Village of North Palm Beach (VNPB) Metal Building

Geotechnical Engineering Report

Prepared for:

CPZ Architects
4316 West Broward Boulevard
Plantation, FL 33317

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September 18, 2024

CPZ Architects
4316 West Broward Boulevard
Plantation, FL 33317

Attn: Ms. Heidi Rodriquez
P: (954) 792-8525
E: heidi@cpzarchitects.com

Re: Geotechnical Engineering Report
Village of North Palm Beach (VNPB) Metal Building
951 US-1
North Palm Beach, Florida
Terracon Project No. HD245051

Dear Ms. Rodriquez:

We have completed the scope of Geotechnical Engineering services for the above referenced project in general accordance with Terracon Proposal No. P34245009 dated May 9, 2024. This report presents the findings of subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations and floor slabs 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

W. Joshua Mele, P.E.
Senior Engineer
FL Registration No. 91015

Rutu H. Nulkar, P.E.
Geotechnical Department Manager
FL Registration No. 70625

This document has been digitally signed and sealed by Rutu H. Nulkar, P.E. on the date adjacent to the seal.
Printed copies of this document are not considered signed and sealed, and the signature must be verified on any electronic copies.

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Note: This report was originally delivered in a web-based format. **Blue Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the Terracon logo will bring you back to this page. For more interactive features, please view your project online at **client.terracon.com**.

Refer to each individual Attachment for a listing of contents.

Introduction

This report presents the results of our subsurface exploration and Geotechnical Engineering services performed for the proposed metal building for a new wash area and water reclamation for the maintenance equipment used at the golf course of the North Palm Beach Country Club along 951 US-1 in North Palm Beach, Florida. The purpose of these services was to provide information and geotechnical engineering recommendations relative to the following:

- Subsurface conditions
- Groundwater conditions
- Site preparation and earthwork
- Dewatering considerations
- Foundation design and construction
- Floor slab design and construction
- Pavement design and construction

The geotechnical engineering Scope of Services for this project included the advancement of test borings, laboratory testing, engineering analyses, and preparation of this report.

Drawings showing the site and boring locations are shown on the **Site Location** and **Exploration Location Plan**, respectively. The results of our field exploration are included on the boring logs in the **Exploration Results** section.

Project Description

Our initial understanding of the project was provided in our proposal and was discussed during project planning. A period of collaboration has transpired since the project was initiated, and our final understanding of the project conditions is as follows:

Item	Description
Information Provided	Project information was provided by Ms. Heidi Rodriquez via an electronic mail (email) correspondence on April 26, 2024. In this email, we were provided an undated site plan showing the proposed building location, along with proposed wall and column loading, and requested boring locations and depths. In addition, Rutu Nulkar performed a site visit with the design team on April 26, 2024.

Item	Description
Project Description	The project will include the design and construction of a metal building for new wash area and water reclamation for the maintenance equipment used at the existing golf course.
Proposed Structure	The planned structure is a one-story, metal building approximately 30 feet by 100 feet in footprint dimensions.
Finished Floor Elevation and Grading	The proposed finished floor elevation for the proposed building is not known at this time; however, we assume that final grades will roughly match those currently existing at the site.
Maximum Loads	Based on the provided Site Plan, we understand the proposed loading includes the following: ▪ Columns: 25 kips ▪ Walls: 2 kips per linear foot (klf) Furthermore, we assume the planned live loads (equipment, etc.) will not exceed the following: ▪ Slabs: 150 pounds per square foot (psf)
Pavements	A preferred pavement surfacing was not provided to us as part of the preliminary information. Asphalt/Concrete surfacing is common in the area for projects of this nature and is the assumed preference. The pavement recommendations will generally utilize the FDOT design and construction guidelines. Anticipated vehicle types include the following: ▪ Passenger vehicles and pickups – 150-200 vehicles per day ▪ Light delivery trucks – 5 vehicles per day ▪ Heavy Duty trucks (3 or more axles) – 2 vehicles per day
Stormwater Management	Detailed information has not been provided; however, we assume that stormwater runoff will be conveyed offsite to a regional stormwater management facility for treatment.

Terracon should be notified if any of the above information is inconsistent with the planned construction, especially the structure and pavement loadings, as modifications to our recommendations may be necessary.

Site Conditions

The following description of site conditions is derived from our site visits during August 2024, in association with the field exploration and our review of publicly available geologic and topographic maps.

Item	Description
Parcel Information	The project site is at the golf course of the North Palm Beach Country Club located along 951 US-1 in North Palm Beach, Florida. 26.829881° Longitude: -80.063559° (approximate) See **Site Location**
Existing Conditions	The proposed area for the building is currently vacant. The grade of the project area is approximately 3 to 4 feet higher than adjacent grades due to the presence of fill in the area. The existing building nearest the project area is currently used to store all the maintenance equipment used at the golf course.
Current Ground Cover	The existing ground cover consists primarily of fill sands and sparce vegetation.
Existing Topography	According to a topographic vicinity map of the project site, the existing ground surface elevation ranges at the site between approximately +9 and +15 feet, NAD27. See **Topographic Vicinity Map**

Geotechnical Characterization

We have developed a general characterization of the subsurface conditions based upon our review of the subsurface exploration, geologic setting, and our understanding of the project. This characterization, termed GeoModel, forms the basis of our geotechnical calculations and evaluation of the site. Conditions observed at each exploration point are indicated on the individual logs. The individual logs can be found in the **Exploration Results** and the GeoModel can be found in the **Figures** attachment of this report.

As part of our analyses, we identified the following model layers within the subsurface profile. For a more detailed view of the model layer depths at each boring location, refer to the GeoModel.

Model Layer	Layer Name	General Description
1	**FILL**	Poorly graded sand (SP)
2	**SAND**	Loose to Medium Dense Fine Sand (SP)

The Boring logs provide detailed descriptions of the subsurface conditions encountered at each boring location. When reviewing the boring logs and the subsurface profile, it should be understood that soil conditions might vary between and away from boring locations. Stratification boundaries on logs represent the approximate depth of the changes in soil types; the transition between materials may be gradual.

The soil borings generally encountered approximately 4 feet of very loose to loose fill soils (Unified Soil Classification SP), underlain by loose to medium dense fine sands (SP) to the boring termination depths of 30 feet below the existing grade. The relative densities of the encountered substrata generally increased with depth.

Groundwater Conditions

Groundwater was encountered in the borings at the time of drilling between the depths of 8 and 9 feet below the existing ground surface. However, groundwater level fluctuations may occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time that the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the structure may be higher or lower than the levels indicated on the boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project. Long term monitoring of cased-holes or piezometers would be required to better define groundwater conditions and potential variability at the site.

Geotechnical Overview

The site appears suitable for the proposed construction based upon the geotechnical conditions encountered in the test borings, provided that the recommendations provided in this report are implemented in the design and construction phases of this project.

