Information To Build On
Engineering • Consulting • Testing

MEMORANDUM

TO: Mr. Mark Schilling – Gulf Interstate Engineering

FROM: Mr. Jonathan K. Thrasher, P.E. and Mr. Ian Kinnear, P.E. – PSI

DATE: November 12, 2014

RE: Summary of Findings
Geotechnical Study
Reunion Compressor Station (CS-7)
Sabal Trail Project
Davenport, Osceola County, Florida
PSI Project No. 07571055

The purpose of this memo is to provide a summary of findings of the geotechnical study that we are currently carrying out in connection with the noted project.

The Reunion Compressor Station (CS-7) site being evaluated is Option 2 located on the north side of Osceola Polk Line Road approximately 0.8 miles west of the intersection of Osceola Polk Line Road and US 17-92. A plan view of the site is included on **Sheet 1**. The geotechnical study included drilling and sampling eleven engineering borings and six auger borings. The approximate locations at which the borings were completed are shown on **Sheet 1**.

Prior to initiating the boring work, GeoView performed geophysical testing at the site, conducting surveys using both Ground Penetrating Radar (GPR) and Electrical Resistivity Imagining (ERI) techniques. The results of GeoView's work is contained in their report dated July 23, 2014, a copy of which is attached hereto.

The engineering borings were sampled following Standard Penetration Test (SPT) procedures of ASTM D-1586. Due to the possible presence of underground utilities, the upper four feet of most of the borings were augured manually prior to starting the SPT sampling. SPT samples were recovered continuously from four feet below the existing ground surface to a depth of 10 feet and at 5 foot intervals thereafter. The engineering borings were extended to depths of up to 92 feet below existing grade.

Drilling was carried out by a PSI drill crew with a Staff Engineer or Field Representative in the field to log the materials recovered from the explorations and to generally coordinate/supervise field activities. Some of the borings were performed with an ATV rig with a safety hammer used to drive the SPT sample spoon while others were performed with a truck-mounted drill rig equipped with an automatic hammer. (The hammer used is noted on the individual boring logs which are attached hereto).

Samples recovered from the SPT borings were visually stratified in our Orlando laboratory following guidelines contained in the Unified Soil Classification System (USCS). Boring logs describing the various subsoil materials in USCS format are attached. Select samples were tested in our laboratory to determine pertinent engineering properties and the results of the classification testing are provided on the attached boring logs adjacent to the depth increment of the test specimen.

Two samples were tested to assess corrosion parameters following FDOT guidelines. The test results are presented in the table below.

Boring No.	Sample Depth (feet)	pH	Resistivity (ohm-cm)	Sulfate (ppm)	Chloride (ppm)	Substructure Environmental Classification	
						Concrete	Steel
BH-2	0 to 2	6.9	18,270	<3	60	Moderately Aggressive	Slightly Aggressive
BH-8	0 to 2	4.4	40,600	<3	60	Extremely Aggressive	Extremely Aggressive

The six auger borings were each advanced to a depth of 10 feet below grade. Soil samples were recovered from the flights of the auger at regular intervals on extraction from the ground. The auger borings were completed to assess the shallow soil and groundwater table conditions in the planned pavement areas. Boring logs indicating the results of the auger borings are attached.

The results of the borings indicate an overburden consisting primarily of interbedded layers of clean fine sands, slightly silty fine sands and silty fine sands. Layers of clay were also encountered in some of the borings, typically at depths of about 33.5 feet below the existing ground surface and at depths just above the regionally continuous limestone formation. Generally, the sand and clay soils extend up to depths in the range 65 to 70 feet below the existing ground surface. The sands varied from being in a very loose to medium-dense condition with occasional dense to very dense layers. The dense and very dense layers typically consisted of a silty sand formation locally referred to as “hardpan”. The clays typically had a soft consistency. As noted on the boring logs, there are zones of weight of hammer material in the overburden soils, notably in borings BH-2 and BH-8/BH-8A.

In several of the deeper borings, shells were encountered in the soil matrix at depth. It is within these materials that we lost circulation of drilling fluid in borings B-8 and B-10, which experienced localized ground collapse during initial drilling.

Below the overburden soils limestone is present. The limestone is a sandy silty rock that is locally very hard and well-cemented. The material is porous and is part of the Floridian Aquifer. SPT blow counts in the limestone ranged from 9 blows per foot (bpf) to 50 blows for essentially no sample spoon penetration.

In boring BH-8, circulation of drilling fluid was lost between 70 and 75 feet below grade. Upon pulling the drill rods in preparation of setting casing to advance the boring further, the ground immediately adjacent to the boring began to collapse. The ground collapse stabilized relatively quickly (within about one hour after it occurred). GeoView performed additional geophysical testing of the area and based on the results of their testing, did not find indications of major voids or cavities. Boring BH-8 was terminated and an offset boring, BH-8A, was performed approximately 20 feet to the south of BH-8. In boring BH-8A, the hole was advanced to 63.5 feet before beginning sampling. The boring was terminated at a depth of 72 feet below grade in the very hard limestone. For additional information on boring BH-8, please see the boring log and our *Boring B-8 at Compressor Station 7* memo dated June 27, 2014.

In boring BH-8A, weight of hammer material was encountered from 63.5 feet to 69.5 feet below grade. Losses in circulation of drilling fluid were noted between 62 feet and 70 feet below grade in this boring with full depth casing and heavier drilling mud being used for borehole advancement. Boring BH-8A was terminated in very hard limestone at a depth of approximately 72 feet below grade. The other borings did not encounter signs of voids in the limestone.

In Boring BH-10, while drilling/washing from 50 to 55 feet below grade, circulation of drilling fluid was lost and the ground slowly began to collapse around the casing. The ground collapse stabilized relatively quickly after initially occurring. The collapse stabilized at a diameter on the order of 6 to 8 feet by about 3 feet deep. Later, PSI was able to continue the boring which was terminated at 66 feet below grade in very hard limestone.

Based on the geophysical testing and the borings performed at Compressor Station 7, GeoView is of the opinion that the collapses were most likely due to loss of fluid into shell beds, causing localized depressions. We generally concur with the findings of GeoView and we are of the opinion that the site does not exhibit ongoing sinkhole activity and/or sinkhole conditions.

The results of the shallow auger borings disclosed a varying sequence of relatively clean sands, slightly silty sands and silty sands in the upper 10 feet. This is consistent with the USDA Soil Survey for Osceola County, which maps the site as being mantled by surficial soil group 16, Immokalee sand. The wetland area to the east, which is skirted by the site, is mapped as Placid fine sand, depressional.

Groundwater was observed in the SPT and auger borings at depths ranging from approximately 1 to 3 feet below grade. Water levels in the soil will fluctuate seasonally in response to rainfall or lack thereof. During the peak of the wet season, we estimate that the normal wet season high groundwater level will be within one foot of the natural ground surface.

The potentiometric surface in the Floridan Aquifer (limestone) is reported to be between about +80 and +90 feet. We have not been provided with site specific topographic data at this time, but based on published topographic information, the ground surface elevation at the site is between about +80 and +90 feet. Therefore, the potentiometric surface is close to that of the ground surface.

We trust that the foregoing and accompanying attachments are of assistance to you at this time. Let us know if you have any questions and/or comments or if you require additional information.

Sincerely,

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

Jonathan K. Thrasher

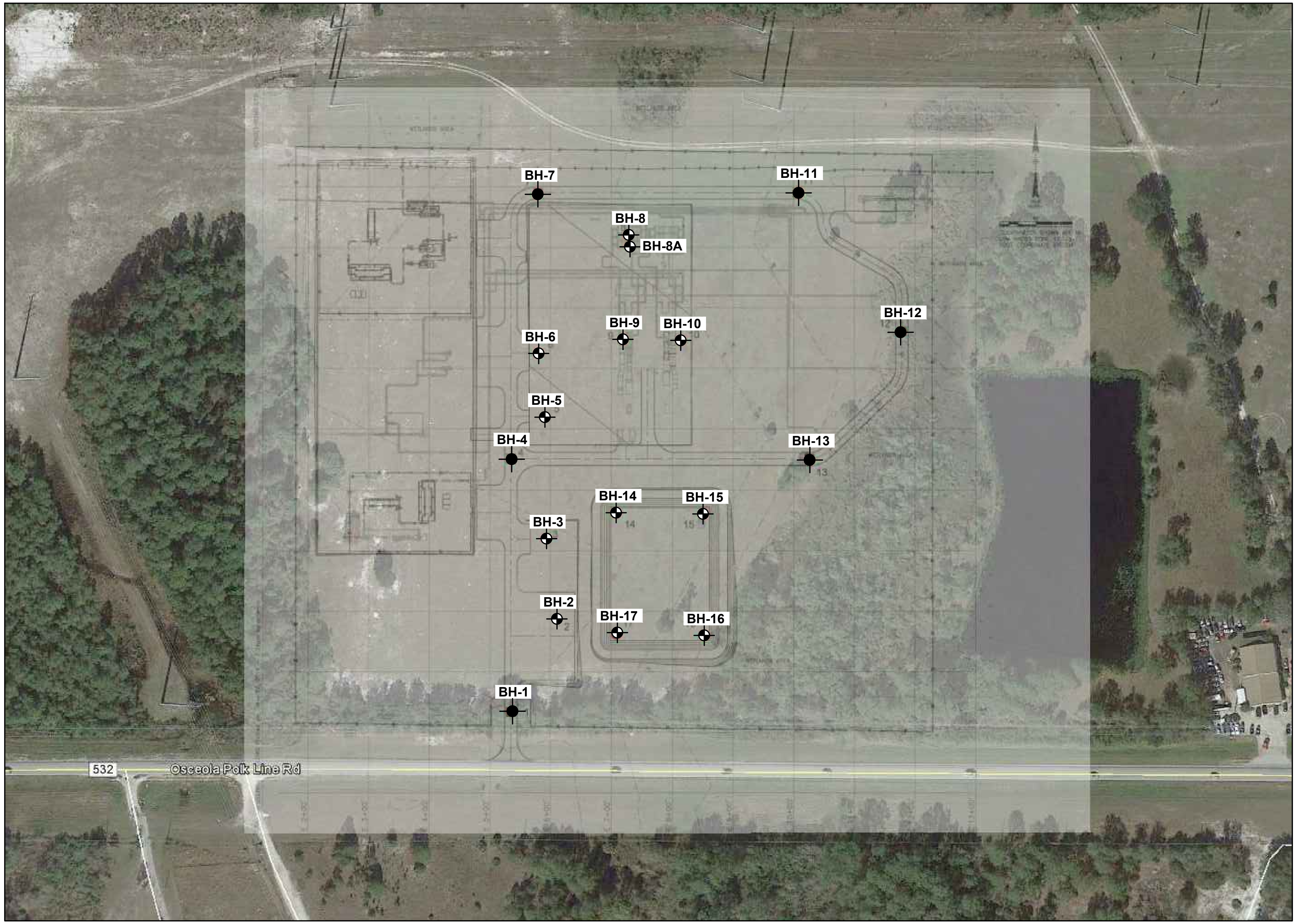
Jonathan K. Thrasher, P.E.
Project Engineer
Florida License No. 76641

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

07571055 (Compressor Station 7 Data Memo)

Attachments

- Sheet 1 – Boring Location Plan
- Boring Logs
- GeoView Report dated July 23, 2014



LOCATION PLAN

SCALE: 1"=200'

N
W E
S

LEGEND

APPROXIMATE LOCATION OF STANDARD PENETRATION TEST BORING

APPROXIMATE LOCATION OF AUGER BORING

GEOTECHNICAL ENGINEERING SERVICES

GULF INTERSTATE ENGINEERING
REUNION COMPRESSOR STATION

OSCEOLA COUNTY, FLORIDA

psi *Information To Build On*

Engineering • Consulting • Testing

DRAWN: DJW	SCALE: NOTED	PROJ. NO: 07571055
CHKD: JKT	DATE: 8-28-14	SHEET: 1

psi *Information To Build On*

Engineering • Consulting • Testing

BORING LOG

BORING NO. BH-1   SHEET 1 OF 1

BORING LOC. SEE SHEET 1

DRILLER RON   LOGGED BY RON

STARTED 6-24-14   FINISHED 6-24-14

GROUND ELEV. –   CASING LENGTH –

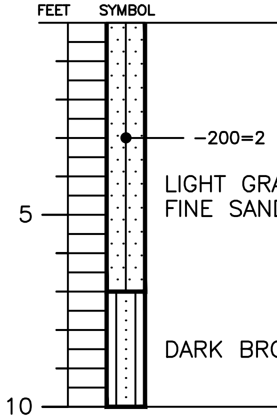
GROUNDWATER TABLE 3.0 FT.

CLIENT GULF INTERSTATE ENGINEERING   JOB NO. 07571055

JOB NAME SABAL TRAIL PIPELINE REUNION COMPRESSOR STATION

JOB LOC. REUNION, OSCEOLA COUNTY, FLORIDA

FEET | SAMPLE SYMBOL | DESCRIPTION OF SOIL



LIGHT GRAY TO BROWN FINE SAND TO FINE SAND WITH SILT, (SP), (SP–SM)

DARK BROWN SILTY HARDPAN, (SM)

BORING TERMINATED AND GROUTED AT 10.0'

−200 = FINES PASSING #200 SIEVE IN PERCENT

REMARKS

psi *Information To Build On*

Engineering • Consulting • Testing

BORING LOG

BORING NO. BH-2	SHEET 1 OF 2
BORING LOC. SEE SHEET 1	
DRILLER BRANDON	LOGGED BY BRANDON
STARTED 8-21-14	FINISHED 8-21-14
GROUND ELEV. –	CASING LENGTH 65.0 FT.
GROUNDWATER TABLE 1.0 FT.	

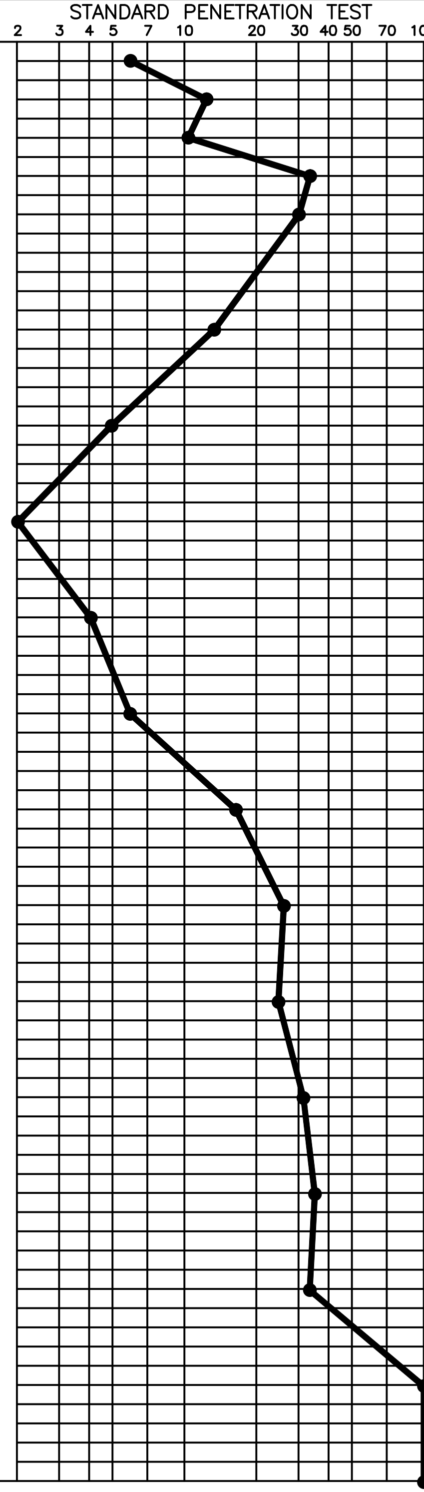
CLIENT GULF INTERSTATE ENGINEERING JOB NO. 07571055

JOB NAME SABAL TRAIL PIPELINE REUNION COMPRESSOR STATION

JOB LOC. REUNION, OSCEOLA COUNTY, FLORIDA

FEET	DESCRIPTION OF SOIL	BLOWS ON SAMPLER	N VALUE
0–6	GRAY-BROWN FINE SAND TO FINE SAND WITH SILT, (SP), (SP-SM)	2,3,3	6
		3,5,8	13
5		3,7,4	11
6–8	DARK BROWN SILTY FINE SAND WITH HARDPAN, (SM)	9,17,17	34
8–23.5	LIGHT BROWN FINE SAND TO FINE SAND WITH SILT, (SP), (SP-SM)	21,13,17	30
15		5,6,8	14
20		2,3,2	5
23.5–58.5	LIGHT BROWN TO GREEN-GRAY SILTY FINE SAND, TRACE SHELL, (SM)		
25		WH	WH
30		4	4
35		3,2,4	6
40		6,8,9	17
45		11,14,13	27
50		8,11,15	26
55		14,17,15	32
58.5–75	LIGHT BROWN LIMESTONE WITH LIMESILTS		
60		13,15,21	36
65		11,15,19	34
70		50/4"	50/4"
75		50/3"	50/3"

STANDARD PENETRATION TEST



REMARKS

psi *Information To Build On*

Engineering • Consulting • Testing

BORING LOG

BORING NO. BH-2 SHEET 2 OF 2

BORING LOC. SEE SHEET 1

CLIENT GULF INTERSTATE ENGINEERING JOB NO. 07571055

JOB NAME SABAL TRAIL PIPELINE REUNION COMPRESSOR STATION

JOB LOC. REUNION, OSCEOLA COUNTY, FLORIDA

DRILLER BRANDON LOGGED BY BRANDON

STARTED 8-21-14 FINISHED 8-21-14

GROUND ELEV. – CASING LENGTH 65.0 FT.

