



# **Hancock Bridge Parkway Water Main Replacement**

# **Basis of Design Report**

**Lee County Utilities  
Solicitation No. CN 140526  
Project No. 7462**

October 2018



**GREELEY AND HANSEN**

## Table of Contents

<b>Executive Summary .....</b>	<b>ES-1</b>
Project Area .....	ES-1
Purpose of the Project.....	ES-1
Proposed Design.....	ES-2
<b>Section 1 Introduction .....</b>	<b>1-1</b>
1.1 Project Description and Scope of Services .....	1-1
1.2 Purpose of the Basis of Design Report .....	1-1
<b>Section 2 Existing Conditions.....</b>	<b>2-1</b>
2.1 Existing Corridor.....	2-1
2.2 Soils Investigation and Existing Condition.....	2-2
<b>Section 3 Proposed Water Main Pipeline Design .....</b>	<b>3-1</b>
3.1 Design Methods and Permitting .....	3-1
3.2 Design Criteria .....	3-1
3.3 Pipeline Material.....	3-2
3.4 Hydraulic Design Criteria.....	3-3
3.5 Pipeline Appurtenances .....	3-3
3.6 Connections to Existing Main.....	3-3
3.7 Subsurface Utility Engineering (SUE) .....	3-4
3.8 Corridor Analysis.....	3-7
3.8.1 Hancock Bridge Parkway .....	3-9
3.8.2 Moody Road.....	3-12
3.9 Property Requirements .....	3-16
3.10 Pipe Bedding and Backfill Requirements .....	3-16
3.11 Pipe Thrust Restraint .....	3-16
3.12 Construction Constraints.....	3-17
<b>Section 4 Horizontal Directional Drill Design .....</b>	<b>4-1</b>
4.1 HDD Design Criteria.....	4-1
4.2 HDD Design Calculations.....	4-1

## Table of Contents

<b>Section 5 Construction Timeline.....</b>		<b>5-1</b>
5.1	Procurement and Construction Schedule.....	5-1
<b>Section 6 Opinion of Probable Cost .....</b>		<b>6-1</b>
6.1	Basis of Opinion of Probable Cost .....	6-1
6.2	Opinion of Probable Construction Cost .....	6-2

### **List of Tables**

Table 3-1: Hancock Bridge Parkway Permit Schedule and Requirements .....	3-1
--	-----

### **List of Figures**

Figure 1-1: Project Location .....	1-2
Figure 2-1: Geotechnical Investigation Locations .....	2-4
Figure 3-1: General Pipe Alignment and Connection Points.....	3-5
Figure 3-2: Subsurface Utility Engineering (SUE) Locations with Details .....	3-6
Figure 3-3: Replacement Pipe at Hancock Bridge Parkway and Palm Avenue .....	3-8
Figure 3-4: Hancock Bridge Parkway Alignment 1 (Recommended) .....	3-10
Figure 3-5: Moody Road Alignment 1 (Recommended).....	3-13
Figure 3-6: Moody Road Alignment 2 .....	3-14
Figure 3-7: Moody Road Alignment 3 .....	3-15
Figure 4-1: Hancock Bridge Parkway Horizontal Directional Drill Elevation View .....	4-2
Figure 4-2: Moody Road Horizontal Directional Drill Elevation View.....	4-3

### **Appendices**

1. Follow-up Letter from Ardaman and Associates
  
2. Geotechnical Report

## Executive Summary

### Project Area

The project area is mostly residential and is accessed by four public roadways, Hancock Bridge Parkway, Moody Road, Anchor Way, and Seaworthy Road. Hancock Bridge Parkway is a four-lane divided roadway. The intersection of Hancock Bridge Parkway and Palm Avenue is at the eastern end of the project boundary. The project alignment begins at the Palm Avenue intersection, curves southwest and extends across Yellow Fever Creek via the Hancock Bridge until it crosses Moody Road. The western boundary of the project extends about 230 feet west of the intersection of Hancock Bridge Parkway and Moody Road. The project location is shown in **Figure 1.1**.

Moody Road is a two-lane collector street running north and south that intersects Anchor Way before crossing over Hancock Creek then continuing to Seaworthy Road. The northern end of the project is about 150 feet north of the intersection of Moody Road and Seaworthy Road and extend south along Moody Road to 140 feet south of its intersection with Hancock Bridge Parkway.

### Purpose of the Project

The project is located in North Fort Myers and The purpose of the Hancock Bridge Parkway Water Main Improvement project is to replace approximately 3,750 linear feet (LF) of 8-inch and 10-inch of water main pipe, as well as the 2-inch and 4-inch service lines located on Seaworthy Road and Anchor Way due to the poor condition of the pipe and unsuitability of the materials.

In order to design these improvements, a design criteria was established and documented herein based on existing information and information obtained through land survey and geotechnical investigations.

First of all, numerous meetings/workshops took place order to establish and document Lee County Utilities' (LCU's) preferences and needs aside from the Lee County regulations and standards.

Second, G&H reviewed existing data provided by LCU such as record drawings for the existing water pipes and bridges along the existing water main alignment. The record drawings of the existing water main provided location and the number of service connections. The record drawings for the bridges provided vital information regarding the geotechnical investigation results and installation of the bridge.

Later, a land survey was performed in order to obtain physical features in the area, location of existing utilities, easements, Rights-Of-Way (ROW) and topography. In addition, legal descriptions were requested from the surveyor to include easements for two areas which are not part of the ROW and are necessary to provide adequate alignment.

Along the alignment several geotechnical investigations were performed, in order to determine soil conditions and assist with the evaluation of installation methods such as trenchless and open cut. Other considerations in selecting an installation method are locations of existing utilities, impact to traffic flow, land features, soil conditions and maintenance considerations.

## Proposed Design

Section 3.8 describes the initial alignments concepts; however, as a results of additional design considerations, utility locations, land and geotechnical analysis results, the alignment was modified. The latest alignments based on the most recent land survey and geotechnical results are shown in the plans.

The proposed design includes the pipeline improvements along Moody Road, the installation of approximately 900 feet of ten inch HDPE along the west side of the bridge using horizontal directional drilling (HDD), crossing 24 feet under Hancock Creek, and ending north of the intersection of Seaworthy and Moody Road. The open-cut portion along Moody Road will be 8 inch PVC. The pipeline improvements along Hancock Bridge Parkway include a 1700 ft. horizontal directional drill using 12-inch HDPE, crossing 36 feet underneath Yellow Fever Creek and open-cut replacement of the existing pipeline with 10-inch PVC along Hancock Bridge Parkway from the eastern most HDD location to just west of Palm Avenue. The HDD emerges on the southwest side of the intersection of Hancock Bridge Parkway and Moody Road. This streamlines construction with the use of a single trenchless installation technique, reduces the impact to the adjacent wetlands, and minimizes traffic disruptions. Open cut installations connecting to the existing mains will be 10-inch PVC.

Roadway crossings at Moody Road and Seaway Avenue, Moody Road and Anchor Way and west of the intersection with Moody Road and Hancock Bridge are all designed using Jack and Bore methods. These crossings are all 8-inch ductile iron pipe in 18-inch steel casing. The construction bid form will allow the alternative for installation using 10-inch HDPE by HDD providing there is a benefit to the project in using HDD at those locations.

Existing service lines along Seaway Road and Anchor Way will be replaced with PVC pipe and polytube connections to existing meter boxes. Additionally, all existing hydrants that are connected to the existing lines which are being abandoned, will be replaced with new hydrants. Existing waterlines greater than 2-inch in diameter will be abandoned in-place, capped and filled with grout. Waterlines 2-inch and smaller will be capped and abandoned in-place.

## Section 1 Introduction

### 1.1 Project Description and Scope of Services

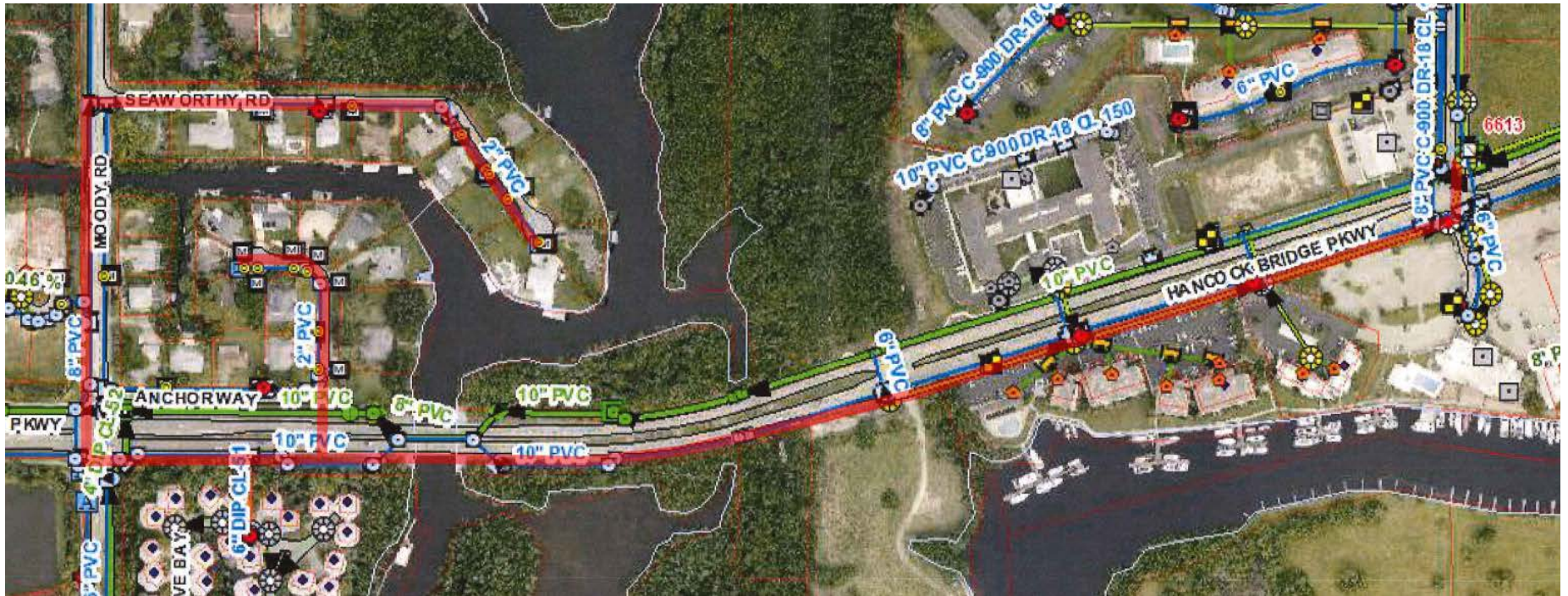
Lee County Utilities retained Greeley and Hansen (G & H) to provide engineering services to design and support bidding services for the replacement of a water main along Hancock Bridge Parkway, between Moody Road and Palm Avenue and along Moody Road from Hancock Bridge Parkway to Seaworthy Road, as well as the water main along the entire length of Anchor Way and Seaworthy Road.

Specifically, the COUNTY requested the replacement of the existing 8-inch and 10-inch water mains along Hancock Bridge Parkway between Moody Road and Palm Avenue. This project involves replacing the existing 10-inch water main on Hancock Bridge Parkway with a new 10-inch diameter equivalent (12-inch HDPE) water main and replacing the existing 8-inch water main on Moody Road with an 8-inch equivalent (10-inch HDPE) water main. In addition, existing two-inch mains on Anchor Way and Seaworthy Road will be replaced with 8-inch and 4-inch PVC mains. The PROJECT includes two subaqueous crossings, one under Yellow Fever Creek and the other under the Hancock Creek Canal. The project location is shown in Figure 1.

### 1.2 Purpose of the Basis of Design Report

The purpose of this report is to collect and review the available data about the existing utilities in the project location. This report includes a review of the right-of-way information, survey data, as-built road construction, bridge plans, and any other available records relating to the project. The existing utilities and pavement locations will be verified by a land survey in the project area. A geotechnical investigation that includes soil borings, a visual soil classification, and soil composition profile will be performed at various locations critical to pipeline construction. Recommendations for the pipeline's alignment and a preliminary construction cost opinion for the project will be included in this report.

**Figure 1-1**  
**Project Location**





## Section 2 Existing Conditions

### 2.1 Existing Corridor

The project area contains five public roadways, Hancock Bridge Parkway, Palm Avenue, Moody Road, Anchor Way, and Seaworthy Road. Hancock Bridge Parkway is a four-lane divided roadway. Palm Avenue intersects Hancock Bridge Parkway along the eastern end of the project boundary. The project alignment begins at the Palm Avenue intersection, curves southwest and extends across Yellow Fever Creek via the Hancock Bridge until it crosses Moody Road. A storm drain runs underneath Moody Road just north of the Hancock Bridge Parkway and Moody Road intersection.

Moody Road is a two-lane collector street running north and south that intersects Anchor Way before crossing over Hancock Creek, then continuing to Seaworthy Road. A storm drain runs underneath the road shortly north of the bridge over Hancock Creek.

Existing utilities and infrastructure located within the project area that have been identified are specified below:

- One bridge along Hancock Bridge Parkway crossing over Yellow Fever Creek.
- One bridge along Moody Road crossing over Hancock Creek.
- 10-inch, 8-inch and 2-inch PVC water main.
- 10-inch and 8-inch PVC and 4-inch DIP Gravity Sewer.
- 10-inch PVC Force Main under Hancock Bridge Parkway.
- 12" HDPE encased in 24" HDPE under Hancock Bridge Parkway at Palm Avenue.
- 4-inch and 6-inch AC Main under Moody Road, Anchor Way, and Seaworthy Road.
- Buried fiber optic and telephone cables along south side of Hancock Bridge Parkway and west side of Moody Road.
- Gas main running east-west along Hancock Bridge Parkway.

- Overhead Power Lines along the median of Hancock Bridge Parkway and the west side of Moody Road, in addition to various overhead lines servicing the residences along Anchor Way and Seaworthy Road
- 6-foot wide sidewalk along the southern edge of Hancock Bridge Pkwy between Palm Avenue and Moody Road.
- 6-foot wide sidewalk along the eastern edge of Moody Road and Moody Bridge.

## 2.2 Soils Investigation and Existing Condition

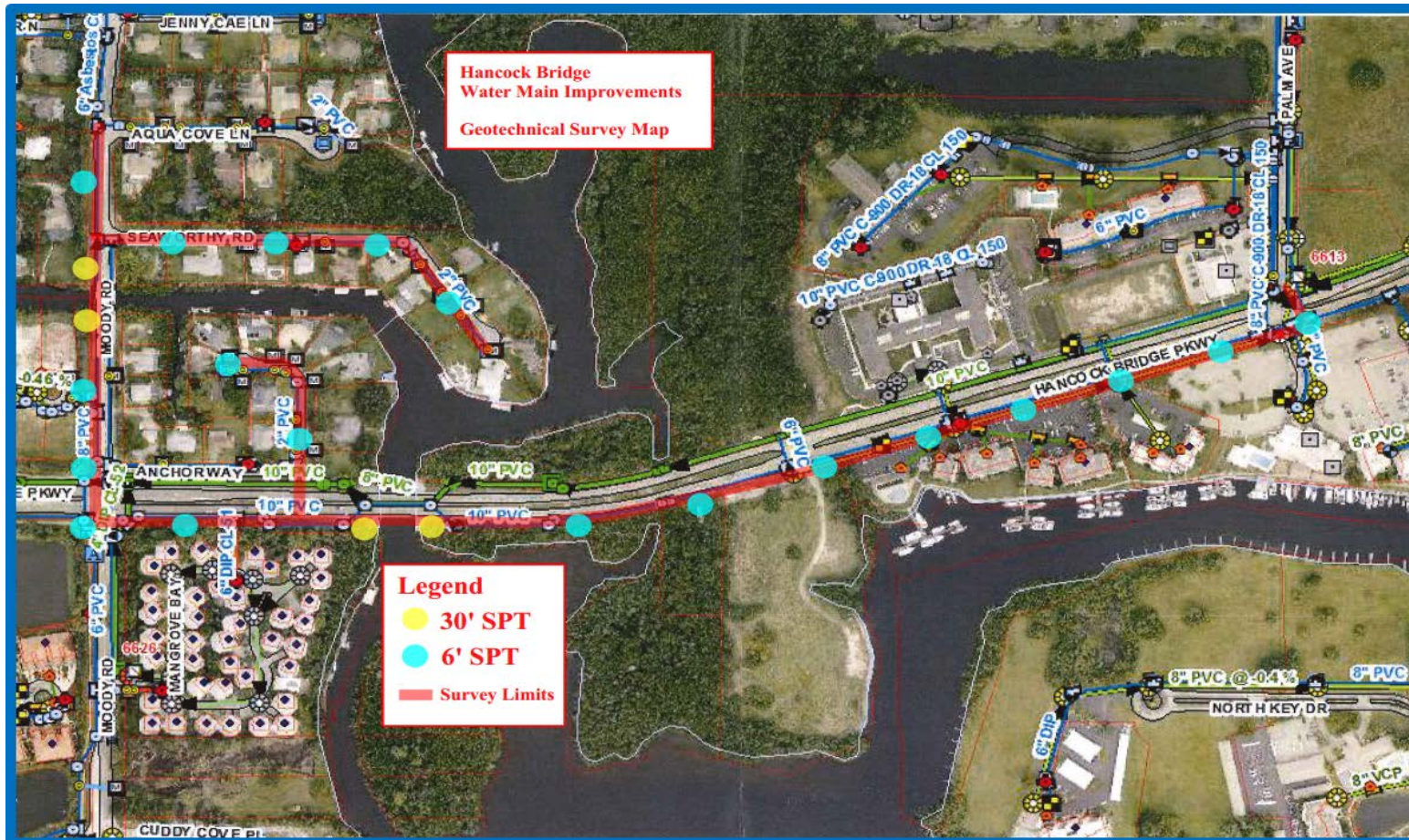
The soils investigations results is included in the appendix. The borings selected were nineteen 6-foot deep hand auger borings taken along proposed replacement pipeline locations and four 30-foot deep standard proctor test (SPT) borings at horizontal directional drill locations under Hancock Bridge Parkway and Moody Road. Refer to Figure 2.1 for boring locations. The findings of the soils investigation are summarized follow:

- Hand auger borings along replacement pipeline locations:
  - The hand auger borings along the proposed alignment typically encountered fine sands (SP/SP-SM Or A-3) from the ground surface to depths ranging from 3 to 6 feet below the existing ground surface. Below the fine sands, the borings typically encountered clayey or silty fine sands extending to the termination of the hand auger borings
- Horizontal Directional Drill locations:
  - Under Yellow Fever Creek along Hancock Bridge Parkway
    - ❖ Borings SPT-3 and SPT-4 encountered 1-foot of asphalt and rock base at the surface. Below the pavement section, the borings typically encountered silty and fine sands to depths ranging from about 12.5 to 15.5 feet below the existing road surface. Below the fine sands, the borings typically encounter stratum of silty or silty clayey fine sands and clayey fine sands or sandy lean clays extending to a depth of 37.5 feet underlain by sandy fat clays to the termination of the borings at a depth of 50 feet below the surface.