Based on the conditions encountered and estimated load-settlement relationships, the proposed structures can be supported on conventional continuous or spread footings, as described in **Shallow Foundations**.

Site preparation recommendations, including subgrade improvement and fill placement, are provided in the **Earthwork** section.

The **Floor Slabs** section addresses slab-on-grade support of structures. The groundwater table should be considered during design and construction of the development.

The **Pavements** section addresses the design of pavement systems based on the traffic criteria described in **Project Description**.

The recommendations contained in this report are based upon the results of field testing (presented in the **Exploration Results**), engineering analyses, and our current understanding of the proposed project. The **General Comments** section provides an understanding of the report limitations.

Earthwork

Earthwork is anticipated to include stripping of the surficial grass and topsoil layers, and then cut, spreading, and replacement of the existing fill. The following sections provide recommendations for use in the preparation of specifications for the work. Recommendations include critical quality criteria, as necessary, to render the site in the state considered in our geotechnical engineering evaluation for foundations, floor slabs, and pavements.

Stripping

Surface vegetation along with any organic laden topsoil within the proposed building footprint and at least 5 feet beyond the outer edge of proposed foundations, should be cleared, grubbed, and removed from the proposed construction area.

For areas outside the proposed building footprints and foundation influence zones, existing utilities should be removed where they conflict with proposed utilities and new pavements. In such cases, utilities should be removed to a depth of at least 2 feet below the affected utility or design pavement subgrade elevation.

Site Preparation

General Site Drainage

Site drainage measures should be implemented prior to or concurrent with initial mass grading and may include excavation of perimeter ditches with supplemental lateral ditches extending into the site, if required. The ditches should be constructed and maintained to gravity drain throughout the site preparation process. Failure to control surface water runoff can significantly impact the earthwork construction schedule and result in unnecessary reworking of the subgrade.

Surface Water Control

Surface water should not be allowed to pond on the site and soak into the soil during construction. Construction staging should provide for drainage of surface water and precipitation away from the structure areas. Any water that collects over or adjacent to construction areas should be promptly removed, along with any softened or disturbed soils.

Subgrade Preparation

As previously mentioned, the footprint of the planned building has up to 4 feet of loosely placed fill which will need to be cut and replaced to lower the grade to roughly match that of the surrounding grade. The exposed and replaced subgrade soils within 5 feet of the planned building and pavement areas should then be compacted with at least eight overlapping passes of a vibratory drum roller with a static operating weight of at least 40,000 pounds and a drum diameter of at least 36 inches. The roller passes should be divided into an equal number of passes in perpendicular directions. If pumping or instability occurs, the Geotechnical Engineer may require static compaction, an initial bridge lift of clean sand, or other methods at the time of construction. A compaction criterion of 95% of the native soil's maximum dry density (ASTM D1557) should be achieved to a depth of 24 inches. The effectiveness of the densification will be dependent on the moisture content of the subsoils at the time of construction. Moisture conditioning of the soils will likely be required.

Proofrolling

The subgrade should be proofrolled with an adequately loaded vehicle such as a fully loaded tandem-axle dump truck (loaded to a gross weight of about 25 tons). The proofrolling should be performed under the direction of the Geotechnical Engineer. Areas excessively deflecting under the proofroll should be delineated and subsequently addressed by the Geotechnical Engineer. Such areas are most likely the result of uncontrolled fill placement. If the compaction techniques as described in the Subgrade Preparation section above do not render the required compaction criteria, these subsoils may require overexcavation to a depth of about 24 inches and then re-backfilled in compacted lifts.

Fill Material Types

Fill required to achieve design grade should be classified as structural fill and general fill. Structural fill is material used below, or within 10 feet of structures, pavements or constructed slopes. General fill is material used to achieve grade outside of these areas.

Imported Fill Materials: Imported fill materials should meet the following material property requirements. Regardless of its source, compacted fill should consist of approved non-plastic materials that are free of organic matter and debris.

Soil Type [1]	USCS Classification	Desired Parameters (for Structural Fill)
Granular	SP, SP-SM	No more than 12% Passing No. 200 sieve.
Fill Placed Below Groundwater	GP, GW or FDOT 57 Stone	Inorganic, non-plastic material, free of any manmade debris, with ASTM classification (USCS) of GP, GW or FDOT 57 Stone with less than 5 percent material finer than the No. 200 sieve and a maximum particle size of 3 inches. The FDOT 57 stone should not be placed more than one foot above the water level.

1. Structural and general fill should consist of approved non-plastic materials free of organic matter and debris. A sample of each material type should be submitted to the Geotechnical Engineer for evaluation prior to use on this site.

Fill Placement and Compaction Requirements

Structural and general fill should meet the following compaction requirements.

Item	Structural Fill	General Fill
Maximum Lift Thickness	▪ 12 inches or less in loose thickness when heavy, self-propelled compaction equipment is used. ▪ 4 to 6 inches in loose thickness when lighter hand-guided equipment (e.g., jumping jack or plate compactor) is used.	Same as structural fill.
Minimum Compaction Requirements [1,2,3]	▪ 98% of max. in first 12 inches below foundations and within 1 foot beneath pavement base. ▪ 95% of max. above foundations, below floor slabs, and more than 1 foot below finished pavement subgrade or foundations.	95% of max.

Item	Structural Fill	General Fill
Water Content Range [1]	▪ ±2% of optimum moisture content	As required to achieve min. compaction requirements.

1. Maximum density and optimum moisture content as determined by the modified Proctor test (ASTM D 1557).
2. Engineered fill materials should be placed in horizontal, loose lifts not exceeding 12 inches in thickness and should be thoroughly compacted. Where light compaction equipment is used, as is customary within a few feet of utility trenches, the lift thickness will need to be reduced to achieve the desired degree of compaction.
3. We recommend that engineered fill be tested for moisture content and compaction during placement. Should the results of the in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested as required until the specified moisture and compaction requirements are achieved.

Grading and Drainage

All grades must provide effective drainage away from the building during and after construction and should be maintained throughout the life of the structure. Water retained next to the building can result in soil movements greater than those discussed in this report. Greater movements can result in unacceptable differential floor slab and/or foundation movements, cracked slabs and walls, and roof leaks. The roof should have gutters/drains with downspouts that discharge onto splash blocks at a distance of at least 10 feet from the building.

Exposed ground should be sloped and maintained at a minimum 5% away from the building for at least 10 feet beyond the perimeter of the building. Locally, flatter grades may be necessary to transition ADA access requirements for flatwork. After building construction and landscaping have been completed, final grades should be verified to document effective drainage has been achieved. Grades around the structure should also be periodically inspected and adjusted, as necessary, as part of the structure's maintenance program. Where paving or flatwork abuts the structure, a maintenance program should be established to effectively seal and maintain joints and prevent surface water infiltration.

