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Engineering • Consulting • Testing

November 11, 2014

Sabal Trail Pipeline Project
Evaluation of Karst Topography and Sinkhole Potential for Pipeline and Facilities

Gulf Interstate Engineering
Attention: Mr. Denys Stavnychyi - Project Engineer

RE: Evaluation of Karst Feature - Spread 5
Milepost 335.3
Parcel FL-GI-078.000
Gilchrist County, FL

Mr. Stavnychi,

In general accordance with our proposal dated September 23, 2013 and subsequent agreement, Professional Service Industries, Inc. (PSI) has been carrying out geotechnical services directed at evaluating Karst Topography and sinkhole potential for the pipeline and facilities that will be constructed in connection with the Sabal Trail Pipeline Project.

As part of our work on the assignment, we have performed further evaluation of karst features identified from the desktop study performed or field observations. This report addresses the karst feature identified at Milepost (MP) 335.3 in Spread 5. The approximate coordinates of the feature are 29 36' 59.19" N, 82 40' 12.17" W

Feature Identification

Several small circular depressions were identified in the vicinity of the proposed alignment during review of historical aerial photos, alignment maps and published topographic and geologic information. The depressions appeared to be approximately 10 to 15 feet in diameter as can be seen on the following images.

Photo of Alignment from GIE GIS Viewer

Historic Aerial Photo of Area from Google Earth (Image Date February 28. 2006)

Based on the desktop study and field observations, the feature was classified as having a moderate potential for sinkhole development and a MEDIUM risk ranking and further evaluation of the area was recommended. Ground surface elevations at the site are on the order of 90 to 100 feet above mean sea level.

Area Geology

Gilchrist County lies within two major physiologic zones, the Central Highlands and the Gulf Coastal Lowlands. The southern portion of the alignment from the Alachua/Gilchrist County line to where the alignment crosses CR 47 is located within the Central Highlands. This region is divided into to two geomorphic subdivisions, the Brooksville Ridge and the High Springs Gap. The Central Highlands includes a series of highlands and ridges and intervening lowlands. Surface elevations are approximately 100 feet above mean sea level.

Based on the US Department of Natural Resources Recharge Map for Florida (1980) the pipeline alignment falls in a high recharge region. The potentiometric surface along the alignment ranges from approximately +10 to +60 NAD83 (SJRWMD, May 2009). According to the Gilchrist County Soil Survey the predominant feature in the alignment area is the Ocala Limestone formation. This karstic layer can be encountered as shallow as 5 feet below grade to depths of 80 feet.

Overall the sinkhole risk is considered medium to high along the alignment. Sinkhole occurrence is frequent. The sinkholes that develop are typically shallow, small diameter (less than 10') and develop gradually. Cover-subsidence and solution sinkholes are the most common. There are also numerous springs and underground streams throughout the southern part of the county.

Geophysical Testing Results

Geophysical testing consisting of a Ground Penetrating Radar Survey was conducted by GeoView on September 3, 2014 and the results were transmitted in a September 9, 2014 report, a copy of which is attached. The survey identified three anomalous areas characterized by down warping of the GPR reflector set and an increase in penetration depth of the GPR signal.

Geotechnical Soil Borings

Based on the results of the geophysical testing and field observations, soil borings were performed within the A-1 and A-2 anomalous areas identified by GeoView to further assess the risk of sinkhole development in this area. A third soil boring outside of the anomalous areas was also performed along the alignment adjacent to the circular depression. The approximate boring locations are provided on the attached Boring Location Plan and boring logs summarizing the subsurface conditions at each location are also attached for reference.

In general, the soil borings performed within the anomalous areas identified by the GPR survey, encountered loose to medium dense clean to silty sands to depths of approximately 22 feet underlain by fat clay (CH). The limestone formation was encountered approximately 33 to 38 feet below current grade. The initial limestone encountered in the borings was weathered to depths of about 45 to 50 feet where the measured SPT resistance values indicated hard materials. The upper limestone was particularly weathered within boring B-335-1 performed at the northern anomaly with measured SPT resistance values ranging from 2 to 7 blows per foot (BPF).

A third soil boring was performed along the alignment near the circular depression identified in the aerial photograph review. The boring encountered approximately 13 feet of very loose to medium dense clean to silty sand. SPT resistance values within the surficial sands generally increased with depth. Soft to firm, sandy clay to clay was then encountered to approximately 48 feet where the limestone formation was encountered. The limestone was generally very hard at this location.

Groundwater was not apparent within the upper 10 feet of any of the soil borings performed.

