I-75 (SR 93) at NW 49th Street PD&E Study

Final

Geotechnical Data Report for Bridge Structures

FDOT Office
District Five

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The environmental review, consultation, and other actions required by applicable federal environmental laws for this project are being, or have been, carried out by the Florida Department of Transportation (FDOT) pursuant to 23 U.S.C. §327 and a Memorandum of Understanding dated December 14, 2016 and executed by the Federal Highway Administration and FDOT.

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1.0 Project Description

The project entails the investigation of the provision of a new I-75 interchange to be located between the existing I-75/US 27 interchange to the south (2.24 miles) and the existing I-75/SR 326 interchange to the north (2.04 miles) just northwest of Ocala in Marion County, Florida. A recently completed Interchange Justification Report (IJR) concluded that the existing I-75 interchange ramp movements and intersections at US 27 and at SR 326 will operate at failing levels of service. A new I-75 interchange at NW 49th Street (approximately midway between the two existing interchanges) is thus vital to avoid complete gridlock, "traffic stress" and undesirable safety conditions along the local street network. The western limit of this project is NW 44th Avenue (west of I-75) and the eastern limit is the NW 35th Street connection to NW 49th Street just east of the new proposed interchange site. It should be noted that this proposed NW 35th Street/NW 49th Street connection will be constructed by the county and is anticipated to be completed prior to the interchange being constructed.

Figure 1-1 | Project Location Map

2.0 Purpose and Scope of Services

The purpose of this study is to provide factual geotechnical data (i.e. subsurface soil conditions and related engineering properties) for the proposed NW 49th/35th Street Bridge over the I-75 (SR 93). The following services were provided in order to achieve the preceding objective:

1. Reviewed published soil information from the "Soil Survey of Marion County, Florida" published by the United States Department of Agriculture (USDA) and Natural Resources Conservation Service (NRCS). Reviewed topographic and potentiometric information obtained from "Ocala West, Florida" USGS Quadrangle map and the "Potentiometric Surface of the Upper Floridan Aquifer in the St. Johns River Water Management District and Vicinity, Florida" maps published by the United States Geological Survey (USGS).

2. Executed a program of subsurface exploration consisting of two (2) test borings and subsurface sampling. Tierra has performed two (2) Standard Penetration Test (SPT) borings advanced to depth of approximately 100 to 115 feet below the existing grade.

3. Visually classified and stratified the samples in the laboratory using the Unified Soil Classification System (USCS) in general accordance with the American Society of Testing and Materials (ASTM) test designation D-2487 and D-2488. Conducted laboratory testing on selected soil samples to confirm the visual classification.

4. Conducted environmental corrosion tests on recovered soil samples obtained from the bridge site to provide a basis for environmental classification.

5. Prepared this geotechnical data report, which summarizes the course of study pursued, the field and laboratory data generated, and the subsurface conditions encountered within the area of the proposed bridge structure.

3.0 Review of Published Data

3.1 Regional Geology

Marion County Geology was paraphrased from the Florida Geological Survey, Open-File Report 80, 2001 and other geologic references.

The near surface geologic deposits and formations from youngest to oldest in Marion County include: Undifferentiated sediments (Qu, TQu), Beach ridge and dune sediments (Qbd), the Cypresshead Formation (Tc), the Hawthorn Group Coosawhatchie Formation (Thc), the Undifferentiated Hawthorn Group (Th), and the Ocala Limestone (To).

The Undifferentiated sediments and Beach ridge and dunes are siliciclastics that are light gray, tan, brown to black, unconsolidated to poorly consolidated, clean to clayey silty, unfossiliferous, variably organic-bearing sands to blue green to olive green, poorly to moderately consolidated, sandy, silty clays.

The Cypresshead Formation occurs above 100 feet msl and consists of reddish brown to reddish orange, unconsolidated to poorly consolidated, fine to very coarse grained, clean to clayey sands. The Cypresshead Formation is found only in eastern Marion County.

