**Florida Department of Environmental Protection**

Southwest District Office
13051 North Telecom Parkway, Suite 101
Temple Terrace, Florida 33637-0926

Rick Scott
Governor

Carlos Lopez-Cantera
Lt. Governor

Noah Valenstein
Secretary

July 26, 2017

**PERMITTEE:**
Sia Mollanazar, P.E. Deputy Director of Engineering Services
Manatee County Public Works Department
1022 26th Avenue East
Bradenton, FL 34208
sia.mollanazar@mymanatee.org

| | |
|---|---|
| **PERMIT NUMBER:** | CS41-0182063-190-DWC/CG |
| **ISSUE DATE:** | July 26, 2017 |
| **EXPIRATION DATE:** | July 25, 2022 |
| **COUNTY:** | Manatee |
| **PROJECT NAME:** | Forcemain 11 Replacement |
| **WWTF NAME:** | Southwest Regional |
| **FACILITY ID:** | FLA012619 |

**NOTIFICATION OF ACCEPTANCE OF USE OF A GENERAL PERMIT**

Dear Mr. Mollanazar,

This letter acknowledges receipt of your Notification/Application for Constructing a Domestic Wastewater Collection/Transmission System for the subject project. Our Office received the Notice on July 25, 2017.

This is to advise you that the Department does not object to your use of this general permit for the following: 12-inch diameter forcemain.

Please note the attached requirements apply to your use of this general permit for constructing the proposed domestic wastewater collection/transmission system.

You are further advised that the construction activity must conform to the description contained in your Notification/Application for Constructing a Domestic Wastewater Collection/Transmission System and that any deviation may subject the permittee to enforcement action and possible penalties.

If you have any questions, please contact Tonya S. Haugland at (813) 470-5759 or via email at tonya.haugland@dep.state.fl.us.

Sincerely,

*For* Pamala Vazquez
Program Administrator
Permitting & Waste Cleanup Program
Southwest District

Copies furnished to:
W. Wade Wood, P.E., Kimley-Horn & Associates, Inc., wade.wood@kimley-horn.com
Jordan Walker, P.E., Kimley-Horn & Associates, Inc., jordan.walker@kimley-horn.com
Sarah Ecker, E.I., Kimley-Horn & Associates, Inc., sarah.ecker@kimley-horn.com
Tonya S. Haugland, FDEP SWD, tonya.haugland@dep.state.fl.us

**REQUIREMENTS FOR USE OF THE GENERAL PERMIT FOR DOMESTIC WASTEWATER COLLECTION/TRANSMISSION SYSTEMS:**

1. This general permit is subject to the general permit conditions of Rule 62-4.540, F.A.C., as applicable. This rule is available at the Department's Internet site at: http://www.dep.state.fl.us/water/rulesprog.htm#ww *[62-4.540]*

2. This general permit does not relieve the permittee of the responsibility for obtaining a dredge and fill permit where it is required. *[62-604.600(6)(b)1]*

3. This general permit cannot be revised, except to transfer the permit. *[62-604.600(6)(b)2]*

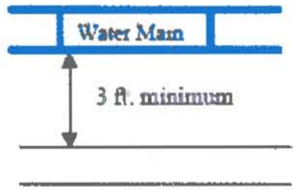
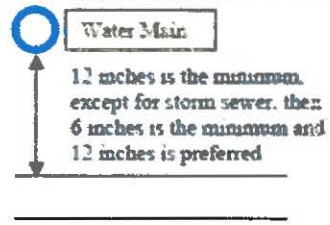
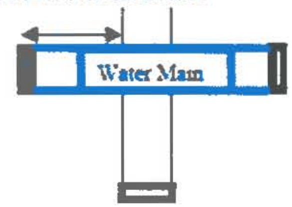
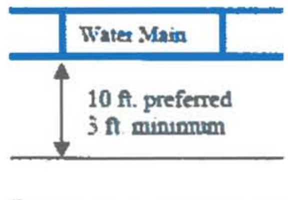
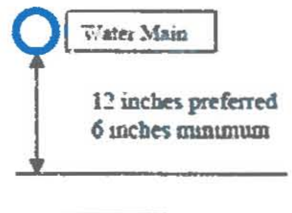
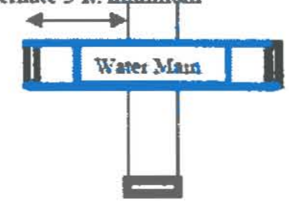
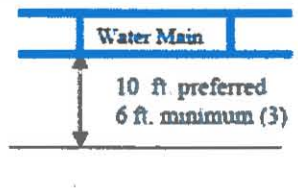
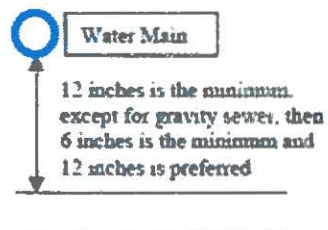
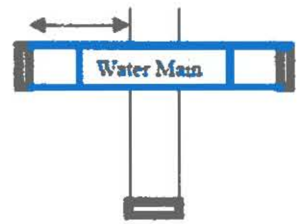
4. This general permit will expire five years from the date of issuance. If the project has been started and not completed by that time, a new permit must be obtained before the expiration date in order to continue work on the project. *[62-4.030]*

5. Upon completion of construction of the collection/transmission system project, and before placing the facilities into operation for any purpose other than testing for leaks or testing equipment operation, the permittee shall submit to the Department's Southwest District Office Form 62-604.300(8)(b), Request for Approval to Place a Domestic Wastewater Collection/Transmission System into Operation. This form is available at the Department's Internet site at: http://www.dep.state.fl.us/water/wastewater/forms.htm *[62-604.700(2)]*

6. The new or modified collection/transmission facilities shall not be placed into service until the Department clears the project for use. *[62-604.700(3)]*

7. Abnormal events shall be reported to the Department's Southwest District Office in accordance with Rule 62-604.550, F.A.C. For unauthorized spills of wastewater in excess of 1000 gallons per incident, or where information indicates that public health or the environment may be endangered, oral reports shall be provided to the STATE WATCH OFFICE TOLL FREE NUMBER (800) 320-0519 as soon as practical, but no later than 24 hours from the time the permittee or other designee becomes aware of the circumstances. Unauthorized releases or spills less than 1000 gallons per incident are to be reported orally to the Department's Southwest District Office within 24 hours from the time the permittee, or other designee becomes aware of the circumstances. *[62-604.550]*

## LOCATION OF PUBLIC WATER SYSTEM MAINS IN ACCORDANCE WITH F.A.C. RULE 62-555.314

| Other Pipe | Horizontal Separation | Crossings (1) | Joint Spacing @ Crossings (Full Joint Centered) |
|---|---|---|---|
| Storm Sewer, Stormwater Force Main, Reclaimed Water (2) |   |   | Alternate 3 ft. minimum   |
| Vacuum Sanitary Sewer |   |   | Alternate 3 ft. minimum   |
| Gravity or Pressure Sanitary Sewer, Sanitary Sewer Force Main, Reclaimed Water (4) |   |   | Alternate 6 ft. minimum   |
| On-Site Sewage Treatment & Disposal System | 10 ft. minimum | --- | --- |

(1) Water main should cross above other pipe. When water main must be below other pipe, the minimum separation is 12 inches.
(2) Reclaimed water regulated under Part III of Chapter 62-610, F.A.C.
(3) 3 ft. for gravity sanitary sewer where the bottom of the water main is laid at least 6 inches above the top of the gravity sanitary sewer.
(4) Reclaimed water not regulated under Part III of Chapter 62-610, F.A.C.

Disclaimer – This document is provided for your convenience only. Please refer to F.A.C. Rule 62-555.314 for additional construction requirements.

**SUBSURFACE SOIL EXPLORATION AND GEOTECHNICAL ENGINEERING EVALUATION FORCE MAIN 11, HOLMES BEACH, MANATEE COUNTY, FLORIDA**


Ardaman & Associates, Inc.

