SUBSURFACE SOIL EXPLORATION
ANALYSIS AND RECOMMENDATIONS
PROPOSED MULTI-FAMILY RESIDENTIAL DEVELOPMENT
SOUTH PART OF ALICO INTERCHANGE PARK
SWC OF I-75 AND ALICO ROAD
FORT MYERS, LEE COUNTY, FLORIDA

Ardaman & Associates, Inc.

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Ardaman & Associates, Inc.

Geotechnical, Environmental and
Materials Consultants

Ardaman Project No. 18-33-4520
June 14, 2018

COURTELIS COMPANY
703 Waterford Way, Suite 800
Miami, FL 33126

Attention: Mr. Elias Vassilaros

SUBJECT: Subsurface Soil Exploration
Analysis and Recommendations
Proposed Multi-Family Residential Development
South Part of Alico Interchange Park
SWC of I-75 and Alico Road
Fort Myers, Lee County, Florida

Gentlemen:

As requested and authorized by **Courtelis Company**, 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 at the site and provide recommendations for site preparation and foundation design.

This report documents our findings and conclusions. It has been prepared for the exclusive use of **Courtelis Company** 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 12 Standard Penetration Test (SPT) borings and three test pits to determine the nature and condition of the subsurface soils.

2. Reviewing each soil sample obtained in our field exploration program by a geotechnical engineer in our laboratory for further identification and assignment of laboratory tests.

3. Performing the appropriate laboratory tests on selected samples.

4. Analyzing the existing soil conditions with respect to the proposed construction as it relates to foundation design.

5. Preparing this report to document the results of our field exploration, engineering analysis and foundation design recommendations.

SITE LOCATION

The proposed multi-family development will be located on a parcel south of Alico Road, west of Interstate 75 and east of Three Oaks Parkway in Fort Myers, Lee County, Florida. The Lee County Property Appraiser identifies the lot by STRAP No. 10-46-25-00-00001.1000. A **Site Location Map** is presented as **Figure 1**.

The parcel is presently used for cattle grazing. The north and east areas of the site are heavily wooded. The southeast corner of the site has a pond. Based on historical aerial photograph review, we understand the south part of the site was a pond excavated for soil borrow purposes and subsequently partially filled in between 2007 and 2012.

FIELD EXPLORATION PROGRAM

Our field exploration consisted of performing 12 Standard Penetration Test (SPT) borings. The SPT borings were drilled to depths of 20, 30 and 35 feet below the existing ground surface. The SPT borings were conducted using methods consistent with ASTM D-1586. The equipment and procedures used in the SPT borings are described in detail in the **Appendix**.

Our field exploration also included the excavation of three test pits. The test pits were excavated by others using a Komatsu bucket excavator. The test pits were generally excavated to a depth of 17 feet below the existing ground surface, except for test pit location TP-1, which encountered refusal at 6.5 feet due to rock

The locations of the borings and test pits are shown on the attached **Test Location Plan** (**Figure 2**). The test locations were identified in the field by reference to an aerial photograph obtained from the Lee County Property Appraiser's website. 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 and test pit 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.

The general soil profile consisted of very loose to dense fine sands (SP) and slightly silty fine sands (SP-SM/SM) from the ground surface to depths ranging from 4 to 12.5 feet below the existing ground surface. Below the fine sands, the borings typically encountered very loose to dense silty fine sands (SM) and silty clayey fine sands (SC-SM) extending to depths ranging from 7.5 to 22.5 feet below the existing ground surface. Below this the borings encountered alternating layers of very loose to medium dense slightly silty sands (SP-SM), very loose to medium dense silty sands (SM), very loose fine sands (SP), very loose to medium dense silty clayey sands (SC-SM) and very loose to loose sandy silt (ML) with varying amounts (if any) of gravel consisting of cemented sands and rock fragments extending to the termination of the borings at depths of 20, 30 and 35 feet below the existing ground surface. Borings SPT-1 and SPT-3 encountered loose clayey sands (SC) or hard sandy lean clays (CL) near the termination of the borings at about 32.5 feet extending to the termination of the borings at 35 feet. Also, borings SPT-3 through SPT-5 and SPT-8 through SPT-11 encountered soft weathered to hard limestone at depths ranging from 7.5 to 11 feet extending to depths ranging from 11 to 17 feet below the existing ground surface. In addition, test pits TP-1 thru TP-3 encountered weathered limestone at depths ranging from approximately 6.5 to 12 feet extending to depths of 12 and 14 feet below the existing ground surface.

Groundwater was encountered in the test pits at depths ranging from 6 to 9 feet below the existing ground surface at the time of our field exploration (May 10th, 2018). Groundwater was encountered in the boreholes at depths ranging from 4 to 7 feet below the existing ground surface at the time of our field exploration (April 18th and 20th, 2018, and June 6 and 7, 2018). The groundwater depths shown on the boring logs represent the groundwater surface encountered on the dates shown. 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 and Percent Finer than the U.S. No. 200 Sieve (percent silt and clay).

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.

PROPOSED CONSTRUCTION

The proposed multi-family development is planned to include two 4-story wood-framed apartment buildings with floor slab-on-grade. We also understand the proposed development will include parking/drive areas and a lake for fill dirt and stormwater management. We anticipate site grading to include approximately 2 to 3 feet of site filling.

For the purposes of evaluating the bearing capacity and settlement values, we have been given maximum loading conditions of 50 kips for individual column footings and 6 kips per lineal foot for continuous wall footings. The recommendations contained in this report will not necessarily apply if loading conditions are in excess of the above assumed loading conditions.

ANALYSIS AND RECOMMENDATION

In view of our findings, subsurface conditions appear to be adequate for shallow foundation support of the proposed four-story structures with the floor slabs supported on grade. Note that these structures will have limitations on maximum column loads of less than about 100 kips and maximum wall loads of less than about 11 kips her lineal foot. Structures with heavier column or wall loads may require additional ground improvement such as vibro-replacement to limit settlements to tolerable levels.

Filling of the existing pond for support of the proposed multi-family buildings and surface parking will require dewatering of the pond so that the backfill soils may be placed under dry conditions. End-dumping and pushing fill soils into the pond up to grade without any compactive effort will in our opinion be insufficient to allow use of spread footing foundation design for support of any structures. Intolerable ground surface settlement will likely result over time.

