

June 29, 2023

Kimley-Horn and Associates, Inc.
201 North Franklin St. Suite 1400
Tampa, FL 33602

Attn: Ms. Shari Barnwell, P.E.

**RE: Report of Geotechnical Engineering Services
Lena Road from North of 44th Avenue East to SR 64
Manatee County, Florida
Manatee County Project No.: 6107560
Kimley-Horn Project No.: 148400100
Tierra Project No. 6511-22-127**

Ms. Barnwell:

Tierra, Inc. (Tierra) has performed geotechnical engineering services for the proposed mast arm signal poles associated with the above-referenced project. This letter report presents the findings of our field exploration, results from laboratory testing, and geotechnical recommendations for design of the proposed mast arm signal pole structure foundations.

Project Information

Based on the design information provided by Kimley-Horn and Associates, Inc. (Kimley-Horn), three (3) mast arm signal poles are proposed at the intersection of Lena Road and SR 64 at approximate stations 309+24, 41' LT., 311+48, 79' RT. and 309+74, 82' RT. (C/L Const. Lena Road).

Soil Borings

To evaluate the subsurface conditions at the proposed mast arm signal pole foundation locations, Tierra performed Standard Penetration Test (SPT) borings to a depth of approximately 35 feet below existing grades.

Prior to performing the borings, a boring location plan was developed based on design information provided by Kimley-Horn, the guidelines provided in the Soils and Foundations Handbook published by the Florida Department of Transportation (FDOT) and our engineering judgment. The borings were located in the field by a representative of Tierra using a hand-held, non-survey grade Garmin eTrex® Global Positioning System (GPS) device with a manufacturer's reported accuracy of ±10 feet. The station and offset of each boring location were determined using the GPS coordinates obtained in the field in conjunction with project design files provided by Kimley-Horn. Some borings were offset from the originally planned locations due to utility and drill rig access constraints. The approximate boring locations are provided on the **Report of Core Borings** sheet in the **Attachments**. If an accurate determination of the boring locations and elevations is required, Tierra recommends that the locations be survey-located by the project surveyor.

The SPT borings were performed with the use of a mechanical drill rig equipped with an automatic hammer using Bentonite Mud drilling procedures. The soil sampling was performed in

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general accordance with the American Society for Testing and Materials (ASTM) Test Designation D-1586. The initial 4 to 6 feet of the SPT borings were manually hand augered to verify utility clearance. SPT resistance N-values were then taken continuously to a depth of 10 feet and at intervals of 5 feet thereafter to the boring termination depths. Representative portions of the soil samples were sealed, labeled and transferred to our laboratory for classification and analysis.

General Soil Conditions within Borings

The subsurface conditions encountered within the borings generally consist of loose to medium dense sandy soils underlain by very stiff to hard silt to clay to the boring termination depths. Detailed results of the SPT borings are presented on the attached **Report of Core Borings** sheet.

Soil stratification was determined based on a review of recovered samples, laboratory test results, and interpretation of field boring logs. Stratification lines represent approximate boundaries between soil layers of different engineering properties; however, actual transitions between layers may be gradual. In some cases, small variations in properties that were not considered pertinent to our engineering evaluation may have been abbreviated or omitted for clarity. The soil profiles represent the conditions at the particular boring location and variations did occur among the borings. Specific details about subsurface conditions and materials encountered at each boring location can be obtained from the soil profiles presented on the attached **Report of Core Borings** sheet.

Groundwater Information

At the time of our field activities, the groundwater table was encountered within the borings at depths ranging from approximately 3 to 8½ feet below existing grades. The groundwater table levels are presented on the attached **Report of Core Borings** sheet.

Groundwater conditions will vary with environmental variations and seasonal conditions, such as the frequency and magnitude of rainfall patterns, as well as man-made influences (i.e., existing water management canals, swales, drainage ponds, underdrains, and areas of covered soils, such as paved parking lots and sidewalks).

General Recommendations

Shaft Installation

The proposed mast arm signal pole foundations should be installed in accordance with FDOT and/or Manatee County Specifications.

