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Geotechnical Engineering | Material Testing | Inspection Services

Revised January 20, 2020
December 27, 2019

Saltz Michelson Architects
3501 Griffin Road
Fort Lauderdale, FL 33312

Attention: Mr. Norman Schwartz, AIA, NCARB

Re: Geotechnical Engineering Study
Fire Station No. 2-58
Margate, Florida
TSF Project No. 7111-19-446

Dear Norman:

**TIERRA SOUTH FLORIDA, INC. (TSF)** is pleased to transmit our Geotechnical Engineering Services Report for the referenced project. This report includes the results of field exploration and laboratory testing, geotechnical recommendations for foundation and pavement subgrade design, as well as general site development.

We appreciate the opportunity to perform this Geotechnical Study and look forward to continued participation during the design and construction phases of this project. If you have any questions pertaining to this report, or if we may be of further service, please contact our office.

Respectfully submitted,

**TIERRA SOUTH FLORIDA, INC.**

MAXIMO GERMAN PERALTA ALVAREZ
LICENSE
No. 84213
STATE OF FLORIDA
PROFESSIONAL ENGINEER

1/20/20

Maximo Peralta Alvarez, P.E.
Geotechnical Engineer
FL. Registration No. 84213

1/20/20

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Principal Engineer
FL. Registration No. 54873

MPA/RV:

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# 1.0 EXECUTIVE SUMMARY

A geotechnical exploration and evaluation of the subsurface conditions have been completed for the design and construction of the proposed Fire Station No. 2-58 to be constructed in Margate, Florida.

Based on visual classifications underneath the existing topsoil, asphalt, or concrete, the subsurface condition encountered in the majority of borings consisted of sandy soils to de boring termination depth. Limestone was encountered on Boring B-1 between about a depth of 13 and 17 feet. Standard Penetration N-Values indicated the sandy soils to be in medium dense conditions and the limestone to be in moderate hard condition. The groundwater was, typically, encountered between about 4 and 6 feet below the ground surface. **Although limestone was not encountered in the upper 5 feet, limestone could be encountered at shallower. USDA Soil survey map indicates a stratum of limestone at a depth of 58 inches from grade.**

**Above normal excavation efforts should be expected in areas that require excavations through the limestone. In addition, boulder-like fill should be expected when excavating the sandy limestone stratum and should be budgeted accordingly.**

**We understand that the current single-story structure occupying the site will be demolished, we recommend that all construction debris be removed prior to the start of construction so that the debris does not interfere with foundation construction and utility construction. All debris removal areas should be properly backfilled and compacted, as discussed herein.** Existing footing adjacent to excavations (if any) should be adequately protected.

The geotechnical study completed for the proposed construction confirms that the site will be suitable for the planned construction when viewed from a soil mechanics and foundation engineering perspective. After following proper site preparation procedures, the structure may be supported on shallow spread foundations and employ conventional slab-on-grade for the ground floors. Details related to site development, foundation design, and construction considerations are included in subsequent sections of this report.

The owner/designer should not rely solely on this Executive Summary and must read and evaluate the entire contents of this report prior to utilizing our engineering recommendations in preparation for design/construction documents.

# 2.0 PROJECT INFORMATION

## 2.1 Project Authorization

TSF has completed a geotechnical exploration for the proposed Fire Station No. 2-58 to be constructed in Margate, Florida. This geotechnical service was performed in accordance with TSF's Proposal No. 1701-038 revised dated July 22, 2019, and subsequently authorized by Saltz Michelson Architects.

## 2.2 Project Description

Our understanding of the project is based on general information obtained from Saltz Michelson Architects, as well as Site Plans indicating the proposed building. The proposed fire station No. 2-58 location is at 600 North Rock Island in Margate, Florida. We understand that the proposed construction will include 8,800 square feet, one-story fire station with mezzanine, two drive thruways, parking, and driveway. Loading information has not been provided at this time.

The geotechnical recommendations presented in this report are based on the available project information, building location, and the subsurface materials described in this report. If any of the noted information is incorrect, please inform TSF in writing so that we may amend the recommendations presented in this report if appropriate and if desired by the client. TSF will not be responsible for the implementation of its recommendations when it is not notified of changes in the project.