The following are our recommendations for overall site preparation and foundation design that we feel are best suited for the proposed development and existing soil conditions. These recommendations are made as a guide for the design engineer and/or architect, parts of which should be incorporated into the project's general specifications.

SITE PREPARATION:

1. Each building area "footprint" and parking/drive areas, plus a minimum margin of 5 feet, should be stripped and grubbed of all surface vegetation, debris or other deleterious material, as encountered. During the clearing and grubbing operation, roots with a diameter greater than 1-inch or small roots in high density should be completely removed. These materials should be disposed of in areas designated by the Owner.

2. The cleared surfaces in construction areas should be proofrolled using the appropriate compaction equipment for site and soil conditions. Adjust the moisture content of the soil, as necessary, to aid compaction. Sufficient passes should be made to develop a minimum dry density of 95 percent of the Modified Proctor Maximum Dry Density (ASTM D-1557) to a depth of 12 inches below the compacted surface. Replace all material, if determined to be deleterious, in areas that "yield" during the proofrolling operation and replace with suitable fill material conforming to that stated in Item 4.

3. After satisfactory proofrolling of the cleared surface in accordance with the above, filling with suitable material may proceed. Fill material should conform to that stated in Item 4 below. The fill should be placed in level lifts not exceeding 12 inches in uncompacted thickness. Each lift should be compacted by repeated passes with appropriate compaction equipment to achieve at least 95 percent of the Modified Proctor Maximum Dry Density (ASTM D-1557). The filling and compaction operations should continue until the desired elevation(s) is achieved.

4. Fill material should preferably consist of clean to slightly silty fine sands (SP or SP-SM), free of organic or other deleterious materials, with less than 12 percent passing the U.S. Sieve No. 200.

5. Excavate the continuous wall footing lines and/or column footings to the proposed bottom of footing elevations and, thereafter, verify the in-place compaction. If necessary, compact the bottom of the excavations to achieve a minimum dry density of 95 percent of the Modified Proctor Maximum Dry Density (ASTM D-1557). This density should be developed to a minimum depth of 12 inches below the bottom of the footings.

Over-excavate and recompact, as necessary, to fulfill the above compaction criteria. The moisture content of the foundation soils must be controlled during the compaction procedure to aid compaction.

6. Ardaman should be employed by the Owner to observe and test all prepared and compacted areas to document that all unsuitable soils are removed and that the foundation and fill soils are prepared and compacted in accordance with the above recommendations.

FOUNDATION DESIGN:

Foundation soils prepared in accordance with the above recommendations should be suitable for supporting the proposed structure on an economical and conventionally designed shallow foundation system. The foundations may be designed for an allowable net soil contact pressure of 2500 pounds per square foot (psf) or less.

Column footings should be a minimum of 24 inches wide and wall footings should be a minimum of 18 inches wide. Minimum soil coverage of 12 inches should be maintained from the bottom of the exterior foundations to the adjacent outside finished grades.

Based on the boring information and the assumed loading conditions, the recommended allowable net soil contact pressure will yield a minimum factor of safety in excess of two against bearing capacity failure. The total settlement is estimated to be 1 inch or less, and differential settlement between adjacent footings is estimated to be ¾ inch or less. Because foundation soils are mostly coarse-grained, the majority of settlement will occur during construction as the load is being applied.

UTILITY EXCAVATION:

Fine sands (SP) and slightly silty fine sands (SP-SM/SM) are anticipated to be at the ground surface extending to depths ranging from 4 to 17.5 feet below the existing ground surface. These soil types are suitable bedding materials and suitable for reuse as backfill.

Below the sands, strata of silty and silty clayey sands (SM and SC-SM) and limestone rock, are anticipated to be encountered. These are unsuitable materials for use as bedding and backfill and we recommend bedding all pipe in at least 6 inches of gravel such as FDOT No. 89 Stone, if unsuitable soil types or conditions are encountered at pipe invert elevation.

REUSE OF ENCOUNTERED MATERIALS IN THE TEST BORINGS/TEST PITS:

Poorly Graded Sand (SP)
Poorly Graded Sands with Silt (SP-SM)

These sands contain less than 12 percent fines. Sands excavated below the water table should be stockpiled to drain excess moisture. These soil types were encountered typically to depths of 4 to 12.5 feet.

These soil types are suitable as unprocessed fill for use as structural fill. They are also suitable for use in roadway and parking lot embankments and subgrades and as general landscaping fill. Drainage or permeability characteristics of SP materials are good.

Silty Sand (SM)
Silty Clayey Sand (SC-SM)

These silty sands typically contain less than about 35 percent non-plastic or low plasticity fines and are generally suitable for use in roadway and parking lot embankments; however, careful control of the moisture content is needed to achieve required compaction. This soil type was typically encountered at depths of 4 to 12.5 feet generally extending to the termination of the borings at depths of 20, 30 and 35 feet below the existing ground surface. Note, boring SPT-4 encountered a 1-1/2-foot thick stratum of silty clayey fine sands at a depth of 3 feet.

Soft Weathered Limestone
Hard Limestone

Hard limestone or soft weathered limestone were encountered in test locations SPT-2 through SPT-4, SPT-8 through SPT-11 and TP-1 through TP-3 at depths ranging from 6.5 to 12 feet extending to depths ranging from 10 to 17 feet below the existing ground surface. The soft limestone appears as a partially cemented gravelly slightly silty to silty fine sand (SP-SM/SM). As such it is a suitable material for use in roadway/parking lot embankments and subgrades. Cobble and boulder-size fragments should be expected throughout the soft limestone stratum. Soft limestone can typically be excavated with a large excavator. Hard limestone will require use of pneumatic chisels, hoe rams or similar dynamic tools to remove the rock when encountered in an excavation. Use of rock or boulder and cobble-size fragments will require crushing to reduce particle sizes. Typically, we recommend no individual pieces larger than 3-1/2 inches in the upper 1-foot, 6-inches between 1 and 2 feet and 12 inches below a depth of 2 feet. Note that at test pit locations TP-2 and TP-3 the limestone was removed by the bucket excavator; however, at TP-1 the excavator could not remove, hence termination of the test pit on rock.

Sandy Silts (ML)
Clayey Sand (SC)
Sandy Lean Clay (CL)

These plastic sandy silts, clayey sands and sandy clays are not suitable for reuse as structural fill nor may they be used under roadway or parking lot embankments. Reuse will be limited to non-structural areas used as berms. This material will be very difficult to work because of the high moisture content and high plastic fines content. This soil was typically encountered below depths of 25 feet below the existing ground surface.