Very dense sand and indurated clay was encountered within the borings. Drilling into and/or through these materials may be difficult and will require non-conventional construction techniques and specialized equipment. The depth and consistency of these materials can vary.

Temporary casing methods for shaft installation beyond what is required in the FDOT Specifications may be required in order to prevent the collapse of sandy soils and/or groundwater intrusion during shaft construction.

Based on a review of the "Upper Floridan Aquifer Potentiometric Surface" maps published by the USGS, the potentiometric surface elevation in the project vicinity is reported up to approximately +30 feet, NGVD 29. Artesian flow conditions were not encountered within the borings performed at the time of the field activities; however, the contractor should be prepared to address artesian levels up to a head of +30 feet, NGVD 29.

Soil Parameters for Foundation Design

It is our understanding that the design of the mast arm signal pole foundations will be performed utilizing the approved FDOT Mathcad program. The FDOT programs model the subsurface as a uniform soil type with consistent strength properties; however, multilayered soil profiles with different soil types and properties were encountered within the boring depths. Based on our understanding of the FDOT Mathcad program and its one soil type modeling, Tierra has evaluated the results of the soil borings and developed equivalent average N-value tables and soil design parameters for use by the structural engineer. The recommended geotechnical input parameters for the FDOT Mathcad program are provided in the attached **Recommended Soil Parameters for FDOT Mathcad Program** and **Recommended Equivalent Average N-Values for FDOT Mathcad Program** tables. Tierra recommends that the foundations be designed based on saturated conditions, i.e. the groundwater table at the surface.

If the mast arm signal pole foundations are installed on side slopes, the design should include the portion of the shaft with less than 2.5D (D=shaft diameter) horizontal soil cover (face-of-shaft to face-of-slope) as unsupported length and design the portion of the shaft with more than 2.5D horizontal soil cover as though founded in level ground.

Shaft Embedment/Length

The mast arm signal pole foundations should not be tipped/embedded within one (1) shaft diameter of very loose soils to reduce the risk of excessive settlement of the shaft and potential for instability of the shaft bottom during construction. In the event that the shaft tip elevation is determined to be within one (1) shaft diameter of very loose soils based on the design calculations, the shaft should be extended below the very loose soils into denser underlying materials. It is recommended that Tierra be provided the design shaft tip elevations for review prior to the final plan submittal.

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Tierra appreciates the opportunity to be of service to Kimley-Horn and Associated, Inc. on this project. If you have any questions or comments regarding this report, please contact our office at your earliest convenience.

Respectfully Submitted,

TIERRA, INC.

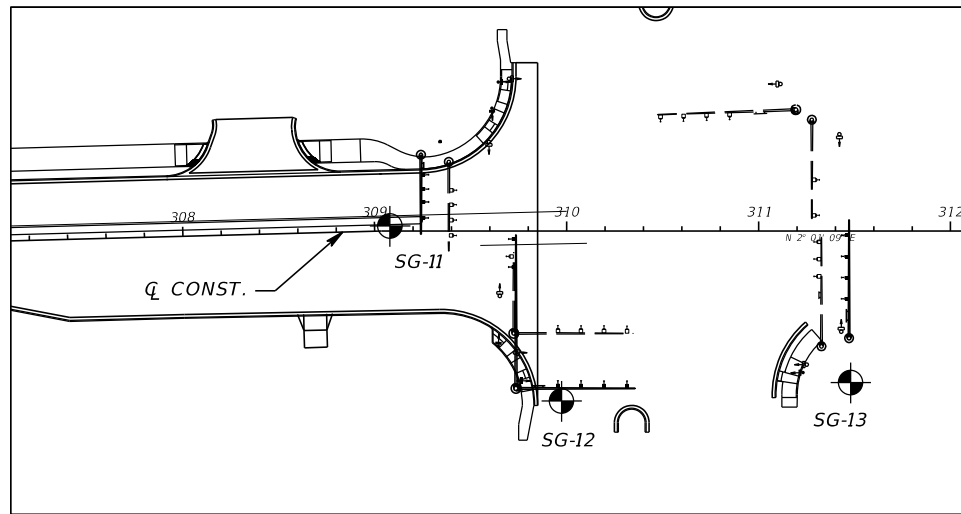


Trevor J. Bianco, E.I.
Geotechnical Engineer Intern



Kevin H. Scott, P.E.
Senior Geotechnical Engineer
Florida License No. 65514

Attachments: **Report of Core Borings Sheet**
Recommended Soil Parameters for FDOT Mathcad Program
Recommended Equivalent Average N-Values for FDOT Mathcad Program