GROUNDWATER TABLE 1.0 FT.

FEET	DESCRIPTION OF SOIL	BLOWS ON SAMPLER	N VALUE
75–92	LIGHT BROWN LIMESTONE WITH LIMESILTS		
80		50/.5"	50/.5"
85		50/0"	50/0"
90		50/0"	50/0"

BORING TERMINATED AND GROUTED AT 92.0'

SAFETY HAMMER USED FOR SAMPLING

WH = FELL UNDER WEIGHT OF ROD AND HAMMER

50/0" = NUMBER OF BLOWS REQUIRED (50) TO DRIVE SAMPLING SPOON 0 INCHES

REMARKS

psi *Information To Build On*

Engineering • Consulting • Testing

BORING LOG

BORING NO. BH-3	SHEET 1 OF 1
BORING LOC. SEE SHEET 1	
DRILLER BRANDON	LOGGED BY BRANDON
STARTED 7-3-14	FINISHED 7-3-14
GROUND ELEV. –	CASING LENGTH 50 FT.
GROUNDWATER TABLE 2.5 FT.	

CLIENT GULF INTERSTATE ENGINEERING JOB NO. 07571055

JOB NAME SABAL TRAIL PIPELINE REUNION COMPRESSOR STATION

JOB LOC. REUNION, OSCEOLA COUNTY, FLORIDA

DESCRIPTION OF SOIL

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

DARK BROWN SILTY FINE SAND, TRACE HARDPAN, (SM)

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

LIGHT BROWN SILTY FINE SAND, (SM)

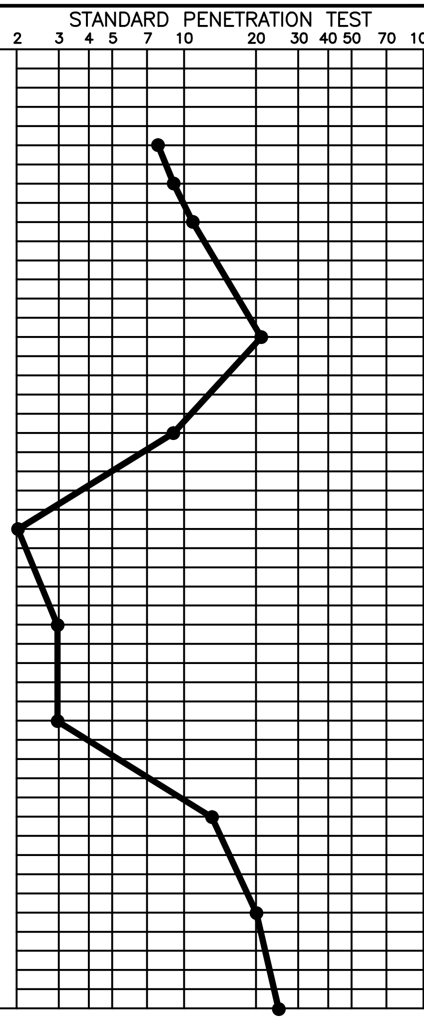
DARK GREEN CLAY, (CH)

W=107
-200=89
LL=73
PI=38

DARK GREEN-GRAY SILTY FINE SAND WITH SHELL, (SM)

DARK GREEN-GRAY SANDY CLAY WITH SHELL FRAGMENTS, (CL)

STANDARD PENETRATION TEST



FEET	BLOWS ON SAMPLER	N VALUE
	AUGERED	HA
	AUGERED	HA
5	3,3,5	8
	6,5,4	9
	6,5,7	12
15	6,9,13	22
20	4,5,4	9
25	1,1,1	2
30	1,2,1	3
35	2,2,1	3
40	6,5,9	14
45	8,7,13	20
50	9,11,15	26

BORING TERMINATED AND GROUTED AT 50.0'

AUTOMATIC HAMMER USED FOR SAMPLING

W = NATURAL MOISTURE CONTENT IN PERCENT

-200 = FINES PASSING #200 SIEVE IN PERCENT

LL = LIQUID LIMIT IN PERCENT

PI = PLASTICITY INDEX

REMARKS

psi *Information To Build On*

Engineering • Consulting • Testing

BORING LOG

BORING NO. BH-4	SHEET 1 OF 1
BORING LOC. SEE SHEET 1	
DRILLER RON	LOGGED BY RON
STARTED 6-24-14	FINISHED 6-24-14
GROUND ELEV. –	CASING LENGTH –
GROUNDWATER TABLE 2.0 FT.	

CLIENT GULF INTERSTATE ENGINEERING JOB NO. 07571055

JOB NAME SABAL TRAIL PIPELINE REUNION COMPRESSOR STATION

JOB LOC. REUNION, OSCEOLA COUNTY, FLORIDA

FEET	SAMPLE SYMBOL	DESCRIPTION OF SOIL
0–10		GRAY TO BROWN FINE SAND TO FINE SAND WITH SILT, (SP), (SP-SM)

BORING TERMINATED AND GROUTED AT 10.0'

REMARKS

psi *Information To Build On*

Engineering • Consulting • Testing

BORING LOG

BORING NO. BH-5 SHEET 1 OF 2

BORING LOC. SEE SHEET 1

DRILLER BRANDON LOGGED BY BRANDON

STARTED 8-14-14 FINISHED 8-14-14

GROUND ELEV. – CASING LENGTH 60.0 FT.

GROUNDWATER TABLE 1.5 FT.

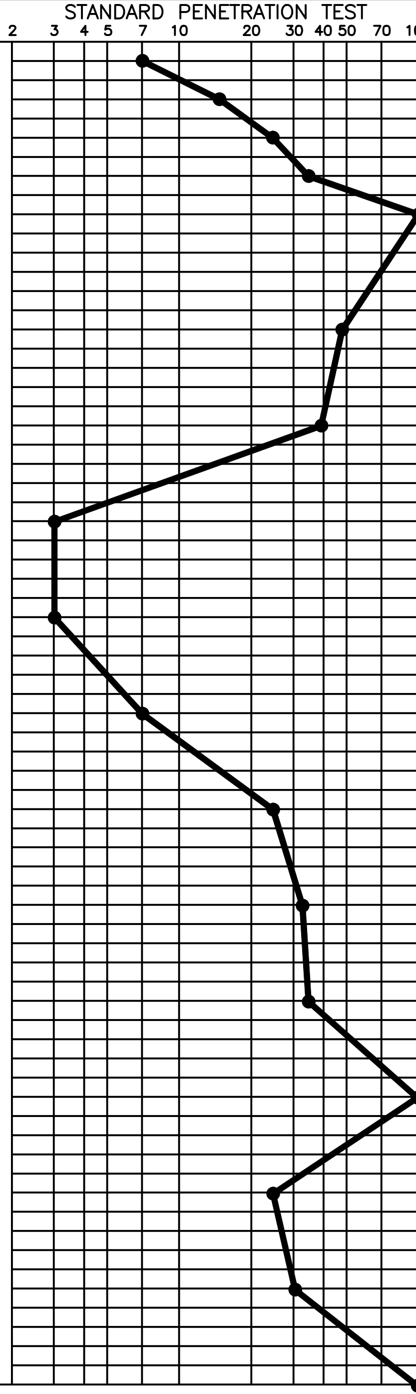
CLIENT GULF INTERSTATE ENGINEERING JOB NO. 07571055

JOB NAME SABAL TRAIL PIPELINE REUNION COMPRESSOR STATION

JOB LOC. REUNION, OSCEOLA COUNTY, FLORIDA

FEET	DESCRIPTION OF SOIL
5	GRAY-BROWN FINE SAND TO FINE SAND WITH SILT, (SP), (SP-SM)
	DARK BROWN SILTY FINE SAND WITH HARDPAN, (SM)
10	-200=4
	BROWN FINE SAND, TRACE HARDPAN, (SP-SM)
15	
20	LIGHT GRAY-BROWN FINE SAND TO FINE SAND WITH SILT, (SP), (SP-SM)
25	
30	LIGHT BROWN TO LIGHT GREEN-GRAY SILTY FINE SAND, (SM)
35	GREEN-GRAY CLAY WITH SHELL, (CH)
40	
45	
50	GREEN-GRAY SILTY FINE SAND, TRACE SHELL, (SM)
55	W=37 -200=24 LL=NP PI=NP
60	
65	
70	LIGHT BROWN LIMESTONE WITH LIMESILTS

STANDARD PENETRATION TEST



BLOWS ON SAMPLER	N VALUE
2,3,4	7
5,7,9	16
7,11,14	25
12,15,20	35
50/3"	50/3"
14,21,27	48
13,17,22	39
2,2,1	3
1,1,2	3
3,4,3	7
8,11,14	25
10,14,19	33
13,15,20	35
19,34,50/3"	50/3"
9,11,15	26
8,13,17	30
50/4"	50/4"

REMARKS

psi Information To Build On
Engineering • Consulting • Testing

BORING LOG

BORING NO. BH-5 SHEET 2 OF 2
BORING LOC. SEE SHEET 1

DRILLER BRANDON LOGGED BY BRANDON
STARTED 8-14-14 FINISHED 8-14-14
GROUND ELEV. – CASING LENGTH 60.0 FT.
GROUNDWATER TABLE 1.5 FT.

CLIENT GULF INTERSTATE ENGINEERING JOB NO. 07571055
JOB NAME SABAL TRAIL PIPELINE REUNION COMPRESSOR STATION
JOB LOC. REUNION, OSCEOLA COUNTY, FLORIDA

FEET	SAMPLE SYMBOL	DESCRIPTION OF SOIL	STANDARD PENETRATION TEST (2 3 4 5 7 10 20 30 40 50 70 100)	BLOWS ON SAMPLER	N VALUE
70		LIGHT BROWN LIMESTONE WITH LIMESILTS			
75			100	50/1"	50/1"
80			100	50/1"	50/1"
85					

BORING TERMINATED AND GROUTED AT 82.0'

SAFETY HAMMER USED FOR SAMPLING

CASING WAS ADVANCED BY HAMMERING WITH THE SAFETY HAMMER

50/4" = NUMBER OF BLOWS REQUIRED (4) TO DRIVE SAMPLING SPOON 4 INCHES

W = NATURAL MOISTURE CONTENT IN PERCENT

-200 = FINES PASSING #200 SIEVE IN PERCENT

LL = LIQUID LIMIT IN PERCENT

PI = PLASTICITY INDEX

REMARKS

psi Information To Build On

Engineering • Consulting • Testing

BORING LOG

BORING NO. BH-6	SHEET 1 OF 1
BORING LOC. SEE SHEET 1	
DRILLER BRANDON	LOGGED BY BRANDON
STARTED 7-3-14	FINISHED 7-3-14
GROUND ELEV. –	CASING LENGTH 50 FT.
GROUNDWATER TABLE 2.5 FT.	

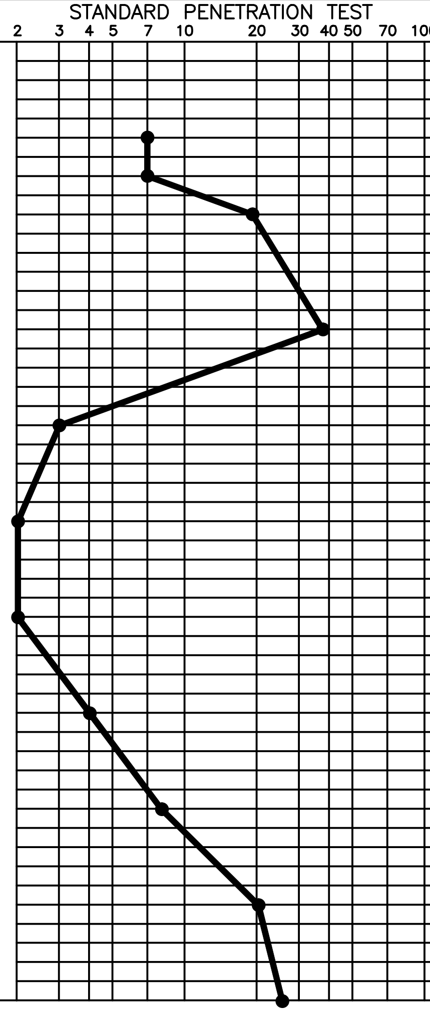
CLIENT GULF INTERSTATE ENGINEERING JOB NO. 07571055

JOB NAME SABAL TRAIL PIPELINE REUNION COMPRESSOR STATION

JOB LOC. REUNION, OSCEOLA COUNTY, FLORIDA

FEET	DESCRIPTION OF SOIL	BLOWS ON SAMPLER	N VALUE
0–23.5	LIGHT GRAY-BROWN TO DARK BROWN FINE SAND TO FINE SAND WITH SILT, (SP), (SP-SM)	AUGERED	HA
		AUGERED	HA
5		3,4,3	7
		6,4,3	7
		6,9,10	19
15		20,17,21	38
20		1,1,2	3
23.5–33.5	LIGHT BROWN SILTY FINE SAND, (SM)		
25		1,1,1	2
30		1,1,1	2
33.5–38.5	DARK GREEN CLAY, (CH)		
35		1,2,2	4
38.5–50	GREEN-GRAY SILTY FINE SAND WITH SHELL, (SM)		
40		4,3,5	8
45		8,11,9	20
50		7,11,15	26

STANDARD PENETRATION TEST



BORING TERMINATED AND GROUTED AT 50.0'

AUTOMATIC HAMMER USED FOR SAMPLING

REMARKS

Information To Build On

Engineering • Consulting • Testing

BORING LOG

BORING NO. BH-7	SHEET 1 OF 1
BORING LOC. SEE SHEET 1	
DRILLER RON	LOGGED BY RON
STARTED 6-24-14	FINISHED 6-24-14
GROUND ELEV. –	CASING LENGTH –
GROUNDWATER TABLE 2.0 FT.	

CLIENT GULF INTERSTATE ENGINEERING JOB NO. 07571055

JOB NAME SABAL TRAIL PIPELINE REUNION COMPRESSOR STATION

JOB LOC. REUNION, OSCEOLA COUNTY, FLORIDA

FEET	SAMPLE SYMBOL	DESCRIPTION OF SOIL
0–10		GRAY TO BROWN FINE SAND TO FINE SAND WITH SILT, (SP), (SP-SM)

BORING TERMINATED AND GROUTED AT 10.0'

REMARKS

psi *Information To Build On*

Engineering • Consulting • Testing

BORING LOG

BORING NO. BH-8 SHEET 1 OF 1

BORING LOC. SEE SHEET 1

DRILLER RON LOGGED BY RON

STARTED 6-26-14 FINISHED 6-26-14

GROUND ELEV. – CASING LENGTH 70.0 FT.

GROUNDWATER TABLE 2.1 FT.