COMPACTION RECOMMENDATIONS SUMMARY:

Below is a summary of compaction recommendations for various project elements. We recommend a moisture content range of -4 to +2 percent of the optimum moisture content at the time of compaction as determined by Modified Proctor (ASTM D-1557) procedure.

Location	Percent Compaction ASTM D-1557	Depth	Recommended Test Frequency
Bottom of Footings	95	12 inches	at column footings and every 75 l.f. of wall footing
Slab Subgrade	95	12 inches	per 2,500 s.f.
Structural Fill	95	full depth	per 2,500 s.f. per lift
Paving			
limerock base	98	full thickness	per 10,000 s.f.
stabilized subgrade	98	full thickness	per 10,000 s.f.
embankment	95	full depth	per 5,000 s.f. per lift
Utility Trenches (in paved area)	95	full depth	per 300 l.f. alternate lifts
Utility Trenches (outside paved area)	90	full depth	per 300 l.f. alternate lifts
Beneath Sidewalks and Exterior Slabs	95	12 inches	per 5,000 s.f.

GENERAL COMMENTS

The analysis and recommendations in this report are based on the data obtained from the 12 soil borings and three test piles performed at the approximate locations indicated on the attached **Figure 2–Boring Location Plan**.

This report does not reflect any variations that may occur between the borings. The nature and extent of variations may not become evident until during the course of construction. If variations then appear evident, it will be necessary for a reevaluation of the recommendations of this report to be made after performing on-site observations during the construction period and noting the characteristics of any variations.

When the final design and specifications are completed, we would like the opportunity to review them to determine whether changes in the original concept may have affected the validity of our recommendations and whether these recommendations have been implemented in the design and specifications.

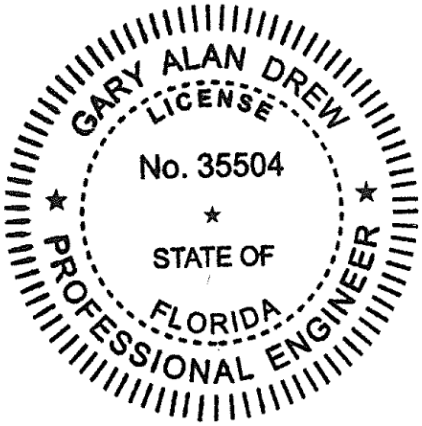
While the borings are representative of subsurface conditions at their respective locations and for their respective vertical reaches, local variations characteristic of the subsurface materials of the region are anticipated and may be encountered. The boring logs and related information are based on 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:

Gary A Drew
2018.06.15 16:40:28 -04'00'

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

- **SITE LOCATION MAP (FIGURE 1)**
- **BORING LOCATION PLAN (FIGURE 2)**
- **BORING LOGS – SPT-1 THROUGH SPT- 12**
- **TEST PIT LOGS – TP-1 THROUGH TP-3**

FIGURE 1
SITE LOCATION MAP

SOURCE: GOOGLE EARTH PRO

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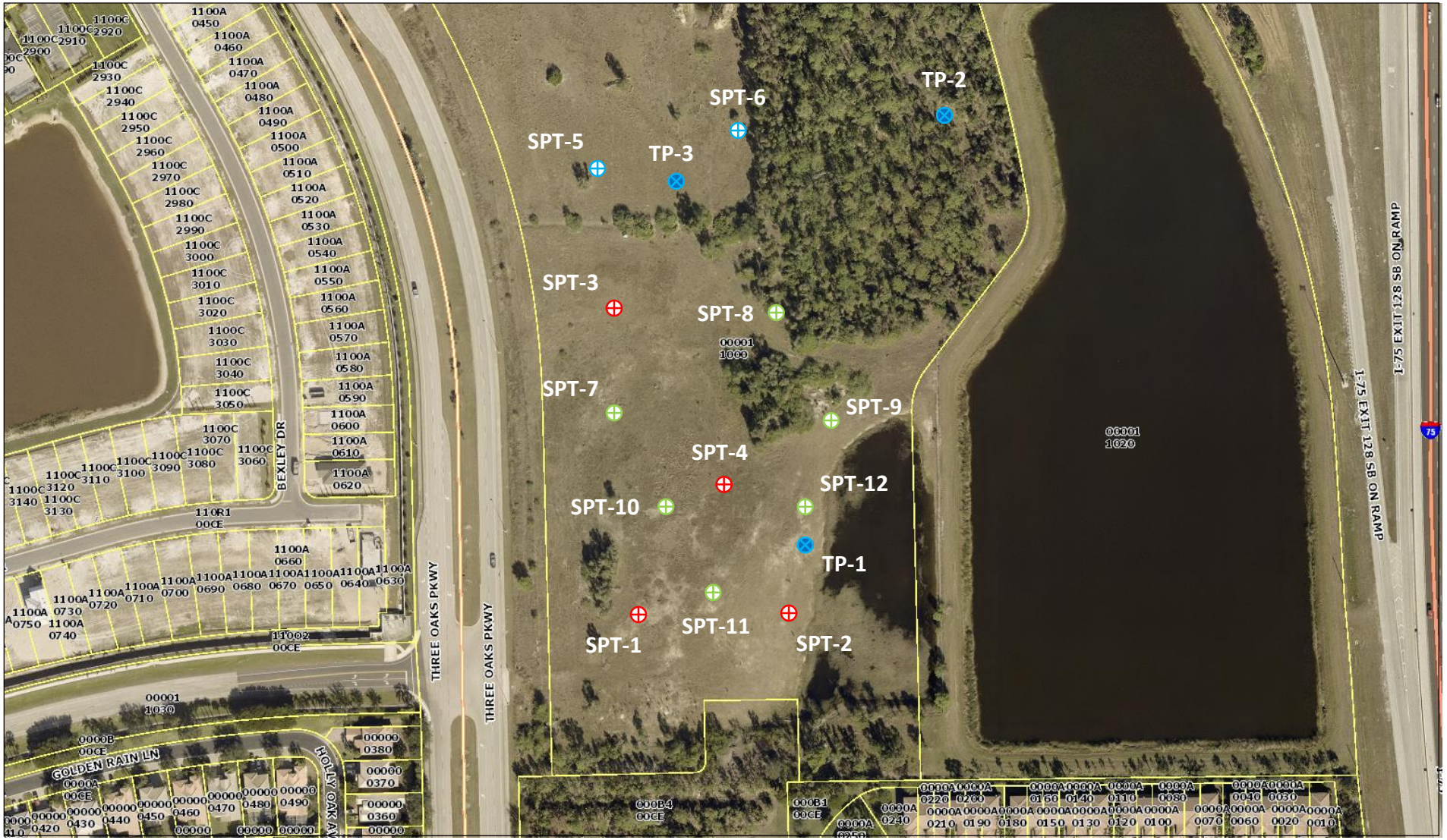
Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