BORING LOCATION PLAN

NOTES:

1. THE BORINGS WERE LOCATED IN THE FIELD USING A HAND-HELD GARMIN ETREX NON-SURVEY GRADE GLOBAL POSITIONING SYSTEM (GPS) DEVICE WITH A REPORTED ACCURACY OF ±10 FEET. THE BORING LOCATION STATION, OFFSET AND ELEVATION WERE DETERMINED USING THE GPS COORDINATES IN CONJUNCTION WITH THE DESIGN FILES PROVIDED BY KIMLEY-HORN. THE BORING LOCATIONS AND ELEVATIONS SHOULD BE CONSIDERED APPROXIMATE.
2. TEMPORARY CASING METHODS BEYOND WHAT IS REQUIRED IN THE PROJECT SPECIFICATIONS FOR THE SHAFT INSTALLATION MAY BE REQUIRED IN ORDER TO PREVENT THE COLLAPSE OF THE SANDY SOILS AND/OR GROUNDWATER INTRUSION DURING THE SHAFT INSTALLATION.
3. BASED ON THE REVIEW OF THE "UPPER FLORIDAN AQUIFER POTENTIOMETRIC SURFACE" MAPS PUBLISHED BY THE USGS, THE POTENTIOMETRIC SURFACE ELEVATION IN THE PROJECT VICINITY IS REPORTED UP TO APPROXIMATELY +30 FEET, NGVD 29. ARTESIAN FLOW CONDITIONS WERE NOT ENCOUNTERED WITHIN THE BORINGS PERFORMED AT THE TIME OF THE FIELD ACTIVITIES; HOWEVER, THE CONTRACTOR SHOULD BE PREPARED TO ADDRESS ARTESIAN LEVELS UP TO A HEAD OF +30 FEET, NGVD 29.
4. VERY DENSE SAND AND INDURATED CLAY WAS ENCOUNTERED WITHIN THE BORINGS. DRILLING INTO AND/OR THROUGH THESE MATERIALS MAY BE DIFFICULT AND WILL REQUIRE NON-CONVENTIONAL CONSTRUCTION TECHNIQUES AND SPECIALIZED EQUIPMENT. THE DEPTH AND CONSISTENCY OF THESE MATERIALS CAN VARY.