## 2.3 Purpose and Scope of Services

The purpose of this study was to explore the subsurface conditions at the site, which is currently accessible to enable an evaluation of acceptable foundation and pavement systems for the proposed construction. This report briefly outlines the testing procedures, describes the site and subsurface conditions, and presents geotechnical recommendations for foundation design and general site development.

Our scope of services included drilling a total of six (6) Standard Penetration Test (SPT) borings to a depth of about 30 feet from ground surface, performing three (3) Borehole Permeability (BHP) tests to a depth of 10 feet per South Florida Water Management District (SFWMD) standards, plus the preparation of this geotechnical report.

This report briefly outlines the testing procedures, presents available project information, describes the site and subsurface conditions, and presents geotechnical recommendations regarding the following:

- ✎- Foundation soil preparation requirements.
- ✎ - Foundation types, depths, allowable bearing capacities, and an estimate of a potential settlement.
- ✎- Pavement Subgrade Design Recommendations.

- ✐- Comments regarding factors that may impact the construction and performance of the proposed construction.

The scope of services did not include an environmental assessment for determining the presence or absence of wetlands or hazardous or toxic materials in the soil, bedrock, surface water, groundwater, or air on or below or around this site. Any statements in this report or on the boring logs regarding odors, colors, and unusual or suspicious items or conditions are strictly for information purposes only.

## 3.0 SITE AND SUBSURFACE CONDITIONS

### 3.1 Site Location and Description

The project site is located at 600 North Rock Island in Margate, Florida. At the time of field exploration, the area was observed to be fairly level. The site is occupied by a single-story building and an associated parking lot and driveways.

### 3.2 Subsurface Conditions

Review of the "Soil Survey of Broward County, Florida," prepared by the United States Department of Agriculture (USDA) Soil Conservation Service (SCS), indicates the site is mapped as Immokalee, limestone substratum-Urban land complex.

Subsurface conditions at the site were explored with engineering borings located as shown on the Boring Location Plan, Sheet 1 in the Appendix. The study included the drilling of six (6) Standard Penetration Test (SPT) borings to a depth of about 30 feet from ground surface, performing three (3) Borehole Permeability (BHP) tests to a depth of 10 feet per SFWMD standards, plus the preparation of this geotechnical report. The soil test boring profiles are presented on Sheet 2 in the Appendix. Samples of the in-place materials were recovered at frequent intervals using a standard split spoon driven with a 140-pound hammer freely falling 30 inches (the SPT after ASTM D 1586). Samples of the in-place soils were returned to our laboratory for classification by a geotechnical engineer, in general accordance with the Unified Soil Classification System (ASTM D 2487).

At the time of our field exploration, based on visual classifications underneath the existing topsoil, the subsurface condition encountered in the borings consisted of sandy soils to de boring termination depth. Limestone was encountered on Boring B-1 between about a depth of 13 and 17. Standard Penetration N-Values indicated the sandy soils to be in medium dense conditions and the limestone to be in moderate hard condition. The groundwater was, typically, encountered between about 4 and 6 feet below the ground surface. **Although limestone was not encountered in the upper 5 feet, limestone could be encountered at shallower. USDA Soil survey map indicates a stratum of limestone at a depth of 58 inches from grade.**

The above subsurface description is of a generalized nature intended to highlight the major subsurface stratification features and material characteristics. The boring logs should be reviewed for specific information at individual boring locations. These records include soil descriptions, stratifications, and penetration resistance. The stratifications shown on the boring logs represent the conditions only at the actual boring locations. Variations may occur and should be expected between boring locations. The stratifications represent the approximate boundary between subsurface materials, and the actual transition may be gradual. Water level information obtained during field operations is also shown on the boring logs. The samples that were not altered by laboratory testing will be retained for 30 days from the date of this report and then will be discarded.

## 3.3 Groundwater Information

Groundwater levels were measured in the borings when first encountered. The groundwater was, typically, encountered between about 4 and 6 feet below the ground surface. Groundwater levels are expected to fluctuate with seasonal fluctuations. We expect the groundwater to, typically, fluctuate within about 2 feet from where it was encountered during the drilling operation.

In general, the seasonal high groundwater level is not intended to define a limit or ensure that future seasonal fluctuations in groundwater levels will not exceed the estimated levels. Post-development groundwater levels could exceed the normal seasonal high groundwater level estimate as a result of a series of rainfall events, changing conditions at the site that alter surface water drainage characteristics, or variations in the duration, intensity, or total volume of rainfall. We recommend that the Contractor determine the actual groundwater levels at the time of the construction to determine groundwater impact on his or her construction procedures.