The Hawthorn Group Coosawhatchie Formation varies from a light gray to olive gray, poorly consolidate, variably clayey and phosphatic sand with few fossils, to an olive gray, poorly to moderately consolidated, slightly sandy, silty clay with few to no fossils. Silicified nodules and phosphate may be present.

The undifferentiated Hawthorn Group sediments are light olive gray to blue gray, to reddish brown, poorly to moderately consolidated, clayey, sands to silty clays and relatively pure clays. The Hawthorn Group sediments are highly variable and occur sporadically at the surface throughout the most of the county.

The Ocala Limestone is generally a white to poorly to well indurated, poorly sorted, very fossiliferous limestone (grainstone, packstone and wackestone). Chert is common in the upper facies. The permeable and highly transmissive carbonates of the Ocala Limestone form the upper part of the Floridan Aquifer System. The Ocala Limestone outcrops near the surface throughout most of the central and southwest portions of the County.

3.2 USDA Soil Survey

Based on review of the published information, it appears that there are two (2) primary soil-mapping unit noted within the vicinity of the bridge. A reproduction of the **USDA Vicinity Map** is included in the **Appendix** and the soil mapping units are summarized in the summary table below.

Table 3-1 | Marion County USDA NRCS Soil Survey Information

SUMMARY OF USDA SOIL SURVEY MARION COUNTY, FLORIDA							
USDA Map Unit and Soil Name	**Depth (in)**	**Soil Classification**		**Permeability (in/hr)**	**pH**	**Seasonal High Water Table**	
		USCS	**AASHTO**			**Depth (feet)**	**Months**
(9) Arredondo sand, 0 to 5 percent slopes	0-65	SP-SM, SM	A-3, A-2-4	6.0 – 20.0	4.5-6.0	> 6.0	Jan-Dec
	65-70	SM, SM-SC	A-2-4	2.0 – 6.0	4.5-6.0		
	70-80	SM-SC, SC	A-2-4, A-2-6, A-4, A-6	2.0 – 6.0	4.5-6.0		
(37) Hague sand, 2 to 5 percent slopes	0-24	SP-SM, SM	A-3, A-2-4	6.0 – 20.0	4.5-6.0	> 6.0	Jan-Dec
	24-49	SM, SM-SC, SC	A-2, A-4, A-6	0.6 – 6.0	4.5-6.5		
	49-74	SM, SM-SC, SC	A-2, A-4, A-6	0.6 – 2.0	4.5-6.0		
	74-80	SM	A-2-4	2.0 – 6.0	5.1-6.5		

3.3 USGS Quadrangle Map

A review of the "Ocala West, Florida" Quadrangle Map indicates that the natural ground surface elevations within the vicinity of the bridge ranges from +75 to +85 feet National Geodetic Vertical Datum of 1929 (NGVD). A reproduction of the **USGS Vicinity Map** is illustrated in the **Appendix**.

3.4 Review of Potentiometric Surface Information

Based on a review of the "Potentiometric Surface of the Upper Floridan Aquifer in the St. Johns River Management District and Vicinity, Florida" maps published by the USGS, the potentiometric surface elevation of the Upper Floridan Aquifer at the bridge location appears to range from approximately elevation +40 to +50 feet, NGVD29. Artesian flow conditions were not encountered during the field exploration.

4.0 Subsurface Exploration

4.1 Boring Location Plan and Utility Clearance

Prior to commencing our subsurface explorations, a boring location plan for the proposed bridge structure was produced. This boring location plan was generated based on a review of the design information supplied by Metric Engineering, Inc. and general guidance provided in the FDOT "Soils and Foundations Handbook" along with our engineering judgment.

Utility clearances were coordinated by Tierra and updated as required prior to performing the soil borings in order to reduce the potential for damage to any underground utilities during the drilling process.

4.2 Soil Borings

Subsurface conditions were explored at the bridge site with two (2) SPT borings to depths of approximately 100 to 115 feet below the existing grade. The results and location of the SPT borings are presented on the **Report of Core Borings** sheets in the **Appendix**.