Conclusions

Drilling fluid circulation was lost in all three borings at or near the limestone interface which is common. No voids or cavities were noted within the limestone formation in any of the borings.

While some zones of soft limestone materials and losses of drilling fluid circulation were noted in the borings, they occurred at or near the limestone interface which are common occurrences when drilling in northern Florida. The density of the upper sands generally increased with depth and at least 10 to 15 feet of clay materials were encountered above the limestone formation which reduces the potential for sinkhole development.

We believe the feature and identified anomalies have a low potential for future sinkhole development and because conventional pipeline construction will be performed in the area, we do not believe sinkhole mitigation is required.

We appreciate the opportunity to be of service on this project and we trust that the foregoing and accompanying attachments are of assistance to you at this time. In the event that you have any questions or if you require additional information, please call.

Respectfully submitted,
PROFESSIONAL SERVICE INDUSTRIES, INC.
Certificate of Authorization No. 3684

Lloyd T. Lasher, Jr. P.E.
Principal Consultant
Florida License No. 56794

Ian Kinnear. P.E.
Chief Geotechnical Engineer
Florida License No. 32614

Attachments: Report of Geophysical Testing – GeoView
Boring Location Plan
Soil Boring Logs

Final Report
Geophysical Investigation
Sable Trail Project - Spread 5 MP 335.3
Gilchrist County, FL

Prepared for Professional Service Industries, Inc.
Orlando, FL

Prepared by GeoView, Inc.
St. Petersburg, FL

September 30, 2014

Mr. Ian Kinnear, P.E.
Professional Service Industries, Inc.
1748 33rd Street
Orlando, FL 32839

**Subject: Transmittal of Final Report for Geophysical Investigation
Sable Trail Project - Spread 5 MP 335.3 - Gilchrist County, FL
GeoView Project Number 21154.08**

Dear Mr. Kinnear,

GeoView, Inc. (GeoView) is pleased to submit the final report that summarizes and presents the results of the geophysical investigation conducted at the Spread 5 MP 335.3 site. Ground penetrating radar was used to evaluate near-surface geological conditions. GeoView appreciates the opportunity to have assisted you on this project. If you have any questions or comments about the report, please contact us.

GEOVIEW, INC.

Michael J. Wightman, P.G.
Principal Geophysicist, President
Florida Professional Geologist
Number 1423

Chris Taylor, P.G.
Vice President
Florida Professional Geologist
Number 2256

1.0 Introduction

A geophysical investigation was conducted at the Sabal Trail Project Spread 5 MP 335.3 site located in Gilchrist County, Florida. The investigation was conducted on September 3, 2014.

The purpose of the geophysical investigation was to help characterize near-surface geological conditions in the survey area and to identify subsurface features that may be associated with sinkhole activity. The location of the geophysical survey area is provided on Figure 1. A discussion of the field methods used to generate the report figures is provided in Appendix A2.1.

2.0 Description of Geophysical Investigation

2.1 Ground Penetrating Radar Survey

A Ground Penetrating Radar (GPR) survey was conducted along a series of parallel transects spaced 10 ft apart. The locations of the GPR transects are shown on Figure 1. The GPR data was collected with a Mala radar system. The GPR settings used for the survey are presented in Table 1.

Table 1
GPR Equipment Settings Used for Survey

Antenna Frequency	Time Range (nano-seconds)	Estimated Depth of GPR Signal Penetration
250 MHz [1/]	156	8 to 13 ft bls

1/ MHz means mega-Hertz and is the mid-range operating frequency of the GPR antenna.

A description of the GPR technique and the methods employed for geological characterization studies is provided in Appendix A2.2.

3.0 Identification of Possible Sinkhole Features Using GPR

The features observed on GPR data that are most commonly associated with sinkhole activity are:

- A downwarping of GPR reflector sets, that are associated with suspected lithological contacts, toward a common center. Such features typically have a bowl or funnel shaped configuration and can be associated with a deflection of overlying sediment horizons caused by the migration of sediments into voids in the underlying limestone. If the GPR reflector sets are sharply downwarping and intersect, they can create "bow-tie" shaped GPR reflection feature, which often designates the apparent center of the GPR anomaly.

- A localized significant increase in the depth of the penetration and/or amplitude of the GPR signal response. The increase in GPR signal penetration depth or amplitude is often associated with either a localized increase in sand content at depth or decrease in soil density.
- An apparent discontinuity in GPR reflector sets, that are associated with suspected lithological contacts. The apparent discontinuities and/or disruption of the GPR reflector sets may be associated with the downward migration sediments.