- Under Hancock Creek along Moody Road
  - ❖ Borings SPT-1 and SPT-2 encountered 1-foot of asphalt and rock base at the surface. Below the pavement section, the borings typically encountered silty and fine sands to depths ranging from about 17.5 to 27.5 feet below the existing road surface. Below the fine sands, the borings typically encounter stratum of silty or silty clayey fine sands and clayey fine sands or sandy lean clays extending to a depth of 37.5 feet underlain by sandy fat clays to the termination of the borings at a depth of 50 feet below the surface.

The soils investigation report indicates the fine sands and slightly fine sands encountered in the test borings are suitable for use as backfill materials and suitable for pipe bedding. However the pipe should be bedded in gravel such as FDOT number 89 or 57 stone if rock occurs within six inches of the pipe bottom, or unsuitable soil types are encountered at pipe invert such as silty clayey sands or clayey sands.

Figure 2-1:  
Geotechnical Investigations Locations



## Section 3 Proposed Water Main Pipeline Design

### 3.1 Design Methods and Permitting

The proposed water mains will be installed by open-cut along the roadway wherever feasible. The two navigable water bodies will be crossed by utilizing a horizontal directional drill and the roads will be crossed by either a jack and bore or horizontal directional drill methods, as appropriate. Any of the proposed methods are considered acceptable by the pertinent regulatory agencies described below.

The water main installation needs to meet regulatory requirements and obtain a permit for construction local and state agencies such as the Florida Department of Environmental Protection (FDEP), United States Army Corp of Engineers (USACE), South Florida Water Management District (SFWMD), and the Lee County Department of Transportation (LCDOT). The table shown below list the agencies, the name and type of permit necessary for this project. It also list the anticipated time for the agency to review the permit application and issue the permit.

**Table 3-1: Hancock Bridge Parkway Permit Schedule and Requirements**

Permitting Agency	Permit Name	Form/Required Documents	Anticipated Review Time	Necessary Project Deliverables
U.S. Army Corps	Section 10 Permit	<u>ENG Form 4345</u>	90 to 120 days	Wetland Delineation (complete) 60% Plan and Profile
FDEP/LCDOH	PWS Extension	<u>62-555.900(7)-Alternate</u>	30 days	60% Plan and Profile
SFWMD	ERP	<u>62-330.060 (exemption)</u> <u>62-330.457</u>	60 days	Wetland Delineation (complete) 60% Plan and Profile
Lee County	Limited Review Development Order	<u>Type D Application</u>	30 days	100% Construction Plans

## 3.2 Design Criteria

The Florida Administrative Code, Lee County Utilities Operations Manual, and the Lee County Administrative Code provide horizontal and vertical alignment criteria for routing of potable water mains. The design criteria and setbacks for this project include:

- Minimum ten feet horizontal separation from existing sewer mains
- Minimum fourteen feet of cover under the river bottom for the subaqueous crossings, maintained at a horizontal distance of at least twenty five feet from the toe of the river side slopes
- Minimum four feet offset from edge of pavement
- Minimum vertical cover of thirty inches and a maximum of 48 inches of cover for open-cut installation in unpaved areas
- Minimum vertical cover of thirty six inches under pavement as measured from the top of the pipe or casing, and any casing must extend four feet beyond the edge of the pavement.

## 3.3 Pipeline Material

The construction project will utilize different pipeline materials including: high density polyethylene (HDPE), polyvinyl chloride (PVC), and ductile iron pipe (DIP) that will either be installed directly or in a steel casing. The subaqueous and roadway crossings will utilize either the jack and bore technique with an installed casing, a direct install horizontal directional drill, pipe ramming, micro tunneling, or pipe bursting, as appropriate.

The following water main material is approved in Section 5.3 of the Lee County Utilities Operations Manual:

- Ductile Iron Pipe (DIP)
  - DIP shall be used for all vertical deflections, ditch crossings, subaqueous crossings, and under all pavement unless otherwise approved by LCU.
  - Water mains larger than 12-inch shall be constructed of Ductile Iron Pipe.

- Ductile Iron Pipe shall be a minimum pressure Class 250 and will be accepted in any diameter for use within the distribution system.
  - The pipe wall thickness shall not be less than that required by a working pressure of 250 psi in laying condition Type 4 "B" with 5-foot cover in conformance with ANSI Standard A21.50.
- High Density Polyethylene (HDPE) AWWA C906 PE 3408 DR11
- HDPE water mains shall have the same equivalent internal diameter as DI water mains and equivalent pressure class rating as corresponding PVC water mains.
  - HDPE shall be ductile iron pipe sized (DIPS).
- Polyvinyl Chloride Pipe (PVC) AWWA C900 DR18, minimum Class 150
- PVC pipe 4-inch in diameter or larger shall have provisions for expansion and contraction provided in the joints.
  - All PVC pipe less than 4-inch in diameter shall be Schedule 80 with a pressure rating of 200 psi solvent welded.

Steel casing pipe for proposed jack and bores shall be in accordance with the minimum specifications and wall thicknesses as identified in Lee County Administrative Code 11-12.

### 3.4 Hydraulic Design Criteria

Hydraulic modeling is not included in the scope of services. Previous analysis by Lee County Utilities has confirmed that 10-inch and 12-inch diameter mains are required.

### 3.5 Pipeline Appurtenances

The Project will include pipeline appurtenances, which facilitate construction, operation and maintenance of the water main. Isolation valves shall be placed at pipe terminations, all intersecting water mains, fire hydrants, on both sides of all canal crossings, and all other locations necessary to provide an operable, easily maintained and repaired water distribution system, per the Lee County Operations Manual. The maximum length of water main between valves, which can be used for shutting down the line for repair work, shall not exceed 500 feet in commercial and industrial areas, and 1,000 feet in residential areas.

### 3.6 Connections to Existing Main

A connection to existing Lee County Utilities water mains will be made at Palm Avenue, the intersection of Hancock Bridge Parkway and Moody Road, the intersection of Moody Road and Seaworthy Road.

See **Figure 3.1**

### 3.7 Subsurface Utility Engineering (SUE)

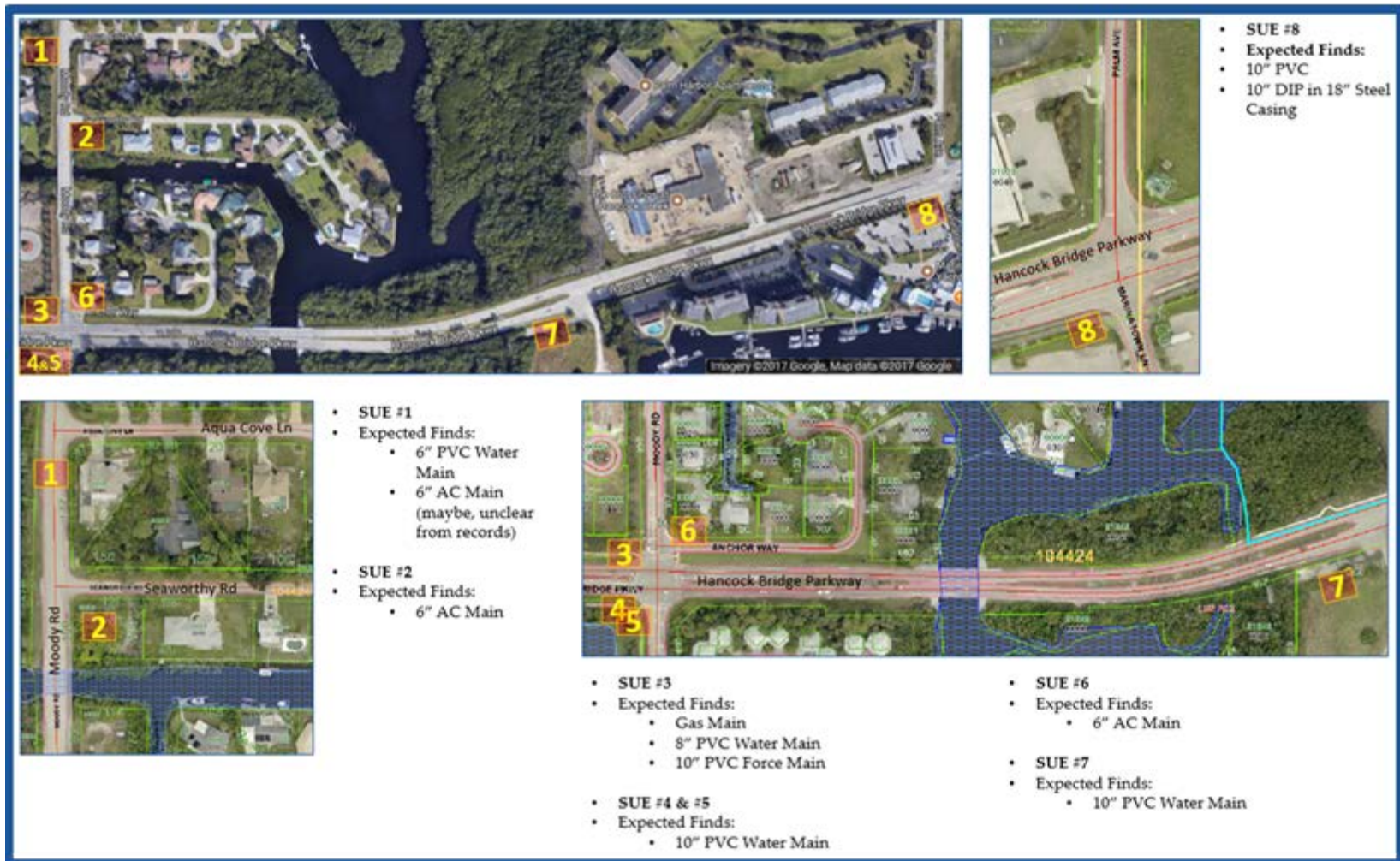
Eight vacuum excavations (“soft digs”) will be conducted at proposed connections and potential conflict points to obtain accurate horizontal and vertical alignment of existing mains and utilities. Proposed locations are listed in **Figure 3.2**.



**Figure 3-1:**  
**General Pipe Alignment and Connection Points**



**Figure 3-2: Subsurface Utility Engineering (SUE) Locations with Details**



### 3.8 Corridor Analysis

The corridor along Hancock Bridge Parkway is relatively wide and contains numerous existing utilities running parallel to the road and crossing underneath it. As the project goal involves replacing existing mains along a heavily trafficked corridor, care and consideration will be given to minimize traffic and service disruptions, to ensure safety of construction personnel and to avoid unnecessary complexities involving existing infrastructure.

The corridors along Moody Road and the connecting residential streets of Anchor Way and Seaworthy Road are narrow and contain several critical existing utilities. Existing asbestos cement (AC) water main lies along the east side of Moody Road between Hancock Bridge Parkway and Aqua Cove Lane, located north of the project area. Additionally, six-inch AC and two-inch PVC mains service the homes along Anchor Way and Seaworthy Road.

Several water main alignment alternatives along the project area were analyzed to determine the most cost-efficient and feasible route. The proposed pipe alignment along Hancock Bridge Parkway at Palm Avenue is shown in **Figure 3.3**. The alternative alignments are only proposed for pipeline replacement under Moody Road. These alternative installation techniques are presented in further detail in Sections 3.8.1. and 3.8.2 below.

**Figure 3-3: Replacement Pipe at Hancock Bridge Parkway and Palm Avenue**



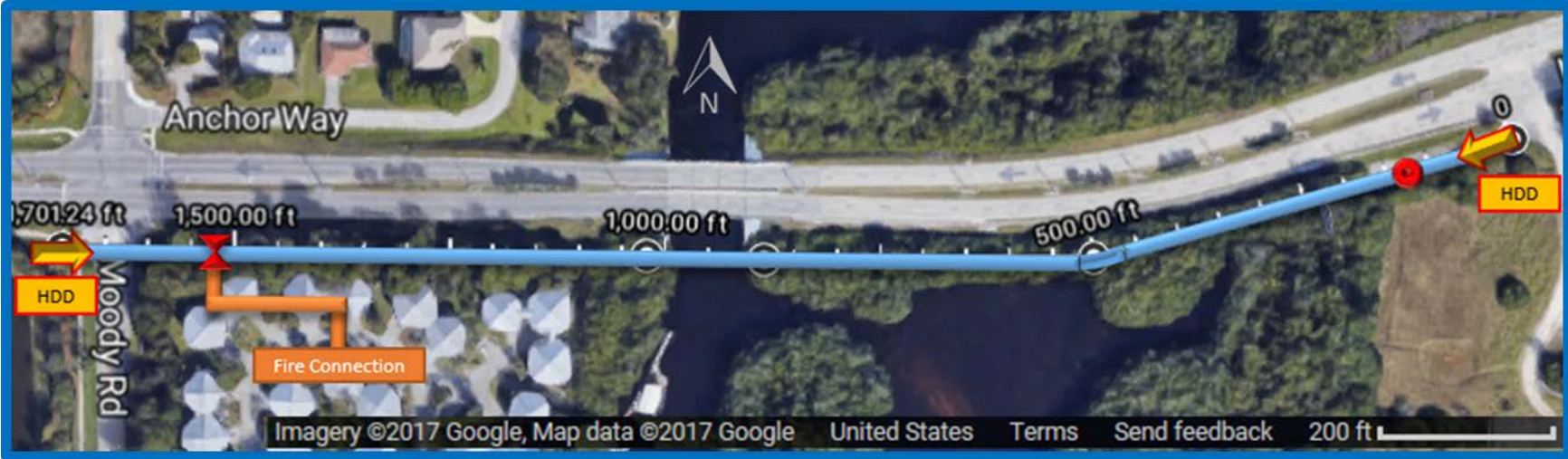
### 3.8.1 Hancock Bridge Parkway

Each pipe alignment alternative along Hancock Bridge Parkway involves installation of a twelve inch HDPE pipeline along the south side of the road, extending from Palm Avenue, crossing under Yellow Fever Creek, and ending at the west side of Moody Road.

The recommended alignment, shown in **Figure 3.4**, involves a 1700 ft. horizontal directional drill underneath Yellow Fever Creek and open-cut replacement of the existing pipeline along Hancock Bridge Parkway from the eastern most HDD location to Palm Avenue. The HDD emerges on the southwest side of the intersection of Hancock Bridge Parkway and Moody Road. This alternative was chosen because it streamlines construction with the use of a single trenchless installation technique, reduces the impact to the adjacent wetlands, and minimizes traffic disruptions.

Alternative two, shown in **Figure 3.5**, uses a jack and bore to cross underneath Moody Road at Hancock Bridge Parkway. This method would potentially have a higher construction cost and a larger required construction area.

Figure 3-4: Hancock Bridge Parkway Alignment 1 (Recommended)



Features:

- ~1,700 ft HDD 12" HDPE
- Leak Detection Assembly
- All construction in ROW, all setbacks maintained

**Figure 3-5: Hancock Bridge Parkway Alignment 2**



**Features:**

- ~1,400 ft HDD 12" HDPE
- ~200 ft. Jack and Bore under Moody Rd (12" HDPE in 18" steel)
- Leak Detection Assembly
- All construction in ROW, all setbacks maintained

### 3.8.2 Moody Road

Pipeline improvements along Moody Road include the installation of a twelve-inch HDPE along the west side of the roadway, extending from Hancock Bridge Parkway, crossing under Hancock Creek, and ending north of the intersection of Seaworthy and Moody Road.

