

GEOTECHNICAL INVESTIGATION

**BANNERMAN AND BULL HEADLEY ROAD
MAST ARM FOUNDATION
LEON COUNTY, FLORIDA**

Prepared For:

PBS&J
2639 NORTH MONROE STREET
BUILDING C
TALLAHASSEE, FL 32303

Prepared By:

ENVIRONMENTAL AND GEOTECHNICAL SPECIALISTS, INC.
3154 ELIZA ROAD
TALLAHASSEE, FLORIDA 32308
(850) 386-1253

*August 2009
22-31-09-01*



ENVIRONMENTAL AND GEOTECHNICAL SPECIALISTS, INC.

August 3, 2009

EGS File Number: 22-31-09-01

PBS&J
2639 North Monroe Street
Building C
Tallahassee, FL 32303

ATTN: Dan Bracken
Project Manager

SUBJECT: Geotechnical Investigation
Bannerman and Bull Headley Road
Mast Arm Foundation
Leon County, Florida

Dear Dan:

Environmental and Geotechnical Specialists, Inc. (**EGS**) has completed the geotechnical investigation, as authorized by **PBS&J** for the design of the mast arm foundation at the intersection of Bannerman Road and Bull Headley Road. The location of the foundation was located in the field based on the technical drawing provided by **PBS&J**. This Report contains a summary of the field investigation, the materials encountered, foundation design recommendations and construction considerations.

Site Location

The site investigated during this study was located at the intersection of Meridian Road and Bannerman Road in Leon County, Florida. A Site Location Map has been provided as **Figure 1**.

Scope of Services

The Scope of Services authorized by **PBS&J** for this project consisted of the following:

- installation of one (1) soil boring to a depth of thirty-two (32) feet at the location of the proposed mast arm foundation;

- conducting standard penetration tests (**SPT**) or equivalent, on two and one-half (2½) feet centers to evaluate the strength and uniformity of the subsoils;
- laboratory testing of the representative soil samples;
- development of design recommendations; and,
- preparation of this Report.

Subsurface Investigation

The subsurface investigation outlined in this Report was conducted in July of 2009 under the supervision of Myron Hayden, P.E. The location of the soil boring for the proposed mast arm was located based on the electronic drawing provided by **PBS&J**.

EGS installed the Soil Boring **BBMA-1** using a hand auger coupled with Static Cone Penetrometer Index (**CPI**) tests conducted on two and one-half (2 ½) feet intervals to a depth of seven and one-half (7½) feet. This is done in order to reduce possible conflict with buried utilities. Standard penetration tests (**SPT**) were conducted on two and one-half feet intervals from a depth of seven and one-half (7½) feet to the boring termination. To facilitate easier use of the **CPI** test data, they have been converted to equivalent standard penetration test (**SPT**) "**N**" values in this Report using the correlation of **SPT "N" = CPI "C"/4**. An arial photograph of the boring location has been included in **Figure 2** as well as on the Report of Core Borings Sheet as shown in **APPENDIX A**.

Representative soil samples were collected at the sample locations, classified in the field by **EGS** personnel and then sealed and transported to **EGS's** laboratory for additional testing. The laboratory tests performed included water contents, grain-size distributions, and Atterberg Limits. The soil samples were classified with respect to the Unified Soil Classification (**UNIFIED**) system and the American Association of State Highway and Transportation Officials (**AASHTO**) soil classification system. Global Positioning Satellite Coordinates (**GPS**) of the boring location have been provided in **TABLE 1**. A copy of the Report of Core Boring and the Soil Boring Log for the soil boring has been provided in **APPENDIX A** and **B** respectively. The Soil Classification Data has been provided as **APPENDIX C**.

Subsurface Conditions

Soils

The subsurface conditions are shown on the "Generalized" Soil Profile provided in **APPENDIX D**.

Soil Boring BBMA-1

- 0.0 – 7.5 Medium Dense – Silty Fine Sand (**SM/A-2-4**)
- 7.5 – 32.0 Firm – Highly Plastic Clay (**CH/A-7-6**)

Groundwater

Groundwater was not encountered within thirty-two (32) feet of the ground surface. A review of the United States Geological Survey's (**USGS**) Topographic Survey Map, which has been included as **Figure 3**, indicates that permanent groundwater should be at an elevation of around EL 160 feet to EL 170 feet. This supports **EGS's** belief that significant groundwater will not be encountered within thirty-two (32) feet of the ground surface at the location of the Mast Arm Foundation. A summary of the groundwater data has been provided in **TABLE 1**.

It should be noted that because of the existence of the plastic clay at a relatively shallow depth, "perched" groundwater may be encountered after periods of heavy or prolonged rainfall.

Design Recommendations

Based on the subsurface investigation conducted at the proposed Mast Arm Foundation location, **EGS recommends** that a drilled shaft foundation be used to support the mast arm signal pole. **EGS** considered the use of spread footings as a design option; however, the bending moments created by the mast arms eliminate the viability of using spread footings.

Based on the subsurface investigation conducted for this study, **EGS** developed geotechnical design parameters to facilitate the design and construction of the drilled shaft foundations. These design values are provided in **TABLE 2**. Since the minimum diameter and length of the drilled shaft is dependent upon both the subsurface and loading conditions, **EGS** understands the diameter and length of drilled shafts are to be determined by others. It should be noted that **EGS** assumed a shaft diameter of four (4) feet for the values shown in **TABLE 2**. The sample calculations used to develop the values shown in **TABLE 2** are provided in **APPENDIX D**.