The greater the severity of these features or a combination of these features the greater the likelihood that the identified feature is a sinkhole. It is not possible based on the GPR data alone to determine if an identified feature is a sinkhole or, more important, whether that feature is an active sinkhole.

4.0 Survey Results

Results of the GPR survey indicated the presence of one well-defined, relatively continuous set of GPR reflectors at a depth range of approximately 3 to 6 ft bls. The reflector set is most likely associated with some change in lithological conditions at that depth range.

Three GPR anomaly areas possibly associated with karst activity were identified within the survey area. The anomaly areas are designated as GPR Anomalies A-1 through A-3 on Figure 1. The anomalies are numbered in order of significance with GPR Anomaly A-1 being the most significant and GPR Anomaly A-3 being the least significant. A description of each of the anomalies is as follows:

<u>GPR Anomaly A-1</u>

GPR Anomaly A-1 is semi-elliptical in shape and is located in the northern portion of the site. The apparent vertical relief of the upper portion of the anomaly area is 2 to 3 ft as characterized by the observed downwarping of the GPR reflector set. A localized increase in the depth of penetration of the GPR signal was also observed within the anomaly area. The apparent center of the feature is characterized as the area of maximum downwarping of the previously referenced GPR reflectors.

GPR Anomaly A-2

GPR Anomaly A-2 is irregular in shape and is located in the central portion of the site. The apparent vertical relief of the upper portion of the anomaly area is 1 to 2 ft as characterized by the observed minor downwarping of the GPR reflector set. A localized increase in the depth of penetration of the GPR signal was also observed within the anomaly area. The apparent center of the feature is characterized as the area of maximum downwarping of the previously referenced GPR reflectors.

GPR Anomaly A-3

GPR Anomaly A-3 was observed on one transect located in the northern portion of the site. The apparent vertical relief of the upper portion of the anomaly area is 1 to 2 ft as characterized by the observed minor downwarping of the GPR reflector set. A localized increase in the depth of penetration of the GPR signal was also observed within the anomaly area. The apparent center of the feature is characterized as the area of maximum downwarping of the previously referenced GPR reflectors.

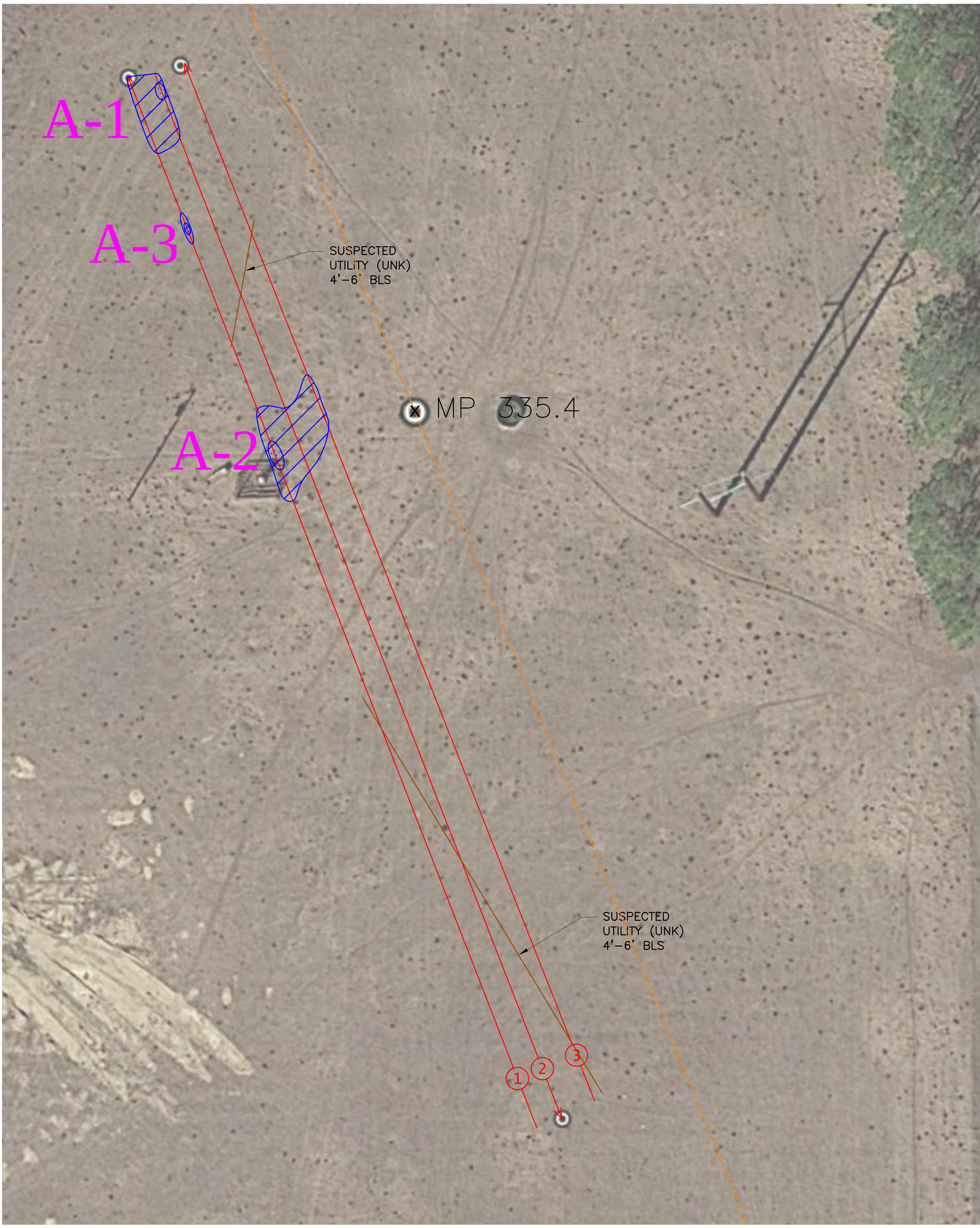
This GPR investigation was not designed to locate buried utilities. However, two possible utilities were identified within the survey area at a depth range of approximately 4 to 6 ft bls (Figure 1). The coordinates of the centers of the GPR anomalies are provided in Table 2. An example of the GPR data collected across the anomaly areas are provided in Appendix 1. A discussion of the limitations of the GPR technique in geological characterization studies is provided in Appendix 2.