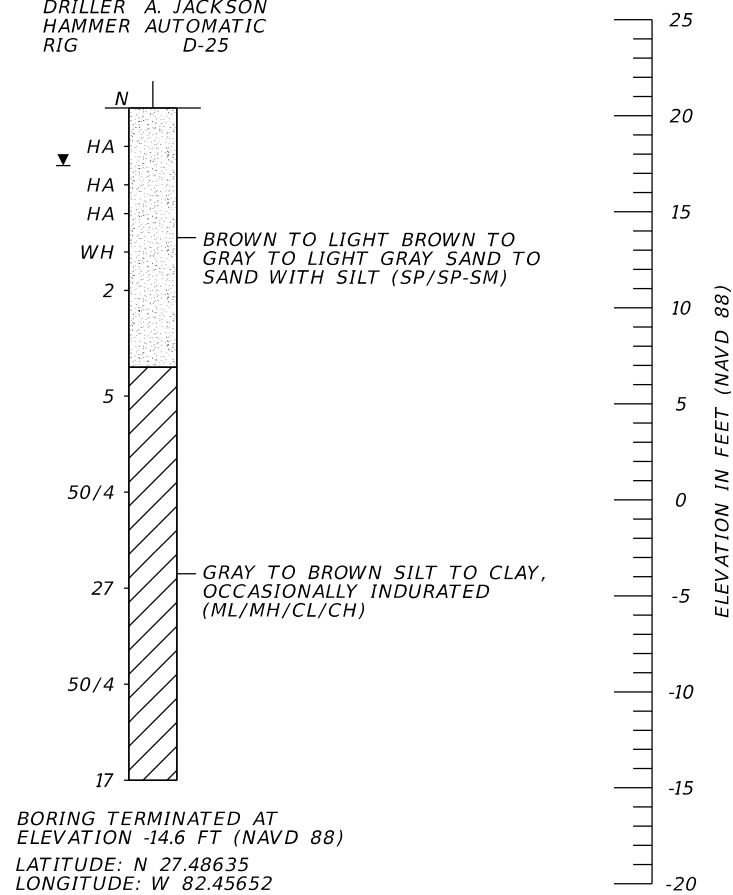
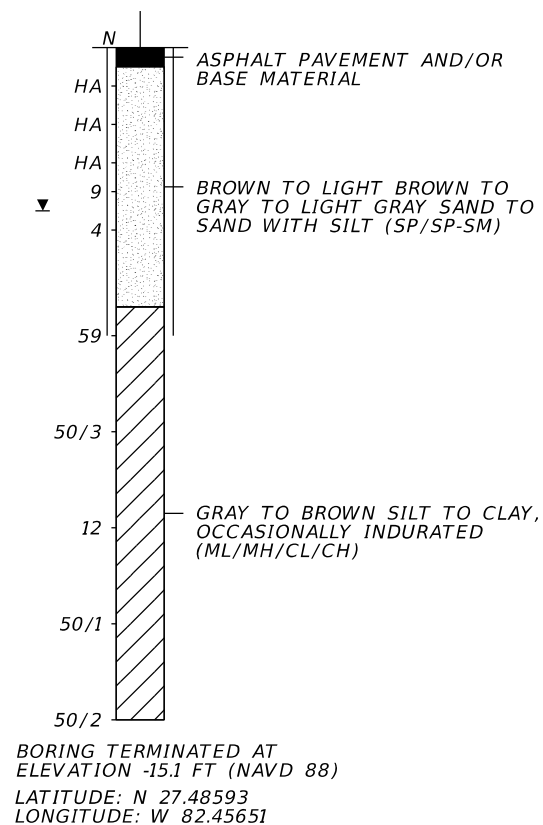
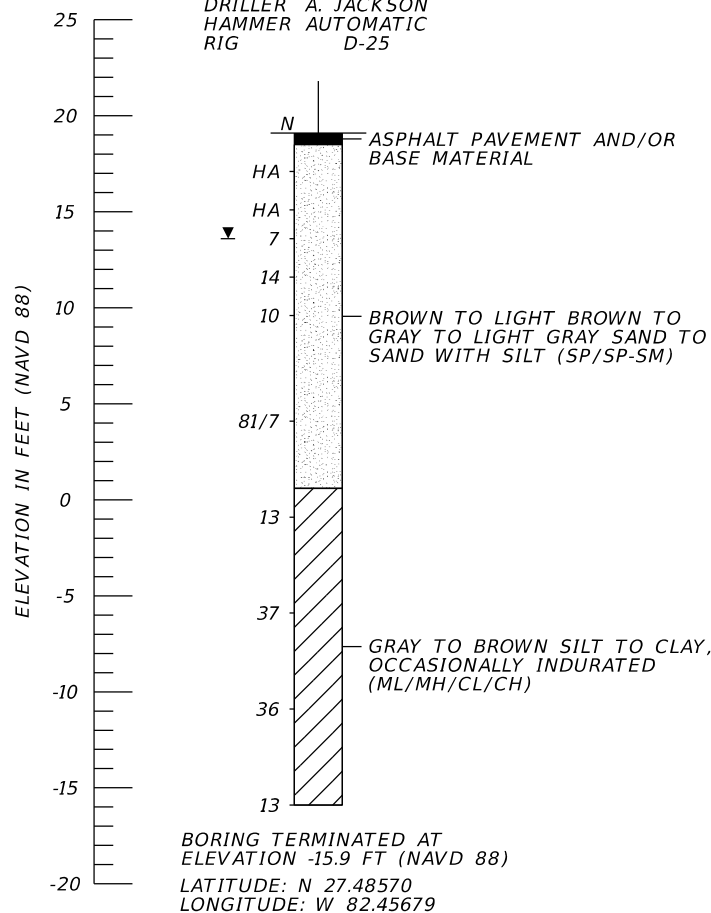
LEGEND