Proposed Multi-Family Residential Development
South Part of Alico Interchange Park
SWC of I-75 and Alico Road
Estero, Lee County, FL

Drawn By:	Checked By:	Date:
ME	GD	6/15/18

File No.:	Approved By:	Figure No:
18-33-4520	Gary Drew, P.E.	1



⊕ = 35' SPT Borings

⊕ = 30' SPT Borings

⊕ = 20' SPT Borings

⊗ = Test Pits

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FIGURE 2

TEST LOCATION PLAN

SOURCE: LEEPA.ORG

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

Proposed Multi-Family Residential Development
South Part of Alico Interchange Park
SWC of I-75 and Alico Road
Estero, Lee County, FL

Drawn By:	Checked By:	Date:
ME	GD	6/15/18

File No.:	Approved By:	Figure No:
18-33-4520	Gary Drew, P.E.	2

BORING LOCATION: SEE BORING LOCATION PLAN
LATITUDE: N 26°29'169" **LONGITUDE:** W 81°47'888"
DATE DRILLED: 18-APR-18 **START:** **FINISH:**
GROUND SURFACE ELEVATION: **TIME:**
WATER TABLE DEPTH (ft): 4.0' **DATE:** 18-APR-18

CLIENT: COURTELIS COMPANY
PROJECT: PROPOSED MULTI-FAMILY RESIDENTIAL DEVELOPMENT
LOCATION: ALICO INTERCHANGE PARK
DRILL CREW: LOCKLEY / BENAVIDES / SKEWIS **LOGGED BY:** M. ELMORE,

DRILL MAKE & MODEL: MOBILE B-57/AUTO **BIT:** 2-15/16" DIA. TRI CONE ROLLER **DRILLING RODS:** AW
DRILLING METHOD: ROTARY WASH WITH DRILLING FLUID **WEATHER CONDITIONS:** SUNNY

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	11- 7- 9	16	1		SP-SM	Poorly Graded Sand with Silt - Brown slightly silty fine sand, trace gravel (rock fragments).	15' OF HW CASING INSTALLED					
	9- 10- 10	20	2									
	12- 14- 16	30	3									
5	8- 9- 8	17	4									
	4- 2- 1	3	5					18.9	12.1			
	3- 4- 14	18	6		SP	Poorly Graded Sand - Brown fine sand.						
10	11- 7- 8	15	7		SC-SM	Silty Clayey Sand - Brown silty clayey fine sand.						
					SM	Silty Sand - Brown silty fine sand, trace to some gravel (rock fragments).						
15	4- 4- 2	6	8									
					SP-SM	Poorly Graded Sand with Silt and Gravel - Gray partially cemented slightly silty medium to fine sand, some gravel (rock fragments and cemented sands).						
20	1- 0- 2	2	9									
					SP	Poorly Graded Sand - Brown fine sand.						
25	2- 1- 1	2	10									
					SM	Silty Sand - Light brown silty fine sand, trace gravel (rock fragments).						
30	4- 6- 8	14	11									
					SC	Clayey Sand - Gray clayey fine sand.						
35	3- 2- 3	5	12			TERMINATED AT 35.5'						

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

REVIEWED BY: GARY A. DREW, P.E. **FILE NO:** 18-33-4520 **BORING NO.:** SPT-1

BORING LOCATION: SEE BORING LOCATION PLAN
LATITUDE: N 26°29'168" **LONGITUDE:** W 81°47'859"
DATE DRILLED: 20-APR-18 **START:** **FINISH:**
GROUND SURFACE ELEVATION: **TIME:**
WATER TABLE DEPTH (ft): 4.0' **DATE:** 20-APR-18

CLIENT: COURTELIS COMPANY
PROJECT: PROPOSED MULTI-FAMILY RESIDENTIAL DEVELOPMENT
LOCATION: ALICO INTERCHANGE PARK
DRILL CREW: LOCKLEY / BENAVIDES / SKEWIS **LOGGED BY:** M. ELMORE, E.I.

DRILL MAKE & MODEL: MOBILE B-57/AUTO **BIT:** 2-15/16" DIA. TRI CONE ROLLER **DRILLING RODS:** AW
DRILLING METHOD: ROTARY WASH WITH DRILLING FLUID **WEATHER CONDITIONS:** SUNNY

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	14- 8- 9	17	1		SP-SM	Poorly Graded Sand with Silt - Brown slightly silty fine sand, trace to some gravel (rock fragments).	15' OF HW CASING INSTALLED					
	7- 6- 6	12	2									
	4- 6- 4	10	3									
5	3- 3- 4	7	4									
	5- 9- 17	26	5		SP	Poorly Graded Sand - Brown fine sand.						
	12- 14- 21	35	6									
10	13- 13- 11	24	7		SP-SM	Poorly Graded Sand with Silt - Brown slightly silty fine sand.						
							Loss of drilling fluid circulation at 11.5'					
					SM	Silty Sand - Light brown silty fine sand, trace to some gravel (rock fragments).						
15	1- 1- 0	1	8									
					SP-SM	Poorly Graded Sand with Silt - Gray partially cemented slightly silty medium to fine sand, trace to some gravel (rock fragments and cemented sands).						
20	7- 7- 10	17	9									
					SM	Silty Sand - Gray partially cemented silty medium to fine sand, trace to some gravel (rock fragments and cemented sands).						
25	4- 3- 4	7	10					26.7	26.1			
					SP-SM	Poorly Graded Sand with Silt - Brown slightly silty fine sand.						
30	3- 2- 1	3	11									
					SC-SM	Silty Clayey Sand - Gray silty clayey fine sand.						
35	6- 6- 5	11	12			TERMINATED AT 35.5'						

BORING LOCATION: SEE BORING LOCATION PLAN
LATITUDE: N 26°29'252" **LONGITUDE:** W 81°47'890"
DATE DRILLED: 18-APR-18 **START:** **FINISH:**
GROUND SURFACE ELEVATION: **TIME:**
WATER TABLE DEPTH (ft): 4.5' **DATE:** 18-APR-18

CLIENT: COURTELIS COMPANY
PROJECT: PROPOSED MULTI-FAMILY RESIDENTIAL DEVELOPMENT
LOCATION: ALICO INTERCHANGE PARK
DRILL CREW: LOCKLEY / BENAVIDES / SKEWIS **LOGGED BY:** M. ELMORE, E.I.