Earthwork Construction Considerations

Shallow excavations for the proposed structure are anticipated to be accomplished with typical construction equipment. Upon completion of filling and grading, care should be taken to maintain the subgrade water content prior to construction of grade-supported improvements such as floor slabs and pavements. Construction traffic over the completed subgrades should be avoided. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. Water collecting over or adjacent to construction areas should be removed. If the subgrade desiccates, saturates, or is disturbed, the affected material should be removed, moisture conditioned, and recompacted prior to floor slab construction.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, "Excavations" and its appendices, and in accordance with any applicable local and/or state regulations.

Construction site safety is the sole responsibility of the contractor who controls the means, methods, and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean Terracon is assuming responsibility for construction site safety or the contractor's activities; such responsibility shall neither be implied nor inferred.

Excavations or other activities resulting in ground disturbance have the potential to affect adjoining properties and structures. Our scope of services does not include review of available final grading information or consider potential temporary grading performed by the contractor for potential effects such as ground movement beyond the project limits. A preconstruction/precondition survey should be conducted to document nearby property/infrastructure prior to any site development activity. Excavation or ground disturbance activities adjacent to or near property lines should be monitored or instrumented for potential ground movements that could negatively affect adjoining property and/or structures.

Groundwater Considerations

Though a grading plan is not yet available, we do not anticipate groundwater will be encountered in excavations for the building foundations. However, the Contractor should be prepared to implement a dewatering program for deeper excavations, such as those for installation of stormwater pipes or other utilities. Based on observations at our soil borings, it is anticipated that groundwater could be encountered in excavations beyond about 6 feet below the existing site grade. A temporary dewatering system consisting of sumps with pumps or well points may be necessary depending on the depth of excavations.

Construction Observation and Testing

The earthwork efforts should be observed by Terracon. Observation should include documentation of adequate removal of surficial materials (vegetation and topsoil) evaluation and remediation of existing fill materials, as well as proofrolling and mitigation of unsuitable areas delineated by the proofroll.

Each lift of compacted fill should be tested, evaluated, and reworked, as necessary, as recommended by the Geotechnical Engineer prior to placement of additional lifts. Each lift of fill should be tested for density and water content at a frequency of at least one test for every 2,500 square feet of compacted fill in the building areas and 5,000 square feet in pavement areas. Where not specified by local ordinance, one density and water content test should be performed for every 100 linear feet of compacted utility trench backfill and a minimum of one test performed for every 12 vertical inches of compacted backfill.

In areas of foundation excavations, the prepared bearing subgrade should be tested for density and water content at a frequency of at least one test for every 100 square feet for footings (at least one per column) and at least one test per 50 feet for continuous strip footings. If unanticipated conditions are encountered, the Geotechnical Engineer should prescribe mitigation options.

In addition to the documentation of the essential parameters necessary for construction, the continuation of the Geotechnical Engineer into the construction phase of the project provides the continuity to maintain the Geotechnical Engineer's evaluation of subsurface conditions, including assessing variations and associated design changes.

Shallow Foundations

If the site has been prepared in accordance with the requirements noted in **Earthwork**, the following design parameters are applicable for shallow foundations.

Design Parameters – Compressive Loads

Item	Description
Net Allowable Bearing Pressure [1, 2]	2,500 psf
Required Bearing Stratum [3]	GeoModel Layers 1 or 2
Minimum Foundation Dimensions	Isolated column – 24 inches Continuous bearing wall – 18 inches
Sliding Resistance [4]	0.40 ultimate coefficient of friction
Minimum Embedment below Finished Grade [5]	18 inches

Item	Description
Estimated Total Settlement from Structural Loads [2]	Less than 1 inch
Estimated Differential Settlement [2, 6]	Less than half of an inch

1. The maximum net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. Values assume that exterior grades are no steeper than 20% within 10 feet of structure.
2. Values provided are for maximum loads noted in **Project Description**. Additional geotechnical consultation will be necessary if higher loads are anticipated.
3. Unsuitable or soft soils should be overexcavated and replaced per the recommendations presented in **Earthwork**.
4. Can be used to compute sliding resistance where foundations are placed on suitable soil/materials. Frictional resistance for granular materials is dependent on the bearing pressure which may vary due to load combinations.
5. Embedment necessary to minimize the effects of seasonal water content variations. For sloping ground, maintain depth below the lowest adjacent exterior grade within 5 horizontal feet of the structure.
6. Differential settlements are noted for equivalent-loaded foundations and bearing elevation as measured over a span of 50 feet.

Design Parameters – Overturning and Uplift Loads

Shallow foundations subjected to overturning loads should be proportioned such that the resultant eccentricity is maintained in the center-third of the foundation (e.g., $e < b/6$, where b is the foundation width). This requirement is intended to keep the entire foundation area in compression during the extreme lateral/overturning load event. Foundation oversizing may be required to satisfy this condition.

Uplift resistance of spread footings can be developed from the effective weight of the footing and the overlying soils with consideration to the IBC basic load combinations.

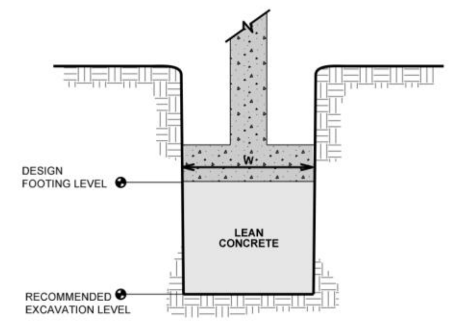
Item	Description
Soil Moist Unit Weight	115 pcf
Soil Effective Unit Weight[1]	53 pcf
Soil weight included in uplift resistance	Soil included within the prism extending up from the top perimeter of the footing at an angle of 20 degrees from vertical to ground surface

1. Effective (or buoyant) unit weight should be used for soil above the foundation level and below a water level.

Foundation Construction Considerations

As noted in **Earthwork**, the footing excavations should be evaluated under the observation of Terracon. The base of all foundation excavations should be free of water and loose soil, prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. Excessively wet or dry material or any loose/disturbed material in the bottom of the footing excavations should be removed/reconditioned before foundation concrete is placed.

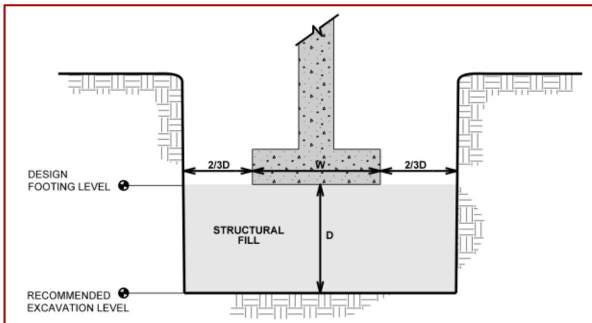
If unsuitable bearing soils are observed at the base of the planned footing excavation, the excavation should be extended deeper to suitable soils, and the footings could bear directly on these soils at the lower level or on lean concrete backfill placed in the excavations. The lean concrete replacement zone is illustrated on the sketch below.