## 3.4 Borehole Permeability (BHP) Test Results

Three (3) BHP tests were performed using the usual open-hole, constant head methodology per South Florida Water Management District Standard. The holes were 10 feet deep and were drilled with a solid stem auger so that soil samples could be retrieved for visual classification by an engineer. The borings were completed as open well with gravel pack (6-20 silica sand). The well screen slot widths were 0.020 inches. Water from the drill rig tank was then pumped into the open well, and the amount of water required maintaining a constant head was recorded.

The results of our field permeability tests are attached in the Appendix.

# 4.0 EVALUATION AND RECOMMENDATIONS

## 4.1 Geotechnical Discussion

The geotechnical study completed for the proposed construction confirms that the site will be suitable for the planned construction when viewed from a soil mechanics and foundation engineering perspective. After following proper site preparation procedures as recommend Section 4.2 in this report, the structure may be supported on shallow spread foundations with an allowable bearing pressure of 3,000 pounds per square foot (psf) and employ conventional slab-on-grade for the ground floors.

**Although limestone was not encountered in the upper 5 feet, limestone could be encountered at shallower. USDA Soil survey map indicates a stratum of limestone at a depth of 58 inches from grade.**

**Above normal excavation efforts should be expected in areas that require excavations through the limestone. In addition, boulder-like fill should be expected when excavating the sandy limestone stratum and should be budgeted accordingly.**

**We understand that the current single-story structure occupying the site will be demolished, we recommend that all construction debris be removed prior to the start of construction so that the debris does not interfere with foundation construction and utility construction. All debris removal areas should be properly backfilled and compacted, as discussed herein.** Existing footing adjacent to excavations (if any) should be adequately protected.

Recommendations for the geotechnical aspects of site preparation, foundation design, and related construction are presented in the following sections of this report.

## 4.2 Site Preparation

To prepare for construction, we recommend that any topsoil, foundation remnants, debris, and existing vegetation, including trees, roots, and any organic soils be removed in its entirety from the footprint of the proposed construction and wasted. Existing utilities, if any, should be removed from the building footprint area. The building footprint should be compacted with a self-propelled roller (Ingersoll-Rand SD-100D or equivalent) with at least 20 passes **(with an operating vibration frequency of 31.5 Hz/1890 VPM and average speed of 1.4 mph)** and until the subsoils achieve 95 percent of maximum dry density per ASTM D 1557 (Modified Proctor) to a depth of at least 12 inches below the existing grade. Unsuitable soil and material such as organics or muck if any encountered under the proposed construction should also be removed and replaced with properly compacted structural fill as recommended in this report. The soil densification should encompass the entire footprint of the structure plus a 10-foot wide perimeter that extends beyond the maximum lines of the superstructure.

The rolled subgrade should be visually observed for signs of pumping, weaving, or other types of instability. Signs of such instability could be due to the existence of weak and/or compressible subsoils. Corrective action for this condition should include excavation of weak subsoils followed by replacement with clean granular fill compacted to 95 percent of the ASTM D 1557 maximum dry density. Structural fill used to raise the site to structure bottom levels should consist of clean sand and/or sand and gravel (ASTM D 2487), with a maximum of 12 percent passing the U.S. Standard No. 200 sieve. The structural fill should be placed in thin lifts (12-inch thick loose measure), near the optimum moisture content for compaction, and be compacted to at least 95 percent of maximum dry density (ASTM D 1557).

Near existing structures (within 50 feet), proofrolling should be performed in static mode. Ground vibrations induced by the compaction operations should be closely monitored to assess if there is a potential impact on the existing structures. Ground vibrations induced by the compaction operations should be closely monitored to assess if there is a potential impact on the existing buildings.

Following site preparation as discussed herein, the foundation areas should be excavated, and the footing subgrade should be compacted with a heavy roller or at least a heavy plate compactor to the above mentioned 95% criteria. Unsuitable material or organic soils (if any) found at foundation bottoms should be removed and replaced with structural fill, as discussed above. In areas where footings bear at lower elevations (possibly close to or slightly below the water table) such as the truck well area, the footing excavation should be dewatered, and the footing subgrade should be compacted in the dry with a heavy roller or at least a heavy plate compactor to the above mentioned 95% criteria to a depth of at least 12 inches below the existing grade. The footings should be formed and poured in-the-dry. Prior to placing the steel for the footings, the footing subgrade should be inspected by a TSF representative.