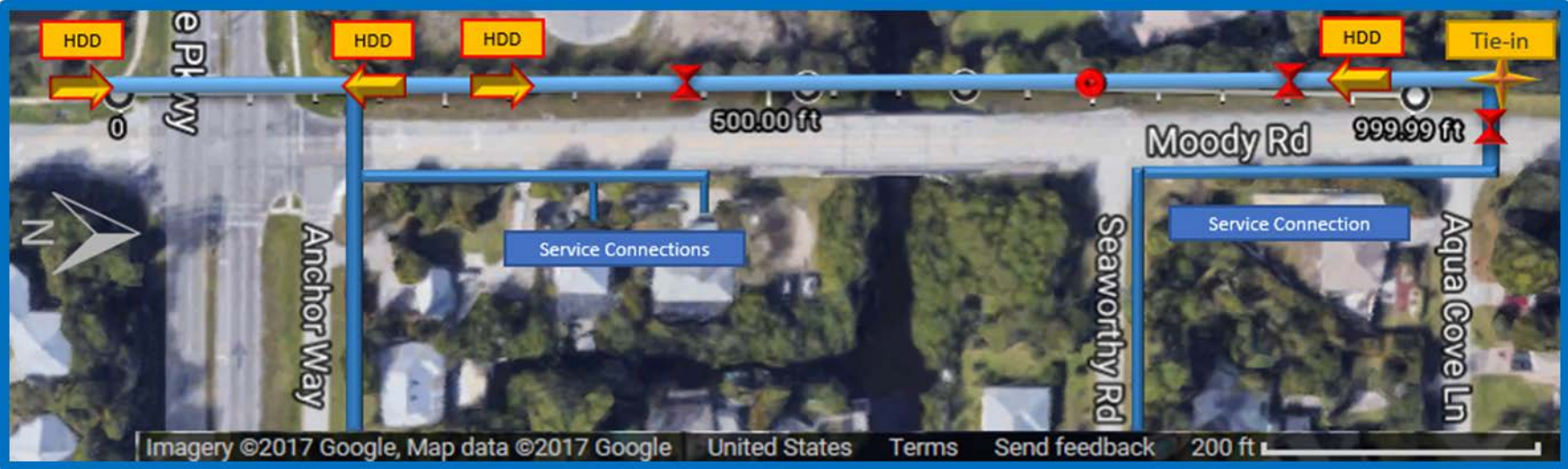
The recommended alignment, shown in **Figure 3.6**, involves two horizontal directional drills, one under Hancock Creek at the Moody Road Bridge, and another under Hancock Bridge Parkway at Yellow Fever Creek. This alternative was chosen because it streamlines construction with the use of a single trenchless installation technique, reduces the impact to the adjacent wetlands, and utilizes a smaller construction footprint.

Alternative 2, shown in **Figure 3.7**, involves a single 1,000 foot directional drill that extends along Moody Road from the south side of Hancock Bridge Parkway to slightly before the Seaworthy Road intersection. This method would potentially include a less complex construction process due to a single HDD covering the roadway and the canal, but the resulting deeper service connections along Moody Road would prove to be more difficult for construction and maintenance purposes.

Alternative 3, shown in **Figure 3.8**, replaces the HDD crossing under Hancock Bridge Parkway with a jack and bore procedure. This method would require a larger construction area and dewatering operations may be affected by the proximity of an existing stormwater pond.



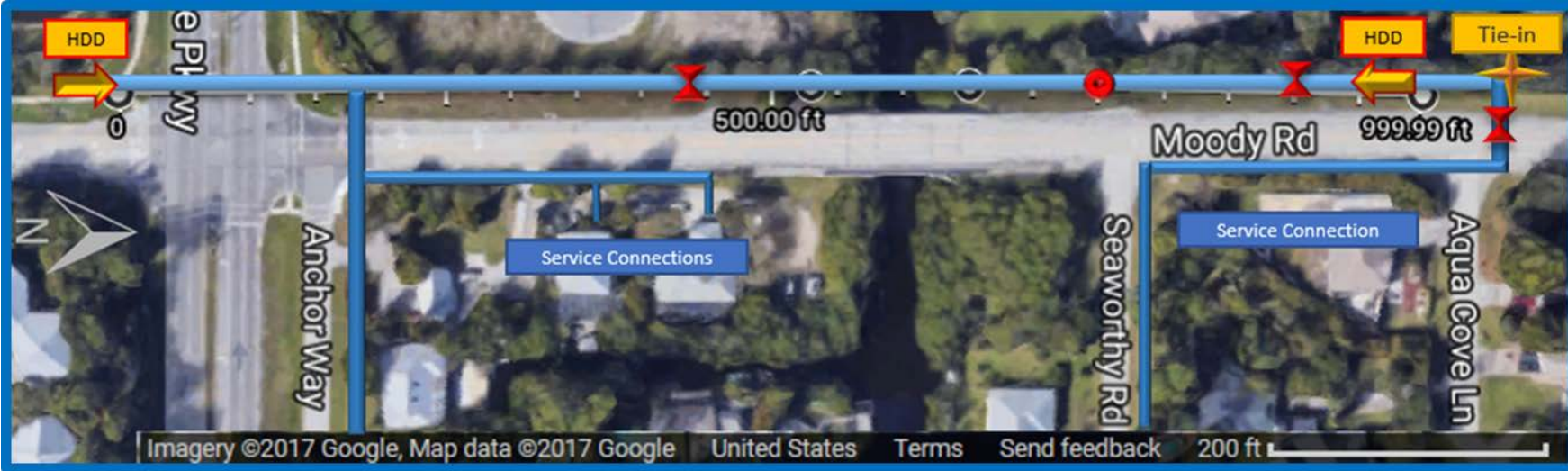
Figure 3-5: Moody Road Alignment 1 (Recommended)



**Features:**

- ~800 ft. HDD 12" HDPE
- ~200 ft. HDD under Hancock Bridge Parkway
- Leak Detection Assembly
- All construction in ROW, all setbacks maintained

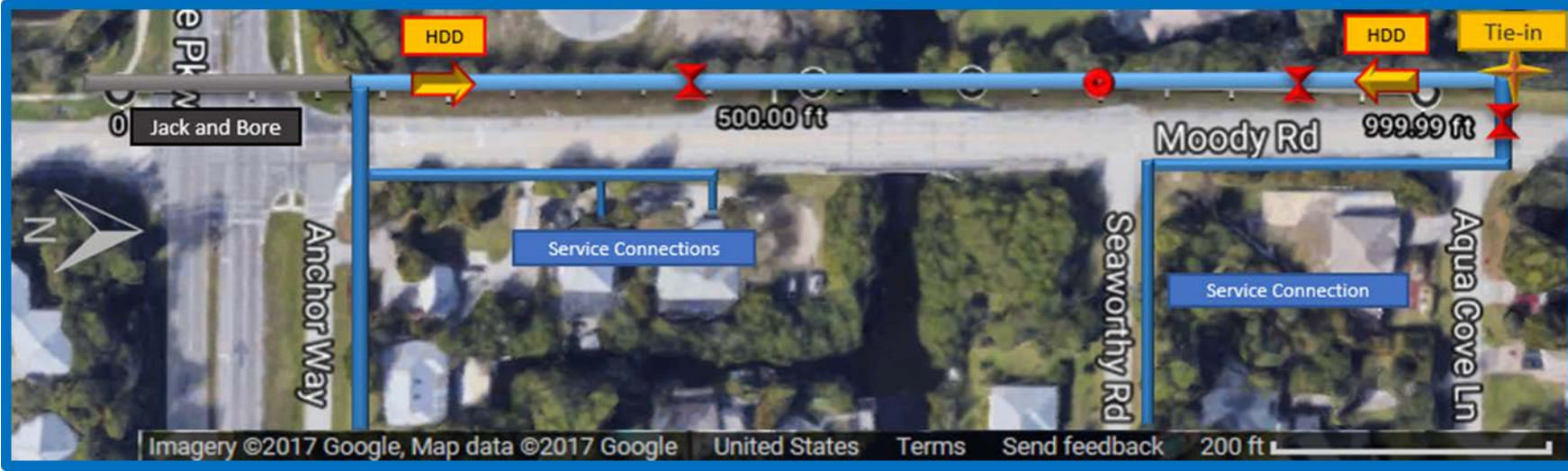
Figure 3-6: Moody Road Alignment 2



**Features:**

- ~1000 ft. HDD 12" HDPE
- Leak Detection Assembly
- All construction in ROW, all setbacks maintained

Figure 3-7: Moody Road Alignment 3



**Features:**

- ~800 ft. HDD 12" HDPE
- ~200 ft. Jack and Bore under Hancock Bridge Parkway (12" HDPE in 18" Steel Casing)
- Leak Detection Assembly
- All construction in ROW, all setbacks maintained

### 3.9 Property Requirements

Given the tight corridors along Hancock Bridge Parkway, it was necessary to obtain legal descriptions for three easements. The following easements will be necessary to install the proposed water main.

- NW corner of Hancock Bridge Parkway and Moody Road (3,911 square feet),
- SW corner of Hancock Bridge Parkway and Moody Road (4,6745 square feet), and
- On Hancock Bridge Parkway (7,200 square feet)

These easements will be added to the bid drawings and a legal description will be used by LCU to process the easements as soon as possible.

### 3.10 Pipe Bedding and Backfill Requirements

Pipe bedding and trench backfill for open-cut construction will comply with the requirements of the Lee County Utilities Operations Manual. The pipe bedding will be select fill compacted to a minimum 98% of the maximum dry density in paved areas and compacted to a minimum 95% in unpaved areas as determined by ASTM D 1557. Pipe laying will proceed in dewatered trenches with a stable bottom. The bedding shall be comprised of fine material with no fragments exceeding a diameter of two inches and shall be thoroughly compacted and tested. The backfill shall be comprised of fragments having a maximum diameter of six inches.

### 3.11 Pipe Thrust Restraint

Thrust is the unbalanced force present in a pressurized conduit at fittings such as bends, valves or outlets. Pipeline thrust at bends can be calculated by the formula:

$$T = 2 \cdot P \cdot A \cdot \sin\left(\frac{\theta}{2}\right)$$

Where: T = force in pounds

P = internal pressure, psi

A = internal pipe area in square inches ( $\pi r^2$ )



$\theta$  = angle of bend

At line valves, outlets, or bulkheads the thrust force is simply the product of the internal pressure and the internal area of the pipe,  $T = P \cdot A$ .

To control thrust and prevent movement of fittings, joint restraints are recommended. Fittings for ductile iron pipe shall conform to the requirements of ANSI/AWWA C153/A21.53 or ANSI/AWWA C110/A21.10, mechanical and push-on joints shall conform to ANSI/AWWA C111/A21.11, and flanged joints shall conform to ANSI/AWWA 115/a21.51. However, precast thrust blocks may be desirable at connections to the existing water mains, at locations where the existing pipe is unrestrained, and at newly installed fire hydrants. Thrust Restraints will be utilized as required by the Lee County Detail Number 9.19 and specified by the engineer.

### 3.12 Construction Constraints

During construction activities, potable water service will need to be maintained with a minimum of disruption to customers in and around the project area. The horizontal directional drill operation will need to maintain necessary setbacks to the existing roadway and the surface water bodies. Additionally, proper precautions erosion control measure will need to be taken to ensure drilling operations do not impair the waterway or the stormwater system. Existing utilities will need to be protected. Finally, the existing site is in close proximity to wetlands, thus any excavated materials from utility installation will need to be stored in upland areas.

## Section 4 Horizontal Directional Drill Design

### 4.1 HDD Design Criteria

Design of the Horizontal Directional Drills (HDD) along Hancock Bridge Parkway and Moody Road is based on Chapter 12 of The Plastic Pipe Institute's Handbook of Polyethylene Pipe, which details best practices and critical design parameters for HDDs. Critical design parameters include entry and exit angles, pipe depth, minimum bending radius and safe pullback force.

Major constraints relevant to the proposed HDDs along Hancock Bridge Parkway and Moody Road include depth of cover under navigable channels and depth of cover under roadways. Regulations enforced by the U.S. Army Corps of Engineers state that there must be a minimum fourteen feet (14 feet) of cover between navigable channel bottom and the top of pipe for subaqueous HDDs. That depth requirement extends twenty-five feet laterally from each channel side slope. Finally, according to Lee County DOT regulations, a minimum of thirty inches cover (30 inches) of depth under their roadways.

### 4.2 HDD Design Calculations

HDD design calculations are based on ASTM F1962 - Standard Guide for Use of Maxi-Horizontal Directional Drilling for Placement of Polyethylene Pipe or Conduit Under Obstacles, Including River Crossings. Greeley and Hansen uses design formulas derived from PLEXCO software. Inputs to the formula include pipe design parameters, including outside diameter, wall thickness, Poisson's Ratio, depth of bore, entry and exit angle, length of drill, etc.

Figure 4-1: Hancock Bridge Parkway Horizontal Directional Drill Elevation View

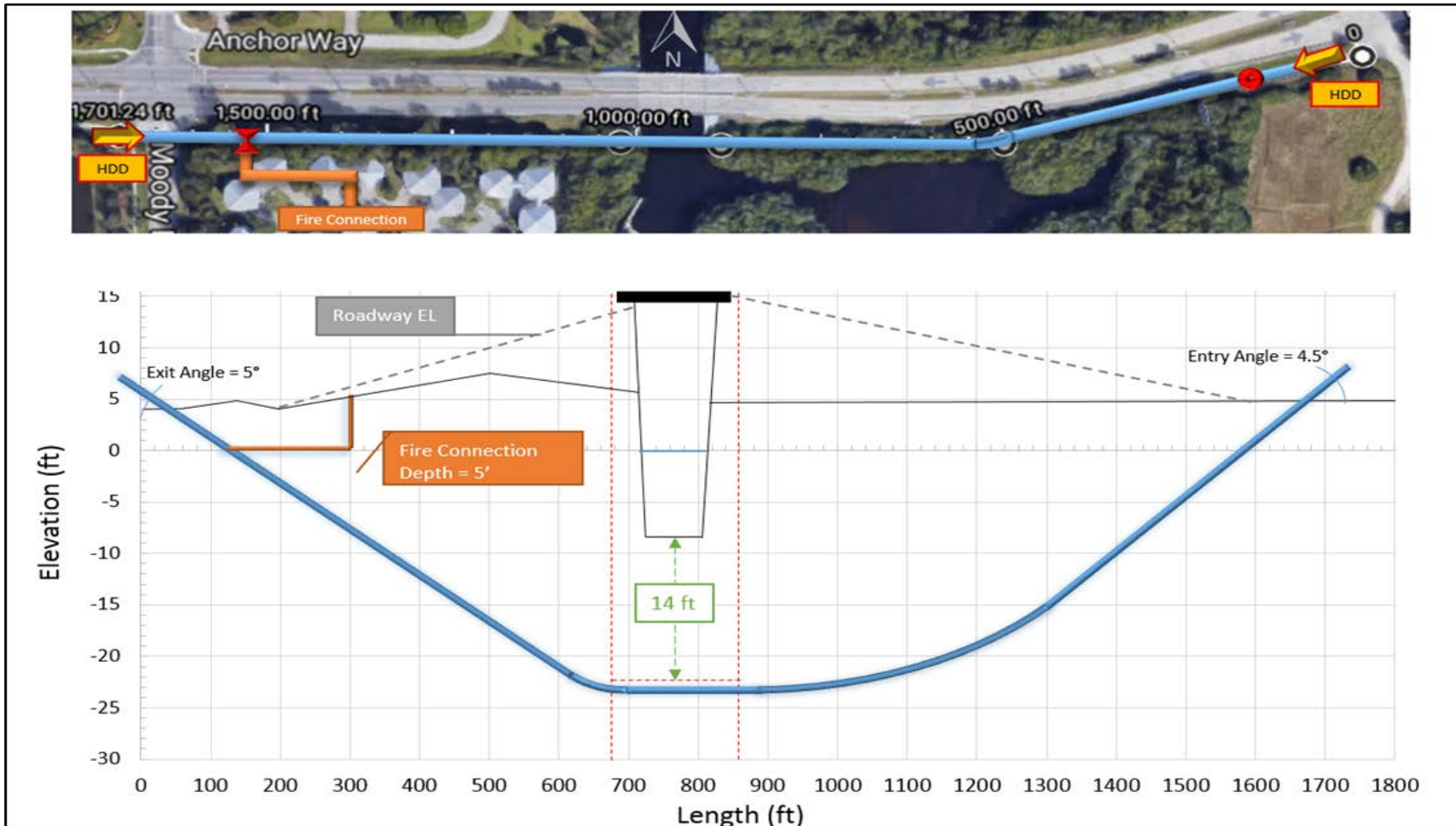
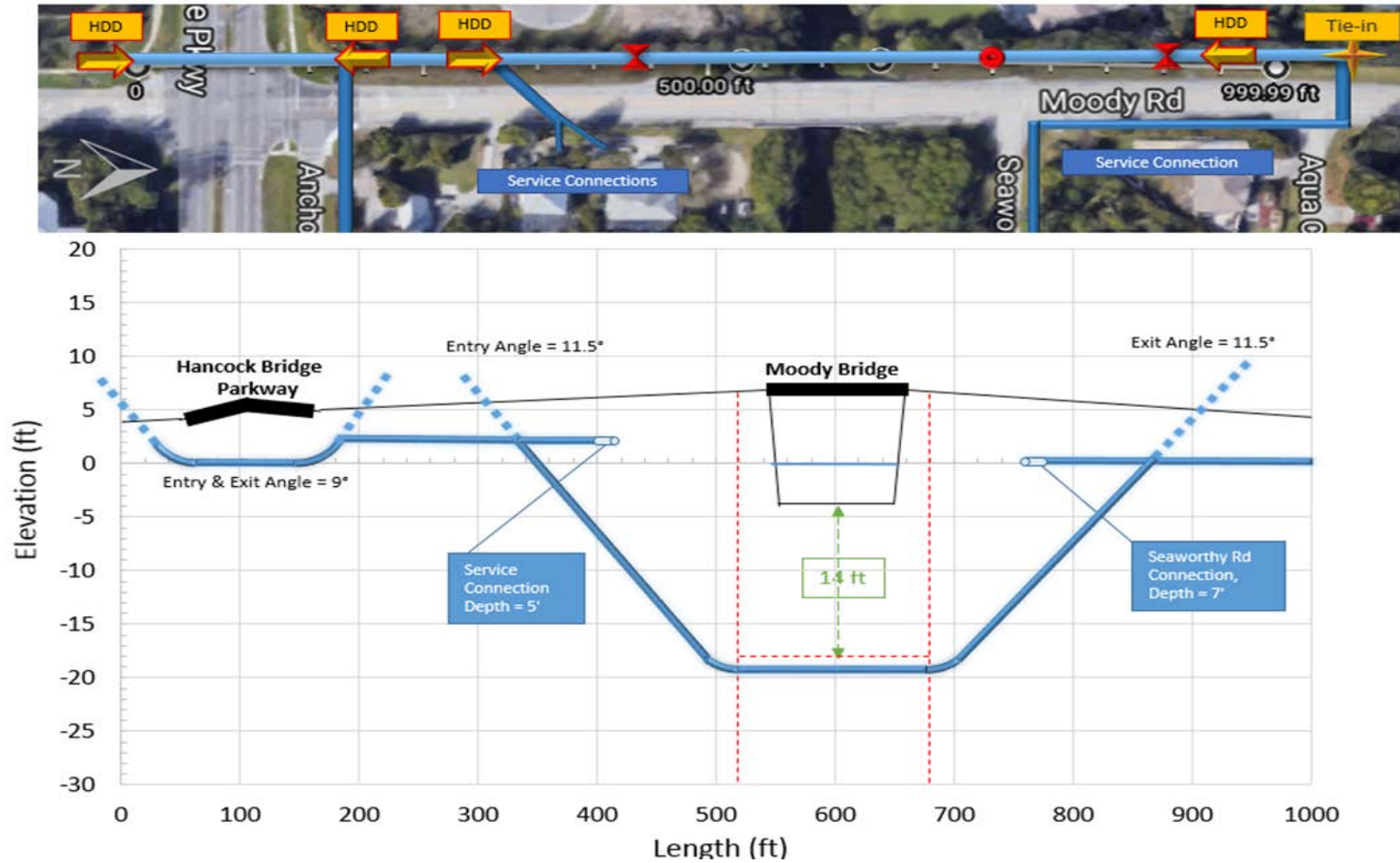