DRILL MAKE & MODEL: MOBILE B-57/AUTO **BIT:** 2-15/16" DIA. TRI CONE ROLLER **DRILLING RODS:** AW
DRILLING METHOD: ROTARY WASH WITH DRILLING FLUID **WEATHER CONDITIONS:** SUNNY

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	2- 4- 5	9	1		SP	Poorly Graded Sand - Brown fine sand.	15' OF HW CASING INSTALLED					
	4- 6- 7	13	2									
	4- 3- 4	7	3									
5	3- 3- 3	6	4									
	2- 1- 0	1	5		SM	Silty Sand - Brown silty fine sand.						
	1- 1- 3	4	6			Soft Weathered Limestone						
10	1- 1- 2	3	7									
					SM	Silty Sand - Gray partially cemented silty medium to fine sand, trace to some gravel (rock fragments and cemented sands).						
15	20- 14- 9	23	8					28.1	25.2			
20	4- 2- 1	3	9									
25	3- 1- 1	2	10									
					SC-SM	Silty Clayey Sand - Gray silty clayey fine sand.						
30	2- 1- 1	2	11									
					CL	Sandy Lean Clay - Greenish gray sandy lean clay.						
35	9- 14- 13	27	12			TERMINATED AT 35.5'						

BORING LOCATION: SEE BORING LOCATION PLAN
LATITUDE: N 26°29'198" **LONGITUDE:** W 81°47'871"
DATE DRILLED: 20-APR-18 **START:** **FINISH:**
GROUND SURFACE ELEVATION: **TIME:**
WATER TABLE DEPTH (ft): 4.0' **DATE:** 20-APR-18

CLIENT: COURTELIS COMPANY
PROJECT: PROPOSED MULTI-FAMILY RESIDENTIAL DEVELOPMENT
LOCATION: ALICO INTERCHANGE PARK
DRILL CREW: LOCKLEY / BENAVIDES / SKEWIS **LOGGED BY:** M. ELMORE, E.I.

DRILL MAKE & MODEL: MOBILE B-57/AUTO **BIT:** 2-15/16" DIA. TRI CONE ROLLER **DRILLING RODS:** AW
DRILLING METHOD: ROTARY WASH WITH DRILLING FLUID **WEATHER CONDITIONS:** SUNNY

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	27- 15- 18	33	1		SP-SM	Poorly Graded Sand with Silt - Brown slightly silty fine sand, trace to some gravel (rock fragments).	15' OF HW CASING INSTALLED					
	14- 11- 11	22	2									
	11- 9- 10	19	3		SC-SM	Silty Clayey Sand - Brown silty clayey fine sand.		15.2	24.1			
5	8- 7- 6	13	4		SP-SM	Poorly Graded Sand with Silt - Brown slightly silty fine sand.						
	3- 4- 9	13	5									
	14- 50-	50/3"	6		SM	Silty Sand - Brown silty fine sand.						
	50/0"- -	50/0"				Hard Limestone						
10							Loss of drilling fluid circulation at 12'					
	50/2"- -	50/2"										
15					SP-SM	Poorly Graded Sand with Silt and Gravel - Gray partially cemented slightly silty medium to fine sand, some gravel (rock fragments and cemented sands).						
20	4- 6- 6	12	7									
					SM	Silty Sand - Gray partially cemented silty medium to fine sand, trace to some gravel (rock fragments and cemented sands).						
25	9- 7- 8	15	8									
30	3- 4- 7	11	9									
35	4- 2- 3	5	10			TERMINATED AT 35.5'						

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REVIEWED BY: GARY A. DREW, P.E. **FILE NO:** 18-33-4520 **BORING NO.:** SPT-4

BORING LOCATION: SEE BORING LOCATION PLAN
LATITUDE: N 26°29'200" **LONGITUDE:** W 81°47'972"
DATE DRILLED: 20-APR-18 **START:** **FINISH:**
GROUND SURFACE ELEVATION: **TIME:**
WATER TABLE DEPTH (ft): 5.0' **DATE:** 20-APR-18

CLIENT: COURTELIS COMPANY
PROJECT: PROPOSED MULTI-FAMILY RESIDENTIAL DEVELOPMENT
LOCATION: ALICO INTERCHANGE PARK
DRILL CREW: LOCKLEY / BENAVIDES / SKEWIS **LOGGED BY:** M. ELMORE, E.I.

DRILL MAKE & MODEL: MOBILE B-57/AUTO **BIT:** 2-15/16" DIA. TRI CONE ROLLER **DRILLING RODS:** AW
DRILLING METHOD: ROTARY WASH WITH DRILLING FLUID **WEATHER CONDITIONS:** SUNNY

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 - Gray to brown fine sand.	15' OF HW CASING INSTALLED					
	2- 3- 4	7	2									
	3- 4- 6	10	3									
5	4- 4- 5	9	4		SP-SM	Poorly Graded Sand with Silt - Brown slightly silty fine sand.		16.6	8.7			
	5- 5- 6	11	5									
	5- 4- 2	6	6					15.9	11.9			
10	1- 10- 3	13	7		SC-SM	Silty Clayey Sand - Brown silty clayey fine sand.						
						Weathered Limestone	Loss of drilling fluid circulation at 12'					
15	1- 3- 3	6	8		SP-SM	Poorly Graded Sand with Silt and Gravel - Brown slightly silty fine sand, some gravel (rock fragments).						
20	8- 4- 5	9	9		SM	Silty Sand - Gray partially cemented silty medium to fine sand, trace to some gravel (rock fragments and cemented sands).						
						TERMINATED AT 20.5'						
25												
30												
35												