Table 2
Coordinates of Anomaly Centers

Name	Northing	Easting
A-1	228959*	2549859
A-2	228916	2549867
A-3	228847	2549894

* US State Plane, Florida North, NAD83 (Conus), Feet

APPENDIX 1
FIGURE AND EXAMPLE OF GPR ANOMALIES
AND POSSIBLE UTILITY



EXPLANATION

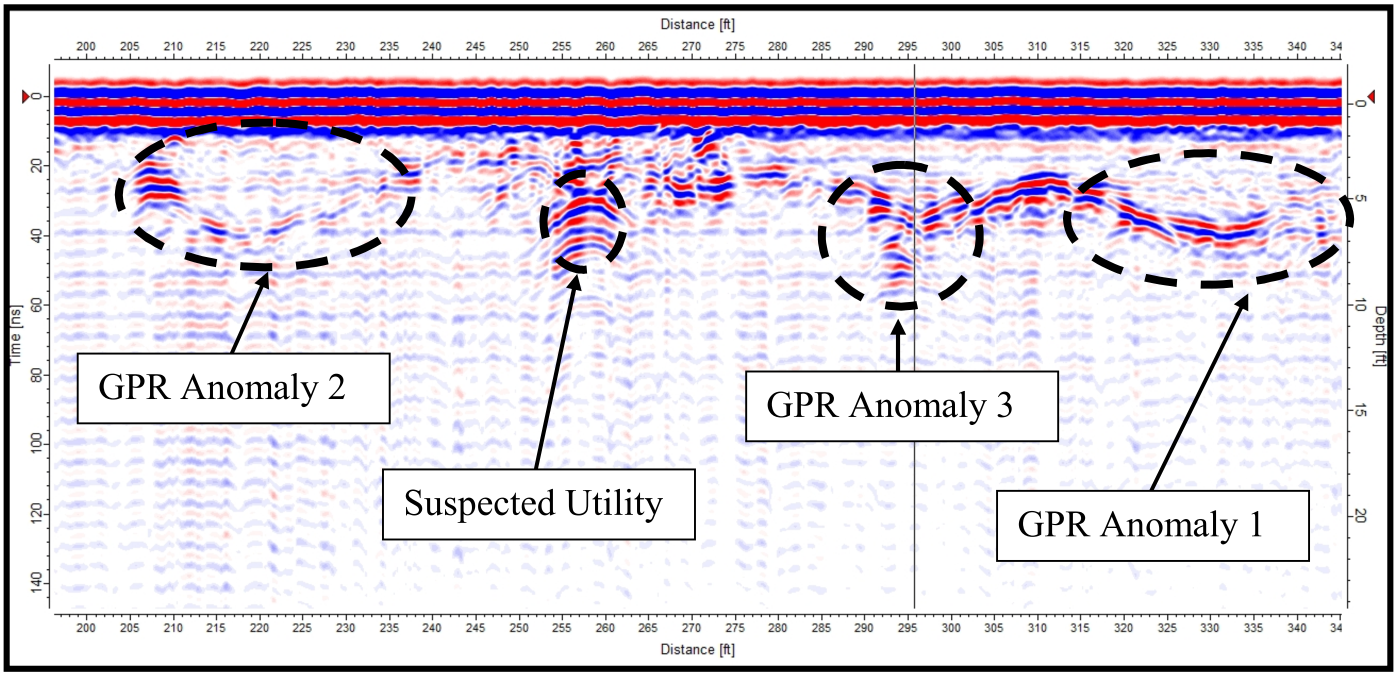
- (10) PATH OF GPR TRANSECT LINES WITH DESIGNATION NUMBER
- MP433 SABAL TRAIL CENTER LINE WITH MILE MARKER POINTS
- A-2 LOCATION OF GPR ANOMALIES WITH DESIGNATION (A-1 MOST SIGNIFICANT, A-3 LEAST SIGNIFICANT)
- APPARENT CENTER OF GPR ANOMALY