The SPT borings were performed with the use of a track-mounted drill rig using Bentonite Mud drilling procedures. The soil sampling was performed in general accordance with the ASTM test designation D-1586. The initial 4 feet of boring BB-132R was manually augered to verify utility clearance. SPT resistance N-values were taken on intervals of 2 feet thereafter to a depth of 16 feet. Then, SPT resistance N-values were taken on intervals of 2.5 feet thereafter to the boring termination depth. Representative portions of these soil samples were sealed in glass jars, labeled and transferred to our Winter Garden laboratory for classification and analyses.

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

5.0 Laboratory Testing

5.1 General

Representative soil samples collected from the SPT borings were classified and stratified in general accordance with the USCS. Our classification was based on visual observations, using the results from the laboratory testing as confirmation. Laboratory testing consisting of fines content (percentage passing the No. 200 sieve), Atterberg limits, and natural moisture content determination were performed on representative materials encountered. In addition, Environmental Corrosion tests were performed to evaluate the corrosive nature of the soil encountered at the bridge site. The results of the laboratory tests are presented on the **Report of Core Borings** sheets in the **Appendix**.

5.2 Test Designation

The following list summarizes the laboratory tests performed and respective test methods.

- Fines Content – The fines content tests and full grain size tests were conducted in general accordance with the AASHTO test designation T-088 (ASTM test designation D-422).

- Atterberg Limits – The liquid limit and the plastic limit tests (“Atterberg Limits”) were conducted in general accordance with the AASHTO test designations T-089 and T-090, respectively (ASTM test designation D-4318).

- Natural Moisture Content – The moisture content tests were conducted in general accordance with the AASHTO test designation T-265 (ASTM test designation D-2216).

- Environmental Corrosion – The Environmental corrosion tests were conducted in general accordance with the FDOT test designations FM 5-550, FM 5-551, FM 5-552, and FM 5-553.

6.0 Results of Subsurface Exploration

6.1 General Subsurface Conditions

The subsurface conditions encountered are shown on the **Report of Core Boring** sheet in the **Appendix**. The soil descriptions and classifications associated with this project are listed below.

Table 6-1 | Soil Descriptions and Classifications

Soil Description	Unified Soil Classification System Symbol
Gray to Gray-Brown SAND to SAND with Silt	SP/SP-SM
Brown Silty SAND to Slightly Clayey SAND with Limestone Fragments	SM/SM-SC
Gray Clayey SILT with Limestone Fragments	MH
Gray Sandy CLAY to CLAY with Limestone Fragments	CH
Limestone	---*

* USCS nomenclature does not have a classification for limestone

6.2 Groundwater

The groundwater table was not apparent within the bridge borings prior to the commencement of mud-rotary drilling. Groundwater Not Apparent (GNA) is indicated on the boring profiles presented in the Report of Core Borings sheets in the Appendix.

7.0 Evaluations of Bridge Foundation Alternatives

Evaluations of foundation alternatives for the proposed bridge were based on the results of our field study at the location of the proposed bridge structure. The following foundation alternatives were considered.

- Shallow Foundations
- Geosynthetic Reinforced Soil Integrated Bridge System (GRS-IBS)
- 20-inch Diameter Steel Pipe Pile and 14x89 Steel H-Pile
- 18 and 24-inch Pre-Cast Pre-Stressed Square Concrete (PPSC) Piles
- Drilled Shafts

The following paragraphs discuss each of these alternatives briefly:

7.1 Shallow Foundations

With shallow foundation systems, the structure loads are supported by the bearing capacity of the foundation soils. The design of shallow foundations is typically governed by the soil bearing capacity and the total and differential settlement criteria. Based on the results of the borings, loose soil zones were encountered at relatively shallow depths in the borings. Therefore, the surficial soils at the bridge site will require soil improvement to achieve an adequate bearing resistance and minimize the potential for differential settlements. The soil improvement will require excavation with densification techniques that will significantly increase construction costs. In addition, maintenance of traffic impacts, prolonged construction timing and staging requirements for construction adjacent to existing traffic usually interfere with the efficiencies of soil improvement operations. Therefore, considering impacts of the soil improvement operations and associated high costs, shallow foundations were not considered further for this Geotechnical Data Report for Bridge Structures.