BORING LOCATION: SEE BORING LOCATION PLAN
LATITUDE: N 26°29'290" **LONGITUDE:** W 81°47'859"
DATE DRILLED: 20-APR-18 **START:** **FINISH:**
GROUND SURFACE ELEVATION: **TIME:**
WATER TABLE DEPTH (ft): 5.0' **DATE:** 20-APR-18

CLIENT: COURTELIS COMPANY
PROJECT: PROPOSED MULTI-FAMILY RESIDENTIAL DEVELOPMENT
LOCATION: ALICO INTERCHANGE PARK
DRILL CREW: LOCKLEY / BENAVIDES / SKEWIS **LOGGED BY:** M. ELMORE,

DRILL MAKE & MODEL: MOBILE B-57/AUTO **BIT:** 2-15/16" DIA. TRI CONE ROLLER **DRILLING RODS:** AW
DRILLING METHOD: ROTARY WASH WITH DRILLING FLUID **WEATHER CONDITIONS:** SUNNY

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 - Gray to brown fine sand.	15' OF HW CASING INSTALLED					
	4- 6- 7	13	2									
	4- 3- 3	6	3									
5	4- 2- 1	3	4		SP-SM	Poorly Graded Sand with Silt - Brown slightly silty fine sand.						
	2- 1- 1	2	5									
	1- 1- 0	1	6					23.0	11.8			
10	1- 0- 0	0	7		SC-SM	Silty Clayey Sand - Brown silty clayey fine sand.	Loss of drilling fluid circulation at 11.5'					
					SM	Silty Sand - Gray partially cemented silty medium to fine sand, trace to some gravel (rock fragments and cemented sands).						
15	5- 10- 10	20	8									
20	3- 2- 1	3	9			TERMINATED AT 20.5'						
25												
30												
35												

BORING LOCATION: SEE BORING LOCATION PLAN
LATITUDE: N 26°29'13.23" **LONGITUDE:** W 81°47'53.51"
DATE DRILLED: 6-JUN-18 **START:** **FINISH:**
GROUND SURFACE ELEVATION: **TIME:**
WATER TABLE DEPTH (ft): 6.0' **DATE:** 6-JUN-18

CLIENT: COURTELIS COMPANY
PROJECT: PROPOSED MULTI-FAMILY RESIDENTIAL DEVELOPMENT
LOCATION: ALICO INTERCHANGE PARK
DRILL CREW: LOCKLEY / BENAVIDES / SKEWIS **LOGGED BY:** M. ELMORE,

DRILL MAKE & MODEL: MOBILE B-57/AUTO **BIT:** 2-15/16" DIA. TRI CONE ROLLER **DRILLING RODS:** AW
DRILLING METHOD: ROTARY WASH WITH DRILLING FLUID **WEATHER CONDITIONS:** SUNNY

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	3- 3- 4	7	1		SP	Poorly Graded Sand, Light brown fine sand.	15' OF HW CASING INSTALLED					
	5- 5- 6	11	2									
	4- 4- 5	9	3									
5	3- 2- 2	4	4									
	2- 1- 1	2	5									
	1- 3- 7	10	6									
10	4- 6- 6	12	7									
					SM	Silty Sand with Gravel - Gray partially cemented silty medium to fine sand, some gravel (rock fragments and cemented sands).						
15	4- 7- 11	18	8									
20	8- 20- 16	36	9									
					SP-SM	Poorly Graded Sand with Silt - Gray slightly silty fine sand, trace gravel (rock and shell fragments).						
25	3- 7- 6	13	10									
					ML	Sandy Silt - Gray sandy silt.						
30	1- 0- 1	1	11									
						TERMINATED AT 30.5'						
35												

BORING LOCATION: SEE BORING LOCATION PLAN
LATITUDE: N 26°29'14.76" **LONGITUDE:** W 81°47'50.94"
DATE DRILLED: 6-JUN-18 **START:** **FINISH:**
GROUND SURFACE ELEVATION: **TIME:**
WATER TABLE DEPTH (ft): 5.0' **DATE:** 6-JUN-18

CLIENT: COURTELIS COMPANY
PROJECT: PROPOSED MULTI-FAMILY RESIDENTIAL DEVELOPMENT
LOCATION: ALICO INTERCHANGE PARK
DRILL CREW: LOCKLEY / BENAVIDES / SKEWIS **LOGGED BY:** M. ELMORE,

DRILL MAKE & MODEL: MOBILE B-57/AUTO **BIT:** 2-15/16" DIA. TRI CONE ROLLER **DRILLING RODS:** AW
DRILLING METHOD: ROTARY WASH WITH DRILLING FLUID **WEATHER CONDITIONS:** SUNNY

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	3- 2- 4	6	1		SP	Poorly Graded Sand, Light brown fine sand.	15' OF HW CASING INSTALLED					
	5- 6- 5	11	2									
	5- 8- 6	14	3									
5 ▼	6- 5- 6	11	4									
	4- 3- 2	7	5		SP-SM	Poorly Graded Sand with Silt - Gray slightly silty fine sand, trace gravel (rock fragments).						
	7- 9- 8	17	6									
10	17- 37- 47	84	7			Hard Limestone.						
					SM	Silty Sand with Gravel - Gray partially cemented silty medium to fine sand, some gravel (rock fragments and cemented sands).						
15	13- 9- 6	15	8									
					SM	Silty Sand - Gray silty fine sand, trace gravel (rock and shell fragments).						
20	1- 0- 0	0	9									
25	4- 3- 4	7	10									
					ML	Sandy Silt - Gray sandy silt.						
30	1- 1- 2	3	11									
						TERMINATED AT 30.5'						
35												

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REVIEWED BY: GARY A. DREW, P.E. **FILE NO:** 18-33-4520 **BORING NO.:** SPT-8

BORING LOCATION: SEE BORING LOCATION PLAN
LATITUDE: N 26°29'13.23" **LONGITUDE:** W 81°47'50.04"
DATE DRILLED: 7-JUN-18 **START:** **FINISH:**
GROUND SURFACE ELEVATION: **TIME:**
WATER TABLE DEPTH (ft): **DATE:** 7-JUN-18

CLIENT: COURTELIS COMPANY
PROJECT: PROPOSED MULTI-FAMILY RESIDENTIAL DEVELOPMENT
LOCATION: ALICO INTERCHANGE PARK
DRILL CREW: LOCKLEY / BENAVIDES / SKEWIS **LOGGED BY:** M. ELMORE,