- BROWN TO LIGHT BROWN TO GRAY TO LIGHT GRAY SAND TO SAND WITH SILT (SP/SP-SM)
- GRAY TO BROWN SILT TO CLAY, OCCASIONALLY INDURATED (ML/MH/CL/CH)
- ASPHALT PAVEMENT AND/OR BASE MATERIAL
- SP UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2487) GROUP SYMBOL AS DETERMINED BY VISUAL REVIEW.
- N NUMBERS TO THE LEFT OF BORINGS INDICATE SPT VALUE FOR 12 INCHES OF PENETRATION (UNLESS OTHERWISE NOTED).
- 50/4 NUMBER OF BLOWS FOR 4 INCHES OF PENETRATION
- HA HAND AUGERED TO VERIFY UTILITY CLEARANCE
- WH SPLIT-SPOON SAMPLER ADVANCED UNDER WEIGHT OF ROD AND HAMMER
- NAVD 88 NORTH AMERICAN VERTICAL DATUM OF 1988
- APPROXIMATE SPT BORING LOCATION
- CASING
- GROUNDWATER LEVEL ENCOUNTERED DURING FIELD EXPLORATIONS

BOR # SG-11
 STA. 309+08
 REF. C/L CONST.
 OFF. 3' LT.
 ELEV. 19.1
 DATE 5/25/2023
 DRILLER A. JACKSON
 HAMMER AUTOMATIC
 RIG D-25

BOR # SG-12
 STA. 309+97
 REF. Q CONST.
 OFF. 89' RT.
 ELEV. 19.9
 DATE 5/9/2023
 DRILLER J. SHAW
 HAMMER AUTOMATIC
 RIG D-25

BOR # SG-13
 STA. 311+48
 REF. Q CONST.
 OFF. 79' RT.
 ELEV. 20.4
 DATE 6/27/2023
 DRILLER A. JACKSON
 HAMMER AUTOMATIC
 RIG D-25



AUTOMATIC HAMMER	
GRANULAR MATERIALS-RELATIVE DENSITY	SPT N-VALUE (BLOWS/FT.)
VERY LOOSE	LESS THAN 3
LOOSE	3 to 8
MEDIUM DENSE	8 to 24
DENSE	24 to 40
VERY DENSE	GREATER THAN 40
SILTS AND CLAYS CONSISTENCY	SPT N-VALUE (BLOWS/FT.)
VERY SOFT	LESS THAN 1
SOFT	1 to 3
FIRM	3 to 6
STIFF	6 to 12
VERY STIFF	12 to 24
HARD	GREATER THAN 24

No.	REVISIONS	DATE	BY

KEVIN H. SCOTT, P.E.
 P.E. LICENSE NUMBER 65514
 TIERRA, INC.
 7351 TEMPLE TERRACE HIGHWAY
 TAMPA, FLORIDA 33637

KHA PROJECT 148400100
 DATE 5/2023
 SCALE AS SHOWN
 DESIGNED BY BJS
 DRAWN BY BJS
 CHECKED BY TB
 MANATEE COUNTY

Manatee County
 LENA ROAD
 LICENSED PROFESSIONAL
 KEVIN H. SCOTT, P.E.
 FL LICENSE NUMBER 65514

REPORT OF CORE BORINGS

SHEET NUMBER

THE OFFICIAL RECORD OF THIS SHEET IS THE ELECTRONIC FILE DIGITALLY SIGNED AND SEALED UNDER RULE 61G15-23.004, F.A.C.