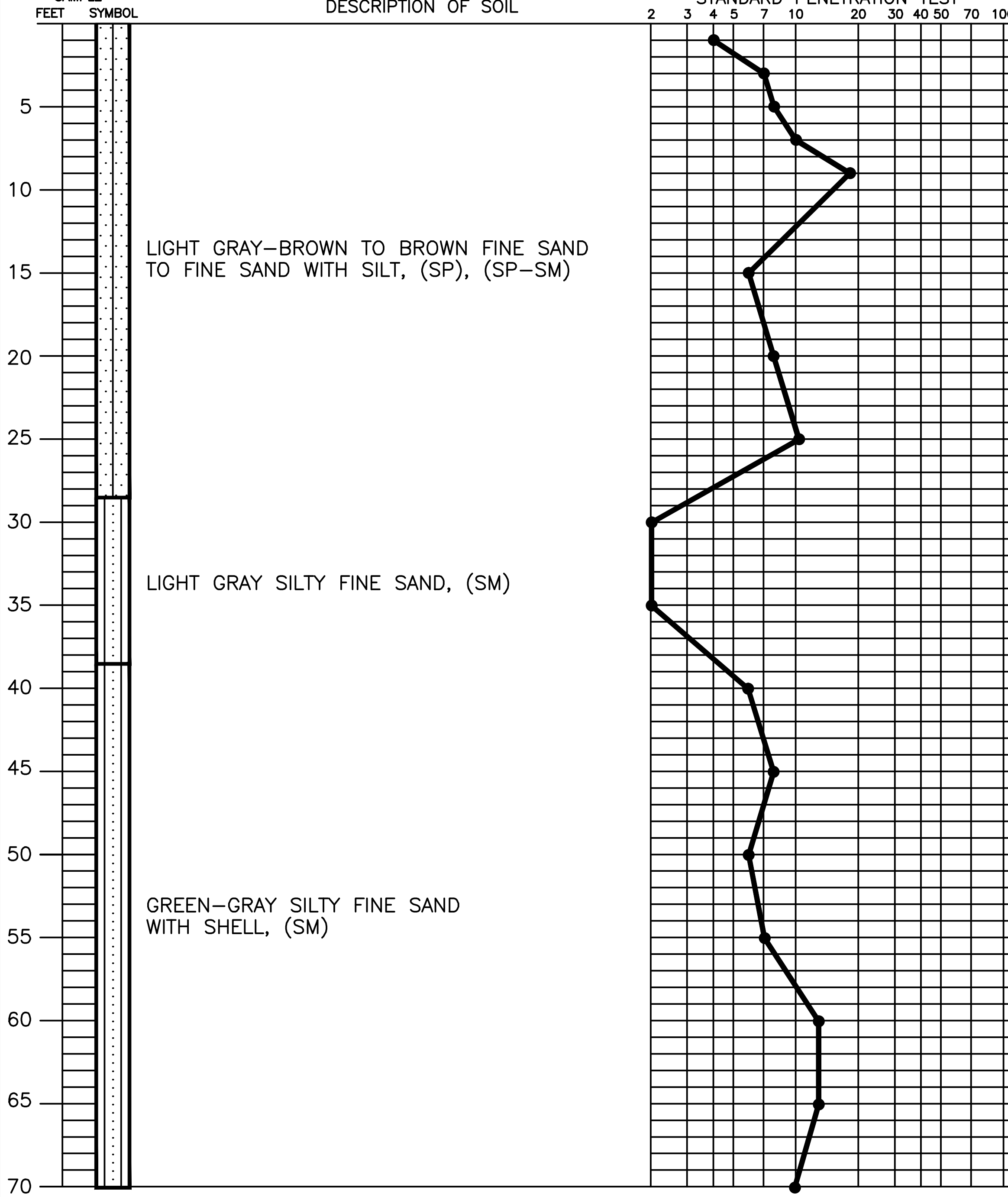
CLIENT GULF INTERSTATE ENGINEERING JOB NO. 07571055

JOB NAME SABAL TRAIL PIPELINE REUNION COMPRESSOR STATION

JOB LOC. REUNION, OSCEOLA COUNTY, FLORIDA

FEET	SAMPLE SYMBOL	DESCRIPTION OF SOIL
0–28.5		LIGHT GRAY-BROWN TO BROWN FINE SAND TO FINE SAND WITH SILT, (SP), (SP-SM)
28.5–38.5		LIGHT GRAY SILTY FINE SAND, (SM)
38.5–70		GREEN-GRAY SILTY FINE SAND WITH SHELL, (SM)

STANDARD PENETRATION TEST



BLOWS ON SAMPLER	N VALUE
1,2,2	4
2,3,4	7
4,4,4	8
4,4,6	10
9,8,10	18
3,3,3	6
4,4,4	8
5,5,6	11
1,1,1	2
1,1,1	2
2,2,4	6
3,4,4	8
3,3,3	6
3,4,3	7
4,6,8	14
5,7,7	14
4,5,5	10

BORING TERMINATED AND GROUTED 70.0'

GROUND SUBSIDENCE GOING FROM 70 TO 75 FEET

REMARKS

psi Information To Build On
Engineering • Consulting • Testing

BORING LOG

BORING NO. BH-8A	SHEET 1 OF 1
BORING LOC. SEE SHEET 1	
DRILLER BRANDON	LOGGED BY BRANDON
CLIENT GULF INTERSTATE ENGINEERING	JOB NO. 07571055
STARTED 8-28-14	FINISHED 8-28-14
JOB NAME SABAL TRAIL PIPELINE REUNION COMPRESSOR STATION	
GROUND ELEV. –	CASING LENGTH 70.0 FT.
JOB LOC. REUNION, OSCEOLA COUNTY, FLORIDA	
GROUNDWATER TABLE GNE	

FEET	SAMPLE SYMBOL	DESCRIPTION OF SOIL	STANDARD PENETRATION TEST (2 3 4 5 7 10 20 30 40 50 70 100)	BLOWS ON SAMPLER	N VALUE
0–63.5		WASHED TO 63.5'			
63.5–68.5		NO RECOVERY		WH	WH
68.5–72		LIGHT BROWN LIMESTONE WITH LIMESILTS		9 50/1"	50/1"

BORING TERMINATED AND GROUTED AT 72.0'
SAFETY HAMMER USED FOR SAMPLING
50/1" = NUMBER OF BLOWS REQUIRED (50) TO DRIVE SAMPLING SPOON 1"
WH = FELL UNDER WEIGHT OF ROD AND HAMMER

REMARKS

psi *Information To Build On*

Engineering • Consulting • Testing

BORING LOG

BORING NO. BH–9 SHEET 1 OF 1

BORING LOC. SEE SHEET 1

DRILLER BRANDON LOGGED BY BRANDON

CLIENT GULF INTERSTATE ENGINEERING JOB NO. 07571055

STARTED 7–3–14 FINISHED 7–3–14

JOB NAME SABAL TRAIL PIPELINE REUNION COMPRESSOR STATION

GROUND ELEV. – CASING LENGTH 50 FT.

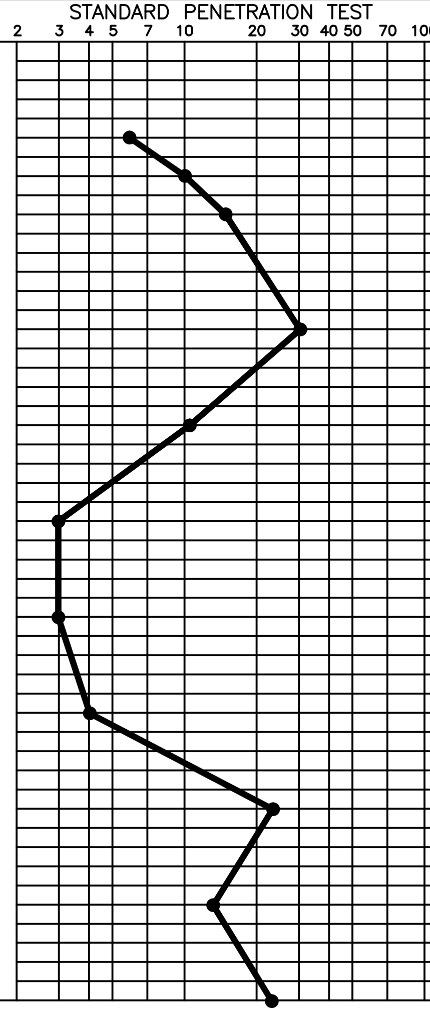
JOB LOC. REUNION, OSCEOLA COUNTY, FLORIDA

GROUNDWATER TABLE 2.0 FT.

FEET	DESCRIPTION OF SOIL
0 – 23.5	LIGHT TO DARK BROWN FINE SAND TO FINE SAND WITH SILT, (SP), (SP–SM)
23.5 – 33.5	LIGHT BROWN TO GREEN–BROWN SILTY FINE SAND, (SM)
33.5 – 50	GREEN–GRAY SILTY FINE SAND WITH SHELL, (SM)

–200=13

STANDARD PENETRATION TEST



BLOWS ON SAMPLER	N VALUE
AUGERED	HA
AUGERED	HA
2,3,3	6
4,6,4	10
5,8,8	16
9,14,17	31
4,6,5	11
2,1,2	3
1,1,2	3
1,1,3	4
7,10,14	24
5,7,7	14
10,13,11	24

BORING TERMINATED AND GROUTED AT 50.0'

AUTOMATIC HAMMER USED FOR SAMPLING

–200 = FINES PASSING #200 SIEVE IN PERCENT

REMARKS

psi *Information To Build On*

Engineering • Consulting • Testing

BORING LOG

BORING NO. BH-10 SHEET 1 OF 1

BORING LOC. SEE SHEET 1

DRILLER RON LOGGED BY RON

STARTED 7-9-14 FINISHED 7-9-14

GROUND ELEV. – CASING LENGTH 50 FT.

GROUNDWATER TABLE 2.1 FT.

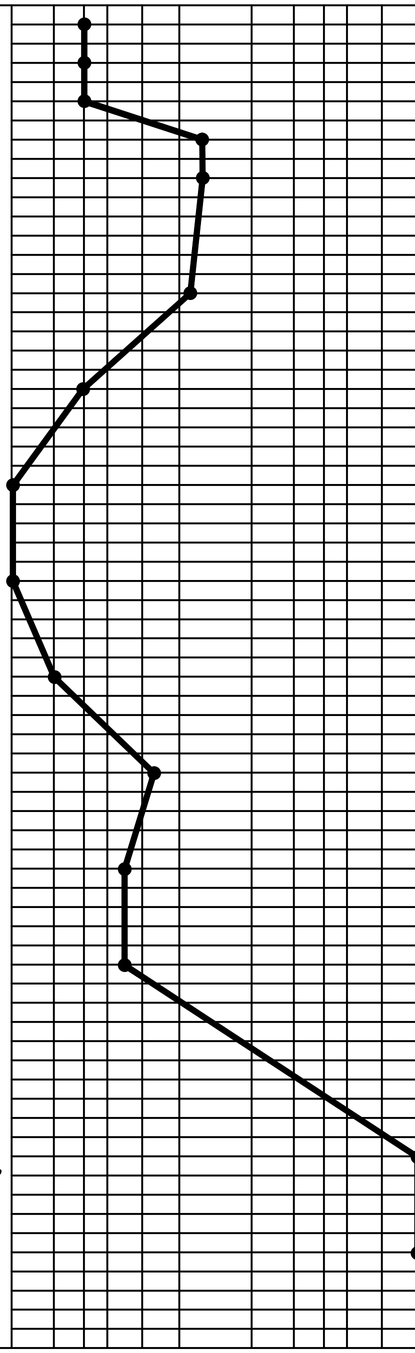
CLIENT GULF INTERSTATE ENGINEERING JOB NO. 07571055

JOB NAME SABAL TRAIL PIPELINE REUNION COMPRESSOR STATION

JOB LOC. REUNION, OSCEOLA COUNTY, FLORIDA

FEET	DESCRIPTION OF SOIL
0–18.5	GRAY TO BROWN FINE SAND TO FINE SAND WITH SILT, (SP), (SP–SM)
18.5–38.5	LIGHT BROWN TO GRAY SILTY FINE SAND, (SM) (−200=13 at 20)
38.5–58.5	GREEN–GRAY SILTY FINE SAND WITH SHELL, (SM)
58.5–63.5	GREEN–GRAY SILTY FINE SAND WITH LIMESTONE, TRACE SHELL, (SM)
63.5–66	LIGHT GRAY LIMESTONE WITH LIMESILTS

STANDARD PENETRATION TEST (2 3 4 5 7 10 20 30 40 50 70 100)



BLOWS ON SAMPLER	N VALUE
2,2,2	4
2,2,2	4
2,2,2	4
4,6,7	13
8,7,6	13
4,6,6	12
2,2,2	4
1,1,1	2
1,1,1	2
1,1,2	3
3,4,4	8
3,3,3	6
3,3,3	6
6,37,50/4"	50/4"
13,13,50/5"	50/5"

BORING TERMINATED AND GROUTED AT 66.0'

−200 = FINES PASSING #200 SIEVE IN PERCENT

AUTOMATIC HAMMER USED FOR SAMPLING

GROUND SUBSIDENCE GOING FROM 50 TO 55 FEET

CASING WAS ADVANCED BY HAMMERING WITH EXTREME DIFFICULTY USING THE AUTOMATIC HAMMER

REMARKS

psi *Information To Build On*

Engineering • Consulting • Testing

BORING LOG

BORING NO. BH-11 SHEET 1 OF 1

BORING LOC. SEE SHEET 1

CLIENT GULF INTERSTATE ENGINEERING JOB NO. 07571055

JOB NAME SABAL TRAIL PIPELINE REUNION COMPRESSOR STATION

JOB LOC. REUNION, OSCEOLA COUNTY, FLORIDA

DRILLER RON LOGGED BY RON

STARTED 6-24-14 FINISHED 6-24-14

GROUND ELEV. – CASING LENGTH –

GROUNDWATER TABLE 2.1 FT.

FEET	SAMPLE SYMBOL	DESCRIPTION OF SOIL
0–10		GRAY TO BROWN FINE SAND TO FINE SAND WITH SILT, (SP), (SP-SM)

BORING TERMINATED AND GROUTED AT 10.0'

REMARKS

psi *Information To Build On*

Engineering • Consulting • Testing

BORING LOG

BORING NO. BH-12	SHEET 1 OF 1
BORING LOC. SEE SHEET 1	
DRILLER RON	LOGGED BY RON
STARTED 6-24-14	FINISHED 6-24-14
GROUND ELEV. –	CASING LENGTH –
GROUNDWATER TABLE 1.9 FT.	

CLIENT GULF INTERSTATE ENGINEERING JOB NO. 07571055

JOB NAME SABAL TRAIL PIPELINE REUNION COMPRESSOR STATION

JOB LOC. REUNION, OSCEOLA COUNTY, FLORIDA

FEET	SAMPLE SYMBOL	DESCRIPTION OF SOIL
0–10		GRAY TO BROWN FINE SAND TO FINE SAND WITH SILT, (SP), (SP–SM)

BORING TERMINATED AND GROUTED AT 10.0'

REMARKS

Information To Build On
Engineering • Consulting • Testing

BORING LOG

BORING NO. BH-13	SHEET 1 OF 1
BORING LOC. SEE SHEET 1	
DRILLER RON	LOGGED BY RON
STARTED 6-24-14	FINISHED 6-24-14
GROUND ELEV. –	CASING LENGTH –
GROUNDWATER TABLE 2.0 FT.	

CLIENT GULF INTERSTATE ENGINEERING JOB NO. 07571055

JOB NAME SABAL TRAIL PIPELINE REUNION COMPRESSOR STATION

JOB LOC. REUNION, OSCEOLA COUNTY, FLORIDA

FEET	SAMPLE SYMBOL	DESCRIPTION OF SOIL
0–10		GRAY TO BROWN FINE SAND TO FINE SAND WITH SILT, (SP), (SP-SM)

BORING TERMINATED AND GROUTED AT 10.0'

REMARKS

psi *Information To Build On*

Engineering • Consulting • Testing

BORING LOG

BORING NO. BH-14 SHEET 1 OF 1

BORING LOC. SEE SHEET 1

DRILLER BRANDON LOGGED BY BRANDON

STARTED 7-3-14 FINISHED 7-3-14

GROUND ELEV. – CASING LENGTH –

GROUNDWATER TABLE 2.5 FT.