Based on the investigation conducted for this study, **EGS believes that the FDOT Standard Design for the Mast Arm Foundations is not appropriate for this foundation**. This is based on the highly plastic clay encountered at a relatively shallow depth.

PBS&J
Bannerman and Bull Headley Road
Mast Arm Foundation
Page Four of Four
August 3, 2009

Closure

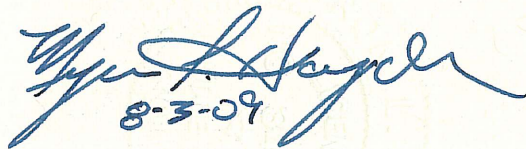
The data and results presented in this Report are intended for the use of **PBS&J** and **Leon County's Department of Public Works** for the design of the mast arm foundation, identified herein. This Report is not intended for any other use and will likely not be applicable. The data and recommendations presented in this Report are based on the boring made at the specific location and depth noted. Subsurface conditions at other locations may vary significantly from those presented herein. Should data become available which is different from the data presented herein, Environmental and Geotechnical Specialists, Inc. requests the opportunity to review the data and make any modifications to the design recommendations which may be appropriate.

If you have any questions concerning the information contained in this Report, please do not hesitate to contact us at (850) 386-1253.

Very truly yours

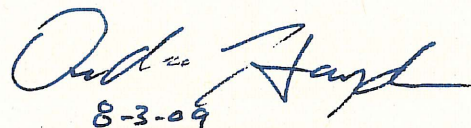
Environmental and Geotechnical Specialists, Inc.

Florida Certificate of Engineering Authorization Number 6222



8-3-09

Myron L. Hayden, Ph.D., P.E.
Senior Geotechnical Engineer
FL P.E. Number 34067



8-3-09

Audra Hayden, E.I.
Geotechnical Engineer I

TABLES

TABLE 1
BORING LOCATION DATA
MAST ARM FOUNDATION
BANNERMAN AND BULL HEADLEY ROAD
LEON COUNTY, FLORIDA

BORING NUMBER	DEPTH ¹ (FEET)	ELEVATION ² (FEET)	STATIONING	OFFSET (FEET)	DEPTH TO GROUNDWATER (FEET)
BBMA-1	32.0	217.5	97+56	35.9 RIGHT	> 32.0 FEET

NOTES: 1. DEPTH IS BELOW EXISTING GROUND SURFACE

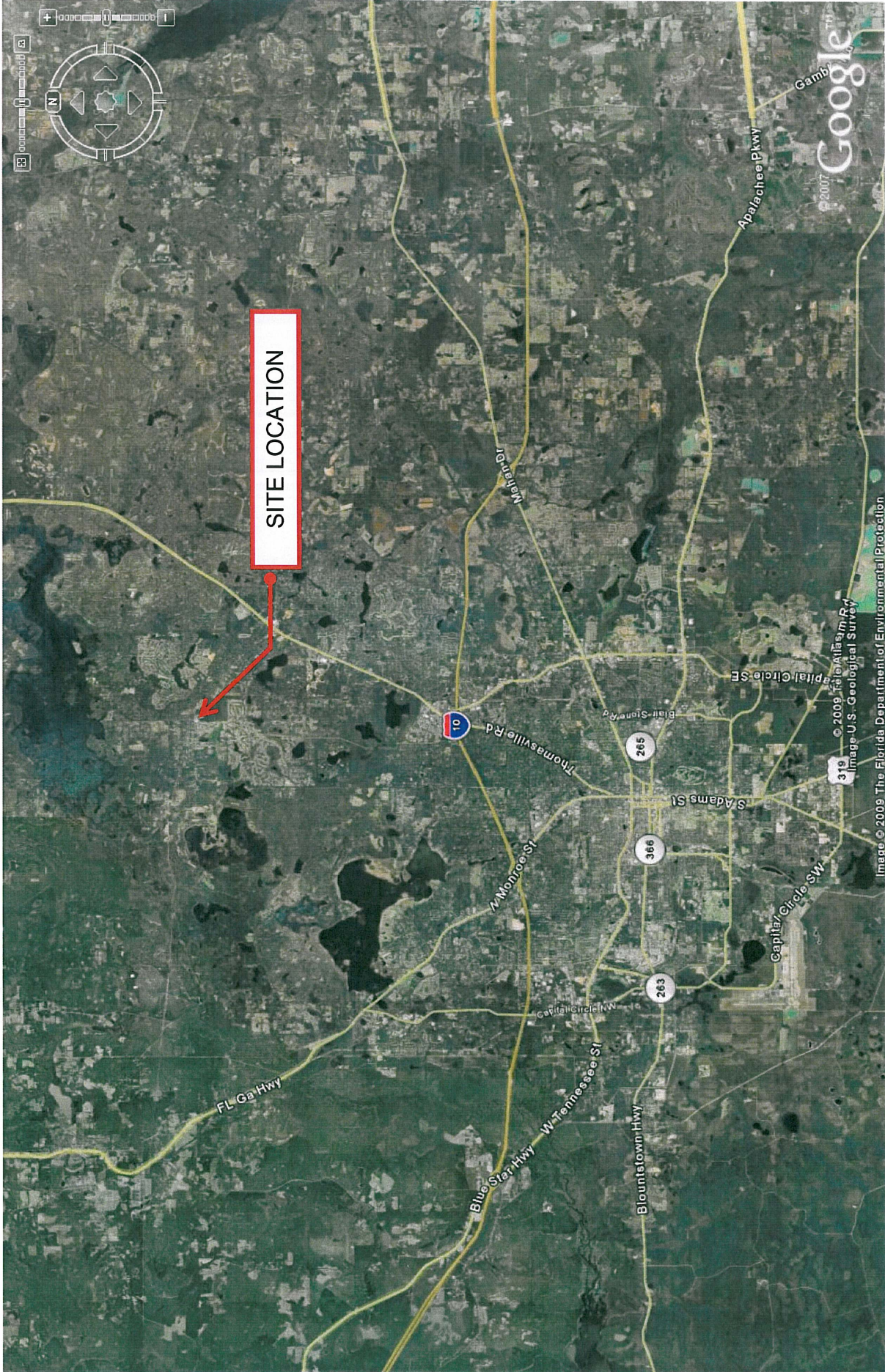
2. ELEVATION ESTIMATED FROM ELECTRONIC DRAWING PROVIDED BY PBS&J.