Figure 4-2: Moody Road Horizontal Directional Drill Elevation View





## Section 5 Construction Timeline

### 5.1 Procurement and Construction Schedule

The timeframe for Bid and Procurement is scheduled to start be at total of 20 weeks. It is anticipated that the subsequent construction period be a total of 23 weeks. These durations are based on recent experience with other local project of similar scope and LCU input.

## Section 6 **Opinion of Probable Cost**

### 6.1 **Basis of Opinion of Probable Cost**

The basis for the project's opinion of probable cost starts with the conceptual estimate developed for the G&H conceptual design. As the project progresses toward completion milestones, the estimate is further developed to include more detail with regards to material types and quantities. Prices are updated based on the construction schedule of the project, using ENR or similar rates to move the cost closer to the proposed construction time frame. Also, cost for similar local projects performed (bid and constructed or in construction) are used to compare or fill in costs.

The project will contain alternative bid items for trenchless pipe installation to give flexibility to the Contractor and possibly save money for the County.

**Basis of Design Report**

## Section 6

## 6.2 Opinion of Probable Construction Cost

Hancock Bridge Parkway Main Improvements 60% Bid Schedule					
Item	Description	Quantity	Unit	Unit Price	Total Price
1	Mobilization/Demobilization	1	LS	\$ 115,000	\$115,000
2	Maintenance of Traffic	1	LS	\$ 20,000	\$20,000
3	Watermain Open Cut Installation				
3a	10" PVC, AWWA C-900 DR-18 Class 150	1258	LF	\$ 48	\$60,384
3b	8" PVC, AWWA C-900 DR-18 Class 150	1832	LF	\$ 36	\$65,952
3c	6" PVC, AWWA C-900 DR-18 Class 150	49	LF	\$ 28	\$1,372
3d	4" PVC, AWWA C-900 DR-18 Class 150	838	LF	\$ 20	\$16,760
4	Pipe and Fittings by Jack and Bore Installation including Casing				
4a	8" PVC Water Main in 18" Steel Casing	162	LF	\$ 480	\$77,760
5	HDPE Water Main by Directional Drilling				
5a	8" HDPE DR 11 Pipe	127	LF	\$ 120	\$15,240
5b	10" HDPE DR 11 Pipe	350	LF	\$ 160	\$56,000
5c	12" HDPE DR 11 Pipe	1731	LF	\$ 250	\$432,750
6	Gate Valves				
6a	6" Diameter Gate Valve	1	EA	\$ 1,451	\$1,451
6b	8" Diameter Gate Valve	6	EA	\$ 1,851	\$11,106
6c	10" Diameter Gate Valve	4	EA	\$ 2,522	\$10,086
7	Leak Detection Assembly	3	EA	\$ 5,000	\$15,000
8	Tie-Ins to existing Watermains				
8a	Connection to Existing 6-inch Water Main	1	EA	\$ 2,500	\$2,500
8b	Connection to Existing 8-inch Water Main	1	EA	\$ 2,800	\$2,800
8c	Connection to Existing 10-inch Water Main	6	EA	\$ 4,100	\$24,600
9	Fire Hydrant Assemblies				
9a	New	4	EA	\$ 4,960	\$19,840
9b	Connect to ex. Hydrant	2	EA	\$ 2,200	\$4,400
10	Tapping Sleeve and Valve	2	EA	\$ 11,515	\$23,030
11	New Services				
11a	Single Service	6	EA	\$ 1,500	\$9,000
11b	Double Service	3	EA	\$ 2,500	\$7,500
12	Reconnect Existing Water Service	5	EA	\$ 900	\$4,500
13	Furnish and Install Automatic Air Release Valve Assembly	4	EA	\$ 10,216	\$40,864
14	Furnish and Install Blow Off Assy	2	EA	\$ 2,566	\$5,132
15	Remove and Replace Driveway Apron	412.38	SY	\$ 59	\$24,330
16	Remove and Replace Street Pavement Surface and Base	561	SY	\$ 26	\$14,362
17	Furnish and Install Additional Fittings	100	LB	\$ 100	\$10,000
18	Remove and Replace Sidewalk	1427	LF	\$ 50	\$71,350
19	Water Main Abandonment/Grouting/Removal				
19a	Abandonment - Grouting of 10" pipe	3203	LF	\$ 8	\$25,624
19b	Abandonment - Grouting of 8" pipe	854	LF	\$ 6	\$5,124
19c	Abandonment - Grouting of 6" pipe	1240	LF	\$ 4	\$4,960
19d	Removal and Disposal of AC Pipe	50	LF	\$ 105	\$5,250
20	Furnish and Install 6-inch Fire Line Backflow Assembly	5	EA	\$ 6,500	\$32,500
21	Special Pipe Bedding	10	CY	\$ 35	\$350
22	Additional Excavation	25	CY	\$ 25	\$625
23	Lanscaping Allowance	1	LS	\$ 10,000	\$10,000
24	Utility Relocation Allowance	1	LS	\$ 20,000	\$20,000
25	Furnish and Install Unreinforced Concrete	10	CY	\$ 150	\$1,500
	<b>SUBTOTAL</b>				<b>\$1,269,002</b>
	30% Contingency				\$380,701
	<b>GRAND TOTAL</b>				<b>\$1,649,703</b>

## **Appendices**

1. Follow-up Letter from Ardaman and Associates
2. Geotechnical report



**Ardaman & Associates, Inc.**

Geotechnical, Environmental and  
Materials Consultants

Ardaman File No. 17-33-4571

September 20, 2018

**TO:** Greeley and Hansen, LLC  
5252 Summerlin Commons Way, Suite 104  
Fort Myers, FL 33907

**ATTN:** Alexandra Terral, P.E.

**SUBJECT:** Hancock Bridge Parkway Water Main Improvements  
Hancock Bridge Parkway and Moody Road  
North Fort Myers, Lee Co, FL

**REFERENCE:** Ardaman & Associates, Inc. Report of Subsurface Soil Exploration  
for the subject project dated May 21, 2018

Dear Alexandra:

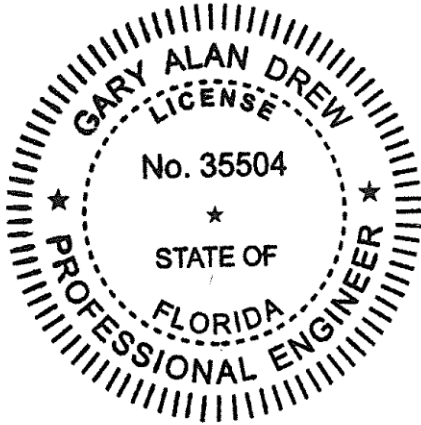
You have requested our opinion on the soil conditions to install a 12-inch water main under the creek crossing Hancock Bridge Parkway by horizontal directional drill (HDD).

For the referenced geotechnical report, test borings SPT-3 and SPT-4 were drilled on the Hancock Bridge Parkway road surface on either side of the creek. Road elevation is estimated to be about +14 feet NAVD88. Both borings disclosed similar subsurface conditions consisting of mostly medium dense sands (SP, SP-SM) to a depth of 12 feet (elev. +2 feet) where very loose and very soft silty sands (SM), clayey sands (SC) and sandy clays (CL) were encountered. These very loose and very soft soil conditions extended to an average depth at about 37 feet (elev. -23 feet). This very loose and very soft zone between 12 and 37 feet could prove problematic for HDD because of the very low shear strength of the soils and associated risk of hydraulic fracturing by the drill fluid. Below a depth of 37 feet (elev. -23 feet), both borings encountered a firm to stiff sandy fat clay (CH) stratum that continued through the 50-foot depth explored. These fat clays exhibit higher shear strength than the SPT N-Values would indicate due to carbonate cementation. Shear strength value of up to 1 to 2 kips per square foot (ksf) are typical. Shear strength issues with HDD installation within this stratum (below elev. -23 feet) are not expected.

Please call me if you have any questions.

Very truly yours,

ARDAMAN & ASSOCIATES, INC.  
Florida Certificate of Authorization No. 00005950



*This document has been digitally  
signed and sealed by*

*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.*

Gary A. Drew, P.E./No. 35504  
Vice President/Branch Manager

GAD/cmb

**SUBSURFACE SOIL EXPLORATION  
HANCOCK BRIDGE PARKWAY WATER MAIN IMPROVEMENTS  
HANCOCK BRIDGE PARKWAY AND MOODY ROAD  
NORTH FORT MYERS, LEE COUNTY, FLORIDA**



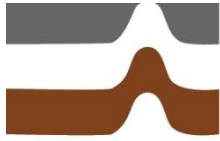
**Ardaman & Associates, Inc.**

OFFICES

- Orlando** - 8008 S. Orange Avenue, Orlando, FL 32809 - Phone: 407-855-3860  
**Bartow** - 1525 Centennial Blvd., Bartow, FL 33830 - Phone: 863-533-0858  
**Baton Rouge** - 316 Highlandia Drive, Baton Rouge, LA 70810 - Phone: 225-752-4790  
**Cocoa** - 1300 N. Cocoa Blvd., Cocoa, FL 32922 - Phone: 321-632-2503  
**Fort Myers** - 9970 Bavaria Road, Fort Myers, FL 33913 - Phone: 239-768-6600  
**Miami** - 2608 W. 84<sup>th</sup> Street, Hialeah, FL 33016 - Phone: 305-825-2683  
**Monroe** - 338 Fontana Road, Monroe, LA 71203 - Phone: 318-343-0900  
**New Orleans** - 1305 Distributors Row, Suite I, Jefferson, LA 70123 - Phone: 504-835-2593  
**Port St. Lucie** - 460 NW Concourse Place, Unit #1, Port St. Lucie, FL 34986 - Phone: 772-878-0072  
**Sarasota** - 78 Sarasota Center Blvd., Sarasota, FL 34240 - Phone: 941-922-3526  
**Shreveport** - 7222 Greenwood Road, Shreveport, LA 71119 - Phone: 318-636-3673  
**Tallahassee** - 3175 West Tharpe Street, Tallahassee, FL 32303 - Phone: 850-576-6131  
**Tampa** - 3925 Coconut Palm Drive, Suite 115, Tampa, FL 33619 - Phone: 813-620-3389  
**West Palm Beach** - 2200 N. Florida Mango Road, Suite 101, West Palm Beach, FL 33409 - Phone: 561-687-8200

MEMBERS:

American Concrete Institute  
American Council of Engineering Companies  
ASTM International  
Geo-Institute  
Geoprofessional Business Association  
Society of American Military Engineers



**Ardaman & Associates, Inc.**

Geotechnical, Environmental and  
Materials Consultants

Ardaman Project No. 17-33-4571

May 21, 2018

**GREELEY AND HANSEN LLC**

5260 Summerlin Commons Way, Suite 104

Fort Myers, FL 33907

Attention: Ms. Alexandra Terral, P.E.

**SUBJECT:** Subsurface Soil Exploration  
Hancock Bridge Parkway Water Main Improvements  
Hancock Bridge Parkway and Moody Road  
North Fort Myers, Lee County, Florida

Dear Ms. Terral:

As requested and authorized by **Greeley and Hansen, LLC**, Ardaman & Associates, Inc. (Ardaman) has completed the subsurface soil exploration program for the subject project. The purposes of this program were to evaluate the general subsurface conditions in the project study area and discuss our findings.

This report documents our findings and conclusions. It has been prepared for the exclusive use of **Greeley and Hansen, LLC** for specific application to the subject project in accordance with generally accepted geotechnical engineering practices. No other warranty, expressed or implied, is made.

**SCOPE**

The scope of our services was limited to the following items:

1. Conducting four Standard Penetration Test (SPT) borings to 50 feet to determine the nature and condition of the subsurface soils at the location of proposed directional drilling at the two



**Ardaman & Associates, Inc.**



creek crossings, and two SPT borings to 20 feet at the location of a jack-and-bore under Hancock Bridge Parkway on the west side of Moody Road.

2. Conducting 19 hand auger borings to a minimum depth of 6 feet to define subsurface conditions along the route of the proposed water main within the roadway right-of-way.
3. Reviewing each soil sample obtained in our field testing program by a geotechnical engineer in our laboratory for further identification and assignment of laboratory tests.
4. Performing the appropriate laboratory tests on select samples.
5. Analyzing the existing soil conditions with respect to the proposed construction.
6. Preparing this report to document the results of our field exploration and laboratory testing programs, and discuss our findings.

## **SITE LOCATION AND PROJECT DESCRIPTION**

The Hancock Bridge Parkway Water Main Improvements project includes the installation of a new water main in the right-of-way of Hancock Bridge Parkway from Palm Avenue to Moody Road and in the right-of-way of Moody Road from Hancock Bridge Parkway to Aqua Cove Lane in North Fort Myers, Lee County, Florida. Installation is also to be performed along Seaworthy Road and Anchor Way. We understand the majority of the installation will consist of cut-and-cover techniques; however, you are planning to directional drill under the creek crossing Hancock Bridge Parkway east of Moody Road and the small creek crossing Moody Road north of Hancock Bridge Parkway. You are also planning to jack-and-bore under Hancock Bridge Parkway at both Moody Road and Palm Avenue.

The hand auger borings along the proposed water main line alignment began on Moody Road, south of Aqua Cove Lane, to Hancock Bridge Parkway and then along Hancock Bridge Parkway to Palm Avenue. Hand auger borings were also performed along Seaworthy Road and Anchor Way. SPT borings were performed on both sides of the proposed directional drills at the two creek crossings and the jack-and-bore under

Hancock Bridge Parkway on the west side of Moody Road. The boring locations are shown on the attached **Boring Location Plan (Figure 1)**.