LEAN CONCRETE BACKFILL

NOTE: EXCAVATIONS ARE SHOWN VERTICAL; HOWEVER, THE SIDEWALLS SHOULD BE SLOPED AS NECESSARY FOR SAFETY

Overexcavation for structural fill placement below footings should be conducted as shown below. The overexcavation should be backfilled up to the footing base elevation, with granular fill placed, as recommended in the **Earthwork** section.



OVER-EXCAVATION / BACKFILL ZONE

NOTE: EXCAVATIONS ARE SHOWN VERTICAL; HOWEVER, THE SIDEWALLS SHOULD BE SLOPED AS NECESSARY FOR SAFETY

Floor Slabs

Design parameters for floor slabs assume the requirements for **Earthwork** have been followed. Specific attention should be given to positive drainage away from the structure and positive drainage of the aggregate base beneath the floor slab.

Floor Slab Design Parameters

Item	Description
Floor Slab Support[1]	Floor slabs should be constructed over a uniform and stable subgrade compacted to a depth of at least 12 inches. The subgrade should be constructed as described below: ▪ On-site sand soils (Model Layers 1 and 2) should be placed for the first 12 inches immediately below the slab. Subgrade should be compacted to recommendations outlined in **Earthwork.**
Estimated Modulus of Subgrade Reaction [2]	150 pounds per square inch per inch (psi/in) for anticipated slab loading conditions.
Compaction Requirements	At least 95 percent of the material's Modified Proctor maximum dry density (ASTM D 1557) in each lift of structural fill.
Minimum Testing Frequency[3]	One field density test per 2,500 square feet (or fraction thereof).

1. Floor slabs should be structurally independent of building footings or walls to reduce the possibility of floor slab cracking caused by differential movements between the slab and foundation. Narrower, turned-down slab-on-grade foundations may be utilized at the approval of the structural engineer. The slabs should be appropriately reinforced to support the proposed loads.
2. Modulus of subgrade reaction is an estimated value based upon our experience with the subgrade condition, the requirements noted in **Earthwork**, and the floor slab support as noted in this table. It is provided for point loads. For large area loads the modulus of subgrade reaction would be lower.
3. We recommend that subgrades be maintained at the proper moisture condition until floor slabs are constructed. If the subgrade should become desiccated prior to construction of floor slabs, the affected material should be removed, or the materials moistened and recompacted. 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.

With proper compaction and moisture conditioning, sand subgrades should be capable of supporting foot traffic from less-invasive slab construction methods. However, locally available fine to medium grained sands may be easily disturbed by exposure to construction equipment and excessive foot traffic, which should be minimized to the extent possible. On buildings where mixers, pumps, equipment, and personnel may be repeatedly traversing the prepared subgrade, we recommend placing a 4-inch-thick base course meeting the material specifications of ACI 302. Locally these materials are referred to as crusher run or graded aggregate base (GAB). Subgrade should be compacted to recommendations outlined in **Earthwork**.

The use of a vapor retarder should be considered beneath concrete slabs-on-grade covered with wood, tile, carpet, or other moisture sensitive or impervious coverings, when the project includes humidity-controlled areas, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.

Saw-cut contraction 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. Joints or cracks should be sealed with a waterproof, non-extruding compressible compound specifically recommended for heavy duty concrete pavement and wet environments.

Where floor slabs are tied to perimeter walls or turn-down slabs to meet structural or other construction objectives, our experience indicates differential movement between the walls and slabs will likely be observed in adjacent slab expansion joints or floor slab cracks beyond the length of the structural dowels. The Structural Engineer should account for potential differential settlement through use of sufficient control joints, appropriate reinforcing or other means.

Floor Slab Construction Considerations

Finished subgrade, within and for at least 10 feet beyond the floor slab, should be protected from traffic, rutting, or other disturbance and maintained in a relatively moist condition until floor slabs are constructed. If the subgrade should become damaged or desiccated prior to construction of floor slabs, the affected material should be removed, and structural fill should be added to replace the resulting excavation. Final conditioning of the finished subgrade should be performed immediately prior to placement of the floor slab support course.

Terracon should observe the condition of the floor slab subgrades immediately prior to placement of the floor slab support course, reinforcing steel, and concrete. Attention should be paid to high traffic areas that were rutted and disturbed earlier, and to areas where backfilled trenches are located.

Pavements

General Pavement Comments

Pavement designs are provided for the traffic conditions and pavement life conditions as noted in **Project Description** and in the following sections of this report. A critical aspect of pavement performance is site preparation. Pavement designs noted in this section must be applied to the site which has been prepared as recommended in the **Earthwork** section.

Pavement Design Parameters

A Limerock Bearing Ratio (LBR) of 12, with a correlated resilient modulus value of 8,500 psi was assumed for the subgrade for flexible pavement component thickness design, as per Table 5.1 of the FDOT Flexible Pavement Design Manual: Relationship between Resilient Modulus (M_R) and Limerock Bearing Ratio (LBR) Sample Values. A modulus of subgrade reaction of 200 pci was assumed for the Portland cement concrete (PCC) pavement thickness design. The value was empirically derived based upon our experience with the sandy subgrade soils and our expectation of the quality of the subgrade as prescribed by the **Site Preparation** conditions as outlined in **Earthwork**. A modulus of rupture of 580 psi was used in design for the concrete (based on correlations with a minimum 28-day compressive strength of 4,000 psi).

Pavement Section Thicknesses

The following table provides our opinion of minimum thickness for AC sections:

Asphaltic Concrete Design

Layer	Thickness (inches)	
	Light Duty[1] **(Passenger cars, light pickup trucks and light delivery vehicles)**	**Heavy Duty[1]** **(Trash collection trucks and tractor trailer trucks)**
AC [2, 3]	1.5	2.5
Limerock or Crushed Concrete Base Course	6	6
Stabilized Subbase Course (LBR=40) [4]	12	12

1. See **Project Description** for more specifics regarding traffic assumptions.

2. All materials should meet the current Florida Department of Transportation (FDOT) specifications for roadway construction.
3. Superpave Asphaltic Concrete surface course type SP-9.5 or SP-12.5.
4. Subgrade stabilization typically accomplished via blending base course material with subgrade and compacting upper 12 inches.

The following table provides our estimated minimum thickness of PCC pavement:

Portland Cement Concrete Design

Layer	Thickness (inches)	
	Light Duty[1] **(Passenger cars, light pickup trucks and light delivery vehicles)**	**Heavy Duty[1]** **(Trash collection trucks and tractor trailer trucks)**
PCC [2]	6	7
Compacted Free-Draining Sandy Subgrade[3]	12	12

1. ACI traffic category. See **Project Description** for more specifics regarding traffic classifications.
2. All materials should meet the current Florida Department of Transportation (FDOT) standard specifications for highway construction.
3. Pavement subgrade should consist of sandy soil with a USCS symbol of SP or SP-SM and should be uniformly compacted to at least 98 percent of the modified Proctor maximum dry density (ASTM D 1557).