TABLE 2
GEOTECHNICAL DESIGN PARAMETERS
MAST ARM FOUNDATION
BANNERMAN AND BULL HEADLEY ROAD
LEON COUNTY, FLORIDA

INTERSECTION	DEPTH (FEET)	ELEVATION (FEET)	SPT 'N' VALUE	ANGLE OF INTERNAL FRICTION (DEGREES) (ϕ)	COHESION (LB/FT ²) (c)	ADHESION COEFFICIENT (α)	LATERAL SOIL MODULUS (KIP/FT ²) (k_h)	SHEAR MODULUS (KIP/FT ²) (G_s)	VERTICAL SHEAR STRESS (KIP/FT ²) (t_v)	EFFECTIVE SOIL UNIT WEIGHT (LB/FT ³) (γ)	ACTIVE EARTH PRESSURE COEFFICIENT (k_a)	POISSON'S RATIO (μ)	PASSIVE EARTH PRESSURE COEFFICIENT (k_p)	SOIL DESCRIPTION
BANNERMAN AT BULL HEADLEY ROAD	0.0 - 7.5	217.5 - 210.0	11	30	--	--	230	800	1.58	115	0.33	0.25	3.00	MEDIUM DENSE SILTY FINE SAND
	7.5 - 32.0	210.0 - 185.5	17	--	2,300	0.40	670	1,200	1.58	115	1.00	0.30	1.00	VERY STIFF HIGHLY PLASTIC CLAY

NOTE: GROUNDWATER WAS NOT ENCOUNTERED

FIGURES



TITLE: SITE LOCATION MAP
 BANNERMAN AND BULL HEADLEY ROAD
 MAST ARM FOUNDATION
 LEON COUNTY, FLORIDA

DATE: JULY 2009

FIGURE NO.: 1

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ENGINEER: M. HAYDEN, P.E.

CLIENT: PBS&J

PROJ. NO.: 22-31-09-01 **SCALE:**



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A. HAYDEN, E.I.

ENGINEER
M. HAYDEN, P.E.

CLIENT
PBS&J

PROJ. NO.: 22-31-09-01

CHECKED:
D. SHEPPARD, P.E.

SCALE:

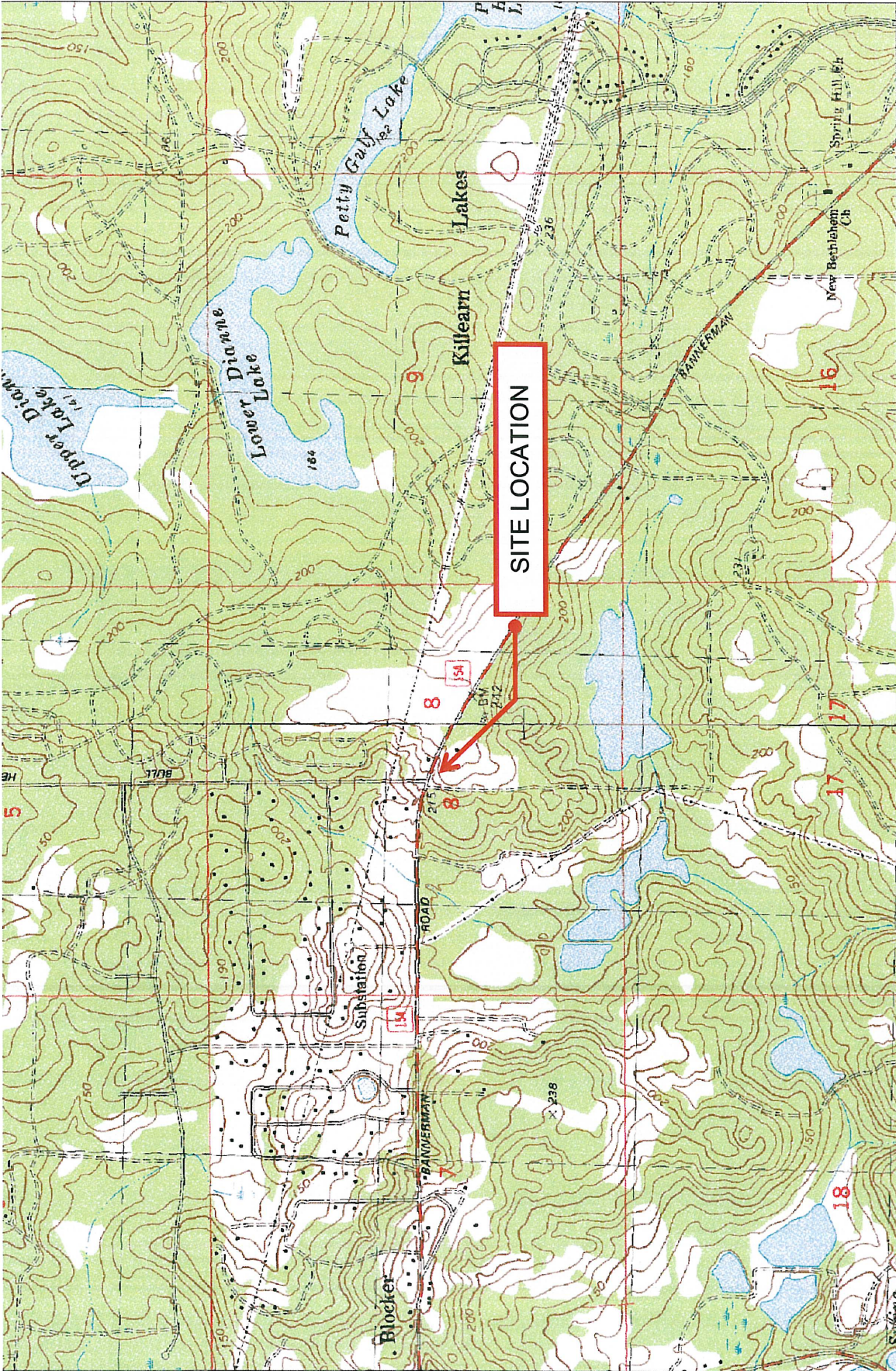
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TITLE: AERIAL PHOTOGRAPH OF BORING LOCATION
 BANNERMAN AND BULL HEADLEY ROAD
 MAST ARM FOUNDATION
 LEON COUNTY, FLORIDA