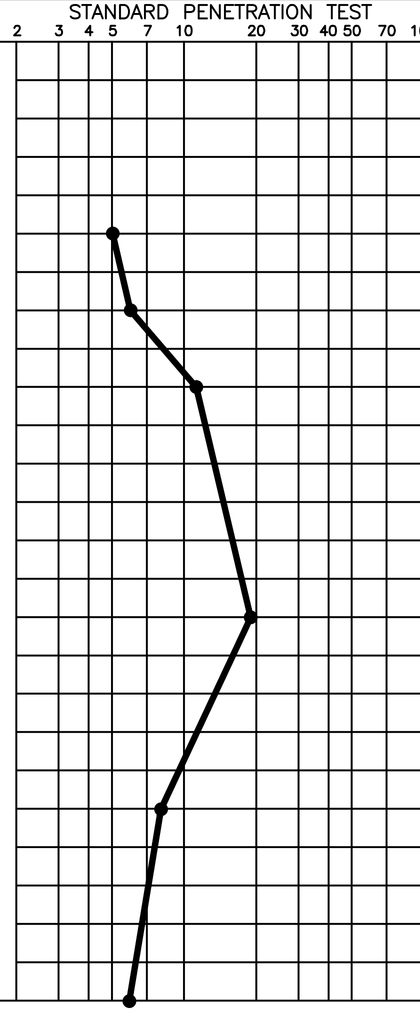
CLIENT GULF INTERSTATE ENGINEERING JOB NO. 07571055

JOB NAME SABAL TRAIL PIPELINE REUNION COMPRESSOR STATION

JOB LOC. REUNION, OSCEOLA COUNTY, FLORIDA

FEET	DESCRIPTION OF SOIL
5	DARK BROWN FINE SAND TO FINE SAND WITH SILT, (SP), (SP-SM)
10	DARK BROWN SILTY HARDPAN, (SM)
15	
20	LIGHT BROWN TO BROWN FINE SAND TO FINE SAND WITH SILT, (SP), (SP-SM)
25	LIGHT BROWN SILTY FINE SAND, (SM)

STANDARD PENETRATION TEST



BLOWS ON SAMPLER	N VALUE
AUGERED	HA
AUGERED	HA
2,2,3	5
4,3,3	6
6,4,8	12
6,8,11	19
3,4,4	8
2,2,4	6

BORING TERMINATED AND GROUTED AT 25.0'

AUTOMATIC HAMMER USED FOR SAMPLING

REMARKS

psi *Information To Build On*

Engineering • Consulting • Testing

BORING LOG

BORING NO. BH-15	SHEET 1 OF 1
BORING LOC. SEE SHEET 1	
DRILLER BRANDON	LOGGED BY BRANDON
STARTED 7-7-14	FINISHED 7-7-14
GROUND ELEV. –	CASING LENGTH –
GROUNDWATER TABLE 1.5 FT.	

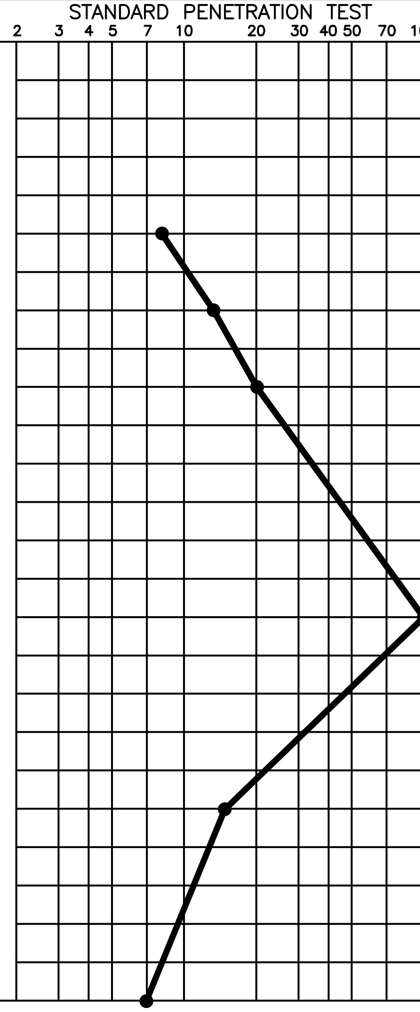
CLIENT GULF INTERSTATE ENGINEERING JOB NO. 07571055

JOB NAME SABAL TRAIL PIPELINE REUNION COMPRESSOR STATION

JOB LOC. REUNION, OSCEOLA COUNTY, FLORIDA

FEET	DESCRIPTION OF SOIL
0 – 13.5	BROWN TO DARK BROWN FINE SAND TO FINE SAND WITH SILT, (SP), (SP-SM)
13.5 – 18.5	DARK BROWN FINE SAND WITH SILT, TRACE HARDPAN, (SP-SM)
18.5 – 25	LIGHT BROWN SILTY FINE SAND, (SM)

STANDARD PENETRATION TEST



FEET	BLOWS ON SAMPLER	N VALUE
1	AUGERED	HA
3	AUGERED	HA
5	3,4,4	8
7	5,7,7	14
9	10,9,11	20
15	50/3"	50/3"
20	5,9,7	16
25	4,3,4	7

BORING TERMINATED AND GROUTED AT 25.0'

AUTOMATIC HAMMER USED FOR SAMPLING

REMARKS

psi Information To Build On
Engineering • Consulting • Testing

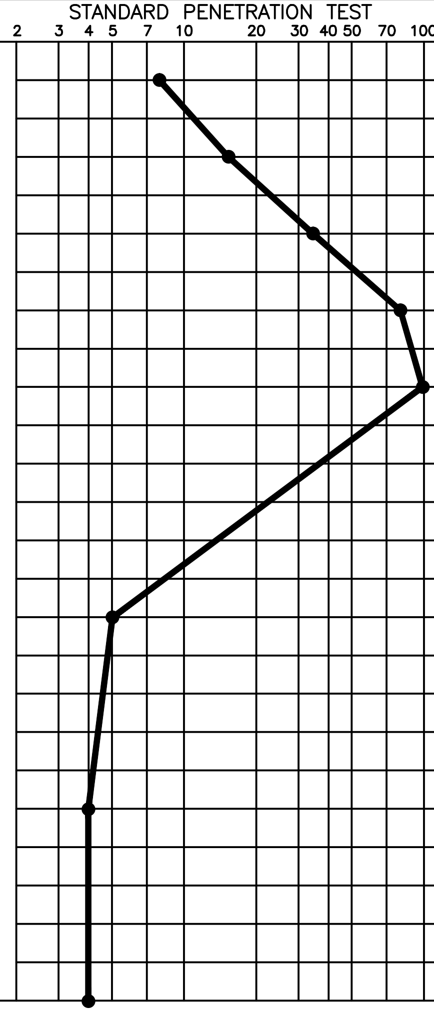
BORING LOG

BORING NO. BH-16 SHEET 1 OF 1
BORING LOC. SEE SHEET 1

CLIENT GULF INTERSTATE ENGINEERING JOB NO. 07571055
JOB NAME SABAL TRAIL PIPELINE REUNION COMPRESSOR STATION
JOB LOC. REUNION, OSCEOLA COUNTY, FLORIDA

DRILLER RON LOGGED BY RON
STARTED 6-24-14 FINISHED 6-24-14
GROUND ELEV. – CASING LENGTH –
GROUNDWATER TABLE 2.1 FT.

FEET	SAMPLE SYMBOL	DESCRIPTION OF SOIL	STANDARD PENETRATION TEST	BLOWS ON SAMPLER	N VALUE
				3,4,4	8
				5,6,10	16
5				10,19,27	36
				29,31,50	81
		LIGHT TO DARK BROWN FINE SAND TO FINE SAND WITH SILT, (SP), (SP-SM)		50/1"	50/1"
10					
15				2,3,2	5
20				2,2,2	4
		LIGHT BROWN SILTY FINE SAND, (SM)			
25				2,2,2	4



BORING TERMINATED AND GROUTED AT 25.0'

SAFETY HAMMER USED FOR SAMPLING

REMARKS 50/1" = NUMBER OF BLOWS REQUIRED (50) TO DRIVE SAMPLING SPOON 1 INCHES

psi Information To Build On

Engineering • Consulting • Testing

BORING LOG

BORING NO. BH-17 SHEET 1 OF 1

BORING LOC. SEE SHEET 1

DRILLER RON LOGGED BY RON

CLIENT GULF INTERSTATE ENGINEERING JOB NO. 07571055

STARTED 6-24-14 FINISHED 6-24-14

JOB NAME SABAL TRAIL PIPELINE REUNION COMPRESSOR STATION

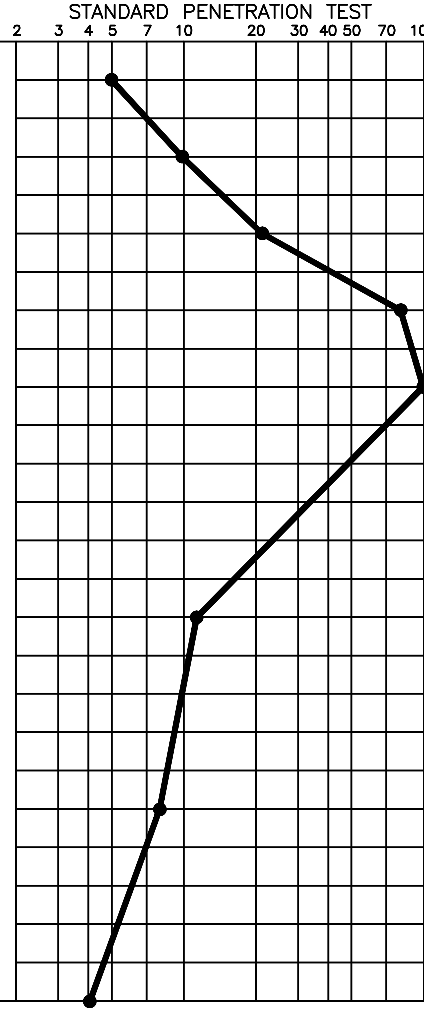
GROUND ELEV. – CASING LENGTH –

JOB LOC. REUNION, OSCEOLA COUNTY, FLORIDA

GROUNDWATER TABLE 2.0 FT.

FEET	SAMPLE SYMBOL	DESCRIPTION OF SOIL	BLOWS ON SAMPLER	N VALUE
		GRAY TO BROWN FINE SAND TO FINE SAND WITH SILT, (SP), (SP-SM)	2,2,3	5
			4,5,5	10
5		BROWN FINE SAND WITH A 1" SEAM OF DARK BROWN SILTY HARDPAN, (SM)	5,7,15	22
		LIGHT BROWN TO BROWN FINE SAND TO FINE SAND WITH SILT, (SP), (SP-SM)	33,39,42	81
			50/2"	50/2"
10				
15			8,6,6	12
20		LIGHT BROWN SILTY FINE SAND, (SM)	4,4,4	8
25			2,2,2	4

STANDARD PENETRATION TEST



BORING TERMINATED AND GROUTED AT 25.0'

SAFETY HAMMER USED FOR SAMPLING

REMARKS 50/2" = NUMBER OF BLOWS REQUIRED (50) TO DRIVE SAMPLING SPOON 2 INCHES

FINAL REPORT
GEOPHYSICAL INVESTIGATION
SABAL TRAIL PROJECT - COMPRESSOR 7 SITE
REUNION, FL

Prepared for Professional Service Industries, Inc.
Orlando, FL

Prepared by GeoView, Inc.
St. Petersburg, FL

July 23, 2014

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

Subject: Transmittal of Final Report for Geophysical Investigation
Sabal Trail Project - Compressor 7 Site (Revision 1) - Reunion, FL
GeoView Project Number 21154.03

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 Sabal Trail Project - Compressor 7 Site. Ground penetrating radar and electrical resistivity were 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

Steve Scruggs, P.G.
Senior Geophysicist
Florida Professional Geologist
Number 2470

TABLE OF CONTENTS

1.0 Introduction

A geophysical investigation was conducted at the Sabal Trail Project - Compressor 7 Site located in Reunion, Florida. The survey area consisted of an open grassy field approximately 440 by 460 feet (ft) in plan dimension. Several borings were performed prior to this investigation as part of a geotechnical study conducted by PSI as shown on Figure 1. At the time of this investigation there was a small depression that formed around boring BH-8. The investigation was performed on June 23, 26 and 27, 2014. To further characterize the suspected top of rock, additional work was performed on July 18, 2014.

There were two objectives to the geophysical investigation. The first objective 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 second objective was to determine the vertical profile of the resistivity earth materials underlying the site. 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 GPR survey was conducted along a series of perpendicular transects spaced 20 ft apart. The locations of the GPR lines 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 GPR Surveys

Antenna Frequency	Time Range (nano-seconds)	Estimated Depth of GPR Signal Penetration
250 MHz 1/	304	38 to 47 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.

2.2 Electrical Resistivity Imaging Survey

The ERI survey was conducted using the Advanced Geosciences, Inc. Sting R8 automatic electrode resistivity system. A total of six initial ERI transects were performed using 47 electrodes on each line with an “a spacing” of 10 ft. On July

18th, two additional ERI lines were performed using 91 electrodes on each line. A dipole-dipole combined with an inverse Schlumberger electrode configuration was used with a maximum “n value” of six. The ERI data was analyzed using EarthImager 2D, a computer inversion program, which provides two-dimensional vertical cross-sectional resistivity model (pseudo-section) of the subsurface. A description of the ERI method and the methods employed for geotechnical characterization studies is provided in Appendix A2.3. A discussion of the modeling process used to create the ERI results is provided in Appendix A2.3.1.

2.3 Vertical Electrical Sounding

A collection of resistivity measurements were collected at various “a spacings” centered about a particular point and are referred to as a vertical electrical sounding or VES. The VES testing was done to determine the electrical resistance of the earth materials underlying the project site. The in-situ values of ground electrical resistivity were determined using a Wenner four-point electrical resistivity array. In such an array, the spacing between the electrodes (“a spacing”) is equal.

The VES testing was performed at 4 locations (BH-2, BH-5, BH-6, and BH-10) as shown on Figure 1. For these locations resistivity measurements were collected using “a spacings” of 2, 5, 10, 15, 20, 30, and 50 ft. It is noted the sounding located near BH-2 was located south of the survey area.

Two VES’s were conducted at each location. Each pair of VES’s was orientated perpendicular to each other in a north/south or east/west orientation. A R8 Super Sting resistivity system, manufactured by Advanced Geosciences, Inc. was used for the investigation. A description of the VES method is provided as Appendix A2.4.

3.0 Identification of Possible Sinkhole Features Using GPR and ERI Methods

3.1 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, towards 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.

3.2 Identification of Possible Sinkhole Features Using ERI

Sinkhole features are typically characterized by one of the following conditions on the ERI profile:

1. The occurrence of highly resistive material that extends to depth in a columnar fashion towards the top of the limestone. Such a feature may indicate the presence of a sand-filled depression or raveling zone.
2. The localized presence of low-resistivity material extending below the interpreted depth to the top of limestone. Such a feature may indicate the presence of a clay-filled void or fracture with the limestone or the presence of highly weathered limestone rock.
3. Any significant localized increase in the depth to limestone. Such a feature may indicate the presence of an in-filled depression (paleo-sink).

When comparing the results of the ERI method, the following considerations should be given. The ERI method, for example, describes the transition from clay to limestone as a transition, rather than a discrete depth. This transition is due to several factors including: a) The vertical density of the resistivity data decreasing with depth and b) The possibility that the upper portion of the limestone is weathered which would create a physical transition zone in terms of resistivity between the clay and competent (non-weathered) limestone and c) The limitations in the modeling process.

4.0 Survey Results

4.1 Discussion of GPR Survey Results

Results of the GPR survey indicated the presence of two well-defined, relatively continuous sets of GPR reflectors at depth ranges of 10 to 21 ft bls and 20 to 38 ft bls. These reflector sets are most likely associated with some change in lithological conditions at those depth ranges.