### FIELD EXPLORATION PROGRAM

Our field exploration consisted of performing six Standard Penetration Test (SPT) borings labeled SPT-1 thru SPT-6 at the proposed directional drilling/jack-and-bore locations and 19 hand auger borings labeled A-1 thru A-19 at select locations along the proposed water main line route. The four SPT borings at the directional drill locations were drilled to a depth of 50 feet below the existing ground surface, and the two SPT borings at the jack-and-bore location west of Moody Road were drilled to a depth of 20 feet. The SPT borings were conducted using methods consistent with ASTM D-1586. A hand-held bucket auger was used to advance each hand auger boring to a depth minimum depth of 6 feet, with the exception of A-18 that encountered a possible utility conflict. The equipment and procedures used in the SPT and hand auger borings are described in detail in the **Appendix**.

The locations of the borings are shown on the attached **Boring Location Plan (Figure 1)**. They were located by reference to the project Geotechnical Survey Map Provided by **Greeley and Hansen, LLC** and by measurement from the site features shown on an aerial photograph of the site obtained from Google Earth Pro©. Therefore, the locations indicated should be considered accurate only to the degree implied by the method of measurement used. If a more precise location of the borings is desired, then we recommend that a registered land surveyor be employed to locate the borings on site. GPS coordinates of each boring location are provided on the boring logs.

### GENERAL SUBSURFACE CONDITIONS

The general subsurface conditions encountered during the field exploration are shown on the attached soil boring logs. Soil stratification is based on examination of recovered soil samples and interpretation of the field boring logs. The stratification lines represent the approximate boundaries between the soil types, the actual transitions may be gradual.

In general, the hand auger borings along the proposed alignment typically encountered fine sands (SP/SP-SM or A-3) from the ground surface to depths ranging from 3 to 6 feet below the existing ground surface. Below the fine sands, the hand auger borings typically encountered clayey or silty fine sands (SC/A-2-6 or SM/A-2-4) extending to the termination of the hand auger borings at a depth of 6 feet. Notable exceptions to the generalized subsurface soil conditions occurred in auger borings A-2, A-14 and A-15, which encountered Peat (PT or A-8) material at depths of 5 to 5.5 feet extending to depths ranging from 6.5 to 8 feet below the existing ground surface. Another notable exception was encountered in hand auger boring A-16, which encountered silty to very silty fine sands (SM or A-2-4/A-4) from the surface to the termination of the boring at a depth of 6 feet.

In general, the borings SPT-1 through 4 encountered 1-foot of asphalt and rock base at the surface. Below the pavement section, the borings typically encountered fine sands (SP/SP-SM or A-3) to depths ranging from about 12.5 to 17.5 feet below the existing road surface. Borings SPT-1 and SPT-4 encountered clayey fine sands (SC or A-2-6) at depths of 4 and 5 feet extending to depths of 5 and 7.5 feet below the existing surface. Below the fine sands, the SPT borings typically encountered stratum of silty or silty clayey fine sands (SM/SC-SM or A-2-4) and clayey fine sands or sandy lean clays (SC/CL or A-2-6/A-6) extending to a depth of 37.5 feet underlain by sandy fat clays (CH/A-7-6) to the termination of the borings at a depth of 50 feet below the existing surface.

In general, the borings SPT-5 and 6 encountered fine sands (SP/SP-SM or A-3) to depths of 9 to 12.5 feet below the existing ground surface underlain by silty clayey fine sands (SC-SM/A-2-4) with trace to some gravel size limerock and shell fragments to the termination of the borings at a depth of 20 feet.

The groundwater depths shown on the boring logs represent the groundwater surface encountered on the dates shown (October 18 and 20, November 1 and 2, 2017 for borings SPT-1 through 4 and A-1 through 19, and May 16, 2018 for borings SPT-5 and 6). Fluctuations in groundwater level should be anticipated throughout the year due to seasonal variations in rainfall, and other factors.

## **LABORATORY TESTING PROGRAM**

Representative soil samples obtained during our field sampling operation were packaged and transferred to our office and, thereafter, examined by a geotechnical engineer to obtain more accurate descriptions of the existing soil strata. Laboratory testing was performed on selected samples as deemed necessary to aid in soil classification and to further define the engineering properties of the soils. The laboratory tests included Natural Moisture Content, Percent Finer than the U.S. No. 200 Sieve (percent silt and clay) and Organic Content.

The test results are presented on the attached soil boring logs at the depths from which the samples were recovered. The soil descriptions shown on the logs are based upon visual-manual procedures in accordance with local practice. Soil classification is in general accordance with the Unified Soil Classification System (ASTM D-2487) and is also based on visual-manual procedures. The soils recovered from the hand auger borings were also classified in accordance with AASHTO M-145 Recommended Procedure for the Classification of Soils and Soil Aggregate Mixtures for Highway Construction Purposes.

## **DISCUSSION**

The majority of the borings performed along the route encountered fine sands (SP/SP-SM or A-3 soils) from the surface to depths ranging from 3 to 6 feet in the hand auger borings and 12.5 to 17.5 feet in the SPT borings. These fine sands are suitable for use as backfill materials and suitable for pipe bedding. However, the pipe should be bedded in fine gravel such as FDOT No. 89 Stone if unsuitable soil types are encountered at pipe invert such as silty sand or sandy silts (SM/ML or A-2-4/A-4) or clayey sands (SC or A-2-6). In addition, borings A-2, A-14 and A-15 encountered peat (PT or A-8) at depths of 5 to 5.5 feet extending to depths ranging from 6.5 to 8 feet below the existing ground surface. This material is unsuitable and should be removed to its vertical extent below pipes and any structures and replaced with suitable fill materials or fine gravel.

## GENERAL COMMENTS

While the borings are representative of subsurface conditions at their respective locations and for their respective vertical reaches, local variations characteristic of the subsurface materials of the region are anticipated and may be encountered. The boring logs and related information are based on the driller's logs and visual examination of selected sample in the laboratory. The delineation between soil types shown on the logs is approximate and the description represents our interpretation of subsurface conditions at the designated boring locations and on the particular date drilled.

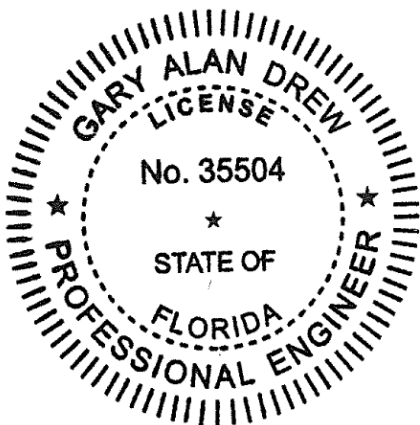
If you have any questions about this report, please contact this office.

Very truly yours,

**Ardaman & Associates, Inc.**  
**Florida Certificate of Authorization No. 00005950**



Matthew R. Elmore, E.I.  
Project Engineer



*This document has been digitally  
signed and sealed by:*

*Printed copies of this document are not  
considered signed and sealed.  
The signature must be verified on the  
electronic documents.*

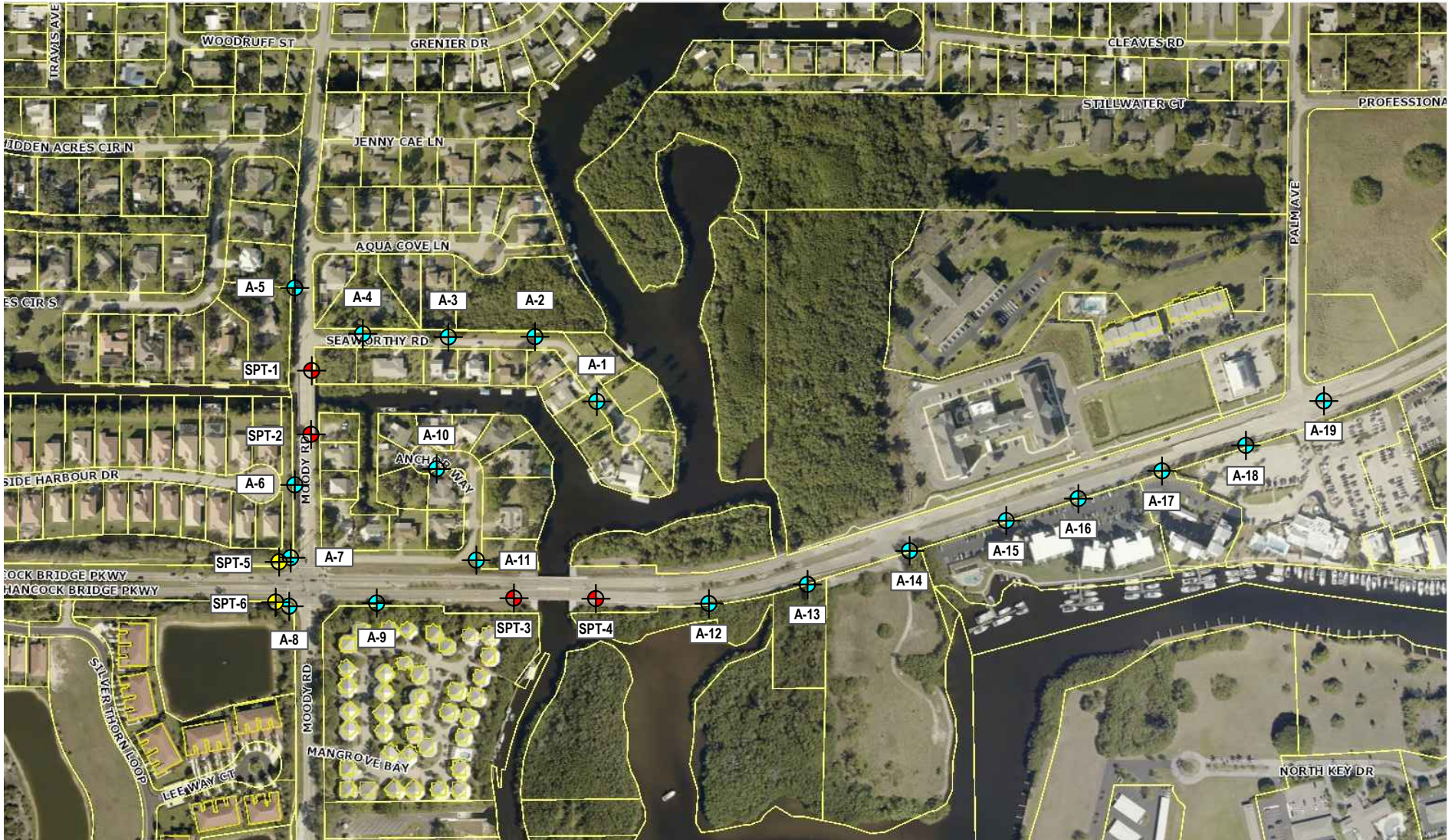
Gary A. Drew, P.E. No. 35504  
Vice President/Branch Manager




MRE:GAD/cmb

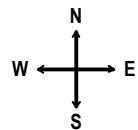
## ATTACHMENTS

- BORING LOCATION PLAN (FIGURE 1)
- BORING LOGS (SPT-1 THRU SPT-6 AND A-1 THRU A-19)






-  = 50' SPT Borings
-  = 20' SPT Borings
-  = Auger Borings



## FIGURE 1 BORING LOCATION PLAN

SOURCE: LEEPA.ORG

 <b>Ardaman &amp; Associates, Inc.</b> <b>Geotechnical, Environmental and Materials Consultants</b>		
Proposed Water Main Improvements Hancock Bridge Pkwy and Moody Rd North Fort Myers, Lee County, FL		
Drawn By: ME	Checked By: GD	Date: 5/18/17
File No. 17-33-4571	Approved By: Gary Drew, P.E.	Figure No. 1


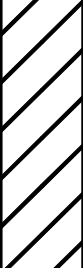
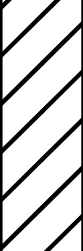
**BORING LOCATION:** SEE BORING LOCATION PLAN  
**LATITUDE:** N 26°39'41.4" **LONGITUDE:** W 81°53'59.0"  
**DATE DRILLED:** 11/02/17 & 5/15/18 **STA:** **OFF:**  
**GROUND SURFACE ELEVATION:** **TIME:**  
**WATER TABLE DEPTH (ft):** EST. 11' **DATE:** 11/02/17 & 5/15/18

**CLIENT:** GREELEY AND HANSEN LLC  
**PROJECT:** HANCOCK BRIDGE PARKWAY WATER MAIN IMP.  
**LOCATION:** N. FT. MYERS, LEE CO., FL  
**DRILL CREW:** WOOTEN / BENAVIDES **LOGGED BY:** M. ELMORE, E.I.

**DRILL MAKE & MODEL:** CME-55 W/ AUTO **BIT:** 2-15/16" DIA. TRICONE ROLLER **DRILLING RODS:** AW  
**DRILLING METHOD:** ROTARY WASH WITH DRILLING FLUID **WEATHER CONDITIONS:** PARTLY CLOUDY / HOT

DEPTH, FT.	BLOWS	SPT N-VALUE	SAMPLE NO.	GRAPHIC LOG	USCS	SOIL DESCRIPTION	REMARKS	% WATER CONTENT	PERCENT FINES	% ORGANIC CONTENT	LIQUID LIMIT	PLAST. INDEX
0						Asphalt and Rock Base.	Hand augered to 4.5'					
			1		SP-SM	Poorly Graded Sand with Silt - Brown slightly silty fine sand.	Auto hammer from 4.5'-TERM					
5	4-4-5	9	2		SC	Clayey Sand - Brown clayey fine sand.						
	5-4-6	10	3		SP-SM	Poorly Graded Sand with Silt - Brown slightly silty fine sand.						
	7-7-8	15	4									
10	8-12-10	22	5		SP	Poorly Graded Sand - Gray and brown fine sand.						
15	WOH- ---	WOH	6		SM	Silty Sand - Light brown silty fine sand, trace to some gravel (cemented sands).		25.1	33.8			
20	WOH- ---	WOH	7		SC	Clayey Sand - Light gray clayey fine sand.						
25	3-1-8	9	8		SC	Clayey Sand - Light gray clayey fine sand, trace to some gravel (cemented sands).						
30	0-1-1	2	9		SC	Clayey Sand - Gray clayey fine sand.	Hole terminated at 30.5' on 11/2/17. Hole washed to 34' on 5/15/18 and advanced to 50.5'	43.9	38.1			
35	2-2-4	6	10									



DEPTH, FT.	BLOWS	SPT N-VALUE	SAMPLE NO.	GRAPHIC LOG	USCS	SOIL DESCRIPTION	REMARKS	% WATER CONTENT	PERCENT FINES	% ORGANIC CONTENT	LIQUID LIMIT	PLAST. INDEX
40	1-2-4	6	11		CH	Sandy Fat Clay - Greenish gray sandy clay, high plasticity.						
45	2-4-5	9	12									
50	1-2-4	6	13									
55						TERMINATED AT 50.5'						
60												
65												
70												
75												






**BORING LOCATION:** SEE BORING LOCATION PLAN  
**LATITUDE:** N 26°39'39.6" **LONGITUDE:** W 81°53'58.9"  
**DATE DRILLED:** 11/02/17 & 5/15/18 **STA:** **OFF:**  
**GROUND SURFACE ELEVATION:** **TIME:**  
**WATER TABLE DEPTH (ft):** EST. 11' **DATE:** 11/02/17 & 5/15/18

**CLIENT:** GREELEY AND HANSEN LLC  
**PROJECT:** HANCOCK BRIDGE PARKWAY WATER MAIN IMP.  
**LOCATION:** N. FT. MYERS, LEE CO., FL  
**DRILL CREW:** WOOTEN / BENAVIDES **LOGGED BY:** M. ELMORE, E.I.

**DRILL MAKE & MODEL:** CME-55 W/ AUTO **BIT:** 2-15/16" DIA. TRICONE ROLLER **DRILLING RODS:** AW  
**DRILLING METHOD:** ROTARY WASH WITH DRILLING FLUID **WEATHER CONDITIONS:** PARTLY CLOUDY / HOT

DEPTH, FT.	BLOWS	SPT N-VALUE	SAMPLE NO.	GRAPHIC LOG	USCS	SOIL DESCRIPTION	REMARKS	% WATER CONTENT	PERCENT FINES	% ORGANIC CONTENT	LIQUID LIMIT	PLAST. INDEX
0						Asphalt and Rock Base.	Hand augered to 6'					
			1		SP-SM	Poorly Graded Sand with Silt - Brown slightly silty fine sand.	Auto hammer from 6'-TERM					
			2									
5												
	3-3-2	5	3									
	2-3-3	6	4		SP	Poorly Graded Sand - Brown and gray fine sand.						
10												
	3-4-3	7	5									
15	WOH- ---	WOH	6		SC	Clayey Sand - Gray clayey fine sand.						
20	WOH- ---	WOH	7									
25	3-0-1	1	8		SC	Clayey Sand - Gray clayey fine sand, trace to some gravel (cemented sands).		24.6	41.4			
30	1-0-1	1	9		CL	Sandy Lean Clay - Gray sandy lean clay.	Hole terminated at 30.5' on 11/2/17. Hole washed to 34' on 5/15/18 and advanced to 50.5'	52.7	52.4			
35	1-0-3	3	10									


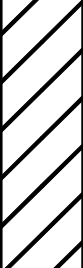
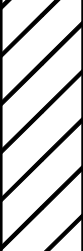
DEPTH, FT.	BLOWS	SPT N-VALUE	SAMPLE NO.	GRAPHIC LOG	USCS	SOIL DESCRIPTION	REMARKS	% WATER CONTENT	PERCENT FINES	% ORGANIC CONTENT	LIQUID LIMIT	PLAST. INDEX
40	1-1-3	4	11		CH	Sandy Fat Clay - Greenish gray sandy clay, high plasticity.						
45	1-3-3	6	12									
50	2-3-5	8	13									
55						TERMINATED AT 50.5'						
60												
65												
70												
75												

**BORING LOCATION:** SEE BORING LOCATION PLAN  
**LATITUDE:** N 26°39'35.1" **LONGITUDE:** W 81°53'52.8"  
**DATE DRILLED:** 11/01/17 & 5/14/18 **STA:** **OFF:**  
**GROUND SURFACE ELEVATION:** **TIME:**  
**WATER TABLE DEPTH (ft):** EST. 13' **DATE:** 11/01/17 & 5/14/18

**CLIENT:** GREELEY AND HANSEN LLC  
**PROJECT:** HANCOCK BRIDGE PARKWAY WATER MAIN IMP.  
**LOCATION:** N. FT. MYERS, LEE CO., FL  
**DRILL CREW:** WOOTEN / BENAVIDES **LOGGED BY:** M. ELMORE, E.I.