N

0 30'

SCALE: 1"=30' APPROXIMATE

GeoView	FIGURE 1 SITE MAP SHOWING RESULTS OF GEOPHYSICAL INVESTIGATION	SABAL TRAIL PROJECT SPREAD 5 MP 335.3 SITE GILCHRIST COUNTY, FLORIDA PROFESSIONAL SERVICE INDUSTRIES, INC. ORLANDO, FLORIDA	PROJECT: 21154.08 DATE: 09/30/14



GPR Transect 1 Showing Example of Suspected Utility and GPR Anomalies 1, 2 and 3

APPENDIX 2
DESCRIPTION OF GEOPHYSICAL METHODS, SURVEY METHODOLOGIES AND LIMITATIONS

A2.1 On Site Measurements

The measurements that were collected and used to create the site map were made using a fiberglass measuring tape and a sub-meter GPS system.

A2.2 Ground Penetrating Radar

Ground Penetrating Radar (GPR) consists of a set of integrated electronic components that transmits high frequency (200 to 1500 megahertz [MHz]) electromagnetic waves into the ground and records the energy reflected back to the ground surface. The GPR system consists of an antenna, which serves as both a transmitter and receiver, and a profiling recorder that both processes the incoming signal and provides a graphic display of the data. The GPR data can be reviewed as both printed hard copy output or recorded on the profiling recorder's hard drive for later review. GeoView uses a Mala GPR system.

A GPR survey provides a graphic cross-sectional view of subsurface conditions. This cross-sectional view is created from the reflections of repetitive short-duration electromagnetic (EM) waves that are generated as the antenna is pulled across the ground surface. The reflections occur at the subsurface contacts between materials with differing electrical properties. The electrical property contrast that causes the reflections is the dielectric permittivity that is directly related to conductivity of a material. The GPR method is commonly used to identify such targets as underground utilities, underground storage tanks or drums, buried debris, voids or geological features.

The greater the electrical contrast between the surrounding earth materials and target of interest, the greater the amplitude of the reflected return signal. Unless the buried object is metal, only part of the signal energy will be reflected back to the antenna with the remaining portion of the signal continuing to propagate downward to be reflected by deeper features. If there is little or no electrical contrast between the target interest and surrounding earth materials it will be very difficult if not impossible to identify the object using GPR.

The depth of penetration of the GPR signal is very site specific and is controlled by two primary factors: subsurface soil conditions and selected antenna frequency. The GPR signal is attenuated (absorbed) as is passes through earth materials. As the energy of the GPR signal is diminished due to attenuation, the energy of the reflected waves is reduced, eventually to the level that the reflections can no longer be detected. As the conductivity of the earth materials increases, the attenuation of the GPR signal increases thereby reducing the signal penetration depth. In Florida, the typical soil conditions that severely limit GPR signal penetration are near-surface clays and/or organic materials.

The depth of penetration of the GPR signal is also reduced as the antenna frequency is increased. However, as antenna frequency is increased the resolution of the GPR data is improved. Therefore, when designing a GPR survey a tradeoff is made between the required depth of penetration and desired resolution of the data. As a rule, the highest frequency antenna that will still provide the desired maximum depth of penetration should be used. For geologic surveys, a low-frequency (250 MHz) antenna is used. This allows for maximum signal penetration and thereby maximum depth from which information will be obtained.