DRILL MAKE & MODEL: MOBILE B-57/AUTO **BIT:** 2-15/16" DIA. TRI CONE ROLLER **DRILLING RODS:** AW
DRILLING METHOD: ROTARY WASH WITH DRILLING FLUID **WEATHER CONDITIONS:** SUNNY

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	9- 39- 42	81	1		SM	Silty Sand - Gray to brown slightly silty fine sand, trace to some gravel (rock fragments).	15' OF HW CASING INSTALLED					
	40- 18- 10	28	2					8.3	16			
	12- 9- 9	18	3									
5	4- 4- 4	8	4									
	4- 7- 8	15	5		SP-SM	Poorly Graded Sand with Silt - Gray slightly silty fine sand, trace gravel (rock fragments).						
	5- 6- 6	12	6									
10	4- 2- 2	4	7									
					SM	Silty Sand with Gravel - Gray partially cemented silty medium to fine sand, some gravel (rock fragments and cemented sands).						
15	5- 1- 2	3	8			Hard Limestone.						
					SM	Silty Sand with Gravel - Gray partially cemented silty medium to fine sand, some gravel (rock fragments and cemented sands).						
20	1- 0- 0	0	9									
					SM	Silty Sand - Gray silty fine sand, trace gravel (rock and shell frgaments).						
25	2- 1- 1	2	10									
					ML	Sandy Silt - Gray sandy silt.						
30	1- 1- 2	3	11									
						TERMINATED AT 30.5'						
35												

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REVIEWED BY: GARY A. DREW, P.E. **FILE NO:** 18-33-4520 **BORING NO.:** SPT-9

BORING LOCATION: SEE BORING LOCATION PLAN
LATITUDE: N 26°29'11.87" **LONGITUDE:** W 81°47'52.83"
DATE DRILLED: 7-JUN-18 **START:** **FINISH:**
GROUND SURFACE ELEVATION: **TIME:**
WATER TABLE DEPTH (ft): 7.0' **DATE:** 7-JUN-18

CLIENT: COURTELIS COMPANY
PROJECT: PROPOSED MULTI-FAMILY RESIDENTIAL DEVELOPMENT
LOCATION: ALICO INTERCHANGE PARK
DRILL CREW: LOCKLEY / BENAVIDES / SKEWIS **LOGGED BY:** M. ELMORE,

DRILL MAKE & MODEL: MOBILE B-57/AUTO **BIT:** 2-15/16" DIA. TRI CONE ROLLER **DRILLING RODS:** AW
DRILLING METHOD: ROTARY WASH WITH DRILLING FLUID **WEATHER CONDITIONS:** SUNNY

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	2- 4- 9	13	1		SM	Silty Sand - Gray to brown slightly silty fine sand, trace to some gravel (rock fragments).	15' OF HW CASING INSTALLED					
	12- 17- 14	31	2									
	10- 10- 12	22	3									
5	13- 11- 10	21	4									
	7- 7- 8	15	5					11	13			
	4- 3- 3	6	6									
10	3- 10- 50	60	7			Hard Limestone.						
						Soft Weathered Limestone.						
15	4- 7- 4	11	8		SM	Silty Sand with Gravel - Gray partially cemented silty medium to fine sand, some gravel (rock fragments and cemented sands).	Loss of drilling fluid circulation at 15'					
20	7- 5- 4	9	9									
					SP-SM	Poorly Graded Sand with Silt - Gray slightly silty fine sand, trace gravel (rock fragments).						
25	8- 7- 6	13	10									
					ML	Sandy Silt - Gray sandy silt.						
30	3- 2- 2	4	11									
						TERMINATED AT 30.5'						
35												

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REVIEWED BY: GARY A. DREW, P.E. **FILE NO:** 18-33-4520 **BORING NO.:** SPT-10

BORING LOCATION: SEE BORING LOCATION PLAN
LATITUDE: N 26°29'10.66" **LONGITUDE:** W 81°47'51.86"
DATE DRILLED: 7-JUN-18 **START:** **FINISH:**
GROUND SURFACE ELEVATION: **TIME:**
WATER TABLE DEPTH (ft): 7.0' **DATE:** 7-JUN-18

CLIENT: COURTELIS COMPANY
PROJECT: PROPOSED MULTI-FAMILY RESIDENTIAL DEVELOPMENT
LOCATION: ALICO INTERCHANGE PARK
DRILL CREW: LOCKLEY / BENAVIDES / SKEWIS **LOGGED BY:** M. ELMORE,

DRILL MAKE & MODEL: MOBILE B-57/AUTO **BIT:** 2-15/16" DIA. TRI CONE ROLLER **DRILLING RODS:** AW
DRILLING METHOD: ROTARY WASH WITH DRILLING FLUID **WEATHER CONDITIONS:** SUNNY

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	5- 7- 10	17	1		SM	Silty Sand - Gray to brown slightly silty fine sand, trace to some gravel (rock fragments).	15' OF HW CASING INSTALLED					
	8- 8- 7	15	2									
	8- 8- 10	18	3									
5	15- 11- 10	21	4									
	14- 11- 9	20	5									
	8- 9- 12	21	6									
10	4- 7- 5	12	7									
					SM	Silty Sand with Gravel - Gray partially cemented silty medium to fine sand, some gravel (rock fragments and cemented sands).						
15	3- 4- 3	7	8									
						Hard Limestone.	Loss of drilling fluid circulation at 16.5'					
					SM	Silty Sand with Gravel - Gray partially cemented silty medium to fine sand, some gravel (rock fragments and cemented sands).						
20	5- 4- 8	12	9									
					ML	Sandy Silt - Gray sandy silt, trace gravel (shell fragments).						
25	4- 1- 1	2	10									
30	1- 0- 1	1	11									
						TERMINATED AT 30.5'						
35												

BORING LOCATION: SEE BORING LOCATION PLAN
LATITUDE: N 26°29'11.87" **LONGITUDE:** W 81°47'50.40"
DATE DRILLED: 7-JUN-18 **START:** **FINISH:**
GROUND SURFACE ELEVATION: **TIME:**
WATER TABLE DEPTH (ft): 4.0' **DATE:** 7-JUN-18