DATE: JULY 2009

FIGURE NO.: 2



TITLE: USGS TOPOGRAPHIC MAP
 BANNERMAN AND BULL HEADLEY ROAD
 MAST ARM FOUNDATION
 LEON COUNTY, FLORIDA

DATE: JULY 2009

FIGURE NO.: 3

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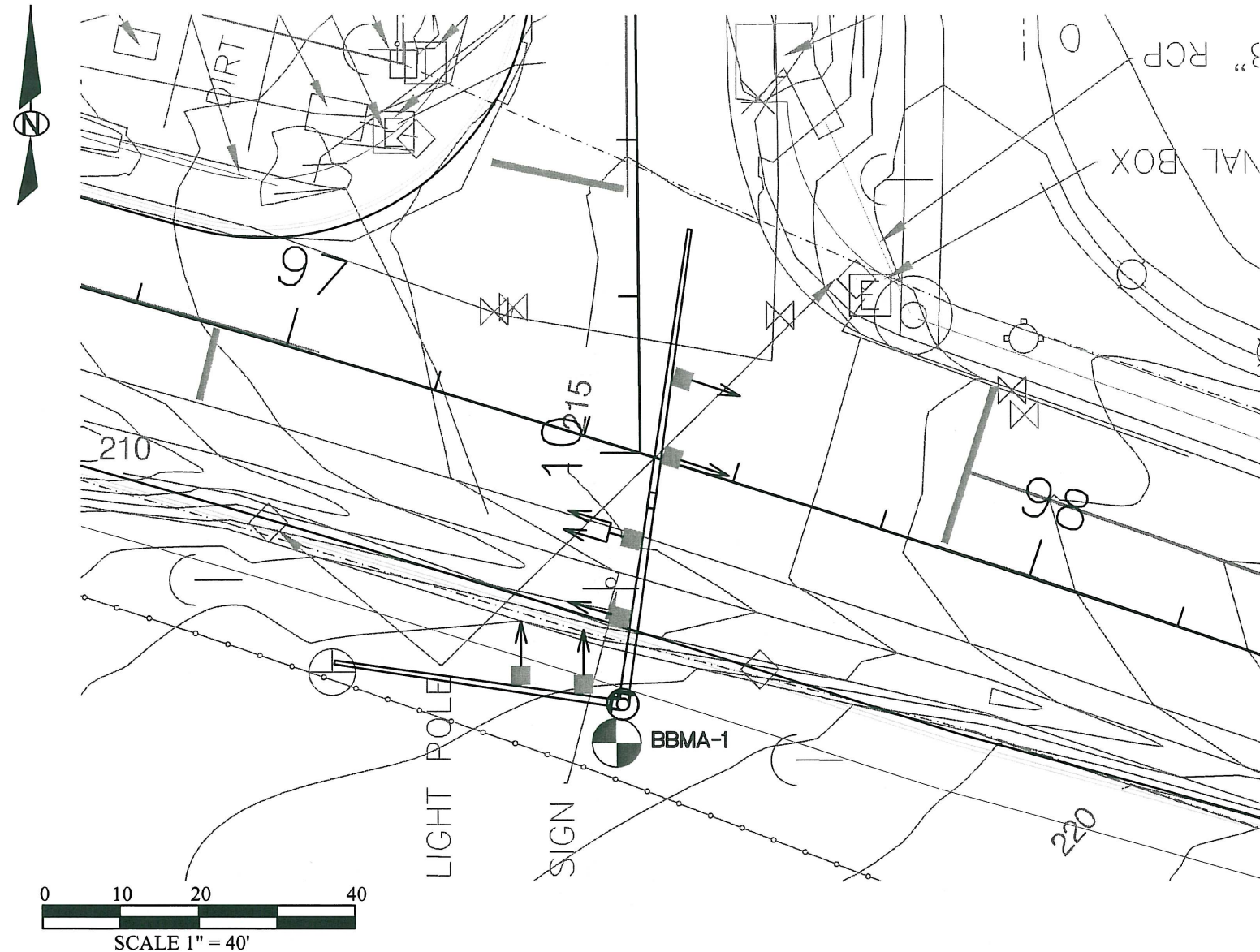
DRAWN: A. HAYDEN, E.I. **CHECKED:** D. SHEPPARD, P.E.