Description of GPR Anomalies

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

GPR Anomaly 1

GPR Anomaly 1 is semi-elliptical in shape and located within the northern portion of the survey area. It is noted that the observed depression around BH-8 was located within this anomaly. The apparent vertical relief of the upper portion of the anomaly area is 8 to 18 ft as characterized by the observed downwarping of both of the GPR reflector sets. A localized increase in the depth of penetration of the GPR signal was also observed within the anomaly area. The apparent centers of the feature are characterized as the area of maximum downwarping of the previously referenced GPR reflectors.

GPR Anomaly 2

GPR Anomaly 2 is semi-elliptical in shape and located within the southern portion of the survey area. The apparent vertical relief of the upper portion of the anomaly area is 5 to 9 ft as characterized by the observed downwarping of the upper 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 3

GPR Anomaly 3 is semi-elliptical in shape and located within the northwestern portion of the survey area. The apparent vertical relief of the upper portion of the anomaly area is 3 to 4 ft as characterized by the observed downwarping of the lower 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.

Examples of the GPR data collected across Anomaly Areas 1 and 2 are provided in Appendix 1.A discussion of the limitations of the GPR technique in geological characterization studies is provided in Appendix 2.

4.2 Discussion of ERI Survey Results

Results from the six ERI surveys are presented in Appendix 1. The ERI transects are of acceptable quality (a discussion of the criteria used to determine the quality of an ERI inversion model is provided in Appendix A2.3.1).

Analysis of the ERI Transects indicate the presence of high resistivity near-surface soil materials across the majority of the project site to a depth range of 20 to 42 ft bls (represented in yellow to red on the ERI transects). This high resistivity layer likely corresponds to sandy soil materials. The surficial high resistivity layer is underlain by a moderate to low resistivity layer (represented in green to blue) to a depth of approximately 100 to 120 ft bls (excluding anomalous areas). The decrease in the apparent resistivity values with respect to depth are most likely associated with an increase in the clay content of the soil materials. A moderate to high resistivity layer was observed (represented in green to yellow) beginning at a depth of approximately 100 to 120 ft bls and extended to the maximum depth of the investigation which was approximately 197 ft bls on Lines 7 and 8. It is suspected that this layer likely corresponds to limestone.

Discussion of ERI Anomalies

Four ERI anomalies that may be associated with sinkhole activity were observed on ERI Transects 1, 2, 7 and 8. The ERI anomalies were characterized by the localized occurrence of relatively more resistive soil materials at depth. These relatively more resistive sediments occurred at an estimated depth range of 20 to 43 ft bls. In addition, Lines 7 and 8 indicate an increased depth to the suspected top of rock to greater than 150 ft bls within the anomaly area.

All four of these ERI anomalies are located in the northeastern corner of the site and are likely part of a singular anomaly. These anomalies correspond to the location of GPR Anomaly 1.

4.3 Correlation of GPR and ERI Survey Results

The GPR survey identified a near surface reflector set at a depth range of 10 to 21 ft bls overlying a deeper reflector set at a depth range of 20 to 38 ft bls. The ERI data demonstrated a strong correlation to the lower GPR reflector set by identifying a layer at a depth range of approximately 20 to 42 ft bls. However, the

ERI data did not identify a corresponding near-surface layer to match the GPR reflector set observed at 10 to 21 ft bls. This indicates that the ERI data did not have the necessary resolution to image the contrast in the near-surface electrical properties to the extent the GPR survey was capable of.

The GPR data indicated three anomaly areas within the survey area. ERI transects were performed only through the area of GPR Anomaly 1 and 2. Accordingly no correlation between GPR Anomaly 3 and the ERI data can be determined. However, the ERI data did indicate four anomalous areas corresponding to GPR Anomaly 1. Therefore, the geophysical methods were in good agreement in this regard. The ERI did not show any anomalous conditions within GPR Anomaly 2. The lack of an ERI anomaly within GPR Anomaly 2 likely indicates that the sediments at depth within the GPR anomaly are similar in composition and density to the surrounding soils.

4.4 Vertical Electrical Sounding Results

The tabulated results of the electrical survey for each of the transects is presented in Appendix 1. Values are presented in ohm-m. A log-log plot of the data in ohm-m is also provided. The smoothness and geometry of the plotted data curves indicates that the data for the majority of each pair of VES's are of high quality and apparently unaffected by any sources of interference.

The resistivity results show a general trend of high resistivity values at the smallest a-spacing (2 ft) which decline to the a-spacing of 5 to 15 ft. Resistivity values then, in general, increase to the a-spacing of 20 to 30 ft and then decrease to the maximum a-spacing of 50 ft. A summary of the resistivity values at the various "a spacings" is provided in Table 2.

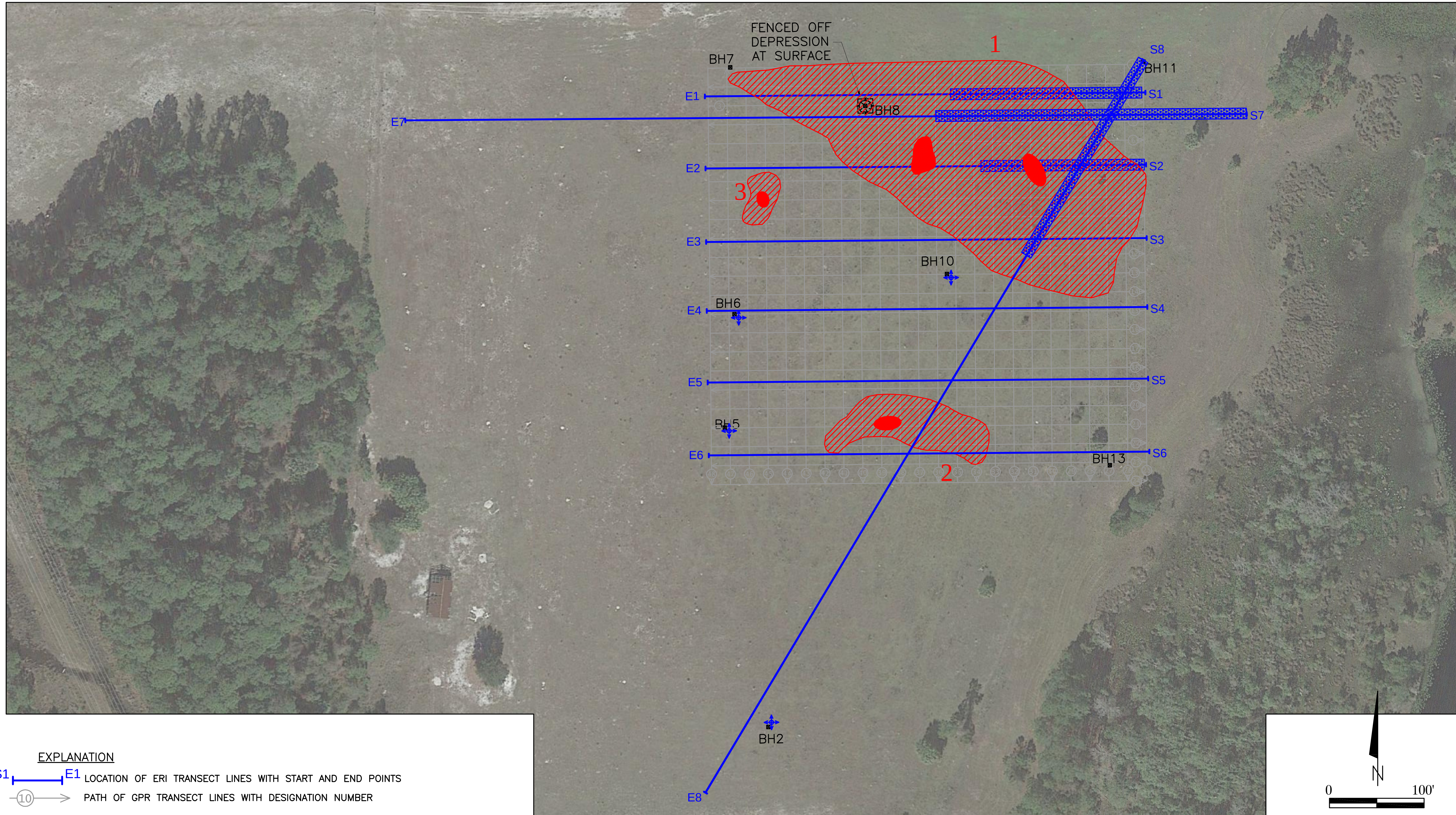
Table 2
Maximum, Minimum and Average Resistivity at Selected A-Spacing's

A-Spacing (in ft)	Minimum Resistance (in ohm-m)	Maximum Resistance (in ohm-m)	Average Resistance (in ohm-m)
2	677	1255	924
5	586	873	744
10	734	890	796
15	586	867	775
20	674	907	784
30	437	810	643
50	161	431	324

Some differences in resistivity's between the VES's with the same "a spacings" at different orientations were observed. It is suspected that the variation in readings is not due to the presence of any sources of interference, as no known sources of interference were present at the site. The variations in readings are likely the result of naturally-occurring variations in the near-surface soils at the site. It is recommended that the average values for the two lines be used for any design calculations.

APPENDIX 1

FIGURE, EXAMPLES OF GPR ANOMALIES, ERI TRANSECTS AND VERTICAL RESISTIVITY SOUNDING RESULTS



EXPLANATION

S1 E1	LOCATION OF ERI TRANSECT LINES WITH START AND END POINTS
10	PATH OF GPR TRANSECT LINES WITH DESIGNATION NUMBER
2	LOCATION OF GPR ANOMALIES WITH DESIGNATION (1 MOST SIGNIFICANT, 3 LEAST SIGNIFICANT)
	APPARENT CENTER OF GPR ANOMALY
	LOCATION OF ERI ANOMALY
	LOCATION OF ELECTRICAL RESISTIVITY SOUNDING
BH2	APPROXIMATE LOCATION OF BORING WITH DESIGNATION