A GPR survey is conducted along survey lines (transects) that are measured paths along which the GPR antenna is moved. An integrated survey wheel electronically records the distance of the GPR system along the transect lines.

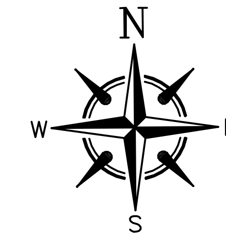
For geological characterization surveys, the GPR survey is conducted along a set of perpendicularly orientated transects. The survey is conducted in two directions because subsurface features such as sinkholes are often asymmetric. Spacing between the transects typically ranges from 10 to 50 ft. Closely spaced grids are used when the objective of the GPR survey is to identify all sinkhole features within a project site. Coarser grids are used when the objective is to provide a general overview of site conditions. After completion of a survey using a given grid spacing, additional more-closely spaced GPR transects are often performed to better characterize sinkhole features identified by the initial survey. This information can be used to provide recommended locations for geotechnical borings.

Depth estimates to the top of lithological contacts or sinkhole features are determined by dividing the time of travel of the GPR signal from the ground surface to the top of the feature by the velocity of the GPR signal. The velocity of the GPR signal is usually obtained from published tables of velocities for the type and condition (saturated vs. unsaturated) of soils underlying the site. The accuracy of GPR-derived depths typically ranges from 20 to 40 percent of the total depth.

Interpretation and Limitations of GPR data

The analysis and collection of GPR data is both a technical and interpretative skill. The technical aspects of the work are learned from both training and experience. Having the opportunity to compare GPR data collected in numerous settings to the results from geotechnical studies performed at the same locations develops interpretative skills for geological characterization studies.

The ability of GPR to collect interpretable information at a project site is limited by the attenuation (absorption) of the GPR signal by underlying soils. Once the GPR signal has been attenuated at a particular depth, information regarding deeper geological conditions will not be obtained. In addition, GPR data can only resolve subsurface features that have a sufficient electrical contrast between the feature in question and surrounding earth materials. If an insufficient contrast is present, the subsurface feature will not be identified. GeoView can make no warranties or representations of geological conditions that may be present beyond the depth of investigation or resolving capability of the GPR equipment or in areas that were not accessible to the geophysical investigation.



LEGEND

APPROXIMATE LOCATION OF STANDARD PENETRATION TEST BORING

LOCATION PLAN

SCALE: 1"=200'

BORING LOCATION PLAN

GULF INTERSTATE ENGINEERING

SABAL TRAIL - KARST MP 335.3

TRENTON, GILCHRIST COUNTY, FLORIDA

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DRAWN:	DJW	SCALE:	NOTED	PROJ. NO:	07571055
CHKD:	JKT	DATE:	11-19-14	SHEET:	1