If additional structural fill is required to achieve design grade, each lift of compacted engineered fill should be tested by a representative of the geotechnical engineer prior to placement of subsequent lifts. The edges of compacted fill should extend 5 feet beyond the edges of buildings prior to sloping.

## 4.3 Foundation Recommendations

Conventional spread footings are generally most economical when the existing soil conditions allow them to be founded at shallow depths. Following the completion of site preparation, as discussed herein, we recommend supporting the planned structures on conventional spread foundations based in engineered fill and/or the surficial granular soils of the site. The footings may be designed and proportioned for a maximum bearing pressure of 3,000 pounds per square foot (psf). Footings widths and depths should follow, at a minimum, Florida Building Code guidelines when the geometry produces a bearing pressure less than the allowable.

The settlement of foundations based in the in-situ granular soils and/or engineered fill will occur as an elastic response of the soils to the building loads applied. For foundations that are based on soils prepared as discussed herein, we estimate that total and differential average foundation settlements should be on the order of 1 inch and ½ inch, respectively. In our opinion, these settlements are within the range considered tolerable for the type of structure planned. The settlement forecast is based on imposed soil bearing pressure of 3,000 pounds per square foot. Because the subsoils at the site are granular in nature, the settlement should occur as the loads are applied to foundations and should essentially be complete by the time the building construction is finished.

Excavating equipment may disturb the granular bearing soil in foundation areas. The upper 12 inches of the footing subgrade should be compacted to achieve not less than 95 percent of the maximum dry density as determined by ASTM D 1557 immediately prior to reinforcing and concrete placement. **The excavations through limestone should be made with an excavator or backhoe with a welded plate tooth**. The welded plate will enable a relatively smooth excavation and minimize the over-excavation of the limestone.

The site preparation and foundation excavations should be observed by a representative of TSF prior to steel or concrete placements to assess those foundation materials are capable of supporting the design loads and are consistent with the materials discussed in this report. Loose soil zones encountered at the bottom of the footing excavations should be removed to the level of medium dense soils or adequately compacted structural fill as directed by the geotechnical engineer.

## 4.4 Floor Slab Recommendations

Following stripping and surface soil preparation as described herein, the building pad area should be leveled and filled to subfloor elevation before placing concrete. Slab subgrade should consist of clean sand and/or sand and gravel (ASTM D 2487), with a maximum of 12 percent passing the U.S. Standard No. 200 sieve and compacted to at least 95 percent of maximum dry density per ASTM D 1557 (Modified Proctor) to a depth of at least 12 inches below the slab grade. Structural fill used to raise the site to floor slab bottom levels should consist of clean granular fill as described above. The structural fill should be placed in thin lifts (12-inch thick loose measure), near the optimum moisture content for compaction, and be compacted to at least 95 percent of maximum dry density (ASTM D 1557).

Our experience indicates that floor slabs constructed without a vapor barrier will often experience future problems associated with moisture and mildew. Therefore, we recommend interior floor slab subgrade soils be covered with a vapor barrier (such as visqueen, normally 6 mil thick) before constructing the slab-on-grade floor.

Slab-on-grade construction may be used for the ground floor slabs of the structure. The slabs should be adequately reinforced to carry the loads that are to be applied. The floor slab design, if based on elastic methods, should employ a modulus of subgrade reaction of 150 pounds per cubic inch (pci). To help avoid potential problems with cracking because of differential loadings, the floor slabs should be liberally jointed and separated from columns and walls.

The friction factor between the soil and floor slabs should be taken as 0.35 without the vapor barrier. A friction factor of 0.21 should be used for the vapor barrier-soil interface.

## 4.5 Utilities

All utilities should be installed per the requirements of the Civil Engineering drawings and specifications. When backfilling over utility lines, clean granular fill should be placed in no more than 6 to 12-inch thick loose lifts and compacted to at least 95% of the material's maximum dry density as determined by the Modified Proctor Compaction Test (ASTM D 1557).

# 5.0 PAVEMENT RECOMMENDATIONS

The parking lot and driveway areas should be prepared and densified, as indicated in the Site Preparation section of this report. Flexible pavement sections in this geographic area typically consist of an asphaltic concrete wearing course, limerock base course, and a stabilized subgrade.