ENGINEER: M. HAYDEN, P.E.

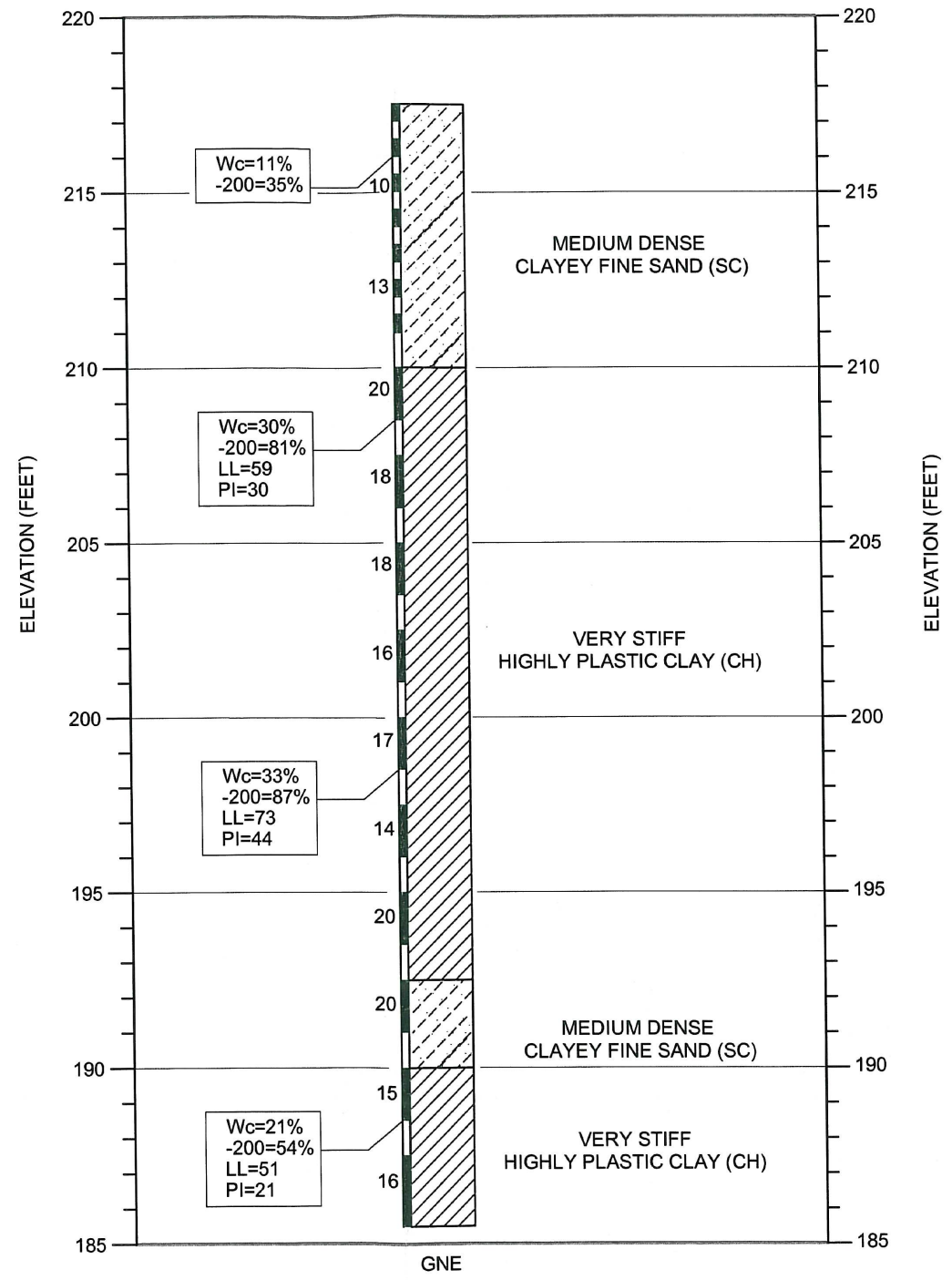
CLIENT: PBS&J

PROJ. NO.: 22-31-09-01 **SCALE:**

APPENDIX A
REPORT OF CORE BORING



BBMA-1
 DATE DRILLED: 7/29/2009
 ELEVATION: 217.5
 STATIONING: 97+56
 OFFSET: 35.9 FEET RIGHT



- Numbers left of borings indicate standard penetration test (SPT) N60-values for 12 in. penetration in accordance with ASTM Standard D 6066
- Water elevations shown represent the water elevations encountered, fluctuations in the elevations of the water should be expected.
- Soil descriptions, test data, and standard penetration values shown are for the soil boring only and may not apply to any other locations except at the location of the soil boring. Extrapolation of the soil boring data to other locations is the sole responsibility of the person performing the extrapolation.