OFFICES

FLORIDA

Orlando, 8008 S. Orange Avenue, Orlando, Florida 32809, Phone (407) 855-3860
Bartow, 1525 Centennial Drive, Bartow, Florida 33830, Phone (863) 533-0858
Cocoa, 1300 N. Cocoa Boulevard, Cocoa, Florida 32922, Phone (321) 632-2503
Fort Myers, 9970 Bavaria Road, Fort Myers, Florida 33913, Phone (239) 768-6600
Miami, 2608 W. 84th Street, Hialeah, Florida 33016, Phone (305) 825-2683
Port St. Lucie, 460 NW Concourse Place, Unit #1, Port St. Lucie, Florida 34986-2248, Phone (772) [illegible]
Sarasota, 78 Sarasota Center Boulevard, Sarasota, Florida 34240, Phone (941) 922-3526
Tallahassee, 3175 West Tharpe Street, Tallahassee, Florida 32303, Phone (850) 576-6131
Tampa, 3925 Coconut Palm Drive, Suite 115, Tampa, Florida 33619, Phone (813) 620-3389
West Palm Beach, 2511 Westgate Avenue, Suite 10, West Palm Beach, Florida 33409, Phone (561) 687-8200

LOUISIANA

Alexandria, 3609 MacLee Drive, Alexandria, Louisiana 71302, Phone (318) 443-2888
Baton Rouge, 316 Highlandia Drive, Baton Rouge, Louisiana 70810, Phone (225) 752-4790
Monroe, 1122 Hayes Street, Monroe, Louisiana 71292, Phone (318) 387-4103
New Orleans, 1305 Distributors Row, Suite 1, Jefferson, Louisiana 70123, Phone (504) 835-2593
Shreveport, 7222 Greenwood Road, Shreveport, Louisiana 71119, Phone (318) 636-3723


**MEMBERS:**
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**American Concrete Institute**
**American Society for Testing and Materials**
**Florida Institute of Consulting Engineers**

Ardaman & Associates, Inc.

Geotechnical Environmental and
Materials Consultants

March 23, 2017
File No. 16-7390

TO: Kimley-Horn & Associates, Inc.
655 North Franklin Street, Suite 150
Tampa, Florida 33602

Attention: Sarah Ecker, E.I.

SUBJECT: Subsurface Soil Exploration and Geotechnical Engineering Evaluation
Force Main 11, Holmes Beach, Manatee County, Florida

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Dear Ms. Ecker:

As requested and authorized by Mr. Wayne White, we have completed a subsurface soil exploration and geotechnical engineering evaluation for the subject project. We understand that the project will include construction of approximately 4,300 lineal feet of force main. We understand that portions of the pipes will be installed by cut-and-cover (open trench) methods and portions by directional drill methods.

The scope of our work included providing geotechnical engineering recommendations for trench stability, pipe bedding, use of excavated soils, the need for dewatering, thrust resistance, and backfill and compaction requirements. Boring data for use in the design of directional drills is provided for informational purposes only, since this type of construction is proprietary in nature.

## SITE LOCATION

The proposed force main is located in Holmes Beach on Anna Maria Island, Manatee County, Florida. We understand that the alignment begins near the intersection of Gulf Drive with 85th Street and runs generally southeast along Gulf Drive and Palm Drive to its intersection with 68th Street, then southwest along 68th Street to Holmes Boulevard, then northwest along Holmes Boulevard to 69th Street. The route can be inferred from the test boring location plan shown on the attached Figure 1.

## REVIEW OF SOIL SURVEY MAPS

Based on USDA Natural Resources Conservation Service (NRCS) "Web Soil Survey" and the 1983 "Soil Survey of Manatee County, Florida," the soils along the force main alignment are mapped primarily as the "32 – Myakka fine sand, shell substratum" and "10 - Canaveral sand, organic substratum" soil series, with a relatively small area mapped as "8 – Canaveral fine sand, 0 to 5 percent slopes" soil series. The soils map for the general area of the proposed Force Main 11 alignment is included in Appendix I of this report.

78 Sarasota Center Boulevard, Sarasota, Florida 34240 Phone (941) 922-3526 FAX (941) 922-6743
Louisiana: Alexandria, Baton Rouge, Monroe, New Orleans, Shreveport
Florida: Bartow, Cocoa, Fort Myers, Miami, Orlando, Port St Lucie, Sarasota, Tallahassee, Tampa, W Palm Beach

Kimley-Horn & Associates, Inc.
File No. 16-7390
March 23, 2017

The mapped locations of the individual soil units and selected characteristics of each, according to the NRCS, are summarized in Appendix I of this report. The characteristics listed are the general ratings for corrosion of concrete, corrosion of steel and for shallow excavations, as reported by the NRCS. These ratings represent the "dominant condition" for the soil map unit and are not site specific.

## FIELD EXPLORATION PROGRAM

### Standard Penetration Test (SPT) Borings

As requested, the field exploration program included performing seven (7) Standard Penetration Test (SPT) borings near the proposed pipeline alignment. The SPT borings were performed at locations 1 through 7, as shown on the attached Figure 1. The SPT borings were drilled to a depth of 20 feet below the existing ground surface using the methodology outlined in ASTM D1586. The borings were initially drilled to a depth of 4½ feet with a hand auger in order to avoid damaging possible underground utilities.

A summary of the boring procedures are included in Appendix II. Split-spoon soil samples recovered during performance of the borings were visually classified in the field and representative portions of the soil samples were transported to our laboratory for further visual classification and laboratory testing.

Where encountered, the groundwater level at each of the boring locations was measured during drilling. The SPT borings were then plugged with cement grout (placed by tremie method, from bottom to top).

### Test Boring Locations

The number of test borings, boring depths and approximate locations were requested by Kimley-Horn & Associates (KHA). Locations were adjusted in the field as necessary to avoid existing utilities or other obstructions, and to maintain a safe working distance from overhead power lines.

The approximate locations of the borings are schematically illustrated on Figure 1. The locations were determined in the field by visual reference to available site features and should be considered accurate only to the degree implied by the method used.

## LABORATORY TESTING PROGRAM

Representative soil samples obtained during our field sampling operation were packaged and transferred to our laboratory for further visual examination and classification. The soil descriptions shown on the soil profiles are based on a visual classification procedure in general accordance with the Unified Soil Classification System (ASTM D-2487 or D-2488).

## GENERAL SUBSURFACE CONDITIONS

### General Soil Profile

The results of the field exploration and laboratory testing programs are graphically summarized on the soil boring profiles presented on Figure 2. The stratification of the boring profiles represents our interpretation of the field boring logs and the results of laboratory examinations of the recovered samples. The stratification lines represent the approximate boundary between soil types. The actual transitions may be more gradual than implied.

The borings encountered a general soil profile consisting primarily of medium dense to dense fine sand (SP) with varying amounts of shell from the ground surface to a depth of approximately 12 feet, underlain by very loose to medium dense fine sand (SP) to silty fine sand (SM) with varying amounts of shell to a depth of approximately 17 feet, underlain by medium dense to very dense fine sand (SP) with varying amounts of shell to the end of boring depth of 20 feet. Exceptions to this included very loose fine sand and fine sand with shell from a depth of approximately 4½ to 7½ feet below the ground surface at boring No. 5. Other than soils with roots at the ground surface, soils with a significant amount of organics (i.e. peat or muck) were not encountered in the borings.

The above soil profile description is in general terms only. Please refer to Figure 2 for soil profile details.

### Groundwater Level

The groundwater levels in the boreholes were measured during drilling. As shown on Figure 2, the groundwater level was encountered at depths of approximately 2 to 3½ feet below the ground surface. Fluctuations in groundwater levels should be anticipated throughout the year, primarily due to seasonal variations in rainfall and other factors that may vary from the time the borings were conducted. Groundwater levels may also be influenced by tidal fluctuations.