The following pavement component thickness could be utilized in the pavement design for light-duty trucks. **Final pavement recommendation should be provided by the Civil Engineer based on actual vehicular loading information.**

| TYPE OF PAVEMENT | MATERIAL DESCRIPTION | LAYER THICKNESS (INCHES) | |
|---|---|---|---|
| | | PARKING AREAS | DRIVEWAY AREAS |
| Flexible | Asphaltic Concrete | 1.5 | 2.0 |
| | Base Course (LBR = 100) | 6 | 8 |
| | Stabilized Subgrade (LBR = 40) | 8 | 10 |

The base course materials in the pavements should consist of limerock, having a minimum Limerock Bearing Ratio (LBR) of 100. Base materials should meet the requirements presented in the latest revisions of the Florida Department of Transportation (FDOT) "Specifications for Road and Bridge Construction," Section 911 (limerock). The base course should be compacted to at least 98 percent of maximum dry density (AASHTO 180).

The subgrade should have a minimum LBR of 40. The stabilized subgrade should be compacted to at least 95 percent of maximum dry density (AASHTO 180).

If dumpsters are to be parked on the pavement, it is recommended that rigid concrete pavement be constructed. In addition, the apron utilized for unloading the dumpsters by heavy-duty trucks should also be provided with a rigid pavement. A minimum Portland concrete pavement thickness of 6 inches is recommended for the project if a rigid pavement is employed. The concrete should be reinforced to withstand the traffic loadings anticipated and should be jointed to reduce the chances for crack development. The minimum rigid pavement thickness recommended above is based upon concrete with an unconfined compressive strength of 3,500 psi and a modulus of rupture of 450 psi.

Actual pavement section thickness should be provided by the Design Civil Engineer based on traffic loads, volume, and the owner's design life requirements. The noted sections represent minimum thickness representative of typical local construction practices and, as such, periodic maintenance should be anticipated. All pavement materials and construction procedures should conform to FDOT, American Concrete Institute (ACI), or appropriate city/county requirements.

## 6.0 CONSTRUCTION CONSIDERATIONS

It is recommended that TSF be retained to provide observation and testing of construction activities involved in the foundation, earthwork, and related activities of this project. TSF cannot accept any responsibility for any conditions that deviate from those described in this report, nor for the performance of the foundation if not engaged to, also provide construction observation and testing for this project.

### 6.1 Excavations

In Federal Register, Volume 54, No. 209 (October 1989), the United States Department of Labor, Occupational Safety and Health Administration (OSHA) amended its "Construction Standards for Excavations, 29 CFR, part 1926, Subpart P." This document was issued to better ensure the safety of workmen entering trenches or excavations. It is mandated by this federal regulation that excavations, whether they be utility trenches, basement excavations, or footing excavations, be constructed in accordance with the new OSHA guidelines. It is our understanding that these regulations are being strictly enforced and if they are not closely adhered, the owner and the contractor could be liable for substantial penalties.

The contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope, or bench the sides of the excavations as required to maintain the stability of both the excavation sides and bottoms. The contractor's "responsible person," as defined in 29 CFR Part 1926, should evaluate the soil exposed in the excavations as part of the contractor's safety procedures. **In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulations.**

We are providing this information solely as a service to our client. TSF does not assume responsibility for construction site safety or the contractor's or other parties' compliance with local, state, and federal safety or other regulations.

## 7.0 INSPECTIONS/QUALITY CONTROL TESTING

During construction, it is important that work be performed under qualified inspection to ensure proper procedures are followed. We will perform all foundation and earthwork related inspections, and reports will be prepared for your records and submission to the appropriate governmental agencies. We can also perform testing services, soils, concrete, and asphalt for compliance with project requirements.

## 8.0 REPORT LIMITATIONS

The recommendations submitted are based on the available subsurface information obtained by TSF and design details furnished by Saltz Michelson Architects for the proposed project. If there are any revisions to the plans for this project or if deviations from the subsurface conditions noted in this report are encountered during construction, TSF should be notified immediately to determine if changes in the foundation recommendations are required. If TSF is not retained to perform these functions, TSF will not be responsible for the impact of those conditions of the project.