LABORATORY RESULTS

WATER CONTENT Wc=
 -200 MESH -200=
 LIQUID LIMIT LL=
 PLASTICITY INDEX PI=
 GROUNDWATER NOT ENCOUNTERED GNE

Granular Materials Relative Density	SPT (blows/12 in.)	Silts and Clays Consistency	SPT (blows/12 in.)
Very Loose	Less than 3	Very Soft	Less than 1
Loose	3 - 7	Soft	1 - 3
Medium or Compact	7 - 21	Firm	3 - 6
Dense	21 - 35	Stiff	6 - 11
Very Dense	Greater than 35	Very Stiff	11 - 21
		Hard	Greater than 21

SC CLAYEY SAND

CH HIGHLY PLASTIC CLAY

REVISIONS

SEAL:
 MYRON L. HAYDEN, P.E.
 P.E. NO.: 34067

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PBS&J
 PROJECT TITLE
 INTERSECTION IMPROVEMENTS

REPORT OF CORE BORINGS

SHEET NO.
 A-1

APPENDIX B
SOIL BORING LOG



PROJECT: BANNERMAN AT BULL HEADLEY
 CLIENT: PBS&J
 PROJECT NO.: 22-31-09-01
 PROJECT LOCATION: TALLAHASSEE, FLORIDA ELEVATION (FEET): 217.5
 BORING NO.: BBMA-1 DATE: 7-29-2009
 DRILLER: R. ROGERS FLUID LOSS: NONE
 DEPTH TO - WATER> INITIAL: ∅ > 32.0' AFTER 24 HOURS: ∅ > 32.0' CAVING> C. NONE

This information pertains only to this boring and should not be interpreted as being indicative of the site.

DEPTH (METERS)	DEPTH (FEET)	SAMPLE	SYMBOL	DESCRIPTION	USCS/	TEST RESULTS	Wc (%)	Wc (%)		N*	N-Value*	
								10	20		10	20
	24			VERY STIFF ORANGE AND WHITE HIGHLY PLASTIC CLAY			31			20		
-7.5												
	27			MEDIUM DENSE BROWN AND ORANGE CLAYEY FINE SAND	SC		12			20		
	30			VERY STIFF BROWN AND ORANGE HIGHLY PLASTIC CLAY	CH	-200%=54 LL=51 PI=21	21			15		
-9												
							17			16		
	33											
-10.5												
	36											
	39											
-12												
	42											

NOTE: ELEVATIONS ESTIMATED FROM ELECTRONIC FILE PROVIDED BY PBS&J, INC.

APPENDIX C
SOIL CLASSIFICATION DATA

SOIL CLASSIFICATION DATA

Project: BANNERMAN AT BULL HEADLEY

Project No.: 22-31-09-01

Client: PBS&J

Location: TALLAHASSEE, FLORIDA

Boring	DEPTH (FEET)	Wc (%)	-4 (%)	-10 (%)	-20 (%)	-40 (%)	-100 (%)	-200 (%)	LL	PI	Org. (%)	N Value	USCS	AASHTO	Description
BBMA-1	0.0-0.5	14											SC	A-2-6	MEDIUM DENSE GRAY CLAYEY FINE SAND
	1.0-1.5	11	100	100	100	98	73	35					SC	A-2-6	MEDIUM DENSE GRAY CLAYEY FINE SAND
	2.0-2.5	13										10	SC	A-2-6	MEDIUM DENSE ORANGE CLAYEY FINE SAND
	3.0-3.5	14											SC	A-2-6	MEDIUM DENSE ORANGE CLAYEY FINE SAND
	4.0-4.5	17											SC	A-2-6	MEDIUM DENSE ORANGE CLAYEY FINE SAND
	5.0-5.5	16										13	SC	A-2-6	MEDIUM DENSE ORANGE CLAYEY FINE SAND
	6.0-6.5	15											SC	A-2-6	MEDIUM DENSE ORANGE CLAYEY FINE SAND
	7.5-9.0	30	100	100	100	100	94	81	59	30		20	CH	A-7-6	VERY STIFF ORANGE AND WHITE HIGHLY PLASTIC CLAY
	10.0-11.5	30										18	CH	A-7-6	VERY STIFF ORANGE AND WHITE HIGHLY PLASTIC CLAY
	12.5-14.0	28										18	CH	A-7-6	VERY STIFF ORANGE AND WHITE HIGHLY PLASTIC CLAY
	15.0-16.5	32										16	CH	A-7-6	VERY STIFF ORANGE AND WHITE