Areas for parking of heavy vehicles, concentrated turn areas, and start/stop maneuvers could require thicker pavement sections. Edge restraints (i.e. concrete curbs or aggregate shoulders) should be planned along curves and areas of maneuvering vehicles.

Proper joint spacing will also be required to prevent excessive slab curling and shrinkage cracking. Joints should be sealed to prevent entry of foreign material and doweled where necessary for load transfer. PCC pavement details for joint spacing, joint reinforcement, and joint sealing should be prepared in accordance with ACI 330 and ACI 325.

Where practical, we recommend early-entry cutting of crack-control joints in PCC pavements. Cutting of the concrete in its "green" state typically reduces the potential for micro-cracking of the pavements prior to the crack control joints being formed, compared to cutting the joints after the concrete has fully set. Micro-cracking of pavements may lead to crack formation in locations other than the sawed joints, and/or reduction of fatigue life of the pavement.

Openings in pavements, such as decorative landscaped areas, are sources for water infiltration into surrounding pavement systems. Water can collect in the islands and migrate into the surrounding subgrade soils thereby degrading support of the pavement. Islands with raised concrete curbs, irrigated foliage, and low permeability near-surface soils are particular areas of concern. The civil design for the pavements with these conditions should include features to restrict or collect and discharge excess water from the islands. Examples of features are edge drains connected to the stormwater collection system, longitudinal subdrains, or other suitable outlets and impermeable barriers preventing lateral migration of water such as a cutoff wall installed to a depth below the pavement structure.

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. Appropriate sub-drainage or connection to a suitable daylight outlet should be provided to remove water from the granular subbase.

Pavement Maintenance

The pavement sections represent minimum recommended thicknesses and, as such, periodic upkeep should be anticipated. 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. Pavement care consists of both localized (e.g., crack and joint sealing and patching) and global maintenance (e.g., surface sealing). Additional engineering consultation 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.

Pavement performance is affected by its surroundings. In addition to providing preventive maintenance, the civil engineer should consider the following recommendations in the design and layout of pavements:

- Final grade adjacent to paved areas should slope down from the edges at a minimum 2%.
- Subgrade and pavement surfaces should have a minimum 2% slope to promote proper surface drainage.

- Install pavement drainage systems surrounding areas anticipated for frequent wetting.
- Install joint sealant and seal cracks immediately.
- Seal all landscaped areas in or adjacent to pavements to reduce moisture migration to subgrade soils.
- Place compacted, low permeability backfill against the exterior side of curb and gutter.
- Place curb, gutter and/or sidewalk directly native or imported subgrade soils rather than on unbound granular base course materials.

General Comments

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Variations will occur between exploration point locations 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. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our Scope of Services 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.

Our services and any correspondence are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

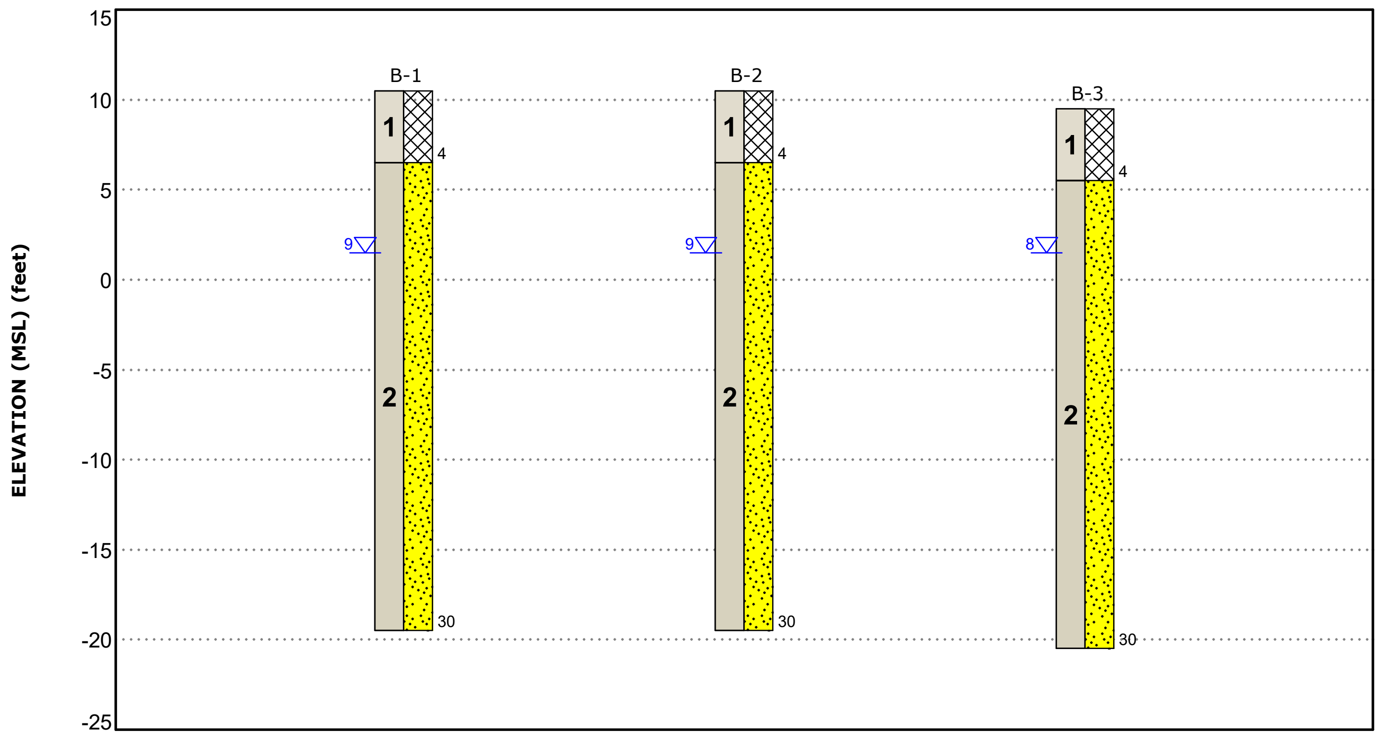
Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly affect excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety and cost estimating including excavation support and dewatering requirements/design are the responsibility of others. Construction and site development have the potential to affect adjacent properties. Such impacts can include damages due to vibration, modification of groundwater/surface water flow during construction, foundation movement due to undermining or subsidence from excavation, as well as noise or air quality concerns. Evaluation of these items on nearby properties are commonly associated with contractor means and methods and are not addressed in this report. The owner and contractor should consider a preconstruction/precondition survey of surrounding development. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

Figures

Contents:

1225 Omar Rd
West Palm Beach, FL

GeoModel



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

Model Layer	Layer Name	General Description
1	**Fill**	Poorly graded fine SAND
2	**Sand**	Poorly graded fine to medium SAND (SP)