**It is imperative that TSF be present for observation and testing during construction in order to provide written confirmation (certifications) that the geotechnical engineering study report has been complied with.**

The geotechnical engineer warrants that the findings, recommendations, specifications, or professional advice contained herein have been made in accordance with generally accepted professional geotechnical engineering practices in the local area. No other warranties are implied or expressed.

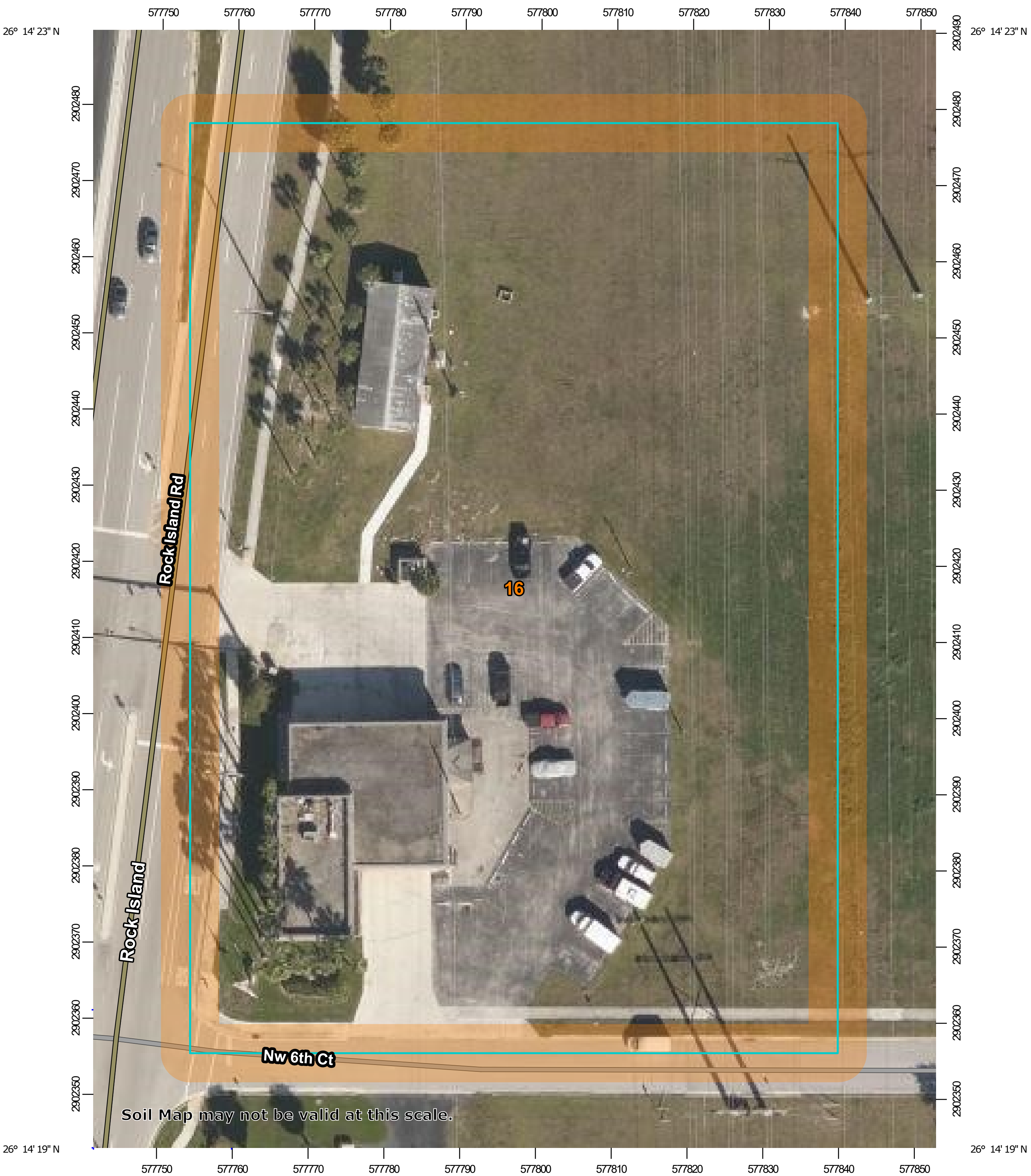
After the plans and specifications are more complete, the geotechnical engineer should be retained and provided the opportunity to review the final design plans and specifications to check that our engineering recommendations have been properly incorporated into the design documents. At that time, it may be necessary to submit supplementary recommendations.