SOIL CLASSIFICATION DATA

Project: BANNERMAN AT BULL HEADLEY

Project No.: 22-31-09-01

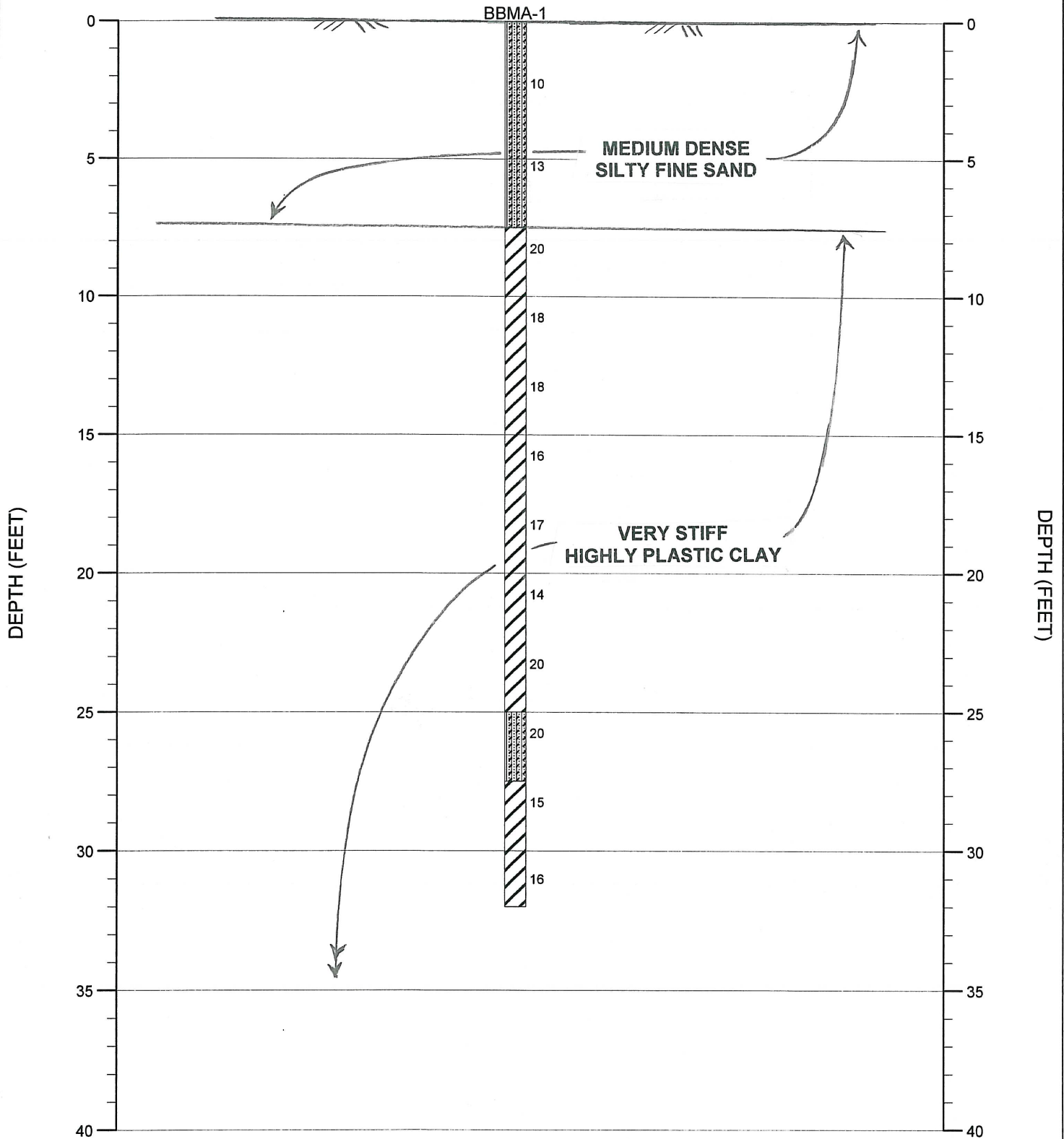
Client: PBS&J

Location: TALLAHASSEE, FLORIDA

Boring	DEPTH (FEET)	Wc (%)	-4 (%)	-10 (%)	-20 (%)	-40 (%)	-100 (%)	-200 (%)	LL	PI	Org. (%)	N Value	USCS	AASHTO	Description
BBMA-1	17.5-19.0	33	100	100	100	97	93	87	73	44		17	CH	A-7-6	HIGHLY PLASTIC CLAY VERY STIFF ORANGE AND WHITE HIGHLY PLASTIC CLAY
	20.0-21.5	39										14	CH	A-7-6	VERY STIFF ORANGE AND WHITE HIGHLY PLASTIC CLAY
	22.5-24.0	31										20	CH	A-7-6	VERY STIFF ORANGE AND WHITE HIGHLY PLASTIC CLAY
	25.0-26.5	12										20	SC	A-2-6	MEDIUM DENSE BROWN AND ORANGE CLAYEY FINE SAND
	27.5-29.0	21	100	100	100	97	68	54	51	21		15	CH	A-7-6	VERY STIFF BROWN AND ORANGE HIGHLY PLASTIC CLAY
	30.0-32.0	17										16	CH	A-7-6	VERY STIFF BROWN AND ORANGE HIGHLY PLASTIC CLAY

APPENDIX D
SAMPLE CALCULATIONS

"GENERALIZED" SOIL PROFILE



NOTES:

1. NUMBERS RIGHT OF BORING INDICATE STANDARD PENETRATION (SPT) 'N' VALUES
2. GROUNDWATER WAS NOT ENCOUNTERED

DRAWN BY:	A. HAYDEN
REVISED:	A. HAYDEN
CHECKED:	M. HAYDEN, P.E.
ENGINEER:	M. HAYDEN, P.E.
SR. ENGINEER:	M. HAYDEN, P.E.
PROJ. NO.:	22-31-09-01

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 TALLAHASSEE, FLORIDA

"GENERALIZED" SOIL PROFILE
 BANNERMAN AT BULL HEADLEY
 TALLAHASSEE, FLORIDA

SCALE:	DATE:	2009
PROJ. NO.:	22-31-09-01	FIGURE NO.:

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f = COEFFICIENT OF VARIATION OF LATERAL
SUBGRADE REACTION WITH DEPTH