Legend

Fill — Poorly-graded Sand

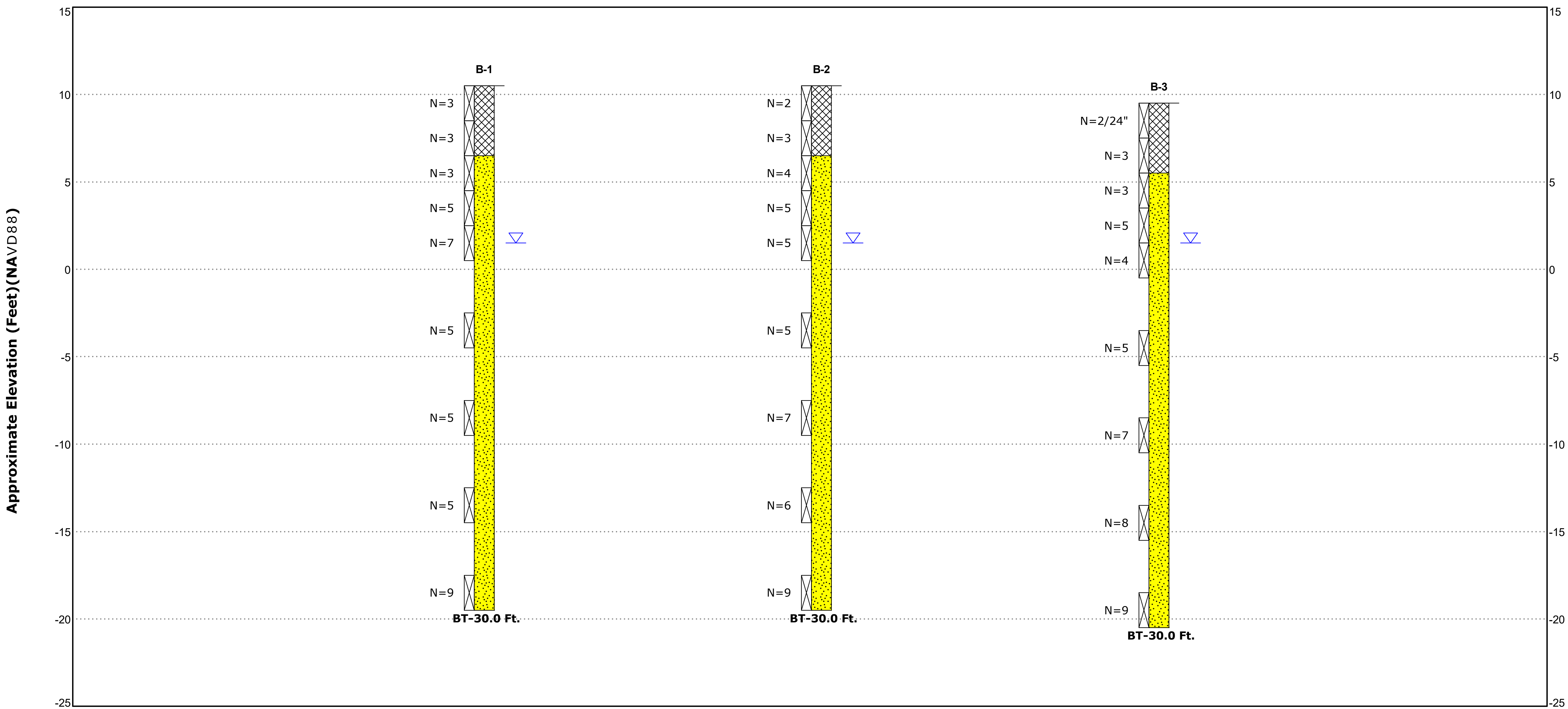
First Water Observation

Groundwater levels are temporal. The levels shown are representative of the date and time of our exploration. Significant changes are possible over time.
Water levels shown are as measured during and/or after drilling. In some cases, boring advancement methods mask the presence/absence of groundwater. See individual logs for details.

NOTES:
Layering shown on this figure has been developed by the geotechnical engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project.
Numbers adjacent to soil column indicate depth below ground surface.

Generalized Subsurface Profile

Terracon
1225 Omar Road
West Palm Beach, FL



Notes	Water Level Observations	Explanation	Material Legend
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination N = Standard Penetration Test (SPT) Resistance (Blows per Foot)	Water Level Reading at time of drilling.	B-1 — Borehole Number Sampling (See General Notes) — Borehole Lithology AR BT — Borehole Termination Type	Fill Poorly-graded Sand

Attachments

Exploration and Testing Procedures

Field Exploration

Number of Borings	Approximate Boring Depth (feet)	Location
3	30	Proposed Building Area

Boring Layout and Elevations: Terracon personnel provided the boring layout using handheld GPS equipment (estimated horizontal accuracy of about ±10 feet) and referencing existing site features. If elevations and a more precise boring layout are desired, we recommend borings be surveyed.

Subsurface Exploration Procedures: We advanced the borings with a Mobile B-59 drill rig using a mud rotary drilling technique. In the mud rotary procedure, drilling fluid was circulated in the boreholes to stabilize the borehole walls and flush soil cuttings to the surface. Five samples were obtained in the upper 10 feet of each boring and at intervals of 5 feet thereafter. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon was driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon was recorded at an interval of 6 inches. The sum of blows in the second and third interval of a normal 18-inch or 24-inch penetration was recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths. We observed and recorded groundwater levels during drilling and sampling. For safety purposes, all borings were backfilled with auger cuttings and bentonite after their completion.