GeoView

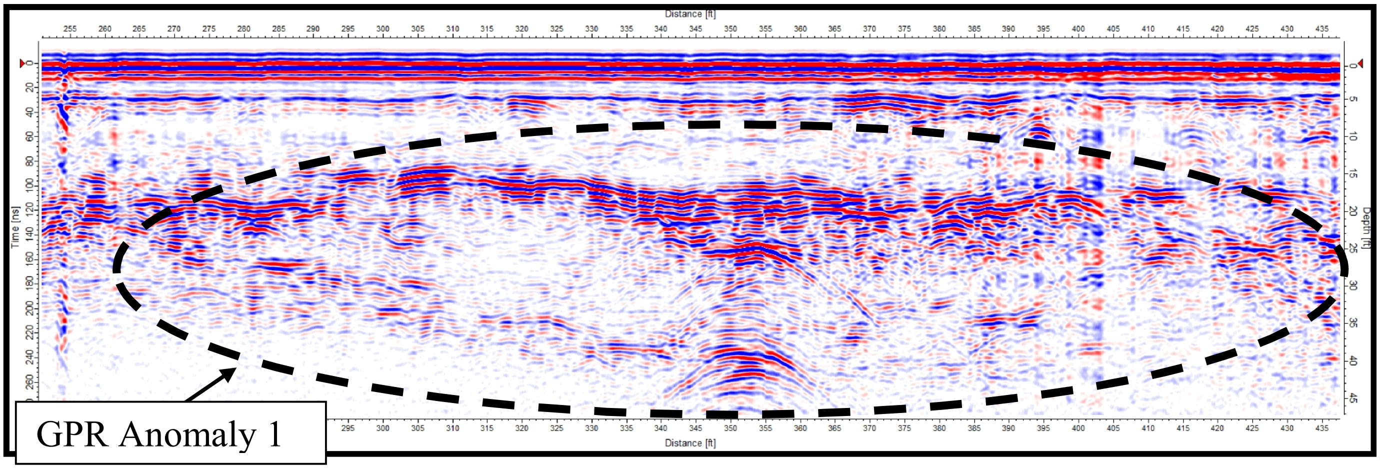
FIGURE 1

SITE MAP
SHOWING RESULTS
OF GEOPHYSICAL
INVESTIGATION

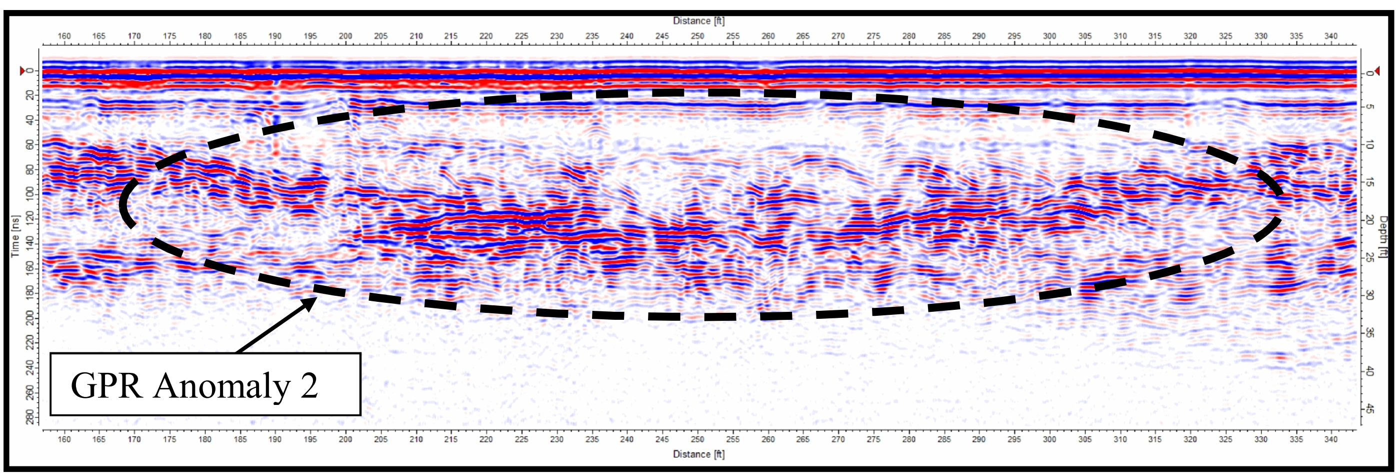
SABAL TRAIL PROJECT-REUNION SITE (REV. 1)
COMPRESSOR STATION 7
REUNION, FLORIDA

PROFESSIONAL SERVICE
INDUSTRIES, INC.
ORLANDO, FLORIDA

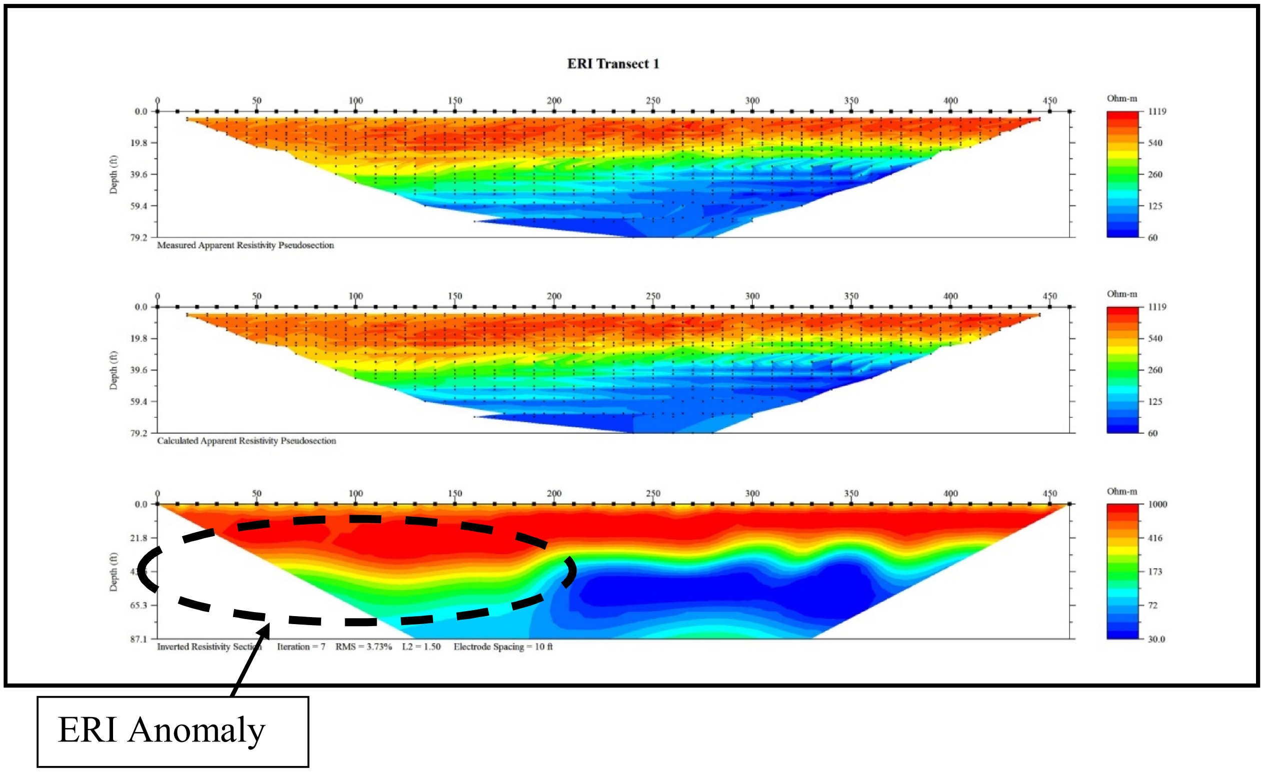
PROJECT: 21154.03
DATE: 07/23/14

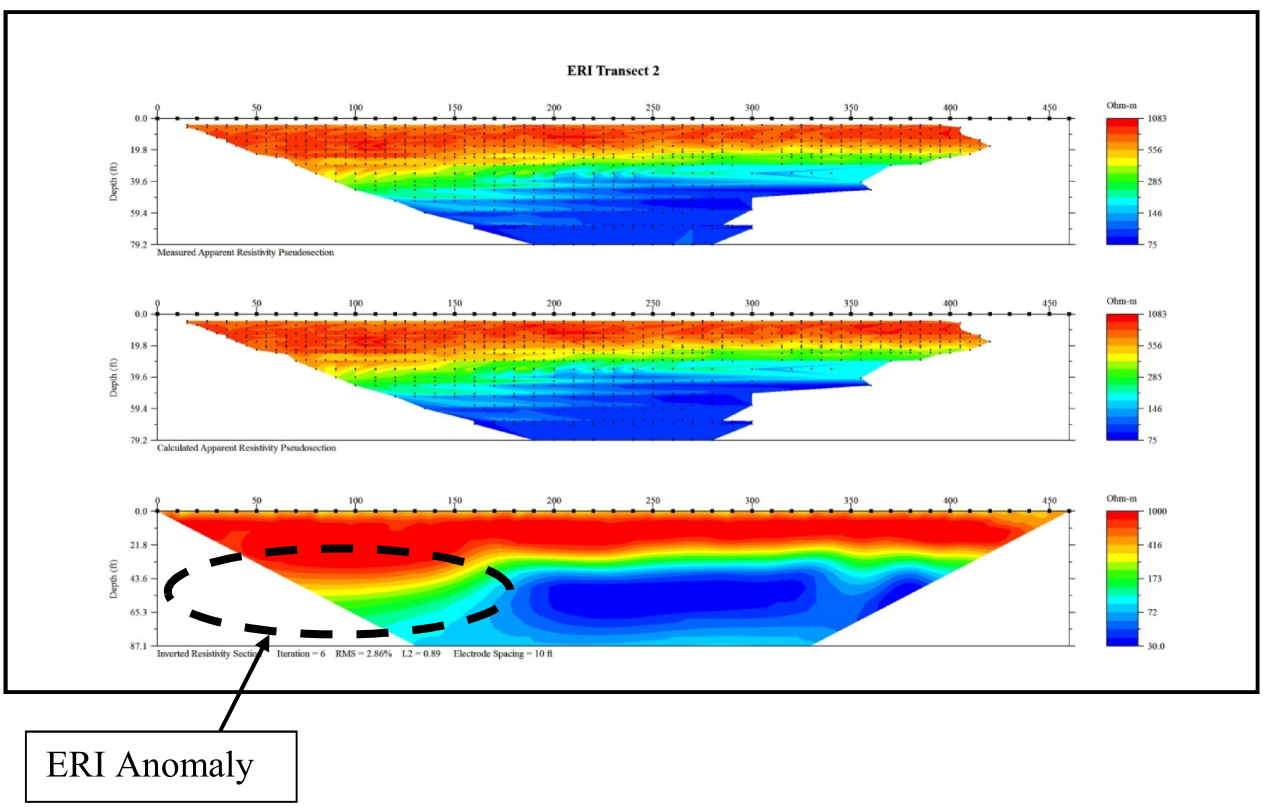


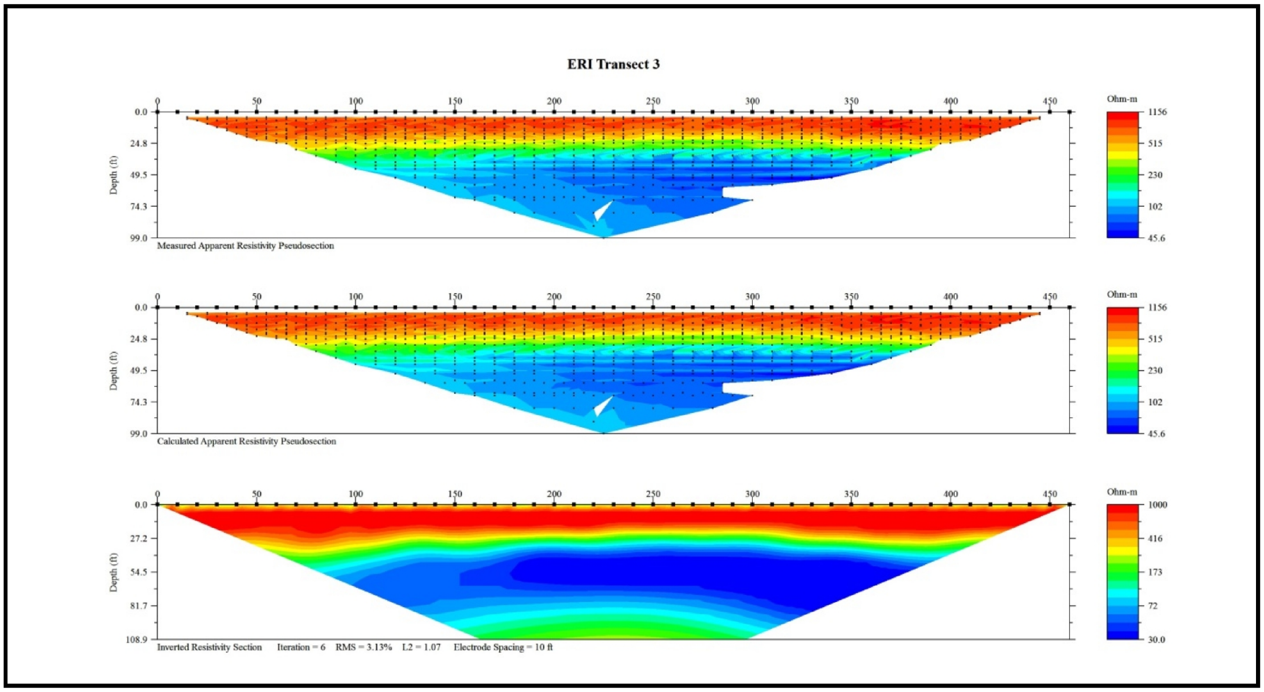
GPR Transect 37 Showing Example of GPR Anomaly 1

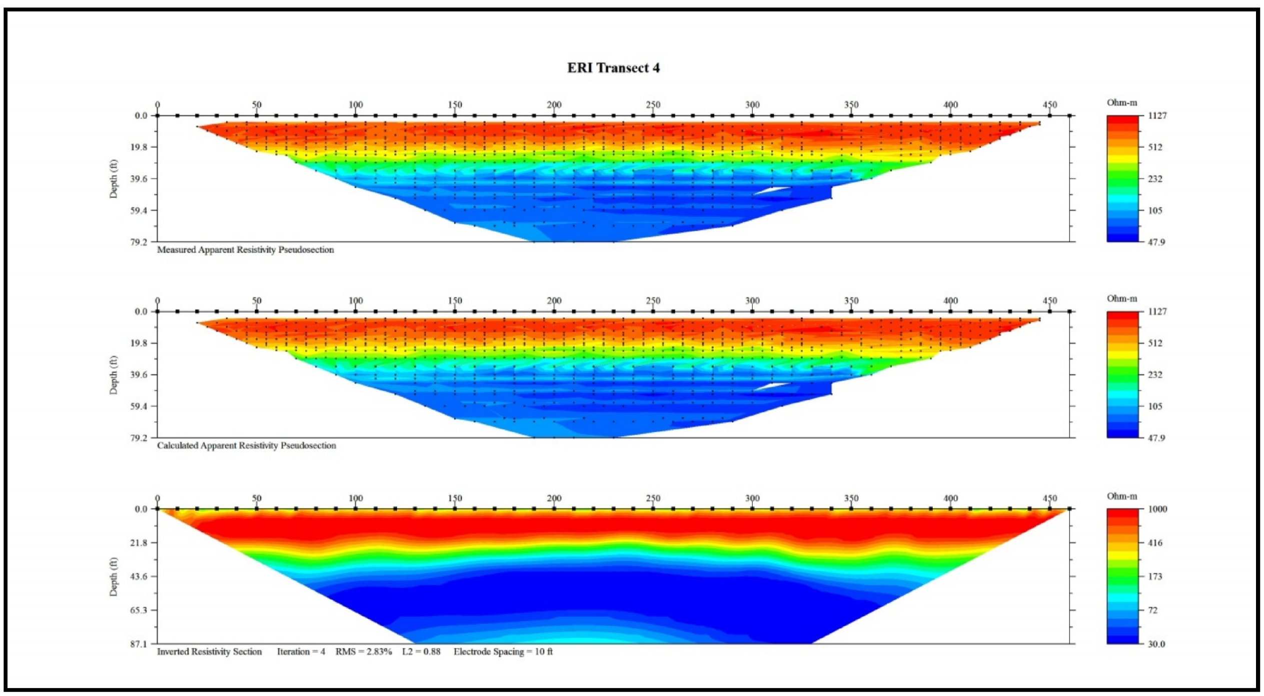


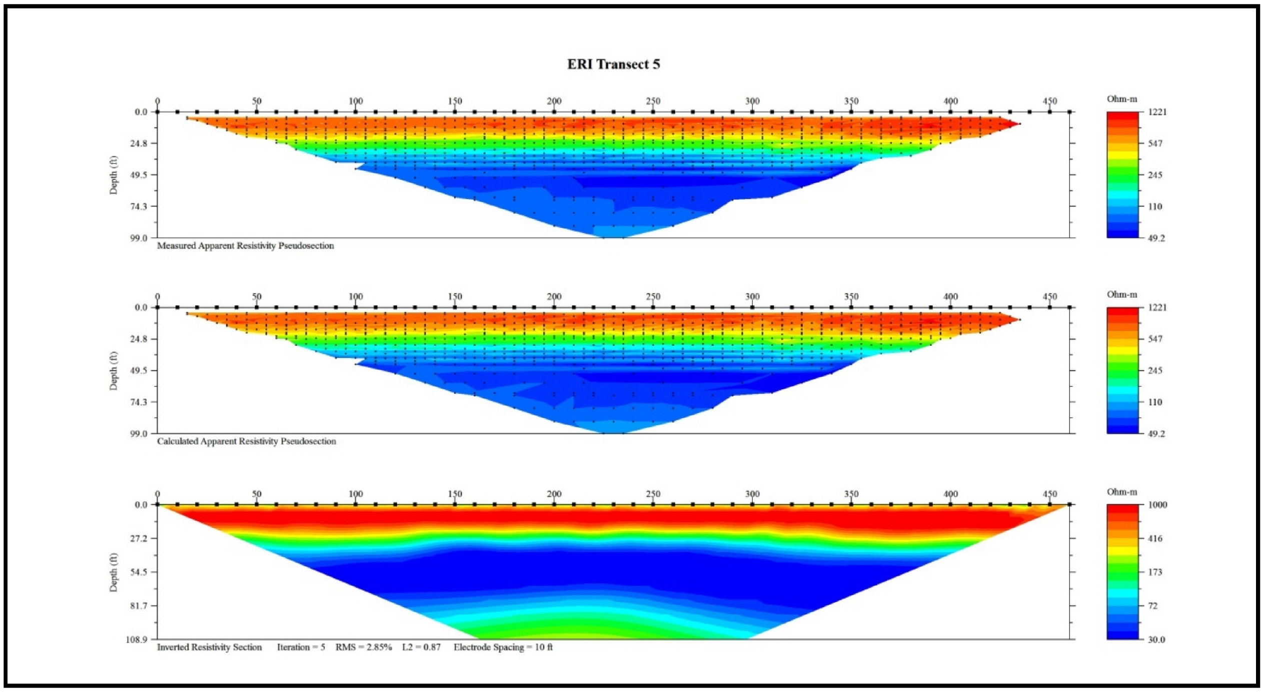
GPR Transect 21 Showing Example of GPR Anomaly 2

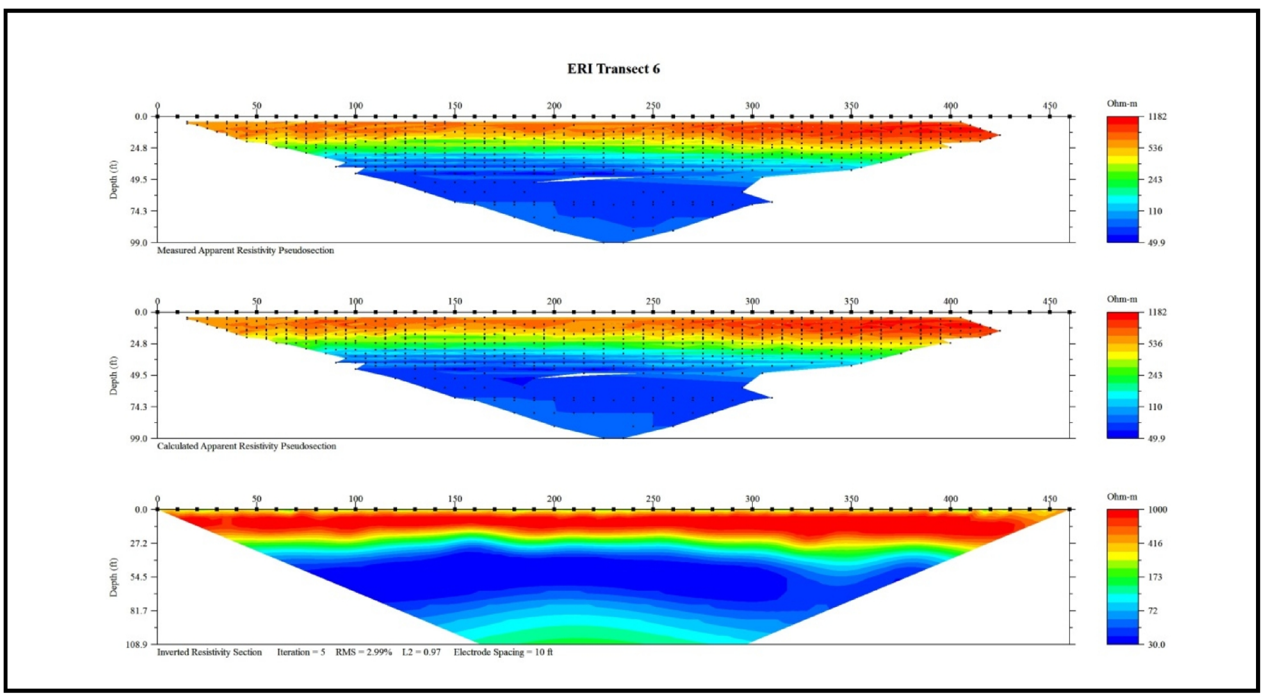

ERI Transect 1
Measured Apparent Resistivity Pseudosection
Calculated Apparent Resistivity Pseudosection
Inverted Resistivity Section
Iteration = 7
RMS = 3.73%
L2 = 1.50
Electrode Spacing = 10 ft
Depth (ft)
Ohm-m
ERI Anomaly