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BORING LOG

BORING NO. B-335-1 SHEET 1 OF 1

BORING LOC. SEE SHEET 1

CLIENT GULF INTERSTATE ENGINEERING JOB NO. 07571055

JOB NAME SABAL TRAIL – KARST MP 335.3

JOB LOC. GILCHRIST COUNTY, FLORIDA

DRILLER BRANDON LOGGED BY BRANDON

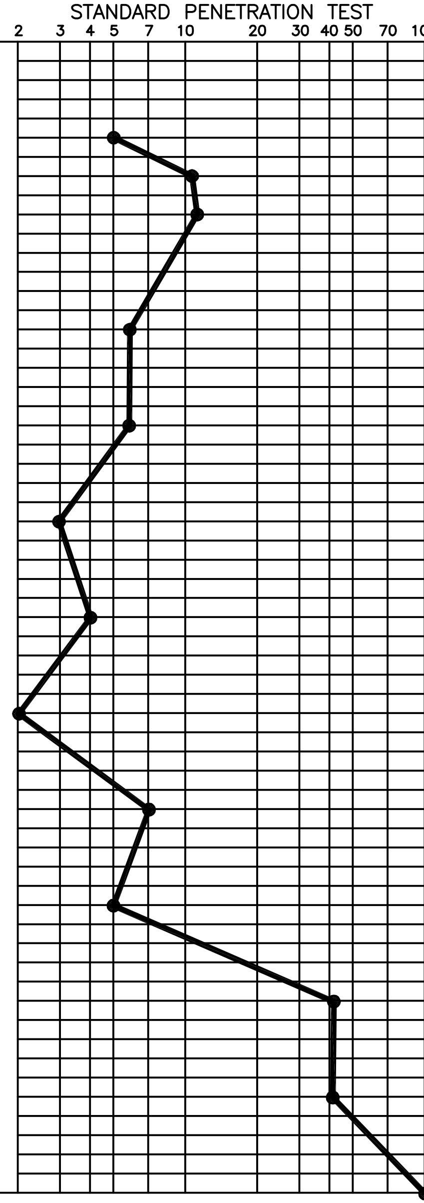
STARTED 10-28-14 FINISHED 10-28-14

GROUND ELEV. – CASING LENGTH –

GROUNDWATER TABLE GNE

FEET	DESCRIPTION OF SOIL	BLOWS ON SAMPLER	N VALUE
0–8	LIGHT BROWN FINE SAND TO FINE SAND WITH SILT, (SP), (SP-SM)	AUGERED	HA
		AUGERED	HA
5		2,2,3	5
		4,6,5	11
		7,7,5	12
8–22.5	ORANGE-BROWN TO BROWN SILTY FINE SAND, (SM)		
15		2,3,3	6
20		3,2,4	6
22.5–32.5	GREEN-GRAY CLAY, (CH)		
25		1,2,1	3
30		3,2,2	4
32.5–60	LIGHT BROWN TO ORANGE-BROWN LIMESTONE WITH LIMESILTS		
35		1,1,1	2
40		4,3,4	7
45		3,2,3	5
50		13,15,27	42
55		15,20,21	41
60		13,50/3"	50/3"

STANDARD PENETRATION TEST



BORING TERMINATED AND GROUTED AT 60.0'