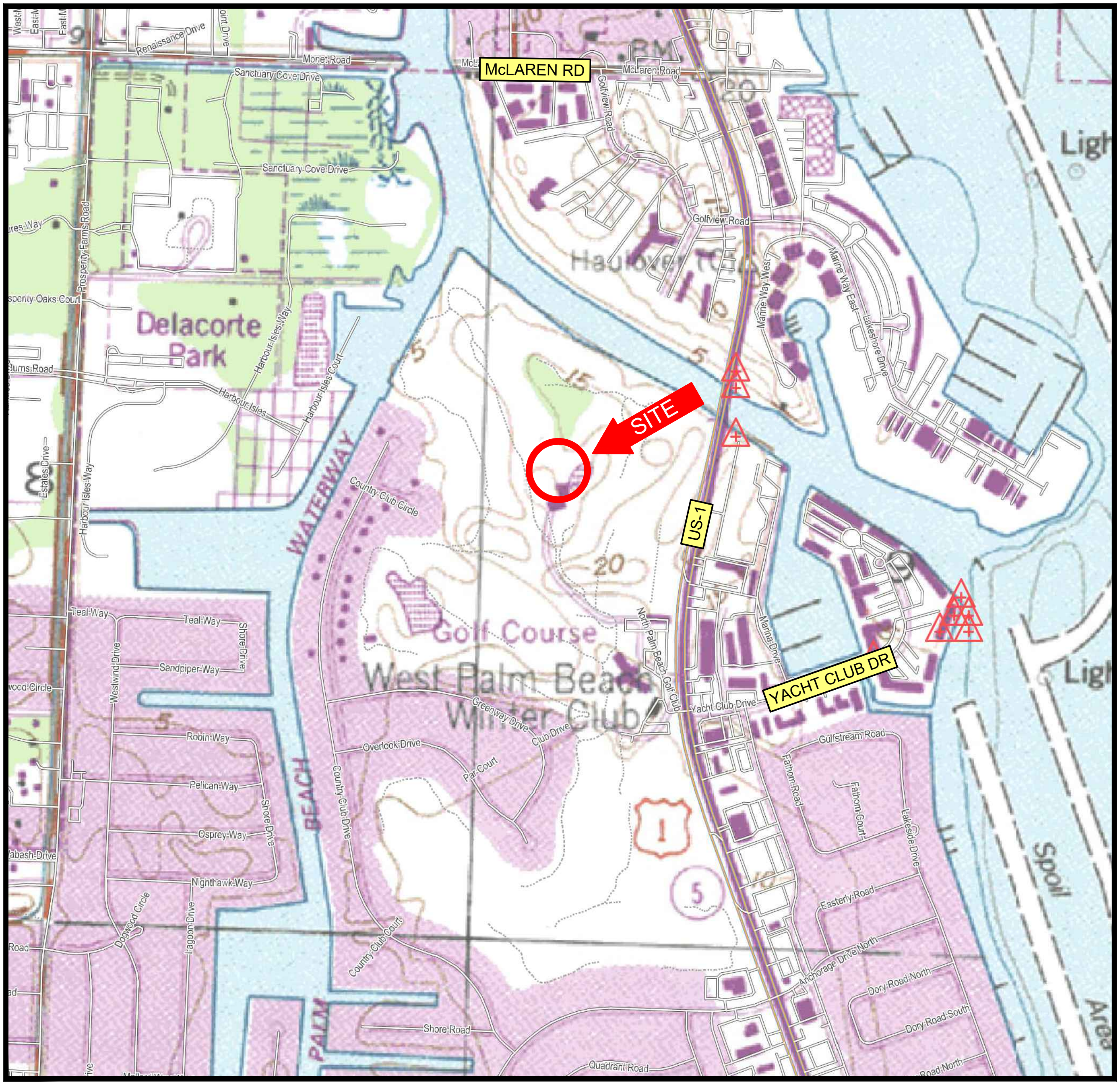
We also observed the boreholes while drilling for the presence of groundwater.

Field Log Recording: The sampling depths, penetration distances, and other sampling information was recorded on the field boring logs. The samples were placed in appropriate containers and taken to our soil laboratory for review and classification by a Geotechnical Engineer. Our exploration team prepared field boring logs as part of the drilling operations. These field logs included visual classifications of the materials observed during drilling and our interpretation of the subsurface conditions between samples. Final boring logs were prepared from the field logs. The final boring logs represent the Geotechnical Engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

Site Location and Exploration Plans

Contents:

UNITED STATES — DEPARTMENT OF THE INTERIOR — GEOLOGICAL SURVEY



SCALE 1"=1000'

FEET

500 0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000

RIVIERA BEACH, FLORIDA
ISSUED: 1985
7.5 MINUTE SERIES (QUADRANGLE)

N

C:\Users\pjcraig\OneDrive - Terracon Consultants Inc\Desktop_PTP REVIEW\HD245051 - Village fo N Palm Beach (VNPB) Metal Bldg. - Joshua\CAD\HD245051.Topo.091824.dwg

Project Mngr: WJM	Project No. HD245051	Terracon Explore with us	TOPOGRAPHIC VICINITY MAP
Drawn By: PJC	Scale: AS SHOWN		GEOTECHNICAL ENGINEERING REPORT
Checked By: WJM	File No. HF245051	1225 OMAR ROAD WEST PALM BEACH, FLORIDA 33405	VILLAGE OF NORTH PALM BEACH (VNPB) METAL BUILDING
Approved By: RHN	Date: 9-18-2024	PH. (561) 689-4299	951 US-1 NORTH PALM BEACH, PALM BEACH COUNTY, FLORIDA

LEGEND

APPROXIMATE LOCATION OF SPT BORING

C:\Users\pjcraig\OneDrive - Terracon Consultants Inc\Desktop_PTP REVIEW\HD245051 - Village fo N Palm Beach (VNPB) Metal Bldg. - Joshua\CAD\HD245051.ELP.091824.dwg

Sep18, 2024-2:35pm

Project Mngr: WJM	Project No. HD245051	Terracon Explore with us	EXPLORATION LOCATION PLAN
Drawn By: PJC	Scale: AS SHOWN		GEOTECHNICAL ENGINEERING REPORT
Checked By: WJM	File No. HD245051		VILLAGE OF NORTH PALM BEACH (VNPB) METAL BUILDING
Approved By: RHN	Date: 9-18-2024	1225 OMAR ROAD WEST PALM BEACH, FLORIDA 33405 PH. (561) 689-4299	951 US-1 NORTH PALM BEACH, PALM BEACH COUNTY, FLORIDA

Exploration Results

Contents:

Terracon
1225 Omar Rd
West Palm Beach, FL

Boring Log No. B-1

Location: See Exploration Plan

Latitude: 26.8302° Longitude: -80.0637°

Model Layer	Graphic Log	Depth (Ft.) / Material Description / Elevation: 10.5 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results
1		**FILL - SAND**, fine grained, gray, loose			X	1-2-1-1 N=3
					X	1-2-1-3 N=3
		4.0 — 6.5				
2		**SAND (SP)**, fine to medium grained, gray to brown, very loose to loose	5		X	2-1-2-3 N=3
					X	2-2-3-3 N=5
				▽	X	3-3-4-4 N=7
			10			
			15		X	2-2-3-4 N=5
			20		X	1-3-2-3 N=5
			25		X	2-2-3-3 N=5
		below 28.0 feet - medium dense			X	2-5-4-5 N=9
		30.0 — -19.5	30			
		Boring Terminated at 30 Feet				

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
▽ 9 ft. during drilling

Drill Rig
Mobile B-59

Hammer Type
Automatic

Driller
T.S.

Notes
Begin Mud Rotary at 10 feet
Elevation shown is in NAVD

Advancement Method
Mud Rotary
Continuous sampling to 10 feet
Samples at 5 foot intervals thereafter

Abandonment Method
Boring backfilled with bentonite chips upon completion.