The normal seasonal high groundwater level each year typically occurs in August to September, which is the period near the end of the rainy season during a year of normal (average) rainfall. The seasonal high groundwater level is affected by a number of factors, such as the drainage characteristics of the soils, the land surface elevation, relief points (such as lakes, rivers, swamp areas, etc.) and distance to relief points.

We estimate that the normal seasonal high groundwater level probably occurs within a depth of 1 to 2 feet or less below the ground surface along most of the propose pipeline alignment. The water table elevations associated with a flood may be higher than the normal seasonal high groundwater levels, however.

## ENGINEERING EVALUATION AND RECOMMENDATIONS - CUT AND COVER

### General

The results of this exploration indicate that the existing soils as encountered in the borings are suitable for supporting the proposed pipelines and associated structures. The following are our recommendations for overall site preparation and foundation support which we feel are best suited for the proposed pipelines and associated structures relative to the soil conditions encountered in the borings shown on Figure 2. The recommendations are made as a guide for the design engineer, parts of which should be incorporated into the project's specifications.

Although we did not encounter any deleterious organic soils in our borings, the soil survey results and our previous experience in the area indicate that pockets of buried deleterious organic soils may be encountered along the pipeline alignment. The contractor should be aware that some buried organic soils may be encountered, and that if they are encountered below the bottom elevation of any pipes/structures, they will need to be completely removed and replaced with suitable compacted backfill in accordance with our recommendations below. Any deleterious organic materials removed are not suitable for use as fill material and should be disposed of as directed by the property owner.

### Pipelines and Associated Structures

#### Excavation

Based on the conditions encountered during the field exploration, we anticipate that the fine sand (SP) and fine sand with silt (SP-SM) can generally be excavated with standard earth moving equipment (i.e., front-end loaders and backhoes). Where these soils are dense or very dense (SPT N-value greater than 30), however, they may be more difficult to excavate and portions may be at least weakly cemented. Note that the N-values are listed adjacent to the boring logs on Figure 2.

The soils below the bottom of the excavations should not be disturbed by the excavation process. If soils become disturbed and difficult to compact, they should be over-excavated below the pipeline and other structures to a depth necessary to remove all disturbed soils. Over-excavated soils should be replaced with compacted backfill meeting the "Backfill Requirements" presented in a subsequent section of this report.

The excavation should be safely braced or sloped to prevent injury to personnel or damage to equipment. Temporary safe slopes should be cut at a minimum 1.5 horizontal (H) to 1 vertical (V) in accordance with OSHA, 29 CFR Part 1926 Subpart P. Flatter slopes should be used if deemed necessary based on actual conditions encountered. Surcharge loads should be kept at least 5 feet from excavations. Spoil banks adjacent to excavations should be sloped no steeper than 2.0H to 1.0V. Provisions for maintaining workers' safety within and adjacent to excavations is the sole responsibility of the Contractor.

#### Dewatering

The control of the groundwater may be required to achieve the necessary depths of excavation and subsequent construction, backfilling and compaction requirements presented in the following sections. The actual method(s) of dewatering should be determined by the Contractor. However, regardless of the method(s) used, we suggest drawing down the groundwater table sufficiently (i.e., 2 to 3 feet) below the bottom of the excavation(s) to preclude "pumping" and/or compaction-related problems with the foundation soils. We recommend that the dewatering be accomplished in advance of the excavation.

Pipeline Bedding

Pipe bedding material should be compacted as necessary to achieve a density equivalent to 95 percent of the maximum dry density, as determined by the Modified Proctor (ASTM D-1557), to a minimum depth of 6 inches below the bottom of the pipe. Compact deeper if recommended by the pipe manufacturer.

The surficial soils with roots are not a suitable bedding material and should be excavated and removed (cleared and grubbed) prior to starting excavations. If deleteriously organic soils are encountered below the pipe, the organic soils should be excavated from directly beneath the pipe and to a horizontal distance of at least 2 feet outside the pipe location.

We recommend that the bedding for the pipe be preshaped by means of a template prior to placement of the pipe to ensure that the upward reaction on the bottom of the pipe will be well distributed over the width of the bedding contact. Based on the cost involved with preshaping the bedding material and the construction time requirements, an alternative procedure may be to utilize a level bed for the pipe and require a higher pipe strength class that will adequately carry the load on a lower class of bedding. It would be prudent to perform an economic analysis of the two alternatives, or specify both design conditions within the contract documents and allow the Contractor to decide the most efficient method.

If level bedding is utilized, it will be necessary to place and compact the haunching backfill (backfill between the bedding and the springline of the pipe) to the springline of the pipe. This material should be placed in simultaneous layers on each side of the pipe and must be compacted in such a manner as to ensure an intimate contact with the sides of the pipe. Do not use blocking under the pipe to raise the pipe to grade.

The final backfill above the haunching or springline of the pipe must extend all the way to the trench walls and should be placed in level lifts not exceeding 12 inches. Each lift should be compacted to at least 95 percent of the maximum dry density, as determined by the Modified Proctor (ASTM D-1557). Care should be taken not to damage the pipe or deflect it by compacting directly above the pipe where there is insufficient cover material present. Minimum cover criteria should be in accordance with the pipe manufacturer's recommendations.

Where the utility line will traverse roadways and/or other permanent structures such as sidewalks, all backfill should be compacted to 95 percent of maximum dry density, as determined by the Modified Proctor (ASTM D-1557), from the top of the pipe to the ground surface. The design engineer may wish to specify greater compaction for the pavement subgrade, to be consistent with the pavement design requirements.

A geotechnical engineer or a designated representative from Ardaman & Associates, Inc. should observe and test all prepared and compacted areas to verify that all bedding, haunching and final backfill are prepared and compacted in accordance with the aforementioned specifications

Backfill Requirements

As a general guide to aid the Contractor, we recommend using fill that consists of fine sand (SP) to fine sand with silt (SP-SM) that contains less the 1 percent organic matter and no greater than 12 percent by dry weight of material passing the U.S. Standard No. 200 sieve size. Soils with more than 12 percent passing the No. 200 sieve will be more difficult to compact due to their inherent nature to retain soil moisture.

Based on the soil samples obtained during our subsurface investigation, the on-site fine sand (SP) and fine sand with silt (SP-SM) soils without roots and/or organic matter appear suitable for use as structural backfill for the pipe. However, material removed from below the groundwater table will be wet and will require time to dry sufficiently.

Silty fine sand (SM) could be used in some applications as structural backfill, but will be more difficult to moisture condition and compact due to its inherent nature to retain moisture. The surficial soils with roots are not a suitable backfill and should be excavated and removed (cleared and grubbed) prior to starting excavations.

Resistance to Horizontal Forces on Pipeline Structures

Horizontal forces which act on structures such as thrust blocks or anchor blocks can be resisted to some extent by the earth pressures that develop in contact with the buried vertical face (buried vertical face is perpendicular and in front of the applied horizontal load) of the block structures and by shearing resistance mobilized along the base of the block structures and soil subgrade interface.

Allowable earth pressure resistance may be determined using an equivalent fluid density of 110 pounds per cubic foot (pcf) for moist soil above the water table and 70 pcf for submerged soils below the water table[1]. The passive earth pressures are developed from ground surface[2] to the bottom of the block structure.

The values presented above presume that the block structures are surrounded by well compacted

1 Equivalent fluid density (moist soil) = $K_p\gamma_m$/S.F. = 110 pcf
Equivalent fluid density (submerged soil) = $K_p$ ($\gamma_s$-$\gamma_w$)/S.F. = 70 pcf

Where: $K_p$ = effective coefficient of passive earth pressure = 3.0
S.F. = safety factor = (values given below)
$\gamma_m$ = unit weight of moist soil = 110 pcf
$\gamma_s$ = unit weight of saturated soils = 120 pcf
$\gamma_w$ = unit weight of water = 62.4 pcf

2 Assuming there is no excavation in the vicinity of the block structure that would reduce the available passive pressure.

sand backfill extending at least 5 feet horizontally beyond the vertical buried face. In addition, it is presumed that the block structures can withstand horizontal movements on the order of one-quarter (1/4) to three-eighths (3/8) inch before mobilizing full passive resistance. The factors of safety assumed in the above recommendations are 2.5 for passive pressure with submerged conditions, and 3.0 for passive pressure without submerged conditions.