**DRILL MAKE & MODEL:** CME-55 W/ AUTO **BIT:** 2-15/16" DIA. TRICONE ROLLER **DRILLING RODS:** AW  
**DRILLING METHOD:** ROTARY WASH WITH DRILLING FLUID **WEATHER CONDITIONS:** PARTLY CLOUDY / HOT

DEPTH, FT.	BLOWS	SPT N-VALUE	SAMPLE NO.	GRAPHIC LOG	USCS	SOIL DESCRIPTION	REMARKS	% WATER CONTENT	PERCENT FINES	% ORGANIC CONTENT	LIQUID LIMIT	PLAST. INDEX
0			1			Asphalt and Rock Base.	Hand augered to 4.5' Auto hammer from 4.5'-TERM					
			2		SP	Poorly Graded Sand - Brown fine sand.						
5	7-6-7	13	3									
	8-8-8	16										
	27-10-4	14	4		SP-SM	Poorly Graded Sand with Silt - Brown slightly silty fine sand, trace to some gravel (rock fragments and shell fragments).						
10	3-5-5	10	5		SP-SM	Poorly Graded Sand with Silt - Brown and gray slightly silty fine sand.						
15	7-6-8	14	6		SP	Poorly Graded Sand - Brown and gray fine sand.						
20	WOH- ---	WOH	7		SC	Clayey Sand - Gray clayey fine sand.						
25	WOH- ---	WOH	8		CL	Sandy Lean Clay - Gray sandy lean clay.	38.3	72.2				
30	1-0-0	0	9		SC	Clayey Sand - Gray clayey fine sand, trace to some gravel (cemented sands).	Hole terminated AT 30.5' on 11/1/17. Hole washed to 34' on 5/14/18 and advanced to 50.5'					
35	1-2-2	4	10									


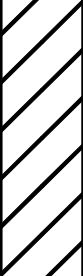
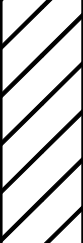
DEPTH, FT.	BLOWS	SPT N-VALUE	SAMPLE NO.	GRAPHIC LOG	USCS	SOIL DESCRIPTION	REMARKS	% WATER CONTENT	PERCENT FINES	% ORGANIC CONTENT	LIQUID LIMIT	PLAST. INDEX
40	2-2-3	5	11		CH	Sandy Fat Clay - Greenish gray sandy clay, high plasticity.						
45	2-2-4	6	12									
50	2-3-5	8	13									
55						TERMINATED AT 50.5'						
60												
65												
70												
75												

**BORING LOCATION:** SEE BORING LOCATION PLAN  
**LATITUDE:** N 26°39'35.2" **LONGITUDE:** W 81°53'50.1"  
**DATE DRILLED:** 11/01/17 & 5/14/18 **STA:** **OFF:**  
**GROUND SURFACE ELEVATION:** **TIME:**  
**WATER TABLE DEPTH (ft):** EST. 12' **DATE:** 11/01/17 & 5/14/18

**CLIENT:** GREELEY AND HANSEN LLC  
**PROJECT:** HANCOCK BRIDGE PARKWAY WATER MAIN IMP.  
**LOCATION:** N. FT. MYERS, LEE CO., FL  
**DRILL CREW:** WOOTEN / BENAVIDES **LOGGED BY:** M. ELMORE, E.I.

**DRILL MAKE & MODEL:** CME-55 W/ AUTO **BIT:** 2-15/16" DIA. TRICONE ROLLER **DRILLING RODS:** AW  
**DRILLING METHOD:** ROTARY WASH WITH DRILLING FLUID **WEATHER CONDITIONS:** PARTLY CLOUDY / HOT

DEPTH, FT.	BLOWS	SPT N-VALUE	SAMPLE NO.	GRAPHIC LOG	USCS	SOIL DESCRIPTION	REMARKS	% WATER CONTENT	PERCENT FINES	% ORGANIC CONTENT	LIQUID LIMIT	PLAST. INDEX
0						Asphalt and Rock Base.	Hand augered to 4.5'					
			1				Auto hammer from 4.5'-TERM					
			2		SP-SM	Poorly Graded Sand with Silt - Brown slightly silty fine sand, trace to some gravel (rock fragments and shell fragments).						
5	7- 10- 8	18			SC	Clayey Sand - Brown clayey fine sand.						
	7- 4- 6	10	3									
	5- 6- 6	12	4		SP-SM	Poorly Graded Sand with Silt - Brown slightly silty fine sand.						
10	7- 8- 8	16	5									
					SC	Clayey Sand - Gray clayey fine sand.						
15	1- 1- 2	3	6									
					SC-SM	Silty Clayey Sand - Dark brown silty clayey fine sand.		25.1	12.8			
20	WOH- - -	WOH	7									
					SC	Clayey Sand - Light gray clayey fine sand.						
25	WOH- - -	WOH	8									
					SC	Clayey Sand - Gray clayey fine sand, trace to some gravel (cemented sands).						
30	7- 2- 4	6	9				Hole terminated at 30.5' on 11/1/17. Hole washed to 34' on 5/14/18 and advanced to 50.5'	21.7	36.5			
					SC							
35	1- 1- 2	3	10									

DEPTH, FT.	BLOWS	SPT N-VALUE	SAMPLE NO.	GRAPHIC LOG	USCS	SOIL DESCRIPTION	REMARKS	% WATER CONTENT	PERCENT FINES	% ORGANIC CONTENT	LIQUID LIMIT	PLAST. INDEX
40	1-1-3	4	11		CH	Sandy Fat Clay - Greenish gray sandy clay, high plasticity.						
45	2-2-3	5	12									
50	2-3-5	8	13									
55						TERMINATED AT 50.5'						
60												
65												
70												
75												

**BORING LOCATION:** SEE BORING LOCATION PLAN  
**LATITUDE:** W 26°39'36.03"      **LONGITUDE:** W 81°53'59.83"  
**DATE DRILLED:** 5/16/18      **STA:**      **OFF:**  
**GROUND SURFACE ELEVATION:**      **TIME:**  
**WATER TABLE DEPTH (ft):** 5.5'      **DATE:** 5/16/18

**CLIENT:** GREELEY AND HANSEN LLC  
**PROJECT:** HANCOCK BRIDGE PARKWAY WATER MAIN IMP.  
**LOCATION:** N. FT. MYERS, LEE CO., FL  
**DRILL CREW:** LOCKLEY / BENAVIDES / SKEWIS      **LOGGED BY:** M. ELMORE, E.I.

**DRILL MAKE & MODEL:** MOBILE B-57 W/ AUTO      **BIT:** 2-15/16" DIA. TRICONE ROLLER      **DRILLING RODS:** AW  
**DRILLING METHOD:** ROTARY WASH WITH DRILLING FLUID      **WEATHER CONDITIONS:** SUN / CLOUDS / RAIN

DEPTH, FT.	BLOWS	SPT N-VALUE	SAMPLE NO.	GRAPHIC LOG	USCS	SOIL DESCRIPTION	REMARKS	% WATER CONTENT	PERCENT FINES	% ORGANIC CONTENT	LIQUID LIMIT	PLAST. INDEX
0	1-2-2	4	1		SP	Poorly Graded Sand - Dark brown to brown fine sand.						
	2-2-3	5	2									
	2-1-2	3	3									
5	2-4-4	8	4									
	3-3-4	7	5									
	4-5-5	10	6									
10	3-2-2	4	7			SC-SM	Silty Clayey Sand - Brown silty clayey fine sand.					
						SC-SM	Silty Clayey Sand - Gray silty clayey fine sand, trace to some gravel (limerock and shell fragments).					
15	3-1-0	1	8									
20	2-1-1	2	9									
						TERMINATED AT 20.5'						
25												
30												
35												



**BORING LOCATION:** SEE BORING LOCATION PLAN  
**LATITUDE:** W 26°39'34.75"      **LONGITUDE:** W 81°53'59.50"  
**DATE DRILLED:** 5/16/18      **STA:**      **OFF:**  
**GROUND SURFACE ELEVATION:**      **TIME:**  
**WATER TABLE DEPTH (ft):** 5.0'      **DATE:** 5/16/18

**CLIENT:** GREELEY AND HANSEN LLC  
**PROJECT:** HANCOCK BRIDGE PARKWAY WATER MAIN IMP.  
**LOCATION:** N. FT. MYERS, LEE CO., FL  
**DRILL CREW:** LOCKLEY / BENAVIDES / SKEWIS      **LOGGED BY:** M. ELMORE, E.I.

**DRILL MAKE & MODEL:** MOBILE B-57 W/ AUTO      **BIT:** 2-15/16" DIA. TRICONE ROLLER      **DRILLING RODS:** AW  
**DRILLING METHOD:** ROTARY WASH WITH DRILLING FLUID      **WEATHER CONDITIONS:** SUN / CLOUDS / RAIN

DEPTH, FT.	BLOWS	SPT N-VALUE	SAMPLE NO.	GRAPHIC LOG	USCS	SOIL DESCRIPTION	REMARKS	% WATER CONTENT	PERCENT FINES	% ORGANIC CONTENT	LIQUID LIMIT	PLAST. INDEX
0	1-1-2	3	1		SP	Poorly Graded Sand - Dark brown to brown fine sand.						
	3-2-2	4	2									
	2-2-2	4	3									
5	1-1-1	2	4									
	1-3-4	7	5									
	2-3-2	5	6									
10	1-0-1	1	7		SP-SM	Poorly Graded Sand with Silt - Gray slightly silty fine sand.						
15	1-1-0	1	8		SC-SM	Silty Clayey Sand - Gray silty clayey fine sand, trace to some gravel (limerock and shell fragments).						
20	4-4-3	7	9									
						TERMINATED AT 20.5'						
25												
30												
35												

**BORING LOCATION:** SEE BORING LOCATION PLAN  
**LATITUDE:** N 26°39'40.4"      **LONGITUDE:** W 81°53'49.8"  
**DATE DRILLED:** 10/18/17      **START:**      **FINISH:**  
**GROUND SURFACE ELEVATION:**      **TIME:**  
**WATER TABLE DEPTH (ft):** 2'      **DATE:** 10/18/17

**CLIENT:** GREELEY AND HANSEN LLC  
**PROJECT:** HANCOCK BRIDGE PARKWAY WATER MAIN IMP.  
**LOCATION:** N. FT. MYERS, LEE CO., FL  
**DRILL CREW:** WOOTEN / BENAVIDES      **LOGGED BY:** M. ELMORE

**DRILL MAKE & MODEL:** N/A      **BIT:** N/A      **DRILLING RODS:** N/A  
**DRILLING METHOD:** HAND-HELD BUCKET AUGER      **WEATHER CONDITIONS:** PARTLY CLOUDY / HOT

DEPTH, FT.	SAMPLE NO.	GRAPHIC LOG	USCS	SOIL DESCRIPTION	REMARKS	% WATER CONTENT	PERCENT FINES	% ORGANIC CONTENT	LIQUID LIMIT	PLAST. INDEX
0			SP-SM	Poorly Graded Sand with Silt - Dark brown slightly silty fine sand. (A-3)						
1										
2			SP	Poorly Graded Sand - Brown fine sand. (A-3)						
5										
6				TERMINATED AT 6'						
10										
15										
20										
25										
30										
35										

**BORING LOCATION:** SEE BORING LOCATION PLAN  
**LATITUDE:** N 26°39'42.3"      **LONGITUDE:** W 81°53'51.9"  
**DATE DRILLED:** 10/18/17      **START:**      **FINISH:**  
**GROUND SURFACE ELEVATION:**      **TIME:**  
**WATER TABLE DEPTH (ft):** 3'      **DATE:** 10/18/17

**CLIENT:** GREELEY AND HANSEN LLC  
**PROJECT:** HANCOCK BRIDGE PARKWAY WATER MAIN IMP.  
**LOCATION:** N. FT. MYERS, LEE CO., FL  
**DRILL CREW:** WOOTEN / BENAVIDES      **LOGGED BY:** M. ELMORE

**DRILL MAKE & MODEL:** N/A      **BIT:** N/A      **DRILLING RODS:** N/A  
**DRILLING METHOD:** HAND-HELD BUCKET AUGER      **WEATHER CONDITIONS:** PARTLY CLOUDY / HOT

DEPTH, FT.	SAMPLE NO.	GRAPHIC LOG	USCS	SOIL DESCRIPTION	REMARKS	% WATER CONTENT	PERCENT FINES	% ORGANIC CONTENT	LIQUID LIMIT	PLAST. INDEX
0			SP	Poorly Graded Sand - Brown fine sand. (A-3)						
1										
5	2		PT	Peat - Dark brown peat. (A-8)		241.7		28.9		
				TERMINATED AT 6.5'						
10										
15										
20										
25										
30										
35										

**BORING LOCATION:** SEE BORING LOCATION PLAN  
**LATITUDE:** N 26°39'42.2"      **LONGITUDE:** W 81°53'54.2"  
**DATE DRILLED:** 10/18/17      **START:**      **FINISH:**  
**GROUND SURFACE ELEVATION:**      **TIME:**  
**WATER TABLE DEPTH (ft):** 4'      **DATE:** 10/18/17

**CLIENT:** GREELEY AND HANSEN LLC  
**PROJECT:** HANCOCK BRIDGE PARKWAY WATER MAIN IMP.  
**LOCATION:** N. FT. MYERS, LEE CO., FL  
**DRILL CREW:** WOOTEN / BENAVIDES      **LOGGED BY:** M. ELMORE

**DRILL MAKE & MODEL:** N/A      **BIT:** N/A      **DRILLING RODS:** N/A  
**DRILLING METHOD:** HAND-HELD BUCKET AUGER      **WEATHER CONDITIONS:** PARTLY CLOUDY / HOT

DEPTH, FT.	SAMPLE NO.	GRAPHIC LOG	USCS	SOIL DESCRIPTION	REMARKS	% WATER CONTENT	PERCENT FINES	% ORGANIC CONTENT	LIQUID LIMIT	PLAST. INDEX
0	1		SP-SM	Poorly Graded Sand with Silt - Brown to gray slightly silty fine sand. (A-3)						
2	2		SP	Poorly Graded Sand - Dark brown fine sand. (A-3)						
5				TERMINATED AT 6'						
10										
15										
20										
25										
30										
35										

**BORING LOCATION:** SEE BORING LOCATION PLAN  
**LATITUDE:** N 26°39'42.3"      **LONGITUDE:** W 81°53'57.1"  
**DATE DRILLED:** 10/18/17      **START:**      **FINISH:**  
**GROUND SURFACE ELEVATION:**      **TIME:**  
**WATER TABLE DEPTH (ft):** 5'      **DATE:** 10/18/17

**CLIENT:** GREELEY AND HANSEN LLC  
**PROJECT:** HANCOCK BRIDGE PARKWAY WATER MAIN IMP.  
**LOCATION:** N. FT. MYERS, LEE CO., FL  
**DRILL CREW:** WOOTEN / BENAVIDES      **LOGGED BY:** M. ELMORE

**DRILL MAKE & MODEL:** N/A      **BIT:** N/A      **DRILLING RODS:** N/A  
**DRILLING METHOD:** HAND-HELD BUCKET AUGER      **WEATHER CONDITIONS:** PARTLY CLOUDY / HOT

DEPTH, FT.	SAMPLE NO.	GRAPHIC LOG	USCS	SOIL DESCRIPTION	REMARKS	% WATER CONTENT	PERCENT FINES	% ORGANIC CONTENT	LIQUID LIMIT	PLAST. INDEX
0	1		SP	Poorly Graded Sand - Brown and gray to gray fine sand. (A-3)						
5	2			TERMINATED AT 6'						
10										
15										
20										
25										
30										
35										

**BORING LOCATION:** SEE BORING LOCATION PLAN  
**LATITUDE:** N 26°39'43.1"      **LONGITUDE:** W 81°53'59.4"  
**DATE DRILLED:** 10/18/17      **START:**      **FINISH:**  
**GROUND SURFACE ELEVATION:**      **TIME:**  
**WATER TABLE DEPTH (ft):** 4'      **DATE:** 10/18/17