B = BASE WIDTH

z = DEPTH

E_s = MODULUS OF ELASTICITY

μ = POISSON'S RATIO

GROUNDWATER WAS NOT ENCOUNTERED

MAST ARM FOUNDATIONS

MEDIUM DENSE SILTY FINE SAND

LAYER 1

APPROX. DEPTH 0.0 to 7.5 FEET
ELEVATION DEPTH 217.5 TO 210.0

$$N := 11 \quad \phi := 30\text{-deg} \quad \gamma_1 := 115 \cdot \frac{\text{lb}}{\text{ft}^3} \quad K_a := \frac{1 - \sin(\phi)}{1 + \sin(\phi)} \quad K_a = 0.33 \quad K_p := \frac{1 + \sin(\phi)}{1 - \sin(\phi)} \quad K_p = 3.00$$

$$B := 4\text{-ft} \quad f_1 := 11\text{-pcf} \quad y_1 := 7.5\text{-ft} \quad z_1 := 3.75\text{-ft} \quad E_s := 20(N)\text{-ksf} \quad \mu_1 := 0.25$$

$$k_{s_bowles} := \frac{3 \cdot (E_s)}{B} \quad k_{s_bowles} = 95 \frac{\text{lb}}{\text{in}^3} \quad \leftarrow \text{BOWLES}$$

$$k_{s_navfac} := \frac{f_1 \cdot z_1}{B} \quad k_{s_navfac} = 12 \frac{\text{lb}}{\text{in}^3} \quad \leftarrow \text{NAVFAC}$$

OVERBURDEN PRESSURE: $\sigma := \gamma_1 \cdot z_1$ $\sigma = 2.99 \frac{\text{lb}}{\text{in}^2}$

$$k_{s_fpier} := 220 \cdot \frac{\text{lb}}{\text{in}^3} \quad \leftarrow \text{FL PIER}$$

$$k_{s_design} := \frac{k_{s_bowles} + k_{s_navfac} + 2 \cdot k_{s_fpier}}{4} \quad k_{s_design} = 236 \frac{\text{kip}}{\text{ft}^3}$$

SHEAR MODULUS

$$G_s := 0.5 \cdot N \cdot \frac{\text{kip}}{\text{in}^2} \quad G_s = 792 \frac{\text{kip}}{\text{ft}^2}$$

VERTICAL SHEAR STRENGTH

$$\tau_s := \frac{N \cdot (110 - N)}{164999} \cdot \frac{\text{kip}}{\text{in}^2} \quad \tau_s = 950.41 \frac{\text{lb}}{\text{ft}^2}$$

RECOMMENDED FBPIER SOIL TYPE

REECE COX KOOP - SAND

f = COEFFICIENT OF VARIATION OF LATERAL
SUBGRADE REACTION WITH DEPTH

B = BASE WIDTH

z = DEPTH

E_s = MODULUS OF ELASTICITY

μ = POISSON'S RATIO

VERY STIFF HIGHLY PLASTIC CLAY

LAYER 2

APPROX. DEPTH 7.5 to 32.0 FEET
ELEVATION DEPTH 210.0 TO 185.5

$$N := 17 \quad \gamma_2 := 115 \cdot \frac{\text{lb}}{\text{ft}^3} \quad C := 29 \cdot (N^{.72}) \cdot 20.885 \cdot \frac{\text{lb}}{\text{ft}^2} \quad C = 4658 \frac{\text{lb}}{\text{ft}^2} \quad c := \frac{C}{2} \quad c = 2329 \frac{\text{lb}}{\text{ft}^2}$$

$$B := 4 \cdot \text{ft} \quad f_2 := 40.0 \cdot \text{pcf} \quad y_2 := 24.5 \cdot \text{ft} \quad z_2 := 12.25 \cdot \text{ft} \quad E_s := 20(N) \cdot \text{ksf} \quad \mu_2 := 0.30 \quad \alpha := 0.40$$

$$k_{s_bowles} := \frac{1.6 \cdot (E_s)}{B} \quad k_{s_bowles} = 79 \frac{\text{lb}}{\text{in}^3} \quad \leftarrow \text{BOWLES}$$

$$k_{s_navfac} := \frac{f_1 \cdot y_1}{B} + \frac{f_2 \cdot z_2}{B} \quad k_{s_navfac} = 166 \frac{\text{lb}}{\text{in}^3} \quad \leftarrow \text{NAVFAC}$$

OVERBURDEN PRESSURE: $\sigma := \gamma_1 \cdot y_1 + \gamma_2 \cdot z_2$

$$\sigma = 15.77 \frac{\text{lb}}{\text{in}^2}$$

$$k_{s_fhwa} := 655 \cdot \frac{\text{lb}}{\text{in}^3} \quad \leftarrow \text{FHWA}$$

$$k_{s_design} := \frac{k_{s_bowles} + k_{s_navfac} + 2 \cdot k_{s_fhwa}}{4}$$

$$k_{s_design} = 389 \frac{\text{lb}}{\text{in}^3} \quad \text{or} \quad k_{s_design} = 671 \frac{\text{kip}}{\text{ft}^3}$$

SHEAR MODULUS

$$G_s := 0.5 \cdot N \cdot \frac{\text{kip}}{\text{in}^2}$$

$$G_s = 1224 \frac{\text{kip}}{\text{ft}^2}$$

VERTICAL SHEAR STRESS

$$\tau_s := \frac{N \cdot (110 - N)}{144238} \cdot \frac{\text{kip}}{\text{in}^2}$$

$$\tau_s = 1.58 \frac{\text{kip}}{\text{ft}^2}$$

RECOMMENDED FBPIER SOIL TYPE

STIFF - CLAY