AUTOMATIC HAMMER USED FOR SAMPLING

GNE = GROUNDWATER NOT EVIDENT IN UPPER 10 FEET OF BORING

50/3" = NUMBER OF BLOWS REQUIRED (50) TO DRIVE SAMPLING SPOON 3 INCHES

⇐ = TOTAL CIRCULATION LOSS

REMARKS ______

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BORING LOG

BORING NO. B-335-2 SHEET 1 OF 1

BORING LOC. SEE SHEET 1

OFFSET 15 FT. WEST OF PLANNED LOCATION

DRILLER BRANDON LOGGED BY BRANDON

STARTED 10-28-14 FINISHED 10-28-14

GROUND ELEV. – CASING LENGTH –

GROUNDWATER TABLE GNE

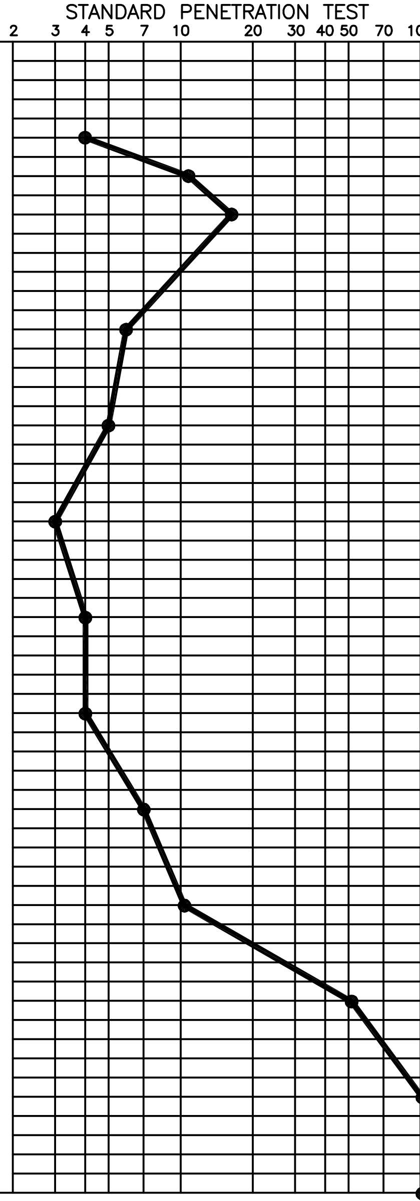
CLIENT GULF INTERSTATE ENGINEERING JOB NO. 07571055

JOB NAME SABAL TRAIL – KARST MP 335.3

JOB LOC. GILCHRIST COUNTY, FLORIDA

FEET	DESCRIPTION OF SOIL	BLOWS ON SAMPLER	N VALUE
1		AUGERED	HA
3	LIGHT BROWN TO ORANGE-BROWN FINE SAND TO FINE SAND WITH SILT, (SP), (SP-SM)	AUGERED	HA
5		3,2,2	4
7		7,5,7	12
9		6,8,9	17
10	ORANGE-BROWN SILTY FINE SAND, (SM)		
15		2,2,4	6
20		3,2,3	5
25		3,2,1	3
30	LIGHT BROWN TO ORANGE-BROWN SANDY CLAY TO CLAY, (CL), (CH)	2,2,2	4
35		3,2,2	4
40		4,3,4	7
45		5,6,5	11
50		13,21,30	51
55	LIGHT BROWN LIMESTONE WITH LIMESILTS	22,50/5"	50/5"
60		50/3"	50/3"

STANDARD PENETRATION TEST



BORING TERMINATED AND GROUTED AT 60.0'

AUTOMATIC HAMMER USED FOR SAMPLING

GNE = GROUNDWATER NOT EVIDENT IN UPPER 10 FEET OF BORING

50/3" = NUMBER OF BLOWS REQUIRED (50) TO DRIVE SAMPLING SPOON 3 INCHES

◁— = TOTAL CIRCULATION LOSS

REMARKS

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BORING LOG

BORING NO. B-335-3 SHEET 1 OF 1

BORING LOC. SEE SHEET 1

OFFSET 15 FT. EAST

DRILLER BRANDON LOGGED BY BRANDON

STARTED 10-29-14 FINISHED 10-29-14

GROUND ELEV. – CASING LENGTH –

GROUNDWATER TABLE GNE

CLIENT GULF INTERSTATE ENGINEERING JOB NO. 07571055

JOB NAME SABAL TRAIL – KARST MP 335.3

JOB LOC. GILCHRIST COUNTY, FLORIDA

FEET | SAMPLE SYMBOL | DESCRIPTION OF SOIL

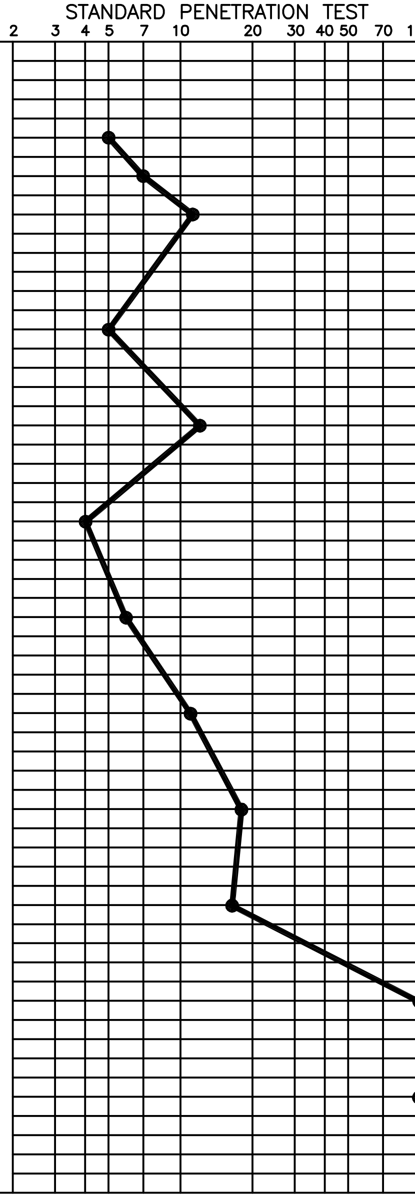
BROWN FINE SAND TO FINE SAND WITH SILT, (SP), (SP-SM)

BROWN SILTY FINE SAND, (SM)

ORANGE-BROWN CLAY, (CH)

LIGHT BROWN LIMESTONE WITH LIMESILTS

STANDARD PENETRATION TEST



BLOWS ON SAMPLER	N VALUE
AUGERED	HA
AUGERED	HA
2,2,3	5
3,4,3	7
5,7,5	12
2,3,2	5
5,5,8	13
2,2,2	4
3,2,4	6
8,5,7	12
10,9,9	18
8,7,10	17
13,15,50	50/3"
50/0"	50/0"

BORING TERMINATED AND GROUTED AT 55.0'

AUTOMATIC HAMMER USED FOR SAMPLING

GNE = GROUNDWATER NOT EVIDENT IN UPPER 10 FEET OF BORING

50/3" = NUMBER OF BLOWS REQUIRED (50) TO DRIVE SAMPLING SPOON 3 INCHES

◁— = TOTAL CIRCULATION LOSS

REMARKS