**CLIENT:** GREELEY AND HANSEN LLC  
**PROJECT:** HANCOCK BRIDGE PARKWAY WATER MAIN IMP.  
**LOCATION:** N. FT. MYERS, LEE CO., FL  
**DRILL CREW:** WOOTEN / BENAVIDES      **LOGGED BY:** M. ELMORE

**DRILL MAKE & MODEL:** N/A      **BIT:** N/A      **DRILLING RODS:** N/A  
**DRILLING METHOD:** HAND-HELD BUCKET AUGER      **WEATHER CONDITIONS:** PARTLY CLOUDY / HOT

DEPTH, FT.	SAMPLE NO.	GRAPHIC LOG	USCS	SOIL DESCRIPTION	REMARKS	% WATER CONTENT	PERCENT FINES	% ORGANIC CONTENT	LIQUID LIMIT	PLAST. INDEX
0			SP-SM	Poorly Graded Sand with Silt - Brown slightly silty fine sand. (A-3)						
1										
5	2		SC	Clayey Sand - Brown and gray clayey fine sand. (A-2-6)						
				TERMINATED AT 6'						
10										
15										
20										
25										
30										
35										

**BORING LOCATION:** SEE BORING LOCATION PLAN  
**LATITUDE:** N 26°39'38.1"      **LONGITUDE:** W 81°53'59.2"  
**DATE DRILLED:** 10/18/17      **START:**      **FINISH:**  
**GROUND SURFACE ELEVATION:**      **TIME:**  
**WATER TABLE DEPTH (ft):** 4.5'      **DATE:** 10/18/17

**CLIENT:** GREELEY AND HANSEN LLC  
**PROJECT:** HANCOCK BRIDGE PARKWAY WATER MAIN IMP.  
**LOCATION:** N. FT. MYERS, LEE CO., FL  
**DRILL CREW:** WOOTEN / BENAVIDES      **LOGGED BY:** M. ELMORE

**DRILL MAKE & MODEL:** N/A      **BIT:** N/A      **DRILLING RODS:** N/A  
**DRILLING METHOD:** HAND-HELD BUCKET AUGER      **WEATHER CONDITIONS:** PARTLY CLOUDY / HOT

DEPTH, FT.	SAMPLE NO.	GRAPHIC LOG	USCS	SOIL DESCRIPTION	REMARKS	% WATER CONTENT	PERCENT FINES	% ORGANIC CONTENT	LIQUID LIMIT	PLAST. INDEX
0	1		SP-SM	Poorly Graded Sand with Silt - Brown slightly silty fine sand. (A-3)						
5	2		SP	Poorly Graded Sand - Brown fine sand. (A-3)						
				TERMINATED AT 6'						
10										
15										
20										
25										
30										
35										

**BORING LOCATION:** SEE BORING LOCATION PLAN  
**LATITUDE:** N 26°39'36.1"      **LONGITUDE:** W 81°53'59.4"  
**DATE DRILLED:** 10/18/17      **START:**      **FINISH:**  
**GROUND SURFACE ELEVATION:**      **TIME:**  
**WATER TABLE DEPTH (ft):** 5'      **DATE:** 10/18/17

**CLIENT:** GREELEY AND HANSEN LLC  
**PROJECT:** HANCOCK BRIDGE PARKWAY WATER MAIN IMP.  
**LOCATION:** N. FT. MYERS, LEE CO., FL  
**DRILL CREW:** WOOTEN / BENAVIDES      **LOGGED BY:** M. ELMORE

**DRILL MAKE & MODEL:** N/A      **BIT:** N/A      **DRILLING RODS:** N/A  
**DRILLING METHOD:** HAND-HELD BUCKET AUGER      **WEATHER CONDITIONS:** PARTLY CLOUDY / HOT

DEPTH, FT.	SAMPLE NO.	GRAPHIC LOG	USCS	SOIL DESCRIPTION	REMARKS	% WATER CONTENT	PERCENT FINES	% ORGANIC CONTENT	LIQUID LIMIT	PLAST. INDEX
0	1		SP-SM	Poorly Graded Sand with Silt - Brown and gray slightly silty fine sand. (A-3)						
5	2		SP	Poorly Graded Sand - Brown fine sand. (A-3)						
				TERMINATED AT 6'						



**BORING LOCATION:** SEE BORING LOCATION PLAN  
**LATITUDE:** N 26°39'34.8"      **LONGITUDE:** W 81°53'59.5"  
**DATE DRILLED:** 10/18/17      **START:**      **FINISH:**  
**GROUND SURFACE ELEVATION:**      **TIME:**  
**WATER TABLE DEPTH (ft):** 3.5'      **DATE:** 10/18/17

**CLIENT:** GREELEY AND HANSEN LLC  
**PROJECT:** HANCOCK BRIDGE PARKWAY WATER MAIN IMP.  
**LOCATION:** N. FT. MYERS, LEE CO., FL  
**DRILL CREW:** WOOTEN / BENAVIDES      **LOGGED BY:** M. ELMORE

**DRILL MAKE & MODEL:** N/A      **BIT:** N/A      **DRILLING RODS:** N/A  
**DRILLING METHOD:** HAND-HELD BUCKET AUGER      **WEATHER CONDITIONS:** PARTLY CLOUDY / HOT

DEPTH, FT.	SAMPLE NO.	GRAPHIC LOG	USCS	SOIL DESCRIPTION	REMARKS	% WATER CONTENT	PERCENT FINES	% ORGANIC CONTENT	LIQUID LIMIT	PLAST. INDEX
0	1		SP	Poorly Graded Sand - Brown fine sand. (A-3)						
5	2			TERMINATED AT 6'						
10										
15										
20										
25										
30										
35										

**BORING LOCATION:** SEE BORING LOCATION PLAN  
**LATITUDE:** N 26°39'35.8"      **LONGITUDE:** W 81°53'56.9"  
**DATE DRILLED:** 10/18/17      **START:**      **FINISH:**  
**GROUND SURFACE ELEVATION:**      **TIME:**  
**WATER TABLE DEPTH (ft):** NE      **DATE:** 10/18/17

**CLIENT:** GREELEY AND HANSEN LLC  
**PROJECT:** HANCOCK BRIDGE PARKWAY WATER MAIN IMP.  
**LOCATION:** N. FT. MYERS, LEE CO., FL  
**DRILL CREW:** WOOTEN / BENAVIDES      **LOGGED BY:** M. ELMORE

**DRILL MAKE & MODEL:** N/A      **BIT:** N/A      **DRILLING RODS:** N/A  
**DRILLING METHOD:** HAND-HELD BUCKET AUGER      **WEATHER CONDITIONS:** PARTLY CLOUDY / HOT

DEPTH, FT.	SAMPLE NO.	GRAPHIC LOG	USCS	SOIL DESCRIPTION	REMARKS	% WATER CONTENT	PERCENT FINES	% ORGANIC CONTENT	LIQUID LIMIT	PLAST. INDEX
0	1		SP-SM	Poorly Graded Sand with Silt - Brown and gray slightly silty fine sand. (A-3)						
5	2		SP	Poorly Graded Sand - Brown fine sand. (A-3)						
				TERMINATED AT 6'						
10										
15										
20										
25										
30										
35										

**BORING LOCATION:** SEE BORING LOCATION PLAN  
**LATITUDE:** N 26°39'38.9"      **LONGITUDE:** W 81°53'54.6"  
**DATE DRILLED:** 10/18/17      **START:**      **FINISH:**  
**GROUND SURFACE ELEVATION:**      **TIME:**  
**WATER TABLE DEPTH (ft):** NE      **DATE:** 10/18/17

**CLIENT:** GREELEY AND HANSEN LLC  
**PROJECT:** HANCOCK BRIDGE PARKWAY WATER MAIN IMP.  
**LOCATION:** N. FT. MYERS, LEE CO., FL  
**DRILL CREW:** WOOTEN / BENAVIDES      **LOGGED BY:** M. ELMORE

**DRILL MAKE & MODEL:** N/A      **BIT:** N/A      **DRILLING RODS:** N/A  
**DRILLING METHOD:** HAND-HELD BUCKET AUGER      **WEATHER CONDITIONS:** PARTLY CLOUDY / HOT

DEPTH, FT.	SAMPLE NO.	GRAPHIC LOG	USCS	SOIL DESCRIPTION	REMARKS	% WATER CONTENT	PERCENT FINES	% ORGANIC CONTENT	LIQUID LIMIT	PLAST. INDEX
0	1		SP-SM	Poorly Graded Sand with Silt - Brown to gray slightly silty fine sand. (A-3)						
5	2		SP	Poorly Graded Sand - Brown fine sand. (A-3)						
				TERMINATED AT 6'						
10										
15										
20										
25										
30										
35										

**BORING LOCATION:** SEE BORING LOCATION PLAN  
**LATITUDE:** N 26°39'36.3"      **LONGITUDE:** W 81°53'53.9"  
**DATE DRILLED:** 10/18/17      **START:**      **FINISH:**  
**GROUND SURFACE ELEVATION:**      **TIME:**  
**WATER TABLE DEPTH (ft):** 2'      **DATE:** 10/18/17

**CLIENT:** GREELEY AND HANSEN LLC  
**PROJECT:** HANCOCK BRIDGE PARKWAY WATER MAIN IMP.  
**LOCATION:** N. FT. MYERS, LEE CO., FL  
**DRILL CREW:** WOOTEN / BENAVIDES      **LOGGED BY:** M. ELMORE

**DRILL MAKE & MODEL:** N/A      **BIT:** N/A      **DRILLING RODS:** N/A  
**DRILLING METHOD:** HAND-HELD BUCKET AUGER      **WEATHER CONDITIONS:** PARTLY CLOUDY / HOT

DEPTH, FT.	SAMPLE NO.	GRAPHIC LOG	USCS	SOIL DESCRIPTION	REMARKS	% WATER CONTENT	PERCENT FINES	% ORGANIC CONTENT	LIQUID LIMIT	PLAST. INDEX
0			SP	Poorly Graded Sand - Brown fine sand. (A-3)						
1			SP-SM	Poorly Graded Sand with Silt - Dark brown slightly silty fine sand. (A-3)						
2				TERMINATED AT 6'						
5										
10										
15										
20										
25										
30										
35										

**BORING LOCATION:** SEE BORING LOCATION PLAN  
**LATITUDE:** N 26°39'35.1"      **LONGITUDE:** W 81°53'45.9"  
**DATE DRILLED:** 10/20/17      **START:**      **FINISH:**  
**GROUND SURFACE ELEVATION:**      **TIME:**  
**WATER TABLE DEPTH (ft):** NE      **DATE:** 10/20/17

**CLIENT:** GREELEY AND HANSEN LLC  
**PROJECT:** HANCOCK BRIDGE PARKWAY WATER MAIN IMP.  
**LOCATION:** N. FT. MYERS, LEE CO., FL  
**DRILL CREW:** WOOTEN / BENAVIDES      **LOGGED BY:** M. ELMORE

**DRILL MAKE & MODEL:** N/A      **BIT:** N/A      **DRILLING RODS:** N/A  
**DRILLING METHOD:** HAND-HELD BUCKET AUGER      **WEATHER CONDITIONS:** PARTLY CLOUDY / HOT

DEPTH, FT.	SAMPLE NO.	GRAPHIC LOG	USCS	SOIL DESCRIPTION	REMARKS	% WATER CONTENT	PERCENT FINES	% ORGANIC CONTENT	LIQUID LIMIT	PLAST. INDEX
0	1		SP-SM	Poorly Graded Sand with Silt - Brown slightly silty fine sand. (A-3)						
			SM	Silty Sand - Gray silty fine sand. (A-2-4)						
5	2		GW	Well Graded Gravel - Gray coarse to fine gravel. (A-1-a)		10.7	18.1			
				TERMINATED AT 6'						
10										
15										
20										
25										
30										
35										

**BORING LOCATION:** SEE BORING LOCATION PLAN  
**LATITUDE:** N 26°39'35.3"      **LONGITUDE:** W 81°53'43.6"  
**DATE DRILLED:** 10/20/17      **START:**      **FINISH:**  
**GROUND SURFACE ELEVATION:**      **TIME:**  
**WATER TABLE DEPTH (ft):** 5'      **DATE:** 10/20/17

**CLIENT:** GREELEY AND HANSEN LLC  
**PROJECT:** HANCOCK BRIDGE PARKWAY WATER MAIN IMP.  
**LOCATION:** N. FT. MYERS, LEE CO., FL  
**DRILL CREW:** WOOTEN / BENAVIDES      **LOGGED BY:** M. ELMORE

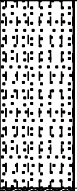
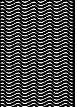
**DRILL MAKE & MODEL:** N/A      **BIT:** N/A      **DRILLING RODS:** N/A  
**DRILLING METHOD:** HAND-HELD BUCKET AUGER      **WEATHER CONDITIONS:** PARTLY CLOUDY / HOT

DEPTH, FT.	SAMPLE NO.	GRAPHIC LOG	USCS	SOIL DESCRIPTION	REMARKS	% WATER CONTENT	PERCENT FINES	% ORGANIC CONTENT	LIQUID LIMIT	PLAST. INDEX
0	1		SP-SM	Poorly Graded Sand with Silt - Brown slightly silty fine sand. (A-3)						
5	2		SM	Silty Sand - Gray silty fine sand. (A-2-4)		20.8	22.6			
				TERMINATED AT 6'						

**BORING LOCATION:** SEE BORING LOCATION PLAN  
**LATITUDE:** N 26°39'36.4"      **LONGITUDE:** W 81°53'40.1"  
**DATE DRILLED:** 10/20/17      **START:**      **FINISH:**  
**GROUND SURFACE ELEVATION:**      **TIME:**  
**WATER TABLE DEPTH (ft):** 5'      **DATE:** 10/20/17

**CLIENT:** GREELEY AND HANSEN LLC  
**PROJECT:** HANCOCK BRIDGE PARKWAY WATER MAIN IMP.  
**LOCATION:** N. FT. MYERS, LEE CO., FL  
**DRILL CREW:** WOOTEN / BENAVIDES      **LOGGED BY:** M. ELMORE

**DRILL MAKE & MODEL:** N/A      **BIT:** N/A      **DRILLING RODS:** N/A  
**DRILLING METHOD:** HAND-HELD BUCKET AUGER      **WEATHER CONDITIONS:** PARTLY CLOUDY / HOT

DEPTH, FT.	SAMPLE NO.	GRAPHIC LOG	USCS	SOIL DESCRIPTION	REMARKS	% WATER CONTENT	PERCENT FINES	% ORGANIC CONTENT	LIQUID LIMIT	PLAST. INDEX
0	1		SP-SM	Poorly Graded Sand with Silt - Brown and gray slightly silty fine sand. (A-3)						
5	2		PT	Peat - Dark brown peat. (A-8)						
8				TERMINATED AT 8'						

**BORING LOCATION:** SEE BORING LOCATION PLAN  
**LATITUDE:** N 26°39'37.2"      **LONGITUDE:** W 81°53'37.6"  
**DATE DRILLED:** 10/20/17      **START:**      **FINISH:**  
**GROUND SURFACE ELEVATION:**      **TIME:**  
**WATER TABLE DEPTH (ft):** 5'      **DATE:** 10/20/17

**CLIENT:** GREELEY AND HANSEN LLC  
**PROJECT:** HANCOCK BRIDGE PARKWAY WATER MAIN IMP.  
**LOCATION:** N. FT. MYERS, LEE CO., FL  
**DRILL CREW:** WOOTEN / BENAVIDES      **LOGGED BY:** M. ELMORE

**DRILL MAKE & MODEL:** N/A      **BIT:** N/A      **DRILLING RODS:** N/A  
**DRILLING METHOD:** HAND-HELD BUCKET AUGER      **WEATHER CONDITIONS:** PARTLY CLOUDY / HOT

DEPTH, FT.	SAMPLE NO.	GRAPHIC LOG	USCS	SOIL DESCRIPTION	REMARKS	% WATER CONTENT	PERCENT FINES	% ORGANIC CONTENT	LIQUID LIMIT	PLAST. INDEX
0	1		SP-SM	Poorly Graded Sand with Silt - Brown and gray slightly silty fine sand. (A-3)						
5	2		PT	Peat - Dark brown peat. (A-8)		197.1		26.7		
				TERMINATED AT 7'						
10										
15										
20										
25										
30										
35										



**BORING LOCATION:** SEE BORING LOCATION PLAN  
**LATITUDE:** N 26°39'37.9"      **LONGITUDE:** W 81°53'34.7"  
**DATE DRILLED:** 10/20/17      **START:**      **FINISH:**  
**GROUND SURFACE ELEVATION:**      **TIME:**  
**WATER TABLE DEPTH (ft):** 5'      **DATE:** 10/20/17

**CLIENT:** GREELEY AND HANSEN LLC  
**PROJECT:** HANCOCK BRIDGE PARKWAY WATER MAIN IMP.  
**LOCATION:** N. FT. MYERS, LEE CO., FL  
**DRILL CREW:** WOOTEN / BENAVIDES      **LOGGED BY:** M. ELMORE