The sliding shearing resistance mobilized along the base of the block structure may be determined by the following formula:

Allowable Shearing Resisting Force, $P = V \tan(2/3\ \phi)/S.F$

Where: $P$ = Shearing Resistance Force (pounds)
$V$ = Net Vertical Force (total weight of block and soil overlying the structure minus uplift forces including buoyancy forces) (pounds)
$\phi$ = Angle of Internal Friction of Soil = 30 degrees
S.F. =Safety Factor = 1.5

The vertical earth pressures developed by the overburden weight of soil can be calculated using the following unit weights:

- Compacted moist soil = 110 pcf
- Saturated soil = 120 pcf

Vertical pressure distributions in accordance with the above do not take into account vertical forces from construction equipment, wheel loads or other surcharge loads.

Foundation Support and Estimated Settlements

The permanent structures such as anchor blocks, thrust blocks, air release valves, blow offs, etc., bearing at least 18 inches below adjacent grade and at least 18 inches wide can be designed for the following maximum vertical bearing capacities:

- 1,500 psf on undisturbed natural granular soils.
- 2,000 psf on compacted natural or backfilled subgrade; this value assumes compaction of at least 95 percent of the Modified Proctor maximum density (ASTM D-1557, AASHTO T-180) to a depth of 1 foot below the structure.

Pipe settlement during and after construction should be negligible (less than 1/2 inch) provided the bedding and backfilling criteria in the above sections are satisfied. The volume of soil displaced by the pipe, compared to the weight of the pipe when full, will result in little if any net increase in bearing stress to the subsurface soils.

Uplift Resistance

Permanent structures submerged below the groundwater table will be subjected to uplift forces caused by buoyancy. The components resisting this buoyancy include: 1) the total weight of the pipe or structure divided by an appropriate factor of safety; 2) the buoyant weight of soil overlying the pipe or structure; and 3) the shearing forces that act on shear planes that radiate vertically upward from the perimeter of the pipe or the edges of the structure to the ground surface. The allowable unit shearing resistance may be determined by the following formula:

Allowable Shearing Resistance, $F=K_o\gamma_m h(2/3 \tan\phi)/S.F.$ (above water table)

Allowable Shearing Resistance, $F=K_o[\gamma_m h_w+\gamma_b(h-h_w)](2/3 \tan\phi)/S.F.$ (below water table)

where: F = unit shearing resistance (psf)
$K_o$ = coefficient of earth pressure at rest = 0.5
$\gamma_m$ = unit weight of moist soil = 110 pcf
$\gamma_b$ = buoyant unit weight of soil = 58 pcf
h = vertical depth (feet) below grade at which shearing resistance is determined
$h_w$ = vertical depth (feet) below grade to groundwater table
$\phi$ = angle of internal friction of the soil = 30 degrees
S.F. = safety factor = 2.0

The values given for the above parameters assume that the permanent structures are covered by clean, well-compacted, granular backfill that extends horizontally at least 2 feet beyond the structures.

Earth Pressure on Shoring and Bracing

If temporary shoring and bracing are required for any excavations, the system should be designed to resist lateral earth pressure. The design earth pressure will be a function of the flexibility of the shoring and bracing system. For a flexible system restrained laterally by braces placed as the excavation proceeds, the design earth pressure for shoring and bracing can be computed using a uniform earth pressure distribution with depth. It is recommended that soils be dewatered around the excavations. For such dewatered excavations, we recommended using the following uniform pressure distribution over the full braced height as follows:

Uniform Soil Pressure Distribution, $p = 0.65\ K_a\gamma_s H$

where: p = uniform pressure distribution for design of braced excavation
$K_a$ = coefficient of active earth pressure = 0.33
$\gamma_s$ = unit weight of saturated soils = 120 pcf
H = depth of excavation

An appropriate factor of safety should be applied for the design of the braced excavations.

Lateral pressure distributions determined in accordance with the above do not take hydrostatic pressures or surcharge loads into account. To the extent that such pressures and forces may act on the walls, they should be included in the design.

Construction equipment and excavated fill should be kept a minimum distance of 5 feet from the edge of the braced or shored excavation. Backfill material placed adjacent to (maintaining a minimum 5-foot horizontal clearance) the braced or shored excavation should have a minimum slope of 2.0H to 1.0V or flatter, if required by site specific conditions and/or to meet OSHA requirements.

Means and methods of excavation and bracing should be the responsibility of the Contractor; however, excavation and/or bracing should, at a minimum, comply with the requirements of the Occupational Safety Health Administration (OSHA).

Lateral Earth Pressures

Lateral loads acting on the embedded structure will include at-rest earth pressures as well as hydrostatic pressures and surcharge loads. The lateral earth pressure will be a function of both the depth below ground surface and the soil unit weight (submerged or moist) plus hydrostatic pressure (if applicable). The following equations can be used to determine the lateral at-rest earth pressure:

$\sigma_h = K_o \gamma_m h$ (above water table)
$\sigma_h = K_o[\gamma_m h_w + \gamma_b(h-h_w)]$ (below water table)

where:
- $\sigma_h$ = lateral earth pressure (psf)
- $K_o$ = coefficient of at rest earth pressure (0.5) (this value assumes that the backfill is lightly compacted yet not overcompacted)
- $\gamma_m$ = moist unit weight of soil = 110 pcf for compacted moist soil above the water table.
- $\gamma_b$ = buoyant unit weight of soil = 58 pcf for compacted saturated soil below the water table.
- h= vertical depth (feet) below grade at which lateral earth pressure is determined.
- $h_w$ = vertical depth (feet) below grade to groundwater table

For design, an appropriate factor of safety should be applied to the lateral earth pressure calculated using the above equation. Lateral pressure distributions determined in accordance with the above do not include hydrostatic pressures or surcharge loads. Where applicable, they should be incorporated in the design.

**Pipeline Directional Drill Locations**

We understand that directionally drilled pipe installation is proposed for at least portions of the pipeline. The SPT borings were conducted to provide soil stratigraphy data for the direction drill design. Further subsurface exploration may be necessary in these areas after final pipe invert elevations are determined.

Classification in accordance with the Unified Soil Classification System and the SPT N-values were used to estimate unit weights, the angles of internal friction, cohesion and the shear modulus for the types of soils encountered in the borings are presented in Appendix III.

The following should be noted when reviewing the data in Appendix III:

- $\gamma_{buoyant} = \gamma_{sat} - \gamma_{water}$
- Values given in Appendix III are based on empirical correlations with the average soil conditions encountered in the referenced boring. Appropriate safety factors should be used with these values.

We caution that the soil layers shown in Appendix III are very generalized and should be used for design purposes only. The soil stratigraphy on the boring profiles (Figure 2) is more detailed than presented in Appendix III. The information in Appendix III should not be used for assessing the constructability of the proposed pipeline. The success of the directional drill program will depend on the means and methods of the directional drill contractor.

## QUALITY CONTROL

We recommend establishing a comprehensive quality control program to verify that all excavation, bedding, and backfilling is conducted in accordance with the appropriate plans and specifications. Materials testing and inspection services should be provided by Ardaman & Associates, Inc. In-situ density tests should be conducted during bedding and backfilling activities to verify that the required densities are achieved.

Backfill for the proposed pipeline should be tested at a minimum frequency of one in-place density test for each lift for each 200 lineal feet of pipe. Additional tests should be performed beneath foundations and in backfill for other associated structures. In-situ density values should be compared to laboratory Proctor moisture-density results for each of the different natural and fill soils encountered.