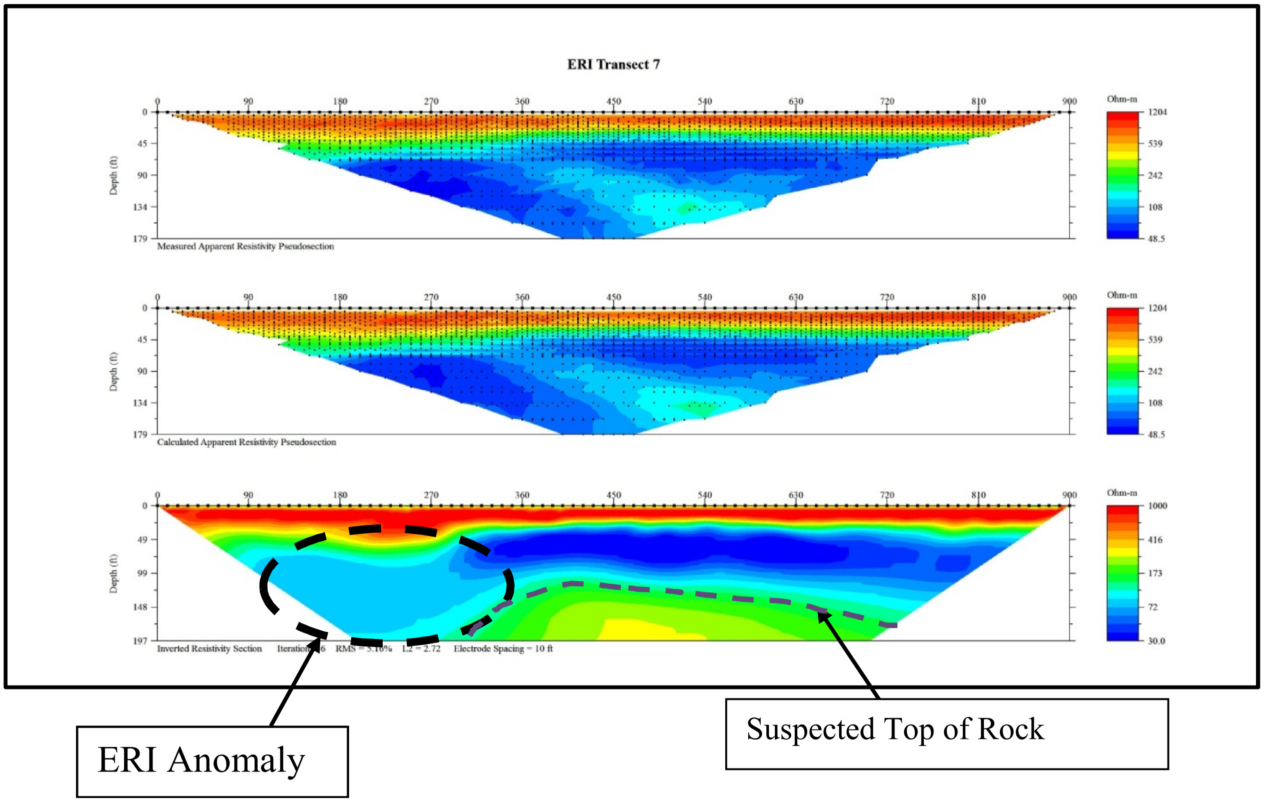

ERI Transect 2
Measured Apparent Resistivity Pseudosection
Calculated Apparent Resistivity Pseudosection
Inverted Resistivity Section
Iteration = 6
RMS = 2.86%
L2 = 0.89
Electrode Spacing = 10 ft
Depth (ft)
Ohm-m
ERI Anomaly

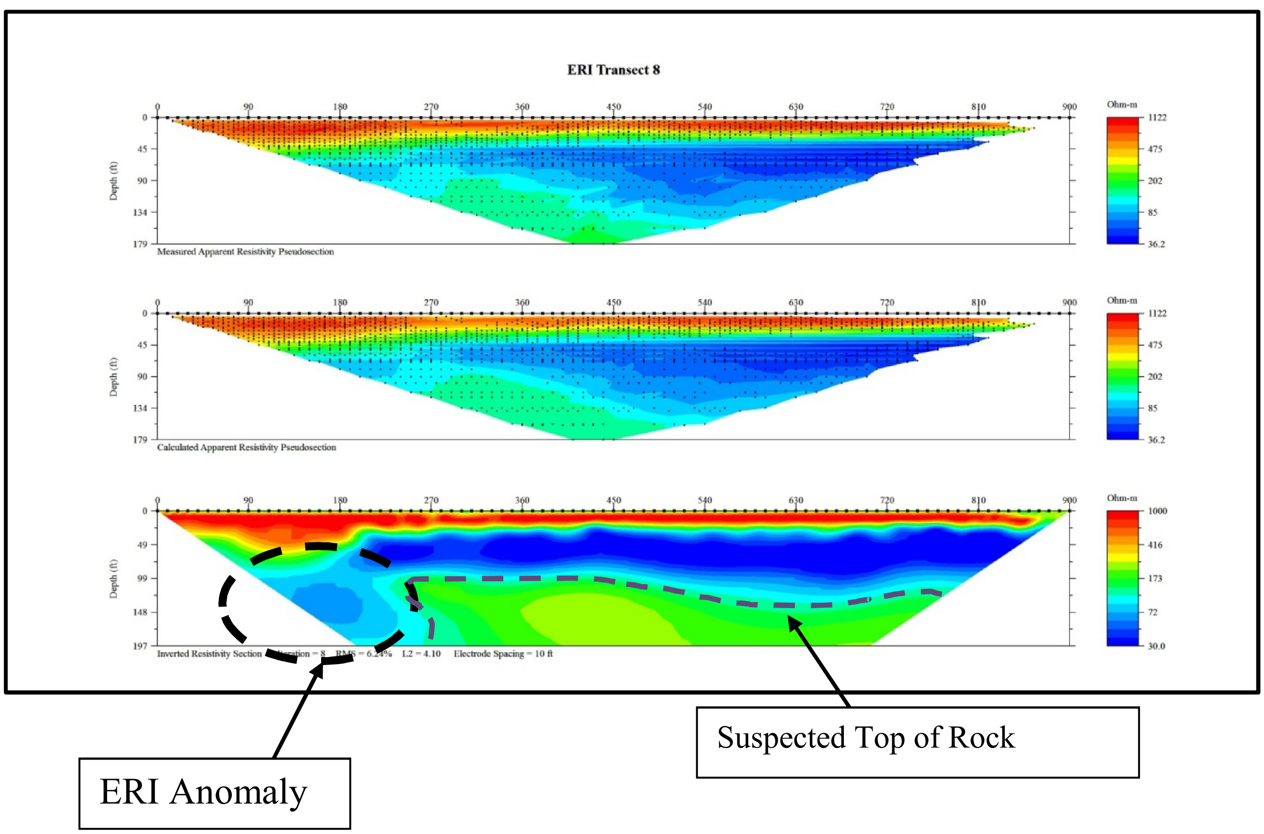

ERI Transect 3
Measured Apparent Resistivity Pseudosection
Calculated Apparent Resistivity Pseudosection
Inverted Resistivity Section Iteration = 6 RMS = 3.13% L2 = 1.07 Electrode Spacing = 10 ft
Depth (ft)
Ohm-m

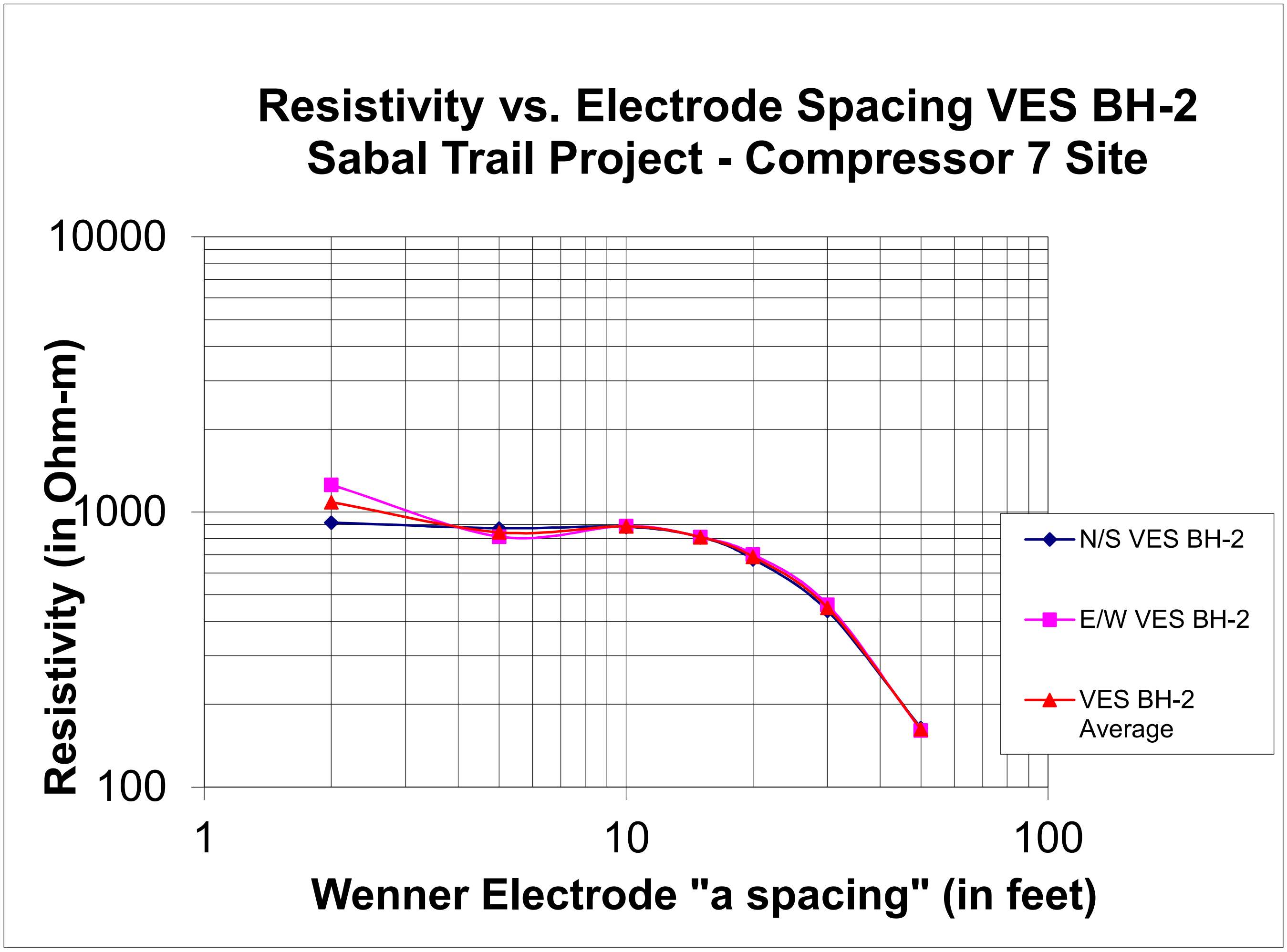

ERI Transect 4
Measured Apparent Resistivity Pseudosection
Calculated Apparent Resistivity Pseudosection
Inverted Resistivity Section Iteration = 4 RMS = 2.83% L2 = 0.88 Electrode Spacing = 10 ft
Depth (ft)
Ohm-m


ERI Transect 5
Depth (ft)
Ohm-m
Measured Apparent Resistivity Pseudosection
Calculated Apparent Resistivity Pseudosection
Inverted Resistivity Section Iteration = 5 RMS = 2.85% L2 = 0.87 Electrode Spacing = 10 ft

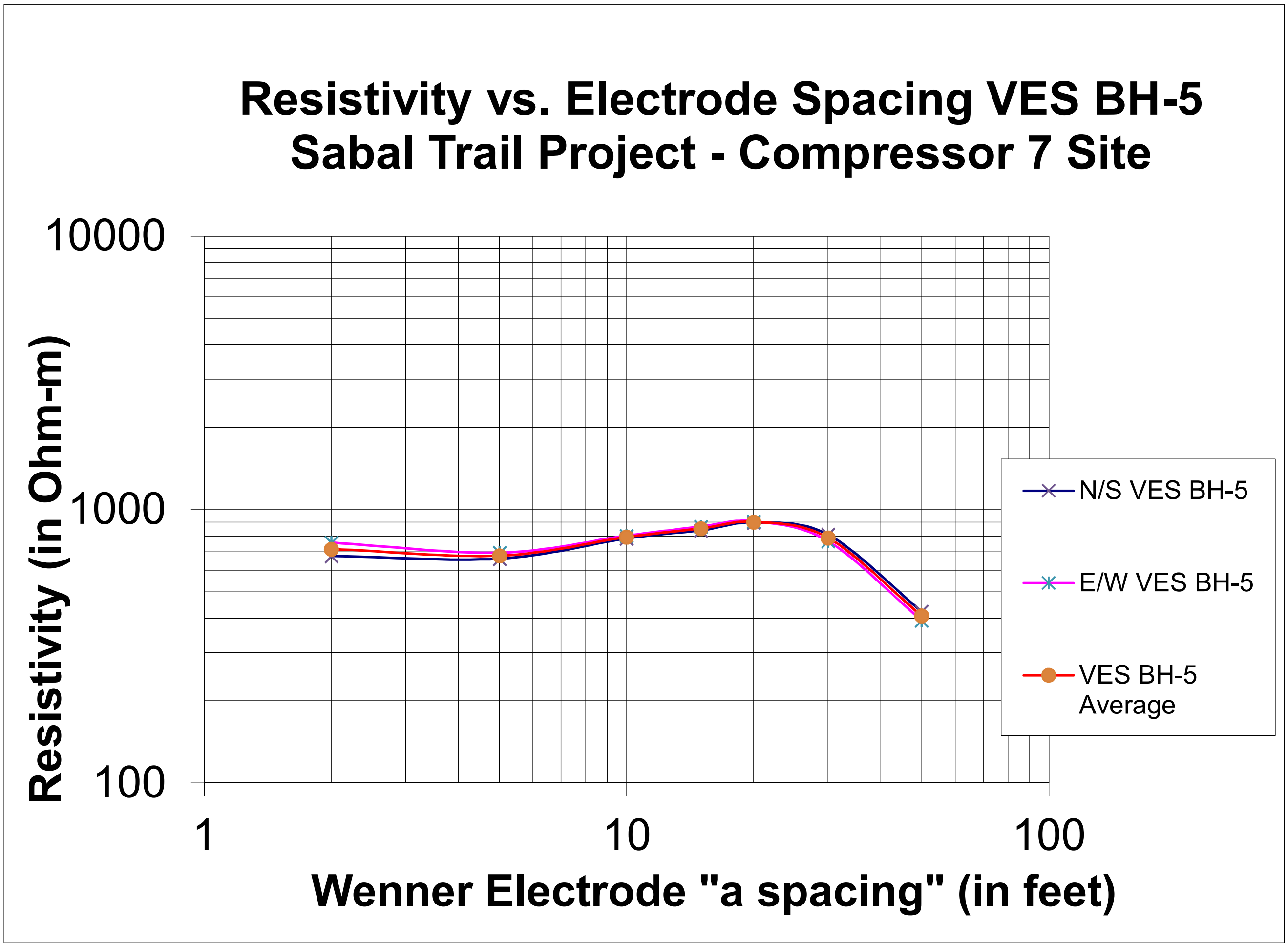

ERI Transect 6
Depth (ft)
Ohm-m
Measured Apparent Resistivity Pseudosection
Calculated Apparent Resistivity Pseudosection
Inverted Resistivity Section Iteration = 5 RMS = 2.99% L2 = 0.97 Electrode Spacing = 10 ft


ERI Transect 7
Ohm-m
Depth (ft)
Measured Apparent Resistivity Pseudosection
Calculated Apparent Resistivity Pseudosection
Inverted Resistivity Section
Electrode Spacing = 10 ft
ERI Anomaly
Suspected Top of Rock

