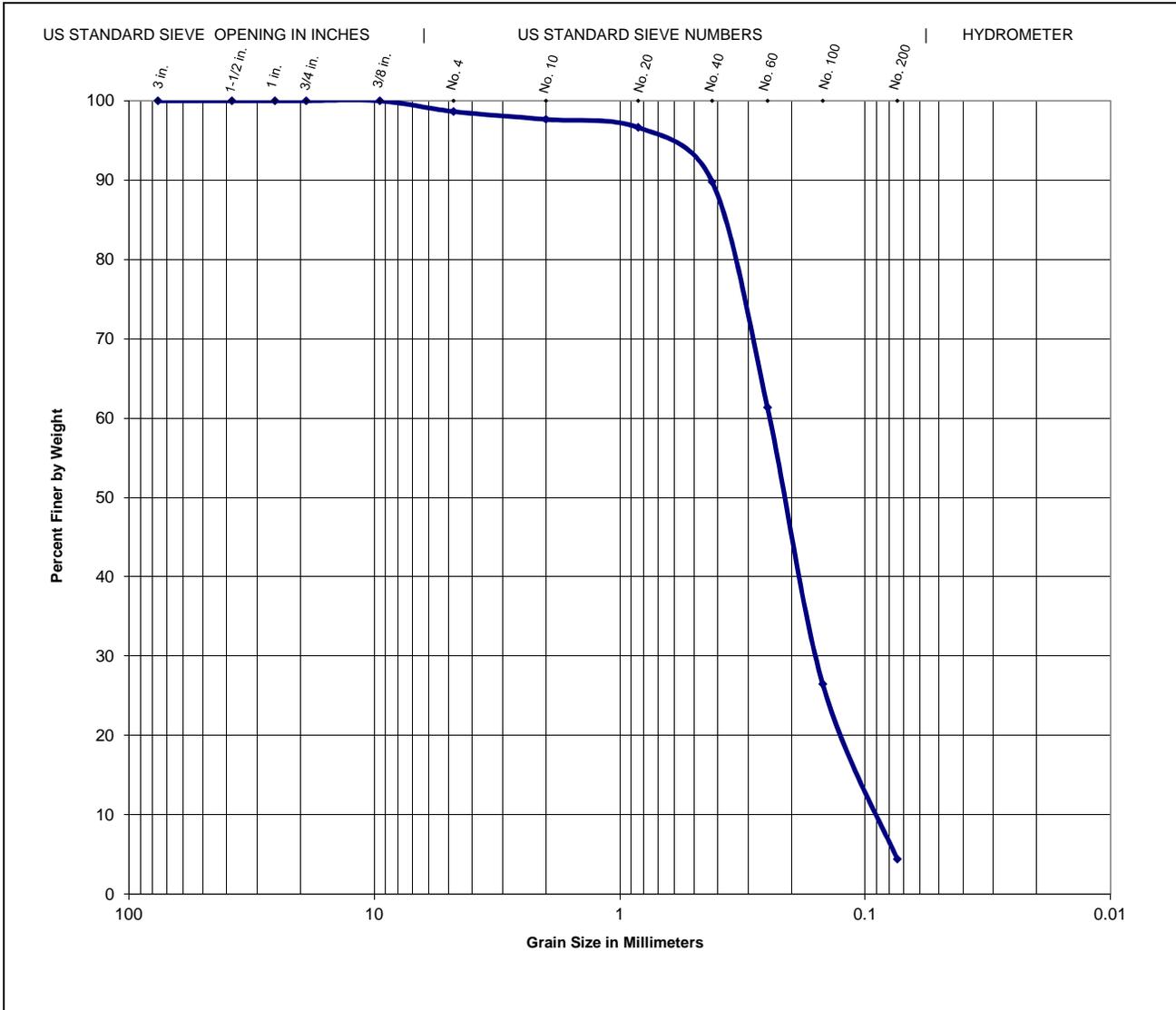
GRAIN SIZE DISTRIBUTION CURVE

Boring Number	Sample Depth	SOIL DESCRIPTION											Moisture Content (%)	
B-9	4.0 - 6.0	Light gray sandy SHELLROCK											16.3	
U.S. Sieve Number:		3 in.	1-1/2 in.	1 in.	3/4 in.	3/8 in.	No. 4	No. 10	No. 20	No. 40	No. 60	No. 100	No. 200	
% Passing:		100	100	100	100	79.3	61.0	49.1	42.1	36.5	29.2	21.6	15.7	
Eff. Size (D10) =		N/A											Unif. Coef. (D60/ D10) = N/A	
Mabbett & Associates, Inc. South Florida National Cemetery Lake Worth, Palm Beach County, Florida Project Number : HD165118 Date : 1/12/18														



GRAIN SIZE DISTRIBUTION CURVE

Boring Number	Sample Depth	SOIL DESCRIPTION											Moisture Content (%)	
B-11	6.0 - 8.0	Brown SAND with silt, some shell fragments											27.8	
U.S. Sieve Number:		3 in.	1-1/2 in.	1 in.	3/4 in.	3/8 in.	No. 4	No. 10	No. 20	No. 40	No. 60	No. 100	No. 200	
% Passing:		100	100	100	100	97.4	93.5	86.1	80.9	72.5	47.8	21.9	11.0	
Eff. Size (D10) =		N/A											Unif. Coef. (D60/ D10) =	N/A
Mabbett & Associates, Inc. South Florida National Cemetery Lake Worth, Palm Beach County, Florida Project Number : HD165118 Date : 1/12/18														