## CLOSURE

The analyses and recommendations submitted herein are based on the data obtained from the soil borings presented on Figure 1. This report does not reflect any variations which may occur adjacent to or between the borings. The nature and extent of the variations between the borings may not become evident until during construction. If variations then appear evident, it will be necessary to re-evaluate the recommendations presented in this report after performing on-site observations during the construction period and noting the characteristics of the variations.

This study is based on a relatively shallow exploration and is not intended to be an evaluation for sinkhole potential. This study does not include an evaluation of the environmental (ecological or hazardous/toxic material related) condition of the site and subsurface.

This report has been prepared for the exclusive use of Kimley-Horn & Associates in accordance with generally accepted geotechnical engineering practices. In the event any changes occur in the design, nature, or location of the proposed improvements, we should review the applicability of conclusions and recommendations in this report. We recommend a general review of final design and specifications by our office to verify that earthwork and foundation recommendations are properly interpreted and implemented in the design specifications. Ardaman & Associates should attend the pre-bid and preconstruction meetings to verify that the bidders/contractor understand the recommendations contained in this report.

We are pleased to be of assistance to you on this phase of the project. Please contact us when we may be of further service to you or should you have any questions.

Very truly yours,

ARDAMAN & ASSOCIATES, INC.
*Certificate of Authorization No. 5950*

Jerry H. Kuehn, P.E.
Senior Project Engineer
*Fl. License No. 35557*

Gregory S. Stevens, P.E.
Project Engineer
*Fl. License No. 71511*

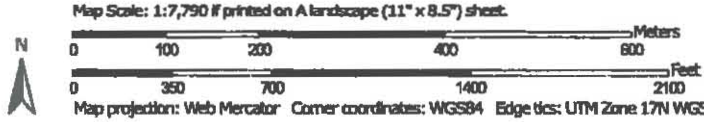
JHK/GSS:ly

# APPENDIX I

## Soil Map and Selected Data from NRCS Soil Survey

# Soil Map—Manatee County, Florida
(Force Main 11)


Map Scale: 1:7,790 if printed on A landscape (11" x 8.5") sheet.




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 1:24,000.

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: Manatee County, Florida
Survey Area Data: Version 13, Sep 14, 2016

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

Date(s) aerial images were photographed: Mar 14, 2011—Mar 3, 2014

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

| Manatee County, Florida (FL081) | | | |
|---|---|---|---|
| Map Unit Symbol | Map Unit Name | Acres in AOI | Percent of AOI |
| 8 | Canaveral fine sand, 0 to 5 percent slopes | 2.4 | 4.5% |
| 10 | Canaveral sand, organic substratum | 24.4 | 46.2% |
| 32 | Myakka fine sand, shell substratum | 24.1 | 45.7% |
| 99 | Water | 1.9 | 3.6% |
| **Totals for Area of Interest** | | **52.7** | **100.0%** |

# Corrosion of Concrete

| Corrosion of Concrete— Summary by Map Unit — Manatee County, Florida (FL081) | | | | |
|---|---|---|---|---|
| Map unit symbol | Map unit name | Rating | Acres in AOI | Percent of AOI |
| 8 | Canaveral fine sand, 0 to 5 percent slopes | Low | 2.4 | 4.5% |
| 10 | Canaveral sand, organic substratum | Low | 24.4 | 46.2% |
| 32 | Myakka fine sand, shell substratum | High | 24.1 | 45.7% |
| 99 | Water | | 1.9 | 3.6% |
| **Totals for Area of Interest** | | | **52.7** | **100.0%** |

## Description

"Risk of corrosion" pertains to potential soil-induced electrochemical or chemical action that corrodes or weakens concrete. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. The concrete in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than the concrete in installations that are entirely within one kind of soil or within one soil layer.

The risk of corrosion is expressed as "low," "moderate," or "high."

## Rating Options

*Aggregation Method:* Dominant Condition

*Component Percent Cutoff: None Specified*

*Tie-break Rule:* Higher

# Corrosion of Steel

| Corrosion of Steel— Summary by Map Unit — Manatee County, Florida (FL081) | | | | |
|---|---|---|---|---|
| Map unit symbol | Map unit name | Rating | Acres in AOI | Percent of AOI |
| 8 | Canaveral fine sand, 0 to 5 percent slopes | High | 2.4 | 4.5% |
| 10 | Canaveral sand, organic substratum | Low | 24 4 | 46.2% |
| 32 | Myakka fine sand, shell substratum | High | 24 1 | 45.7% |
| 99 | Water | | 1.9 | 3.6% |
| **Totals for Area of Interest** | | | **52.7** | **100.0%** |

## Description

"Risk of corrosion" pertains to potential soil-induced electrochemical or chemical action that corrodes or weakens uncoated steel. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than the steel in installations that are entirely within one kind of soil or within one soil layer.

The risk of corrosion is expressed as "low," "moderate," or "high."

## Rating Options

*Aggregation Method:* Dominant Condition

*Component Percent Cutoff: None Specified*

*Tie-break Rule:* Higher

# Shallow Excavations

| Shallow Excavations— Summary by Map Unit — Manatee County, Florida (FL081) | | | | | | |
|---|---|---|---|---|---|---|
| Map unit symbol | Map unit name | Rating | Component name (percent) | Rating reasons (numeric values) | Acres in AOI | Percent of AOI |
| 8 | Canaveral fine sand, 0 to 5 percent slopes | Very limited | Canaveral (90%) | Depth to saturated zone (1.00) | 2 4 | 4 5% |
| | | | | Unstable excavation walls (1.00) | | |
| | | | Myakka, non-hydric (10%) | Depth to saturated zone (1.00) | | |
| | | | | Unstable excavation walls (1.00) | | |
| 10 | Canaveral sand, organic substratum | Very limited | Canaveral, organic substratum (90%) | Unstable excavation walls (1.00) | 24.4 | 46.2% |
| | | | | Depth to saturated zone (0.73) | | |
| | | | Canaveral, filled (10%) | Depth to saturated zone (1.00) | | |
| | | | | Unstable excavation walls (1.00) | | |
| 32 | Myakka fine sand, shell substratum | Very limited | Myakka, shelly/ non-hydric (85%) | Depth to saturated zone (1.00) | 24.1 | 45.7% |
| | | | | Unstable excavation walls (1.00) | | |
| | | | Canaveral (10%) | Depth to saturated zone (1.00) | | |
| | | | | Unstable excavation walls (1.00) | | |
| | | | Myakka, shelly/ hydric (5%) | Depth to saturated zone (1.00) | | |
| | | | | Unstable excavation walls (1.00) | | |
| 99 | Water | Not rated | Water (100%) | | 1.9 | 3.6% |
| **Totals for Area of Interest** | | | | | **52.7** | **100.0%** |

| Shallow Excavations— Summary by Rating Value | | |
|---|---|---|
| Rating | Acres in AOI | Percent of AOI |
| Very limited | 50 9 | 96.4% |
| Null or Not Rated | 1.9 | 3.6% |
| **Totals for Area of Interest** | **52.7** | **100.0%** |

## Description

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for graves, utility lines, open ditches, or other purposes. The ratings are based on the soil properties that influence the ease of digging and the resistance to sloughing. Depth to bedrock or a cemented pan, hardness of bedrock or a cemented pan, the amount of large stones, and dense layers influence the ease of digging, filling, and compacting. Depth to the seasonal high water table, flooding, and ponding may restrict the period when excavations can be made. Slope influences the ease of using machinery. Soil texture, depth to the water table, and linear extensibility (shrink-swell potential) influence the resistance to sloughing.

The ratings are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect the specified use. "Not limited" indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. "Somewhat limited" indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. "Very limited" indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Numerical ratings indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

The map unit components listed for each map unit in the accompanying Summary by Map Unit table in Web Soil Survey or the Aggregation Report in Soil Data Viewer are determined by the aggregation method chosen. An aggregated rating class is shown for each map unit. The components listed for each map unit are only those that have the same rating class as listed for the map unit. The percent composition of each component in a particular map unit is presented to help the user better understand the percentage of each map unit that has the rating presented.