CLIENT: COURTELIS COMPANY
PROJECT: PROPOSED MULTI-FAMILY RESIDENTIAL DEVELOPMENT
LOCATION: ALICO INTERCHANGE PARK
DRILL CREW: LOCKLEY / BENAVIDES / SKEWIS **LOGGED BY:** M. ELMORE,

DRILL MAKE & MODEL: MOBILE B-57/AUTO **BIT:** 2-15/16" DIA. TRI CONE ROLLER **DRILLING RODS:** AW
DRILLING METHOD: ROTARY WASH WITH DRILLING FLUID **WEATHER CONDITIONS:** SUNNY

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	7- 5- 3	8	1		SM	Silty Sand - Gray to brown slightly silty fine sand, trace to some gravel (rock fragments).	15' OF HW CASING INSTALLED					
	2- 1- 1	2	2					15	17			
	2- 1- 2	3	3									
5	1- 0- 1	1	4									
	1- 0- 2	2	5									
	7- 5- 6	11	6									
10	14- 7- 10	17	7		SM	Silty Sand - Gray silty fine sand, trace gravel (rock and shell fragments).						
					SM	Silty Sand with Gravel - Gray partially cemented silty medium to fine sand, some gravel (rock fragments and cemented sands).						
15	12- 7- 4	11	8									
20	1- 3- 1	4	9									
					SM	Silty Sand - Gray silty fine sand, trace gravel (rock and shell frgaments).						
25	3- 2- 2	4	10									
					ML	Sandy Silt - Gray sandy silt.						
30	1- 1- 1	2	11									
						TERMINATED AT 30.5'						
35												

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REVIEWED BY: GARY A. DREW, P.E. **FILE NO:** 18-33-4520 **BORING NO.:** SPT-12

TEST PIT LOGS

Test Pit No. 1 (TP-1) **Water Table Depth (ft): 6'** **Date: 10-MAY-18**

Depth From	To	Soil/Rock Description	NM	-200	LL	PI
0	4'	Brown slightly silty fine sands with gravel and boulders **(SP-SM)**				
4'	5.5'	Brown and gray silty fine sands, with gravel and boulders **(SM)**	8.8	20.1		
5.5'	6.5'	Brown and gray silty clayey fine sands **(SC-SM)**				
6.5'	TERM. (6.5')	Weathered Limestone				

Test Pit No. 2 (TP-2) **Water Table Depth (ft): 7'** **Date: 10-MAY-17**

Depth From	To	Soil/Rock Description	NM	-200	LL	PI
0	4.5'	Gray to brown fine sands **(SP)**				
4.5'	8'	Brown slightly silty fine sands **(SP-SM)**	20.8	9.0		
8'	10'	Brown and gray silty fine sands **(SM)**	22.7	32.1	NP	NP
10'	12'	Weathered Limestone				
12'	TERM. (17')	Brown and gray slightly silty fine sands **(SP-SM)** with Interbedded clayey fine sands layers **(SC)**				

Test Pit No. 3 (TP-3) **Water Table Depth (ft): 9'** **Date: 10-MAY-17**

Depth From	To	Soil/Rock Description	NM	-200	LL	PI
0	4'	Gray to brown fine sands **(SP)**				
4'	9'	Brown slightly silty fine sands **(SP-SM)**				
9'	12'	Gray silty clayey fine sands **(SC-SM)**	16.1	31.3	23	7
12'	14'	Weathered Limestone				
14'	16'	Gray clayey fine sands **(SC)**				
16'	TERM. (17')	Brown and gray silty clayey fine sands **(SC-SM)**				

APPENDIX

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

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 (Qu):

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, Qu
< 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[1]
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 μm) Sieve to No. 10 (2 mm) Sieve
FINE SAND: No. 200 (75 μm) Sieve to No. 40 (425 μm) Sieve

Descriptive adjectives:

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

SILT/CLAY: < #200 (75 μm) 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

Organic Content	Descriptive adjectives	Classification
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(1)
For use with the ASTM D 2487 Unified Soil Classification System
CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES

HIGHLY ORGANIC SOILS AND MATTER

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

STRATIFICATION AND STRUCTURE

Descriptive Term with interbedded	Thickness
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

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

[A] Based on the material passing the 3-in. (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

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

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

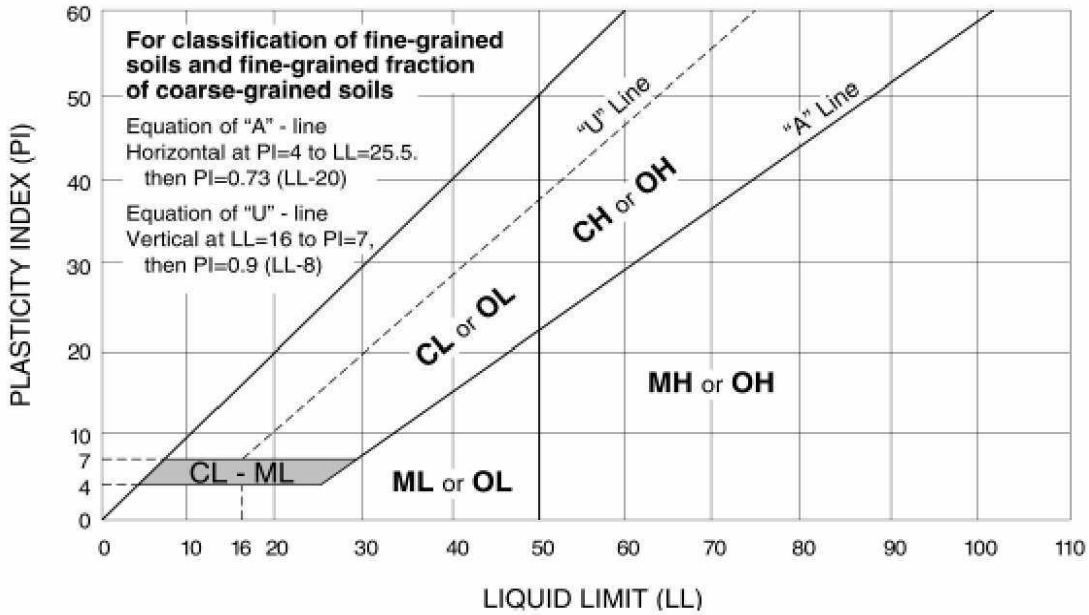
[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.