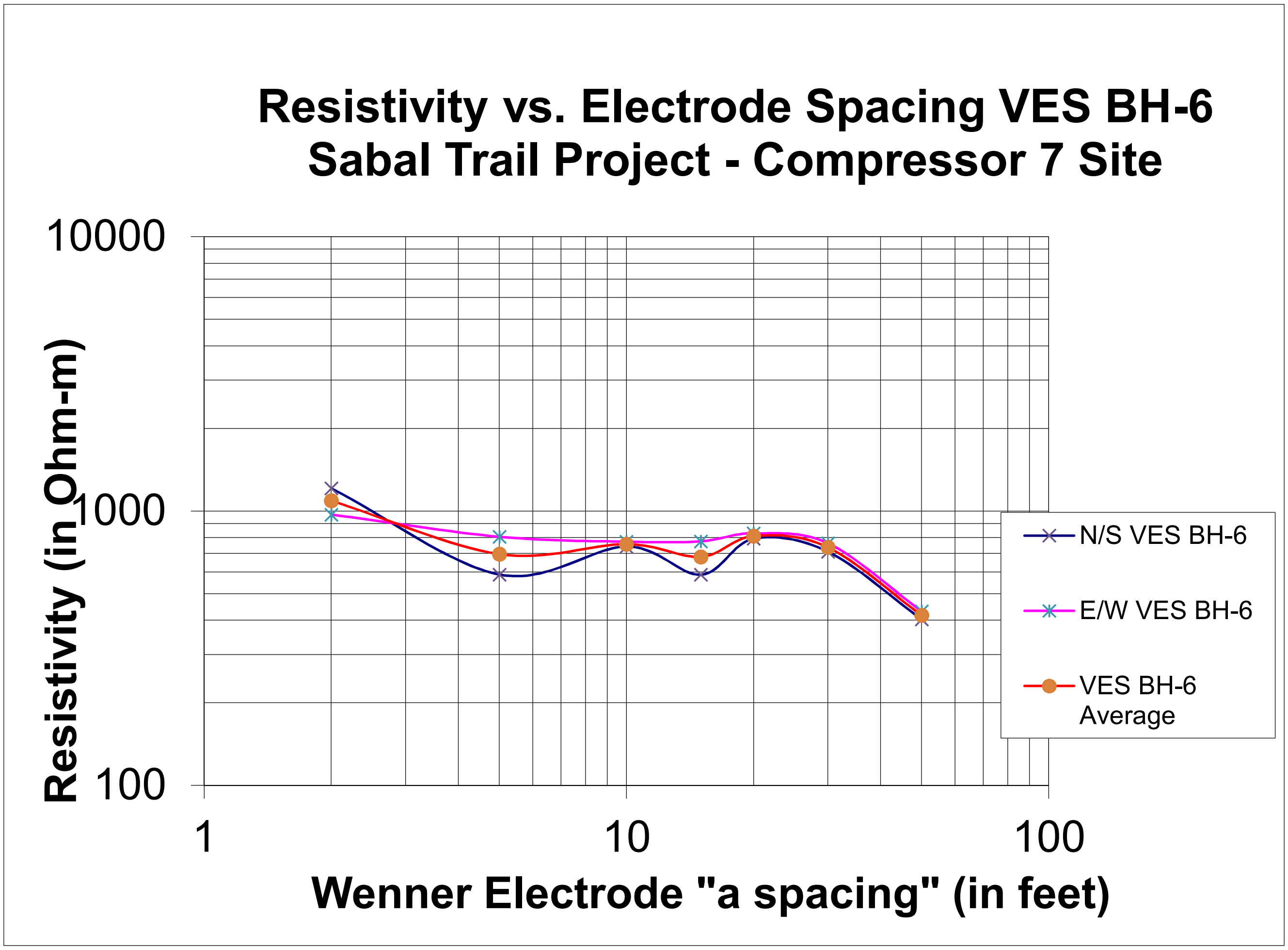

ERI Transect 8
Ohm-m
Depth (ft)
Measured Apparent Resistivity Pseudosection
Calculated Apparent Resistivity Pseudosection
Inverted Resistivity Section
L2 = 4.10
Electrode Spacing = 10 ft
ERI Anomaly
Suspected Top of Rock



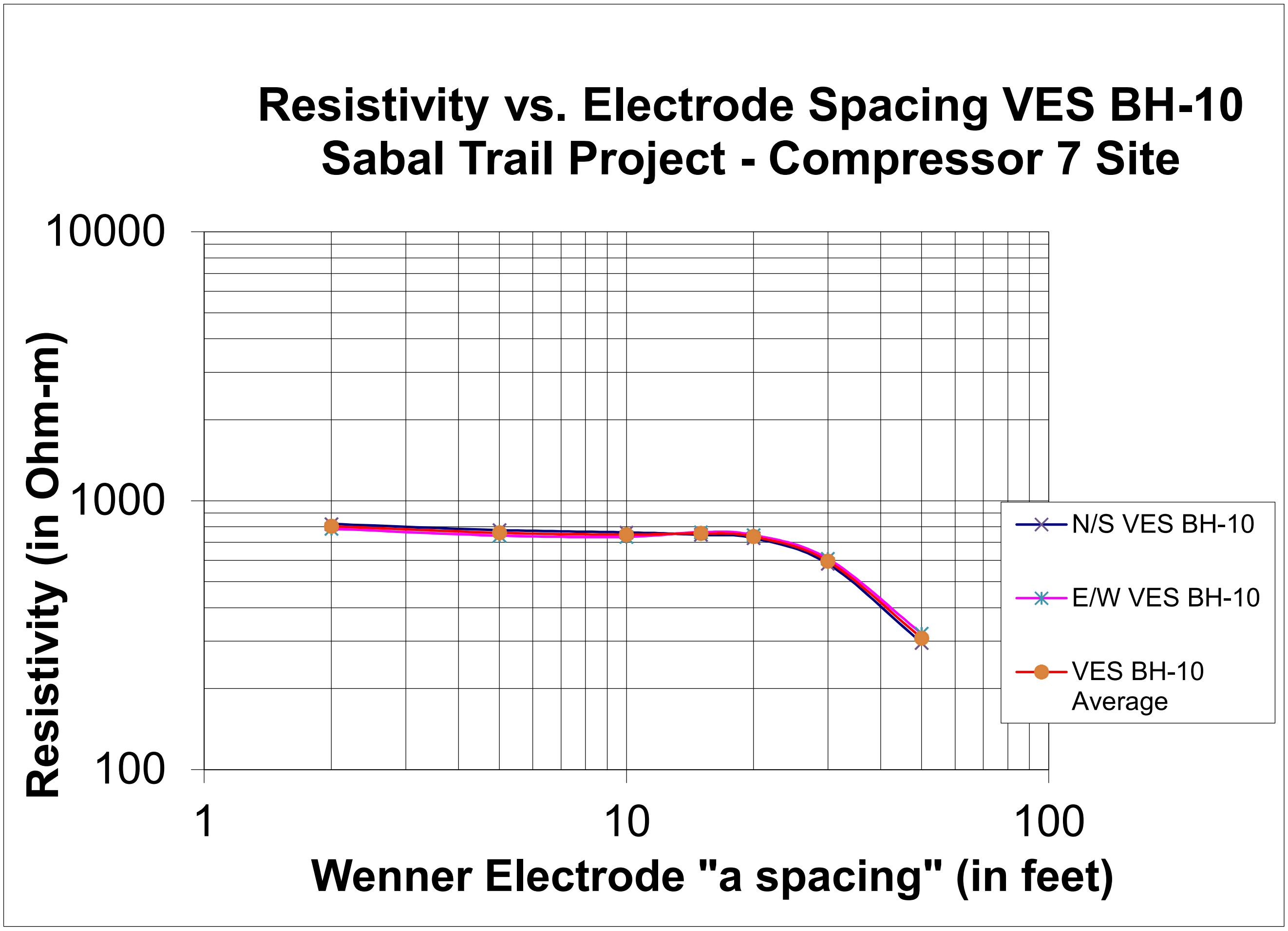
"a" spacing (in feet)	VES-BH-2 Resistance North/South (in Ohms)	VES-BH-2 Apparent Resistivity (ohm-m) North/South	VES-BH-2 Resistance East/West (in Ohms)	VES-BH-2 Apparent Resistivity (ohm-m) East/West	VES 1 and 2 Average Resistivity (ohm-m)
2	239.2	916	327.8	1255	**1086**
5	91.18	873	85.01	814	**844**
10	46.15	884	46.48	890	**887**
15	28.23	811	28.24	811	**811**
20	17.61	674	18.34	702	**688**
30	7.612	437	8.026	461	**449**
50	1.713	164	1.681	161	**162**



"a" spacing (in feet)	VES-BH-5 Resistance North/South (in Ohms)	VES-BH-5 Apparent Resistivity (ohm-m) North/South	VES-BH-5 Resistance East/West (in Ohms)	VES-BH-5 Apparent Resistivity (ohm-m) East/West	VES 1 and 2 Average Resistivity (ohm-m)
2	176.7	677	197.8	758	**717**
5	69.06	661	72.64	696	**678**
10	40.96	784	41.91	803	**793**
15	29.24	840	30.17	867	**853**
20	23.41	897	23.67	907	**902**
30	14.1	810	13.36	768	**789**
50	4.43	424	4.107	393	**409**



"a" spacing (in feet)	VES-BH-6 Resistance North/South (in Ohms)	VES-BH-6 Apparent Resistivity (ohm-m) North/South	VES-BH-6 Resistance East/West (in Ohms)	VES-BH-6 Apparent Resistivity (ohm-m) East/West	VES 1 and 2 Average Resistivity (ohm-m)
2	315.9	1210	253.4	971	**1090**
5	61.25	586	84.11	805	**696**
10	38.74	742	40.35	773	**757**
15	20.4	586	27	776	**681**
20	20.69	792	21.63	828	**810**
30	12.38	711	13.28	763	**737**
50	4.207	403	4.5	431	**417**



"a" spacing (in feet)	VES-BH-10 Resistance North/South (in Ohms)	VES-BH-10 Apparent Resistivity (ohm-m) North/South	VES-BH-10 Resistance East/West (in Ohms)	VES-BH-10 Apparent Resistivity (ohm-m) East/West	VES 1 and 2 Average Resistivity (ohm-m)
2	214	820	205.3	786	**803**
5	81.2	777	77.45	742	**760**
10	39.81	762	38.33	734	**748**
15	26	747	26.6	764	**755**
20	18.93	725	19.45	745	**735**
30	10.14	583	10.59	608	**595**
50	3.095	296	3.347	320	**308**

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. The degree of accuracy of such an approach is typically +/- 2.5% for lengths and +/- 2.5 degrees for angles.

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. A low-frequency (250 MHz) antenna is used which 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.

A2.3 Electrical Resistivity

Electrical resistivity surveying is a geophysical method in which an electrical current is injected into the earth; the subsequent response (potential) is measured at the ground surface to determine the resistance of the underlying earth materials. The resistivity survey is conducted by applying electrical current into the earth from two implanted electrodes (current electrodes C_1 and C_2) and measuring the associated potential between a second set of implanted electrodes (potential electrodes P_1 and P_2). Field readings are in volts. Field readings are then converted to resistivity values using Ohm's Law and a geometric correction factor for the spacing and configuration of the electrodes. The calculated resistivity values are known as "apparent" resistivity values. The values are referred to as "apparent" because the calculations for the values assume that the volume of earth material being measured is electrically homogeneous. Such field conditions are rarely present.

Resistivity of earth materials is controlled by several properties including composition, water content, pore fluid resistivity and effective permeability. For this study the properties that had the primary control on measured resistivity values are composition and effective permeability. The general geological setting of this project area is clay overlain by limestone.

For this study a dipole-dipole combined with an inverse Schlumberger resistivity array configuration was used. The dipole-dipole array is different that most other resistivity arrays in that the electrode and current electrodes are kept together using a constant spacing value referred to as an "a spacing". The current and potential electrode sets are moved away from each other using multiples of the "a spacing" value. The number of multiples is referred to as the "n value". For example, an array with an “a spacing” of 5 ft and a “n value” of 6 would have the current and potential electrode sets spaced 30 ft apart with a separation between the two electrodes in the set of 5 ft. By sampling at varying “n values”, greater depth measurements can be achieved. Inverse Schlumberger data is collected with the current set of electrodes being kept with a fixed separation (L spacing) and the potential electrodes a minimum distance of 5L from the inner current electrodes. Dipole-dipole resistivity data is usually presented in a two-dimensional pseudo-section format. Inverse Schlumberger data is usually presented as a vertical profile of resistivity distribution below the center point between the two current electrodes. The dipole-dipole and inverse Schlumberger data is combined and presented as either a contour of the individual data points (using the calculated apparent resistivity values) or as a geological model using least squares analysis. Such least squares analysis was used for this study using the computer software program (EarthImager 2D) developed for the equipment manufacturer. Apparent resistivity values are calculated using the following formula for a dipole-dipole configuration: $\gamma_a=\pi(b^3/a^2-b)\nabla V/I$:

Where:

γ_a=	apparent resistivity
π=	3.14
a=	“a spacing”
b=	“a spacing” x “n value”
∇V=	voltage between the two potential electrodes
I=	current (in amps)

For a Schlumberger configuration the apparent resistivity is calculated using: $\gamma_a=\pi([s^2-a^2]/4)\nabla V/aI$:

Where:

γ_a=	apparent resistivity
π=	3.14
a=	spacing between the inner set of electrodes”
s=	distance between the outer electrode and nearest inner electrode
∇V=	voltage between the two potential electrodes
I=	current (in amps)

A2.3.1 Inversion Modeling of ERI Data

The objective for inversion modeling of resistivity data is to create a description of the actual distribution of earth material resistivity based on the subsurface geology that closely matches the resistivity values that are measured by the instrumentation. This modeling is done through the use of EarthImager™, a proprietary computer program developed by the equipment manufacturer. When evaluating the validity of the inversion model several factors need to be considered. The RMS, or root mean square error, expresses the quality of fit between the actual and modeled resistivity values for the given set of points in the model. The lower the RMS error the higher the quality of fit between the actual and modeled data sets. In general, inversion models with an RMS error of less than 5 to 10 percent are acceptable. The size of the RMS error is dependent upon the number of bad data points within a data set and the magnitude of how bad the data points are. As part of the modeling process bad data points are typically removed, which decreases the RMS error and improves (with limitations) the quality of the model. The quality of fit between the actual and modeled resistivity values is also expressed as the L-2 norm. When the modeled and actual data sets have converged, the L-2 norm reduces to unity (1.0 or smaller).

However, as the number of data points is reduced, the validity of the inversion model is diminished. Accordingly, when interpreting a particular area of an inversion model the number of data points used to create that portion of the model must be taken into consideration. If very few points are within a particular area of the model, then the modeled solution in that area should be considered suspect and possibly rejected.

The entire ERI transect should be considered suspect if a model has a high RMS error and a large number of removed data points. It is likely that sources of interference have affected the field readings and rendered the modeled solution invalid. Such sources of interference can include buried metallic underground utilities, reinforced concrete slabs, septic leach fields or electrical grounding systems. Accordingly, all efforts need to be made in the field to locate, to the degree possible, the ERI transect lines away from such features. The locations of such features also need to be mapped in the field so their potential effects can be considered when interpreting the modeled results.

A2.4 Vertical Electrical Sounding

In a VES survey, the spacing between the electrodes is increased to provide a progressively deeper measurement of earth resistance. A common center between the electrodes is maintained for a VES survey. For this survey a “Wenner” array electrode configuration was used. In such a configuration, the spacing between the electrodes is kept constant and is referred to as the “a spacing”. Current is applied to the outside electrodes and voltage measurements are collected across the two inner electrodes. Apparent resistivity values are calculated using the following formula: $\gamma_a=2\pi a \nabla V/I$:

Where:

γ_a=	apparent resistivity
π=	3.1457
a=	“a spacing”
∇V=	voltage between the two potential electrodes
I=	current (in amps)

Vertical Electrical Sounding Limitations

The results of this resistivity survey are based on our professional evaluation of the data and our experience with such investigations in the State of Florida. The survey was performed in general accordance to ASTM Standards G57-95a entitled “Standard Test Method for Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method”. The results provided in this report meet the standards of care for our profession. No other warranty or representation, either expressed or implied, is included or intended.