Other components with different ratings may be present in each map unit. The ratings for all components, regardless of the map unit aggregated rating, can be viewed by generating the equivalent report from the Soil Reports tab in Web Soil Survey or from the Soil Data Mart site. Onsite investigation may be needed to validate these interpretations and to confirm the identity of the soil on a given site.

## Rating Options

*Aggregation Method:* Dominant Condition

*Component Percent Cutoff: None Specified*

*Tie-break Rule:* Higher

# APPENDIX II

## Soil Boring, Sampling and Test Methods

## SOIL BORING, SAMPLING AND TESTING METHODS

### Standard Penetration Test

The Standard Penetration Test (SPT) is a widely accepted method of in situ testing of foundation soils (ASTM D-1586). A 2-foot long, 2-inch O.D. split-barrel sampler attached to the end of a string of drilling rods is driven 18 inches into the ground by successive blows of a 140-pound hammer freely dropping 30 inches. The number of blows needed for each 6 inches of penetration is recorded. The sum of the blows required for penetration of the second and third 6-inch increments of penetration constitutes the test result or N-value. After the test, the sampler is extracted from the ground and opened to allow visual examination and classification of the retained soil sample. The N-value has been empirically correlated with various soil properties allowing a conservative estimate of the behavior of soils under load. The following tables relate N-values to a qualitative description of soil density and, for cohesive soils, an approximate unconfined compressive strength (Qu):

Cohesionless Soils:

| N-Value | Description |
|---|---|
| 0 to 4 | Very loose |
| 4 to 10 | Loose |
| 10 to 30 | Medium dense |
| 30 to 50 | Dense |
| Above 50 | Very dense |

Cohesive Soils:

| N-Value | Description | Qu (ton/ft$^2$) |
|---|---|---|
| 0 to 2 | Very soft | Below 1/4 |
| 2 to 4 | Soft | 1/4 to 1/2 |
| 4 to 8 | Medium stiff | 1/2 to 1 |
| 8 to 15 | Stiff | 1 to 2 |
| 15 to 30 | Very stiff | 2 to 4 |
| Above 30 | Hard | Above 4 |

The tests are usually performed at 5-foot intervals. However, more frequent or continuous testing is done by our firm through depths where a more accurate definition of the soils is required. The test holes are advanced to the test elevations by rotary drilling with a cutting bit, using circulating fluid to remove the cuttings and hold the fine grains in suspension. The circulating fluid, which is a bentonitic drilling mud, is also used to keep the hole open below the water table by maintaining an excess hydrostatic pressure inside the hole. In some soil deposits, particularly highly pervious ones, NX-size flush-coupled casing must be driven to just above the testing depth to keep the hole open and/or prevent the loss of circulating fluid.

Representative split-spoon samples from each sampling interval and from every different stratum are brought to our laboratory in air-tight jars for further evaluation and testing, if necessary. After thorough examination and testing of the samples, the samples are discarded unless prior arrangements have been made. After completion of a test boring, the hole is kept open until a steady state groundwater level is recorded. The hole is then sealed, if necessary, and backfilled.

A hammer with an automatic drop release (auto-hammer) is sometimes used. In this case, a correction factor is applied to the raw blow counts, since the energy efficiency of the auto-hammer is greater than that of the safety hammer. Based upon calibration of the auto-hammer (per ASTM D4633) and standard practice, we use a multiplier of 1.24 to correct the auto-hammer blow counts to equivalent safety hammer "N" values.

## Hand Auger Borings

Hand auger borings are used, if soil conditions are favorable, when the soil strata are to be determined within a shallow (approximately 5 to 9 feet) depth or when access is not available to power drilling equipment. A 3-inch diameter, hand bucket auger with a cutting head is simultaneously turned and pressed into the ground. The bucket auger is retrieved to the surface at approximately 6-inch intervals and its contents emptied for inspection. The soil sample so obtained is classified and representative samples put in bags or jars and transported to the laboratory for further classification and testing.

## Laboratory Test Methods

Soil samples returned to our laboratory are examined by a geotechnical engineer or geotechnician to obtain more accurate descriptions of the soil strata. Laboratory testing is performed on selected samples as deemed necessary to aid in soil classification and to further define engineering properties of the soils. The test results are presented on the soil boring logs at the depths at which the respective sample was recovered, except that grain size distributions or selected other test results may be presented on separate tables, figures or plates as described in this report. The soil descriptions shown on the logs are based upon a visual-manual classification procedure in general accordance with the Unified Soil Classification System (ASTM D-2488-84) and standard practice. Following is a list of abbreviations which may be used on the boring logs or elsewhere in this report.

-200 - Fines Content (percent passing the No. 200 sieve); ASTM D1140
DD - Dry Density of Undisturbed Sample; ASTM D2937
Gs - Specific Gravity of Soil; ASTM D854
k - Hydraulic Conductivity (Coefficient of Permeability)
LL - Liquid Limit; ASTM D423
OC - Organic Content; ASTM D2974
pH - pH of Soil; ASTM D2976
PI - Plasticity Index (LL-PL); ASTM D424
PL - Plastic Limit; ASTM D424
Qp - Unconfined Compressive Strength by Pocket Penetrometer;
Qu - Unconfined Compressive Strength; ASTM D2166 (soil), D7012 (rock)
SL - Shrinkage Limit; ASTM D427
ST - Splitting Tensile Strength; ASTM D3967 (rock)
USCS - Unified Soil Classification System; ASTM D2487, D2488
w - Water (Moisture) Content; ASTM D2216

**Soil Classifications**

The soil descriptions presented on the soil boring logs are based upon the Unified Soil Classification System (USCS), which is the generally accepted method (ASTM D-2487 and D-2488) for classifying soils for engineering purposes. The following modifiers are the most commonly used in the descriptions.

| For Sands: | Modifier | Fines, Sand or Gravel Content* |
|---|---|---|
| | with silt or with clay | 5% to 12% fines |
| | silty or clayey | 12% to 50% fines |
| | with gravel or with shell | 15% to 50% gravel or shell |

| For Silts or Clays: | Modifier | Fines, Sand or Gravel Content* |
|---|---|---|
| | with sand | 15% to 30% sand and gravel; and % sand > % gravel |
| | sandy | 30% to 50% sand and gravel; and % sand > % gravel |
| | with gravel | 15% to 30% sand and gravel; and % sand < % gravel |
| | gravelly | 30% to 50% sand and gravel; and % sand < % gravel |

* may be determined by laboratory testing or estimated by visual/manual procedures. Fines content is the combined silt and clay content, or the percent passing the No. 200 sieve.

The USCS also uses a set of Group Symbols, which may also be listed on the soil boring logs. The following is a summary of these.

| Group Symbol | General Group Name* | Group Symbol | General Group Name* |
|---|---|---|---|
| GW | Well-graded gravel | SW | Well-graded sand |
| GP | Poorly graded gravel | SP | Poorly graded sand |
| GW-GM | Well-graded gravel with silt | SW-SM | Well-graded sand with silt |
| GW-GC | Well-graded gravel with clay | SW-SC | Well-graded sand with clay |
| GP-GM | Poorly graded gravel with silt | SP-SM | Poorly graded sand with silt |
| GP-GC | Poorly graded gravel with clay | SP-SC | Poorly graded sand with clay |
| GM | Silty gravel | SM | Silty sand |
| GC | Clayey gravel | SC | Clayey sand |
| GC-GM | Silty, clayey gravel | SC-SM | Silty, clayey sand |
| CL | Lean clay | ML | Silt |
| CL-ML | Silty clay | MH | Elastic silt |
| CH | Fat clay | OL or OH | Organic silt or organic clay |

* Group names may also include other modifiers, per standard or local practice.