GRAIN SIZE DISTRIBUTION CURVE

Boring Number	Sample Depth	SOIL DESCRIPTION											Moisture Content (%)
B-15	0.5 - 2.0	Light brown fine SAND, trace shell											15.8
U.S. Sieve Number:		3 in.	1-1/2 in.	1 in.	3/4 in.	3/8 in.	No. 4	No. 10	No. 20	No. 40	No. 60	No. 100	No. 200
% Passing:		100	100	100	100	100	98.6	97.7	96.6	89.8	61.4	26.5	4.4
Eff. Size (D10) = 0.09 mm		Unif. Coef. (D60/ D10) = 2.78											
Mabbett & Associates, Inc. South Florida National Cemetery Lake Worth, Palm Beach County, Florida Project Number : HD165118 Date : 1/12/18													

APPENDIX C
SUPPORTING DOCUMENTS

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAMPLING	 Auger Cuttings  Grab Sample  Shelby Tube	 Rock Core  No Recovery  Standard Penetration Test	WATER LEVEL	 Water Initially Encountered  Water Level After a Specified Period of Time  Water Level After a Specified Period of Time Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.	FIELD TESTS	(HP) Hand Penetrometer (T) Torvane (DCP) Dynamic Cone Penetrometer (PID) Photo-Ionization Detector (OVA) Organic Vapor Analyzer
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DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS	RELATIVE DENSITY OF COARSE-GRAINED SOILS <small>(More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance</small>		CONSISTENCY OF FINE-GRAINED SOILS <small>(50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance</small>		
	Descriptive Term (Density)	Automatic Hammer SPT N-Value (Blows/Ft.)	Descriptive Term (Consistency)	Unconfined Compressive Strength Qu, (psf)	Automatic Hammer SPT N-Value (Blows/Ft.)
	Very Loose	< 3	Very Soft	less than 500	< 1
	Loose	3 - 8	Soft	500 to 1,000	1 - 3
	Medium Dense	8 - 24	Medium Stiff	1,000 to 2,000	3 - 6
	Dense	24 - 40	Stiff	2,000 to 4,000	6 - 12
	Very Dense	> 40	Very Stiff	4,000 to 8,000	12 - 24
			Hard	> 8,000	> 24

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 - 29
Modifier	> 30

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300 mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm)
Silt or Clay	Passing #200 sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 - 12
Modifier	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1 - 10
Medium	11 - 30
High	> 30

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests ^A				Soil Classification		
				Group Symbol	Group Name ^B	
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 ^C	$Cu \geq 4$ and $1 \leq Cc \leq 3$ ^E	GW	Well-graded gravel ^F	
			$Cu < 4$ and/or $1 > Cc > 3$ ^E	GP	Poorly graded gravel ^F	
		Gravels with Fines: More than 12% fines ^C	Fines classify as ML or MH	GM	Silty gravel ^{F,G,H}	
			Fines classify as CL or CH	GC	Clayey gravel ^{F,G,H}	
	Sands: 50% or more of coarse fraction passes No. 4 sieve	Clean Sands: Less than 5% fines ^D	$Cu \geq 6$ and $1 \leq Cc \leq 3$ ^E	SW	Well-graded sand ^I	
			$Cu < 6$ and/or $1 > Cc > 3$ ^E	SP	Poorly graded sand ^I	
		Sands with Fines: More than 12% fines ^D	Fines classify as ML or MH	SM	Silty sand ^{G,H,I}	
			Fines classify as CL or CH	SC	Clayey sand ^{G,H,I}	
Fine-Grained Soils: 50% or more passes the No. 200 sieve	Silts and Clays: Liquid limit less than 50	Inorganic:	$PI > 7$ and plots on or above "A" line ^J	CL	Lean clay ^{K,L,M}	
			$PI < 4$ or plots below "A" line ^J	ML	Silt ^{K,L,M}	
		Organic:	Liquid limit - oven dried	< 0.75	OL	Organic clay ^{K,L,M,N}
			Liquid limit - not dried		OH	Organic silt ^{K,L,M,O}
	Silts and Clays: Liquid limit 50 or more	Inorganic:	PI plots on or above "A" line	CH	Fat clay ^{K,L,M}	
			PI plots below "A" line	MH	Elastic Silt ^{K,L,M}	
		Organic:	Liquid limit - oven dried	< 0.75	OH	Organic clay ^{K,L,M,P}
			Liquid limit - not dried		OH	Organic silt ^{K,L,M,Q}
Highly organic soils:	Primarily organic matter, dark in color, and organic odor			PT	Peat	

^A Based on the material passing the 3-inch (75-mm) sieve

^B If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

^C Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

^D Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

$$^E Cu = D_{60}/D_{10} \quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$$

^F If soil contains $\geq 15\%$ sand, add "with sand" to group name.

^G If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

^H If fines are organic, add "with organic fines" to group name.

^I If soil contains $\geq 15\%$ gravel, add "with gravel" to group name.

^J If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

^K If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

^L If soil contains $\geq 30\%$ plus No. 200 predominantly sand, add "sandy" to group name.

^M If soil contains $\geq 30\%$ plus No. 200, predominantly gravel, add "gravelly" to group name.

^N $PI \geq 4$ and plots on or above "A" line.

^O $PI < 4$ or plots below "A" line.

^P PI plots on or above "A" line.

^Q PI plots below "A" line.