Logged by

Boring Started
08-26-2024

Boring Completed
08-26-2024

Terracon
1225 Omar Rd
West Palm Beach, FL

Boring Log No. B-2

Location: See Exploration Plan

Latitude: 26.8302° Longitude: -80.0635°

Elevation: 10.5 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.) / Description	Elevation	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results
1	Fill	**FILL - SAND**, fine grained, gray, very loose to loose		0–2		SPT	1-1-1-1 N=2
				2–4		SPT	1-2-1-2 N=3
		4.0	6.5				
2	Sand	**SAND (SP)**, fine to medium grained, gray to brown, very loose to loose		4–6		SPT	2-2-2-3 N=4
				6–8		SPT	2-3-2-2 N=5
				8–10	▽ (9 ft.)	SPT	2-3-2-4 N=5
				13–15		SPT	1-2-3-4 N=5
				18–20		SPT	3-3-4-4 N=7
				23–25		SPT	2-3-3-4 N=6
		below 28.0 feet - meium dense		28–30		SPT	2-4-5-6 N=9
		30.0	-19.5	30			
		Boring Terminated at 30 Feet					

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
▽ 9 ft. during drilling

Drill Rig
Mobile B-59

Hammer Type
Automatic

Driller
T.S.

Notes
Begin Mud Rotary at 10 feet
Elevation shown is in NAVD

Advancement Method
Mud Rotary
Continuous sampling to 10 feet
Samples at 5 foot intervals thereafter

Abandonment Method
Boring backfilled with bentonite chips upon completion.

Logged by

Boring Started
08-26-2024

Boring Completed
08-26-2024

Terracon
1225 Omar Rd
West Palm Beach, FL

Boring Log No. B-3

Location: See Exploration Plan

Latitude: 26.8302° Longitude: -80.0634°

Elevation: 9.5 (Ft.) +/-

Model Layer	Depth (Ft.)	Material Description	Elevation (Ft.)	Water Level Observations	Sample Depth (Ft.)	Field Test Results
1	0.0–4.0	**FILL - SAND**, fine grained, gray, very loose to loose	5.5		0–2	N = 2/24"
					2–4	1-1-2-4 N=3
2	4.0–30.0	**SAND (SP)**, fine to medium grained, gray to brown, very loose to loose	-20.5		4–6	2-1-2-2 N=3
					6–8	2-3-2-3 N=5
				▽ 8 ft.	8–10	2-2-2-2 N=4
					13–15	2-2-3-4 N=5
					18–20	2-3-4-4 N=7
					23–25	2-4-4-5 N=8
		below 28.0 feet - medium dense			28–30	2-4-5-6 N=9

Boring Terminated at 30 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
▽ 8 ft. during drilling

Drill Rig
Mobile B-59

Hammer Type
Automatic

Driller
T.S.

Notes
Begin Mud Rotary at 10 feet
Elevation shown is in NAVD

Advancement Method
Mud Rotary
Continuous sampling to 10 feet
Samples at 5 foot intervals thereafter

Abandonment Method
Boring backfilled with bentonite chips upon completion.

Logged by

Boring Started
08-26-2024

Boring Completed
08-26-2024

Supporting Information

Contents:

Terracon
8001 Baymeadows Way Ste 1
Jacksonville, FL

SPT GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAMPLING

Auger	Split Spoon
Shelby Tube	Macro Core
Ring Sampler	Rock Core
Grab Sample	No Recovery

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
(b/f)	Standard Penetration Test (blows per foot)
(PID)	Photo-Ionization Detector
(OVA)	Organic Vapor Analyzer

DESCRIPTIVE SOIL CLASSIFICATION: Soil classification is based on the United 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 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 handheld GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topography survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More that 50% retained on No. 200 sieve) Density determined by Standard Penetration Resistance		
Descriptive Term (Density)	Safety Hamer SPT N_{60}-Value (Blows/Ft.)	Automatic Hammer SPT N-Value (Blows/Ft.)
Very Loose	0 – 3	< 3
Loose	4 – 9	3 – 8
Medium Dense	10 – 29	9 – 24
Dense	30 – 50	24 – 40
Very Dense	> 50	> 40

CONSISTENCY OF FINE-GRAINED SOILS (50% or more passing the No. 200 sieve) Consistency determined by laboratory shear strength testing, field visual-manual procedures or Standard Penetration Resistance			
Descriptive Term (Consistency)	Unconfined Compressive Strength Qu, (psf)	Safety Hamer SPT N_{60}-Value (Blows/Ft.)	Automatic Hamer SPT N-Value (Blows/Ft.)
Very Soft	Less than 500	0 – 1	< 1
Soft	500 – 1,000	2 – 4	1 – 3
Medium Stiff	1,000 – 2,000	5 – 8	4 – 6
Stiff	2,000 – 4,000	9 – 15	7 – 12
Very Stiff	4,000 – 8,000	16 – 30	13 – 24
Hard	> 8,000	> 30	> 24

RELATIVE PROPORTIONS OF GRAVEL, SAND FINES, OR ORGANIC MATTER	
Descriptive Terms of Constituents	Percent of Dry Weight
Trace	< 5%
Few	5 to < 12%
Little	12 to < 30%
Some	30 to < 50%
Mostly	>50%

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

PLASTICITY DESCRIPTION	
Term	Plasticity Index
Non-Plastic	0
Low Plasticity	1-10
Medium Plasticity	11-30
High Plasticity	>30

ROCK CEMENTATION (NORTH FLORIDA LIMESTONE) CORRELATION OF LABORATORY UNCONFINED COMPRESSION TEST RESULTS AND PENETRATION RESISTANCE WITH RELATIVE DEGREE OF CEMENTATION			
Relative Degree of Cementation	**Unconfined Compressive Strength (ksf)**	**Standard Penetration Resistance (# of Blows, N_{60})**	**Manual Test on Recovered Core**
Weakly Cemented	Uc < 50	N < 100	Friable, easily crumbled or broken with hands
Cemented	50 < Uc < 250	N – 100 or more w/recovery	Some difficulty in breaking with hands
Well Cemented	Uc > 250	No recovery – N>100	Cannot be broken with hands

CORRELATION OF RATE OF EFFERVESCENCE OF DILUTE HYDROCHLORIC ACID WITH RELATIVE DEGREE OF CALCAREOUSNESS	
Relative Degree of Calcareousness	Rate of Effervescence
Slightly calcareous	Weak or Slow
Calcareous	Moderate or Mild
Very Calcareous	Strong or Violent

Unified Soil Classification System

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]				Soil Classification: Group Symbol	Soil Classification: 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≥4 and 1≤Cc≤3 [E]	GW	Well-graded gravel [F]
			Cu<4 and/or [Cc<1 or Cc>3.0] [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≥6 and 1≤Cc≤3 [E]	SW	Well-graded sand [I]
			Cu<6 and/or [Cc<1 or Cc>3.0] [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 above "A" line [J]	CL	Lean clay [K, L, M]
			PI < 4 or plots below "A" line [J]	ML	Silt [K, L, M]
		Organic:	$\frac{LL\ oven\ dried}{LL\ not\ dried} < 0.75$	OL	Organic clay [K, L, M, N]
					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:	$\frac{LL\ oven\ dried}{LL\ not\ dried} < 0.75$	OH	Organic clay [K, L, M, P]
					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] $Cu = D_{60}/D_{10}$ $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
[F] If soil contains ≥ 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 ≥ 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 ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.
[N] PI ≥ 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.