This report has been prepared for the exclusive use of Saltz Michelson Architects for the proposed Fire Station No. 2-58 to be constructed in Margate, Florida.

## APPENDIX

USDA Soil Survey Map
Borehole Percolation Test Results
Summary of Laboratory Tests Results
Boring Location Plan – Sheet 1
Soil Profiles – Sheet 2

Soil Map—Broward County, Florida, East Part




Map Scale: 1:717 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0, 10, 20, 40, 60

Feet: 0, 30, 60, 120, 180

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 17N WGS84

## MAP LEGEND

**Area of Interest (AOI)**
- Area of Interest (AOI)

**Soils**
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

**Special Point Features**
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

**Water Features**
- Streams and Canals

**Transportation**
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

**Background**
- Aerial Photography

## MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Broward County, Florida, East Part
Survey Area Data: Version 15, Sep 16, 2019

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Dec 5, 2018—Jan 9, 2019

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

# Map Unit Legend

| Map Unit Symbol | Map Unit Name | Acres in AOI | Percent of AOI |
|---|---|---|---|
| 16 | Immokalee, limestone substratum-Urban land complex | 2.6 | 100.0% |
| **Totals for Area of Interest** | | **2.6** | **100.0%** |

**Summary of Borehole Permeability (BHP) Test Results**
**Fire Station No. 2-58**
**Margate, Florida**

**TSF Project No. 7111-19-446**

| Test Location | Date Performed | Diameter Hole (Inches) | Diameter Casing (Inches) | Depth of Hole (Feet) | Depth to Groundwater Level Below Ground Surface (Feet) Prior to Test | Depth to Groundwater Level Below Ground Surface (Feet) During Test | Hydraulic Head, $H_2$ (Feet) | Saturated Hole Depth, Ds (Feet) | Average Flow Rate, Q (gpm) | Hydraulic Conductivity (K) ($ft^3$/sec/$ft^2$-ft Head) |
|---|---|---|---|---|---|---|---|---|---|---|
| BHP-1 | 12/24/2019 | 6 | 4 | 10.0 | 3.8 | 0.0 | 3.8 | 6.2 | 1.4 | 9.53E-05 |
| BHP-2 | 11/22/2019 | 6 | 4 | 10.0 | 6.0 | 0.0 | 6.0 | 4.0 | 5.0 | 2.50E-04 |
| BHP-3 | 12/24/2019 | 6 | 4 | 10.0 | 4.0 | 0.0 | 4.0 | 6.0 | 1.6 | 1.05E-04 |

Note:

(1) The above hydraulic conductivity values represent an ultimate value. The designer should decide on the required factor of safety

(2) The hydraulic conductivity values were calculated based on the South Florida Water Management Districts's USUAL OPEN HOLE CONSTANT HEAD percolation test procedure.

(3) Casing diameter was used for the calculation of hydraulic conductivity values.