Recommended Soil Parameters for FDOT Mathcad Program

Lena Road from North of 44th Avenue East to SR 64

Manatee County, Florida

Manatee County Project No.: 6107560

Tierra Project No.: 6511-22-127

Structure Name	Intersection	Approximate Structure Location (C/L Const. Lena Road)		Reference Boring	Approximate Boring Location (C/L Const. Lena Road)		Soil Type	Submerged Unit Weight, γ (lb/ft ³)	Saturated Condition	Friction Angle, ϕ (degrees)
		Station	Offset		Station	Offset				
Mast Arm Pole 1	Lena Road at SR 64	309+24	41' LT.	SG-11	309+08	3' LT.	SAND	50	YES ⁽¹⁾	30
Mast Arm Pole 5	Lena Road at SR 64	309+74	82' RT.	SG-12	309+97	89' RT.	SAND	50	YES ⁽¹⁾	30
Mast Arm Pole 4	Lena Road at SR 64	311+47	56' RT.	SG-13	311+48	79' RT.	SAND	43	YES ⁽¹⁾	29

⁽¹⁾ Assume saturated conditions, i.e. analyze with the groundwater at the surface.

**Recommended Equivalent Average N-Values for FDOT Mathcad Program
Lena Road from North of 44th Avenue East to SR 64
Manatee County, Florida
Manatee County Project No.: 6107560
Tierra Project No.: 6511-22-127**

Approximate Boring Elevation (feet, NAVD 88):	19.1	Reference Boring:	SG-11
		Boring Station & Offset	309+08, 3' LT.
Approximate Ground Elevation at Structure Location (feet, NAVD 88):	19.5	Structure Station & Offset:	309+24, 41' LT.

Mast Arm Pole 1

Approximate Shaft Depth (feet)	Approximate Shaft Elevation (feet, NAVD 88)	Automatic Hammer SPT N-Value	Corrected Safety Hammer N-Value ⁽¹⁾	Average Weighted N-Value for use in Mathcad Torsional Calculation
1	18.1	HA ⁽²⁾	4.0	4
2	17.1	HA ⁽²⁾	4.0	4
3	16.1	HA ⁽²⁾	4.0	4
4	15.1	HA ⁽²⁾	4.0	4
5	14.1	7	8.7	5
6	13.1	7	8.7	6
7	12.1	14	17.4	8
8	11.1	14	17.4	10
9	10.1	10	12.4	10
10	9.1	10	12.4	11
11	8.1	10	12.4	11
12	7.1	10	12.4	11
13	6.1	10	12.4	11
14	5.1	81/7	50.0	12
15	4.1	81/7	50.0	12
16	3.1	81/7	50.0	12
17	2.1	81/7	50.0	13
18	1.1	81/7	50.0	13
19	0.1	13	16.1	13
20	-0.9	13	16.1	12
21	-1.9	13	16.1	12
22	-2.9	13	16.1	12
23	-3.9	13	16.1	12
24	-4.9	37	45.9	13
25	-5.9	37	45.9	14
26	-6.9	37	45.9	15
27	-7.9	37	45.9	15
28	-8.9	37	45.9	16
29	-9.9	36	44.6	16
30	-10.9	36	44.6	16
31	-11.5	36	44.6	16
32	-12.5	36	44.6	17
33	-13.5	36	44.6	17
34	-14.5	13	16.1	16
35	-15.5	13	16.1	16

⁽¹⁾ Automatic Hammer SPT N Value is corrected by a factor of 1.24 to equivalent Safety Hammer N-Value in accordance with the FDOT Soils and Foundations Handbook.

⁽²⁾ HA: Hand augered. Corrected Safety Hammer N-Value treated as 4.

**Recommended Equivalent Average N-Values for FDOT Mathcad Program
Lena Road from North of 44th Avenue East to SR 64
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Approximate Boring Elevation (feet, NAVD 88):	19.9	Reference Boring:	SG-12
		Boring Station & Offset	309+97, 89' RT.
Approximate Ground Elevation at Structure Location (feet, NAVD 88):	19.9	Structure Station & Offset:	309+74, 82' RT.