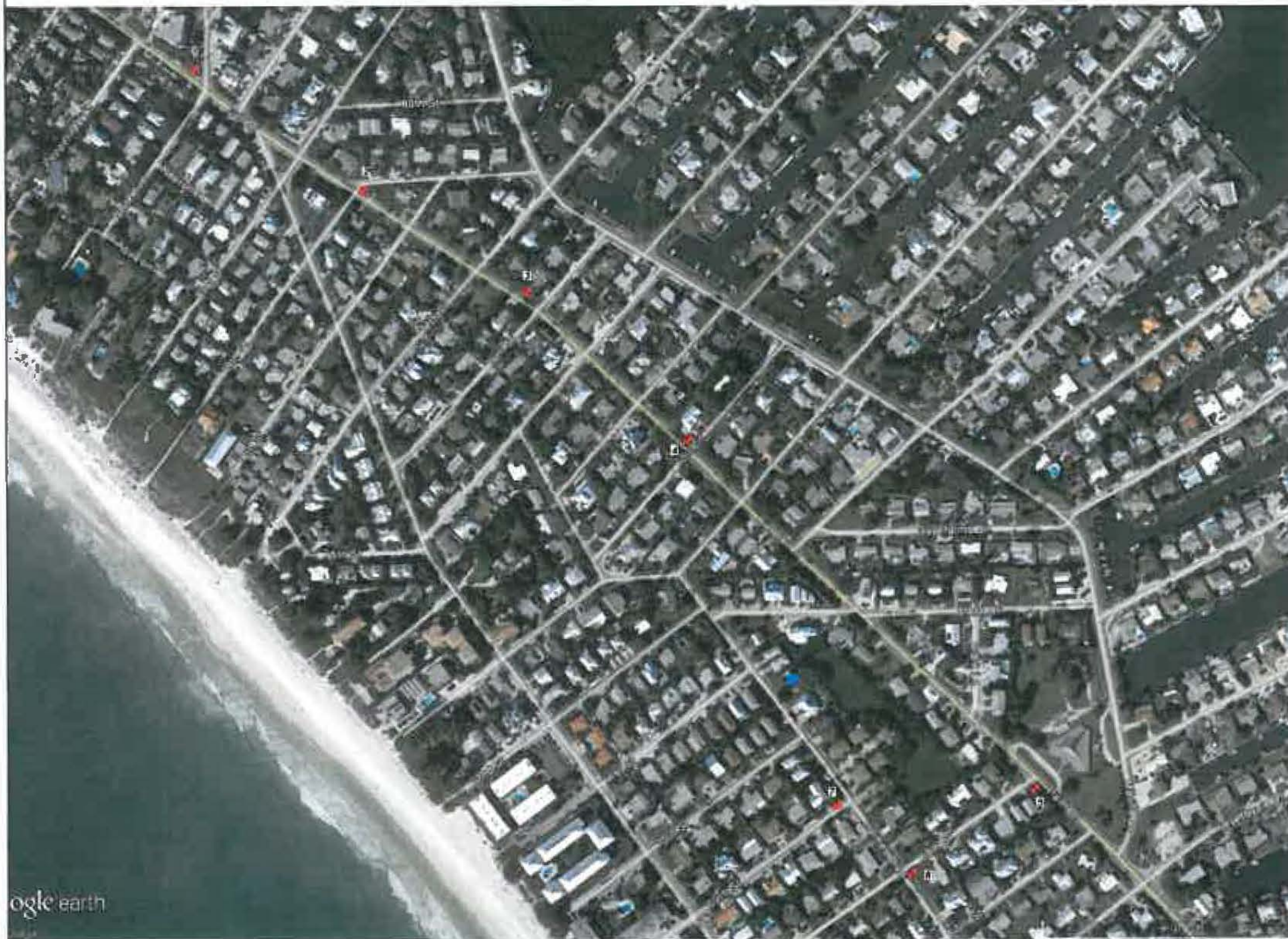
Other soil classification standards may be used, depending on the project requirements. The AASHTO classification system is commonly used for highway design purposes and the USDA soil textural classifications are commonly used for septic (on-site sewage disposal) system design purposes.

# APPENDIX III

## Table of Selected Soil Parameters

| Boring No. | Depth Range (feet) | Soil Classification | Average SPT N-Value | Internal Friction Angle (degrees) | Saturated Soil Weight (pcf) | (see Note 1) Moist Soil Weight (pcf) | (see Note 2) Cohesion (psf) | Shear Modulus (ksf) |
|---|---|---|---|---|---|---|---|---|
| 1 | 0 - 4.5 | SP | --- | 30 | 118 | 100 | --- | 170 |
| | 4.5 - 6 | SP | 12 | 31 | 119 | 101 | --- | 220 |
| | 6 - 7.5 | SP | 25 | 34 | 127 | 112 | --- | 520 |
| | 7.5 - 12 | SP | 43 | >34 | 130 | 120 | --- | 770 |
| | 12 - 17 | SP | 15 | 32 | 121 | 104 | --- | 300 |
| | 17 - 20 | SP | 40 | >34 | 130 | 120 | --- | 730 |
| 2 | 0 - 4.5 | SP/SP-SM | --- | 30 | 118 | 100 | --- | 170 |
| | 4.5 - 6 | SP | 14 | 31 | 120 | 103 | --- | 270 |
| | 6 - 7.5 | SP | 30 | >34 | 130 | 117 | --- | 620 |
| | 7.5 - 12 | SP | 44 | >34 | 130 | 120 | --- | 730 |
| | 12 - 17 | SP | 9 | 30 | 117 | 98 | --- | 170 |
| | 17 - 20 | SP | 19 | 33 | 123 | 107 | --- | 400 |
| 3 | 0 - 4.5 | SP | --- | 30 | 118 | 100 | --- | 170 |
| | 4.5 - 9 | SP | 12 | 31 | 119 | 101 | --- | 220 |
| | 9 - 12 | SP | 19 | 33 | 123 | 107 | --- | 400 |
| | 12 - 17 | SP-SM | 2 | 27 | 112 | 90 | --- | 80 |
| | 17 - 20 | SP | 31 | >34 | 130 | 117 | --- | 630 |
| 4 | 0 - 4.5 | SP/SP-SM | --- | 30 | 118 | 100 | --- | 170 |
| | 4.5 - 6 | SP | 12 | 31 | 119 | 101 | --- | 220 |
| | 6 - 9 | SP | 25 | 34 | 127 | 112 | --- | 520 |
| | 9 - 12 | SP | 42 | >34 | 130 | 120 | --- | 760 |
| | 12 - 17 | SP-SM | 4 | 28 | 113 | 93 | --- | 150 |
| | 17 - 20 | SP | 36 | >34 | 130 | 119 | --- | 690 |
| 5 | 0 - 4.5 | SP | --- | 30 | 118 | 100 | --- | 170 |
| | 4.5 - 7.5 | SP | 1 | 26 | 110 | 88 | --- | 20 |
| | 7.5 - 9 | SP | 11 | 30 | 119 | 100 | --- | 200 |
| | 9 - 12 | SP | 31 | >34 | 130 | 117 | --- | 630 |
| | 12 - 17 | SM | 1 | 27 | 110 | 89 | --- | 40 |
| | 17 - 20 | SP | 61 | >34 | >130 | >120 | --- | >900 |
| 6 | 0 - 4.5 | SP | --- | 30 | 118 | 100 | --- | 170 |
| | 4.5 - 7.5 | SP | 14 | 31 | 120 | 103 | --- | 270 |
| | 7.5 - 12 | SP | 32 | >34 | 130 | 117 | --- | 640 |
| | 12 - 20 | SP | 16 | 32 | 122 | 105 | --- | 320 |
| 7 | 0 - 4.5 | SP | --- | 30 | 118 | 100 | --- | 170 |
| | 4.5 - 6 | SP | 25 | 34 | 127 | 112 | --- | 520 |
| | 6 - 12 | SP | 38 | >34 | 130 | 119 | --- | 710 |
| | 12 - 17 | SP | 5 | 28 | 114 | 94 | --- | 150 |
| | 17 - 20 | SP | 61 | >34 | >130 | >120 | --- | >900 |

Notes: pcf = pounds per cubic foot
psf = pounds per square foot
ksf = kips per square foot
(1) Estimate for a drained soil above the groundwater table.
(2) No value indicates a soil that is generally considered cohesionless.
(3) The values listed above are based upon emperical correlations with the average soil conditions encountered. Appropriate saftey factors should be used with these values.
(4) The soil layers presented above are generalized and should be used for design purposes only. The above values should not be used to assess constructability of the proposed pipeline.