**Summary of Laboratory Test Results**
**Fire Station N0. 2-58**
**Margate, Florida**

**TSF Project No. 7111-19-446**

| Boring Number | Sample Depth (ft) | USCS Symbol | Sieve Analysis, Percentage Passing | | | | | | | | Atterberg Limits | | | Organic Content (%) | Natural Moisture Content (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 3/4" | 3/8" | #4 | #10 | #40 | #60 | #100 | #200 | Liquid Limit | Plastic Limit | Plasticity Index | | |
| B-2 | 8.0-10.0 | SM | 100 | 97 | 95 | 95 | 88 | 62 | 29 | 13 | | | | - | 20.2 |
| B-3 | 4.0-6.0 | SP | 100 | 100 | 100 | 100 | 96 | 79 | 37 | 3 | | | | - | 22.6 |
| | | | | | | | | | | | | | | | |
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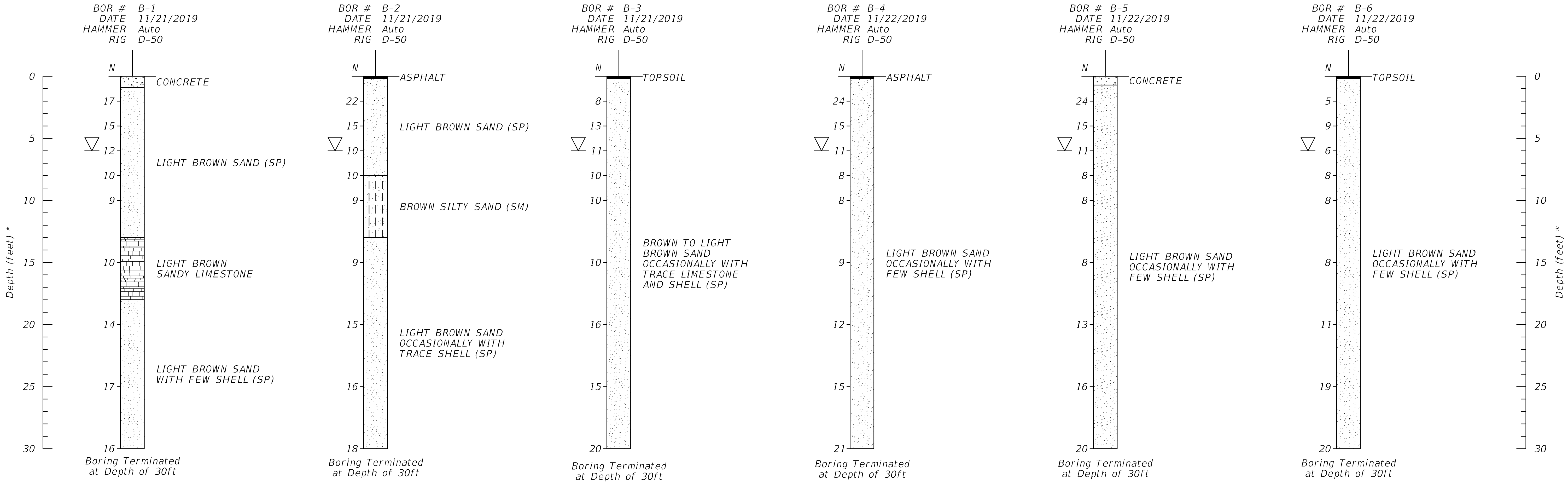
## BORINGS LOCATION PLAN

Approximate SPT Boring Location

Approximate BHP Test Location

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| DRAWN BY: NG<br>CHECKED BY: JO | APPROVED BY: RK<br>DATE: 12-05-2019 | ENGINEER OF RECORD:<br>RAJ KRISHNASAMY, P.E.<br>FLORIDA LICENSE NO.: 53567 | TIERRA SOUTH FLORIDA<br>2765 VISTA PARKWAY, S-10<br>WEST PALM BEACH, FL 33411<br>STATE OF FLORIDA REGISTRATION No. 28073 | SCALE: NTS | PROJECT NUMBER: 7111-19-446 | BORING LOCATION PLAN<br>FIRE STATION No. 2-58<br>MARGATE, FLORIDA | Sheet: 1 |




NOTE: SPT N-VALUES SHOWN ABOVE WERE OBTAINED USING AUTOMATIC HAMMERS. GENERALLY DESIGN CORRELATIONS AND PROGRAMS USE SAFETY HAMMER N-VALUES. HENCE, THE ABOVE N-VALUES NEED TO BE MULTIPLIED BY 1.24 TO OBTAIN EQUIVALENT SAFETY HAMMER N-VALUES FOR DESIGN PURPOSE.

LEGEND

- Concrete
- Sand
- Limestone Soft
- Asphalt
- Silty Sand

NOTES

- ▽ ENCOUNTERED GROUNDWATER TABLE
- N NUMBERS TO THE LEFT OF BORINGS INDICATE SPT VALUE FOR 12" PENETRATION USING AN AUTOMATIC HAMMER.
- * DENOTES DEPTH IN FEET FROM EXISTING GROUND SURFACE

| DRAWN BY: NG | APPROVED BY: RK | ENGINEER OF RECORD: RAJ KRISHNASAMY, P.E. | TIERRA SOUTH FLORIDA<br>2765 VISTA PARKWAY, S-10<br>WEST PALM BEACH, FL 33411<br>STATE OF FLORIDA REGISTRATION No. 28073 | SCALE: NTS | PROJECT NUMBER: 7111-19-446 | BORING LOCATION PLAN<br>FIRE STATION No. 2-58<br>MARGATE, FLORIDA | Sheet: 2 |
|---|---|---|---|---|---|---|---|
| CHECKED BY: JO | DATE: 12-05-2019 | FLORIDA LICENSE NO.: 53567 | | | | | |