Mast Arm Pole 5

Approximate Shaft Depth (feet)	Approximate Shaft Elevation (feet, NAVD 88)	Automatic Hammer SPT N-Value	Corrected Safety Hammer N-Value ⁽¹⁾	Average Weighted N-Value for use in Mathcad Torsional Calculation
1	18.9	HA ⁽²⁾	4.0	4
2	17.9	HA ⁽²⁾	4.0	4
3	16.9	HA ⁽²⁾	4.0	4
4	15.9	HA ⁽²⁾	4.0	4
5	14.9	HA ⁽²⁾	4.0	4
6	13.9	HA ⁽²⁾	4.0	4
7	12.9	9	11.2	5
8	11.9	9	11.2	7
9	10.9	4	5.0	6
10	9.9	4	5.0	6
11	8.9	4	5.0	6
12	7.9	4	5.0	5
13	6.9	4	5.0	5
14	5.9	59	50.0	12
15	4.9	59	50.0	16
16	3.9	59	50.0	19
17	2.9	59	50.0	22
18	1.9	59	50.0	24
19	0.9	50/3	50.0	25
20	-0.1	50/3	50.0	26
21	-1.1	50/3	50.0	27
22	-2.1	50/3	50.0	27
23	-3.1	50/3	50.0	27
24	-4.1	12	14.9	26
25	-5.1	12	14.9	24
26	-6.1	12	14.9	23
27	-7.1	12	14.9	22
28	-8.1	12	14.9	21
29	-9.1	50/1	50.0	21
30	-10.1	50/1	50.0	21
31	-11.1	50/1	50.0	21
32	-12.1	50/1	50.0	21
33	-13.1	50/1	50.0	21
34	-14.1	50/2	50.0	21
35	-15.1	50/2	50.0	21

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Lena Road from North of 44th Avenue East to SR 64
Manatee County, Florida
Manatee County Project No.: 6107560
Tierra Project No.: 6511-22-127**

Approximate Boring Elevation (feet, NAVD 88):	20.4	Reference Boring:	SG-13
		Boring Station & Offset	311+48, 79' RT.
Approximate Ground Elevation at Structure Location (feet, NAVD 88):	21.0	Structure Station & Offset:	311+47, 56' RT.

Mast Arm Pole 4

Approximate Shaft Depth (feet)	Approximate Shaft Elevation (feet, NAVD 88)	Automatic Hammer SPT N-Value	Corrected Safety Hammer N-Value ⁽¹⁾	Average Weighted N-Value for use in Mathcad Torsional Calculation
1	19.4	HA ⁽²⁾	4.0	4
2	18.4	HA ⁽²⁾	4.0	4
3	17.4	HA ⁽²⁾	4.0	4
4	16.4	HA ⁽²⁾	4.0	4
5	15.4	HA ⁽²⁾	4.0	4
6	14.4	HA ⁽²⁾	4.0	4
7	13.4	WH	0.0	2
8	12.4	WH	0.0	2
9	11.4	2	2.5	2
10	10.4	2	2.5	2
11	9.4	2	2.5	2
12	8.4	2	2.5	2
13	7.4	2	2.5	2
14	6.4	5	6.2	2
15	5.4	5	6.2	2
16	4.4	5	6.2	3
17	3.4	5	6.2	3
18	2.4	5	6.2	3
19	1.4	50/4	50.0	6
20	0.4	50/4	50.0	9
21	-0.6	50/4	50.0	11
22	-1.6	50/4	50.0	13
23	-2.6	50/4	50.0	15
24	-3.6	27	33.5	15
25	-4.6	27	33.5	15
26	-5.6	27	33.5	14
27	-6.6	27	33.5	14
28	-7.6	27	33.5	14
29	-8.6	50/4	50.0	15
30	-9.6	50/4	50.0	15
31	-10.0	50/4	50.0	16
32	-11.0	50/4	50.0	16
33	-12.0	50/4	50.0	16
34	-13.0	17	21.1	16
35	-14.0	17	21.1	15

⁽¹⁾ Automatic Hammer SPT N Value is corrected by a factor of 1.24 to equivalent Safety Hammer N-Value in accordance with the FDOT Soils and Foundations Handbook.

⁽²⁾ HA: Hand augered. Corrected Safety Hammer N-Value treated as 4.