Base Aerial From Google Earth Pro

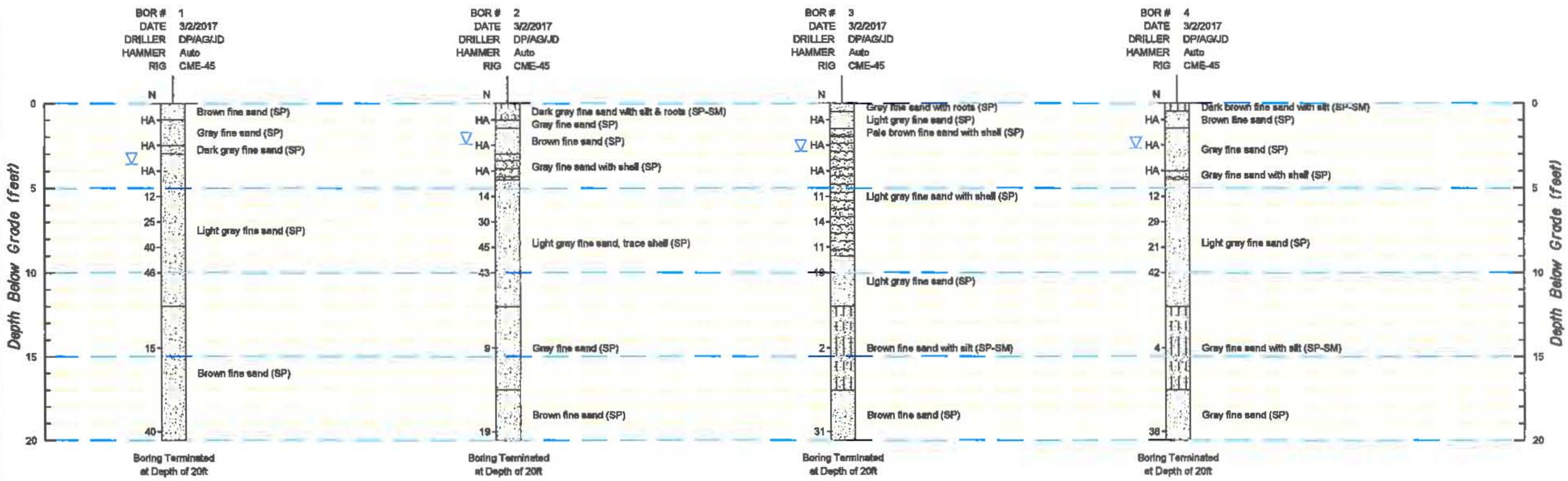
SCALE: 1"=300'

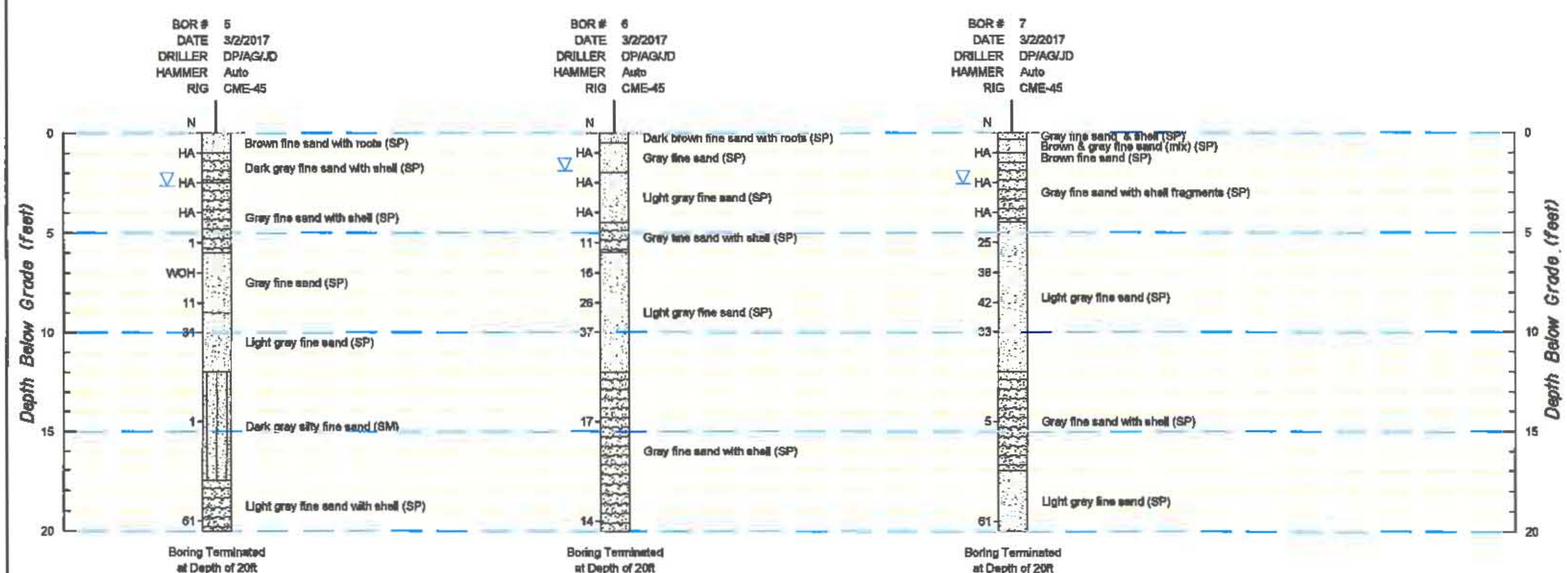
TEST BORING LOCATIONS

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

Test Locations
Force Main 11
Holmes Blvd. to 68th St., Holmes Beach
Manatee County, Florida

| DRAWN BY: KGS | CHECKED BY: | DATE: 3/13/17 |
|---|---|---|
| FILE NO. 16-7390 | APPROVED BY: | FIGURE: 1 |




## LEGEND

▽ GROUNDWATER LEVEL MEASURED ON DATE DRILLED

N SPT N-VALUE IN BLOWS PER FOOT (UNLESS OTHERWISE NOTED)

SPT N VALUES CONVERTED TO EQUIVALENT SAFETY HAMMER

WOH WEIGHT OF HAMMER

| GRANULAR MATERIALS-RELATIVE DENSITY | SPT (BLOWS/FOOT) |
|---|---|
| VERY LOOSE | LESS THAN 4 |
| LOOSE | 4-10 |
| MEDIUM DENSE | 10-30 |
| DENSE | 30-50 |
| VERY DENSE | GREATER THAN 50 |

| SILTS AND CLAYS CONSISTENCY | SPT (BLOWS/FOOT) |
|---|---|
| VERY SOFT | LESS THAN 2 |
| SOFT | 2-4 |
| FIRM | 4-8 |
| STIFF | 8-15 |
| VERY STIFF | 15-30 |
| HARD | GREATER THAN 30 |

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

**Soil Boring Logs**
**Force Main 11**
**Holmes Blvd. to 68th St., Holmes Beach**
**Manatee County, Florida**

| DRAWN BY: KGS | CHECKED BY: | DATE: 3/13/17 |
|---|---|---|
| FILE NO. 16-7390 | APPROVED BY: | FIGURE: 2 |