**DRILL MAKE & MODEL:** N/A      **BIT:** N/A      **DRILLING RODS:** N/A  
**DRILLING METHOD:** HAND-HELD BUCKET AUGER      **WEATHER CONDITIONS:** PARTLY CLOUDY / HOT

DEPTH, FT.	SAMPLE NO.	GRAPHIC LOG	USCS	SOIL DESCRIPTION	REMARKS	% WATER CONTENT	PERCENT FINES	% ORGANIC CONTENT	LIQUID LIMIT	PLAST. INDEX
0			SM	Silty Sand - Brown and gray to gray slightly silty fine sand. (A-2-4)						
1			SM	Silty Sand - Brown very silty fine sand. (A-4)		32.2	42.2			
2										
5				TERMINATED AT 6'						
10										
15										
20										
25										
30										
35										

**BORING LOCATION:** SEE BORING LOCATION PLAN  
**LATITUDE:** N 26°39'38.7"      **LONGITUDE:** W 81°53'23.3"  
**DATE DRILLED:** 10/20/17      **START:**      **FINISH:**  
**GROUND SURFACE ELEVATION:**      **TIME:**  
**WATER TABLE DEPTH (ft):** NE      **DATE:** 10/20/17

**CLIENT:** GREELEY AND HANSEN LLC  
**PROJECT:** HANCOCK BRIDGE PARKWAY WATER MAIN IMP.  
**LOCATION:** N. FT. MYERS, LEE CO., FL  
**DRILL CREW:** WOOTEN / BENAVIDES      **LOGGED BY:** M. ELMORE


**DRILL MAKE & MODEL:** N/A      **BIT:** N/A      **DRILLING RODS:** N/A  
**DRILLING METHOD:** HAND-HELD BUCKET AUGER      **WEATHER CONDITIONS:** PARTLY CLOUDY / HOT

DEPTH, FT.	SAMPLE NO.	GRAPHIC LOG	USCS	SOIL DESCRIPTION	REMARKS	% WATER CONTENT	PERCENT FINES	% ORGANIC CONTENT	LIQUID LIMIT	PLAST. INDEX
0	1		SP-SM	Poorly Graded Sand with Silt - Brown and gray slightly silty fine sand. (A-3)						
5	2		ML	Sandy Silt - Gray sandy silt. (A-4)						
				TERMINATED AT 6'						
10										
15										
20										
25										
30										
35										

**BORING LOCATION:** SEE BORING LOCATION PLAN  
**LATITUDE:** N 26°39'39.4"      **LONGITUDE:** W 81°53'30.1"  
**DATE DRILLED:** 10/20/17      **START:**      **FINISH:**  
**GROUND SURFACE ELEVATION:**      **TIME:**  
**WATER TABLE DEPTH (ft):** NE      **DATE:** 10/20/17

**CLIENT:** GREELEY AND HANSEN LLC  
**PROJECT:** HANCOCK BRIDGE PARKWAY WATER MAIN IMP.  
**LOCATION:** N. FT. MYERS, LEE CO., FL  
**DRILL CREW:** WOOTEN / BENAVIDES      **LOGGED BY:** M. ELMORE

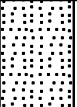
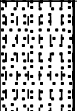
**DRILL MAKE & MODEL:** N/A      **BIT:** N/A      **DRILLING RODS:** N/A  
**DRILLING METHOD:** HAND-HELD BUCKET AUGER      **WEATHER CONDITIONS:** PARTLY CLOUDY / HOT

DEPTH, FT.	SAMPLE NO.	GRAPHIC LOG	USCS	SOIL DESCRIPTION	REMARKS	% WATER CONTENT	PERCENT FINES	% ORGANIC CONTENT	LIQUID LIMIT	PLAST. INDEX
0	1		SP-SM	Poorly Graded Sand with Silt - Brown slightly silty fine sand. (A-3)						
				TERMINATED AT 2.5' DUE TO POSSIBLE UTILITY CONFLICT						
5										
10										
15										
20										
25										
30										
35										

**BORING LOCATION:** SEE BORING LOCATION PLAN  
**LATITUDE:** N 26°39'40.4"      **LONGITUDE:** W 81°53'27.3"  
**DATE DRILLED:** 11/13/17      **START:**      **FINISH:**  
**GROUND SURFACE ELEVATION:**      **TIME:**  
**WATER TABLE DEPTH (ft):** NE      **DATE:** 11/13/17

**CLIENT:** GREELEY AND HANSEN LLC  
**PROJECT:** HANCOCK BRIDGE PARKWAY WATER MAIN IMP.  
**LOCATION:** N. FT. MYERS, LEE CO., FL  
**DRILL CREW:** WOOTEN / BENAVIDES      **LOGGED BY:** M. ELMORE

**DRILL MAKE & MODEL:** N/A      **BIT:** N/A      **DRILLING RODS:** N/A  
**DRILLING METHOD:** HAND-HELD BUCKET AUGER      **WEATHER CONDITIONS:** PARTLY CLOUDY / HOT

DEPTH, FT.	SAMPLE NO.	GRAPHIC LOG	USCS	SOIL DESCRIPTION	REMARKS	% WATER CONTENT	PERCENT FINES	% ORGANIC CONTENT	LIQUID LIMIT	PLAST. INDEX
0	1		SP	Poorly Graded Sand - Brown fine sand. (A-3)						
5	2		SP-SM	Poorly Graded Sand with Silt - Gray slightly silty fine sand. (A-3)						
				TERMINATED AT 6'						
10										
15										
20										
25										
30										
35										

## **APPENDIX**

- **SOIL BORING, SAMPLING AND TESTING METHODS  
PROJECT SOIL DESCRIPTION PROCEDURE – UNIFIED & AASHTO**



## 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 (0.6 m) long, 2-inch (50 mm) O.D. split-barrel sampler attached to the end of a string of drilling rods is driven 18 inches (0.45 m) into the ground by successive blows of a 140-pound (63.5 Kg) hammer freely dropping 30 inches (0.76 m). The number of blows needed for each 6 inches (0.15 m) of penetration is recorded. The sum of the blows required for penetration of the second and third 6-inch (0.15 m) increments penetration constitutes the test result or N-value. After the test, the sampler is extracted from the ground and opened to allow visual description 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 ( $Q_u$ ):

Cohesionless Soils:	N-Value Safety Hammer	N-Value Auto Hammer	Description	Relative Density
	< 4	< 3	Very loose	0 - 15%
	4 - 10	3 - 8	Loose	15 - 35%
	10 - 30	8 - 24	Medium dense	35 - 65%
	30 - 50	24 - 40	Dense	65 - 85%
	> 50	> 40	Very dense	85 - 100%

Cohesive Soils:	N-Value Safety Hammer	N-Value Auto Hammer	Description	Unconfined Compressive Strength, $Q_u$
	< 2	< 1	Very soft	< 0.25 tsf (25 kPa)
	2 - 4	1 - 3	Soft	0.25 - 0.50 tsf (25 - 50 kPa)
	4 - 8	3 - 6	Firm	0.50 - 1.0 tsf (50 - 100 kPa)
	8 - 15	6 - 12	Stiff	1.0 - 2.0 tsf (100 - 200 kPa)
	15 - 30	12 - 24	Very stiff	2.0 - 4.0 tsf (200 - 400 kPa)
	> 30	> 24	Hard	> 4.0 tsf (400 kPa)

The tests are usually performed at 5-foot (1.5 m) 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 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, 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. After completion of a test boring, the hole is kept open until a steady state groundwater level is recorded. The hole is then sealed by backfilling with neat cement.

Representative split-spoon samples from each sampling interval and from different strata are brought to our laboratory in air-tight jars for classification and testing, if necessary. Afterwards, the samples are discarded unless prior arrangements have been made.

### POWER AUGER BORINGS

Auger borings are used when a relatively large, continuous sampling of soil strata close to the ground surface is desired. A 4-inch (100 mm) diameter, continuous flight, helical auger with a cutting head at its end is screwed into the ground in 5-foot (1.5 m) sections. It is powered by the rotary drill rig. The sample is recovered by withdrawing the auger out of the ground without rotating it. The soil sample so obtained, is described and representative samples put in bags or jars and returned to the laboratory for classification and testing, if necessary.

## **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-foot [1.5 m]) depth or when access is not available to power drilling equipment. A 3-inch (75 mm) diameter hand bucket auger with a cutting head is simultaneously turned and pressed into the ground. The bucket auger is retrieved at approximately 6-inch (0.15 m) intervals and its contents emptied for inspection. Sometimes post-hole diggers are used, especially in the upper 3 feet (1 m) or so. The soil sample obtained is described and representative samples put in bags or jars and transported to the laboratory for classification and testing, if necessary.

## **UNDISTURBED SAMPLING**

Undisturbed sampling implies the recovery of soil samples in a state as close to their natural condition as possible. Complete preservation of in-situ conditions cannot be realized; however, with careful handling and proper sampling techniques, disturbance during sampling can be minimized for most geotechnical engineering purposes. Testing of undisturbed samples gives a more accurate estimate of in-situ behavior than is possible with disturbed samples.

Normally, we obtain undisturbed samples by pushing a 2.875-inch (73 mm) I.D., thin wall seamless steel tube 24 inches (0.6 m) into the soil with a single stroke of a hydraulic ram. The sampler, which is a Shelby tube, is 30 (0.8 m) inches long. After the sampler is retrieved, the ends are sealed in the field and it is transported to our laboratory for visual description and testing, as needed. Undisturbed sampling is noted on the boring logs as thus "U-".

## **LABORATORY TEST METHODS**

Soil samples returned to our laboratory are looked at again 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 help 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 discussed in this report, the results of which will be located in an Appendix. The soil descriptions shown on the logs are based upon visual-manual procedures in accordance with local practice. Soil classification is in general accordance with the Unified Soil Classification System (ASTM D-2487) and is also based on visual-manual procedures. Following is a list of abbreviations that may appear in the Remarks column on the boring logs indicating additional laboratory testing was performed, the results of which will usually be located in an Appendix.

- DD:** Unit Weight/Classification of Undisturbed "Shelby Tube" samples
- PP:** Pocket Penetrometer reading on cohesive samples in tons per sq. ft. (tsf)
- k:** Hydraulic Conductivity
- Qu:** Unconfined Compression Strength; ASTM D-2166
- UU:** Unconsolidated-Undrained Triaxial Test; ASTM D 2850
- Consol:** One-Dimensional Consolidation test performed on subsample from undisturbed sample; ASTM D-2435

**THE PROJECT SOIL DESCRIPTION PROCEDURE FOR SOUTHWEST FLORIDA<sup>(1)</sup>**  
**For use with the ASTM D 2487 Unified Soil Classification System**  
**CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES**

BOULDERS (>12" [300 mm]) and COBBLES (3" [75 mm] TO 12" [300 mm]):

GRAVEL:      Coarse Gravel:    3/4" (19 mm) to 3" (75 mm)  
                   Fine Gravel:        No. 4 (4.75 mm) Sieve to 3/4" (19 mm)

Descriptive adjectives:

0 – 5%        ---    no mention of gravel in description  
 5 – 15%      ---    trace  
 15 – 29%     ---    some  
 30 – 49%     ---    gravelly (shell, limerock, cemented sands)

SANDS

COARSE SAND:      No. 10 (2 mm) Sieve to No. 4 (4.75 mm) Sieve  
 MEDIUM SAND:    No. 40 (425  $\mu$ m) Sieve to No. 10 (2 mm) Sieve  
 FINE SAND:         No. 200 (75  $\mu$ m) Sieve to No. 40 (425  $\mu$ m) Sieve

Descriptive adjectives:

0 – 5%        ---    no mention of sand in description  
 5 – 15%      ---    trace  
 15 – 29%     ---    some  
 30 – 49%     ---    sandy

SILT/CLAY:            < #200 (75  $\mu$ m) sieve

SILTY OR SILT: PI < 4  
 SILTY CLAYEY OR SILTY CLAY: 4 ≤ PI ≤ 7  
 CLAYEY OR CLAY: PI > 7

Descriptive adjectives:

0 – 5%                    --- clean (no mention of silt or clay in description)  
 5 – 12% to 15%        --- slightly  
 16 – 35%                --- clayey, silty, or silty clayey  
 36 – 49%                --- very

ORGANIC SOILS

<u>Organic Content</u>	<u>Descriptive adjectives</u>	<u>Classification</u>
0 – 2.5%	no mention of organics in description	See above
2.6 – 5%	slightly organic	See above
5 – 20%	organic	Add "with organic fines" to group name



**THE PROJECT SOIL DESCRIPTION PROCEDURE FOR SOUTHWEST FLORIDA<sup>(1)</sup>**  
**For use with the ASTM D 2487 Unified Soil Classification System**  
**CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES**

HIGHLY ORGANIC SOILS AND MATTER

<u>Organic Content</u>	<u>Description</u>	<u>Classification</u>
20-75%	highly organic sand or muck sandy peat	Peat (PT) Peat (PT)
>75%	amorphous or fibrous peat	Peat (PT)

STRATIFICATION AND STRUCTURE

<u>Descriptive Term</u>	<u>Thickness</u>
with interbedded	
seam:	less than 1/2-inch (13 mm) thick
layer:	1/2 to 12-inches (13 to 300 mm) thick
stratum:	more than 12-inches (300 mm) thick
pocket:	small, erratic deposit, usually less than 1-foot
occasional:	one or less per foot of thickness
frequent:	more than one per foot of thickness
calcareous:	containing calcium carbonate (reaction to diluted HCL)
hardpan:	spodic horizon usually medium dense
marl:	mixture of carbonate clays, silts, shells and sands.

ROCK CLASSIFICATION

Description

Hard Limestone or Caprock – N-values >50 bpf

Soft Weathered Limestone – N values <50 bpf

---

(1) This soil description procedure was developed specifically for projects in southwest Florida because it is believed that the terminology will be better understood as a result of local practice. It is not intended to supplant other visual-manual classification procedures for description and identification of soils such as ASTM D 2488. BY: G.A. DREW, P.E. (1995) (Revised 2016).

# UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D2487)

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

<sup>A</sup> Based on the material passing the 3-in. (75-mm) sieve

<sup>B</sup> If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

<sup>C</sup> 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.

<sup>D</sup> 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

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

<sup>F</sup> If soil contains  $\geq 15\%$  sand, add "with sand" to group name.

<sup>G</sup> If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

<sup>H</sup> If fines are organic, add "with organic fines" to group name.

<sup>I</sup> If soil contains  $\geq 15\%$  gravel, add "with gravel" to group name.

<sup>J</sup> If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

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

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

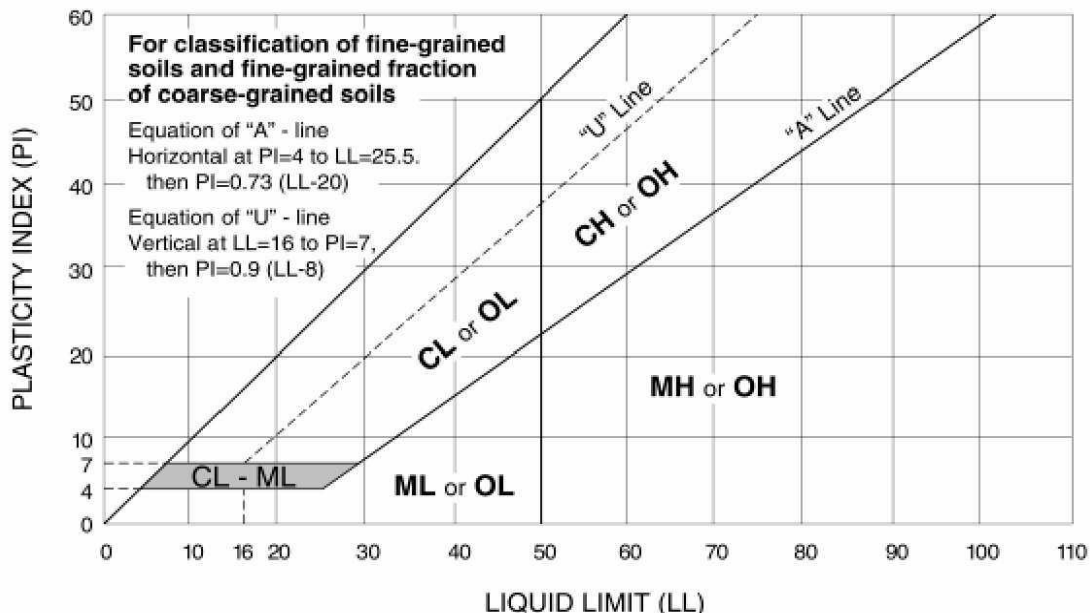
<sup>M</sup> If soil contains  $\geq 30\%$  plus No. 200, predominantly gravel, add "gravelly" to group name.

<sup>N</sup>  $PI \geq 4$  and plots on or above "A" line.

<sup>O</sup>  $PI < 4$  or plots below "A" line.

<sup>P</sup> PI plots on or above "A" line.

<sup>Q</sup> PI plots below "A" line.



Greeley and Hansen LLC  
5252 Summerlin Commons Way, Suite 104  
Fort Myers, FL 33907  
(239) 226-9660  
[www.greeley-hansen.com](http://www.greeley-hansen.com)



**GREELEY AND HANSEN**