7.2 Geosynthetic Reinforced Soil Integrated Bridge System (GRS-IBS)

GRS-IBS consists of a shallow foundation combined with a retaining wall system to provide support for single span bridges which are not at risk of movement due to transverse loading, uplift, etc., or multi-span bridges with simply supported end spans. The use of GRS-IBS abutments on an Interstate or Major Multi-Lane Highway would require the approval of the State Structures Design Engineer. Additionally, the reasons discussed in Section 7.1 that preclude the use of shallow foundations also apply to the use of GRS-IBS. For the reasons discussed herein, it is recommended that a GRS-IBS be precluded as a foundation alternative for support of the proposed bridge. Therefore, a GRS-IBS was not analyzed for this Geotechnical Data Report for Bridge Structures.

7.3 Steel Piles

Steel pile types include pipe piles and H-sections. Steel Pipe Piles and H-Piles are feasible foundation alternatives for support of the proposed bridge structure; however, steel piles are generally more expensive per lineal foot than PPSC piles and do not develop as much capacity for similar penetration depths as PPSC piles. Steel piles are well suited to soil conditions with high variability and where frequent pile splicing is expected. Steel piles may more easily penetrate dense layers if necessary to achieve a desired penetration depth. Steel H-Piles are low displacement piles, and therefore vibrations associated with installations are minimized due to the low-displacement nature of the piles. Pile capacity analyses for steel Pipe Piles and H-Piles were performed for this Geotechnical Data Report for Bridge Structures and are presented on the **Driven Pile Axial Capacity Curves** in the **Appendix**.

7.4 Pre-Cast Pre-Stressed Square Concrete (PPSC) Piles

PPSC pile foundations are a feasible foundation alternative. They are a widely used and proven foundation system in central Florida. PPSC pile foundations are readily available and generally have a lower cost per ton of capacity than other pile types. It should be noted that concrete piles are not as easily spliced as steel piles. The minimum size for PPSC pile foundations for this type of bridge application should be 18 inches as referenced in the Structures Design Guidelines (SDG). Analyses were performed for 18 and 24-inch wide PPSC piles for this

Geotechnical Data Report for Bridge Structures and are presented on the **Driven Pile Axial Capacity Curves** in the **Appendix**.

7.5 Drilled Shafts

Drilled, cast-in-place, straight-sided, concrete shafts have the ability to develop high axial and lateral capacities. One drilled shaft could potentially take the place of several driven piles. However, the quality control of drilled shaft installation requires more engineering judgment and precaution compared with driven piles to ensure that the construction is in accordance with the FDOT Specifications. This type of foundation system is often the chosen alternative for sites where competent limestone or very dense bearing strata are present at a relatively shallow depth with a sufficient thickness. Drilled shafts are a feasible foundation alternative depending on final design loading.

8.0 Report Limitations

Our services have been performed and our findings obtained, in accordance with generally accepted geotechnical engineering principles and practices at the time of this report. This company is not responsible for the conclusions, opinions or recommendations made by others based on these data.

The scope of the exploration was intended to evaluate soil conditions within the influence of the proposed bridge structure for foundation design by others. This report presents the geotechnical conditions based on the data obtained from the soil borings performed at the locations indicated in this report and does not reflect any variations which may occur between these borings. If any variations become evident during the course of design and/or construction, a re-evaluation of the conditions contained in this report is recommended.

The scope of services, included herein, did not include any environmental assessment for the presence or absence of hazardous or toxic materials in the soil, surface water, groundwater, air, on the site, below, and around the site. Any statements in this report or on the boring logs regarding odors, colors, unusual or suspicious items and conditions are strictly for the information of Metric Engineering, Inc. and FDOT.

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

Respectfully Submitted,

TIERRA, INC.

Luis A. Almodovar, E.I.
Geotechnical Engineer Intern

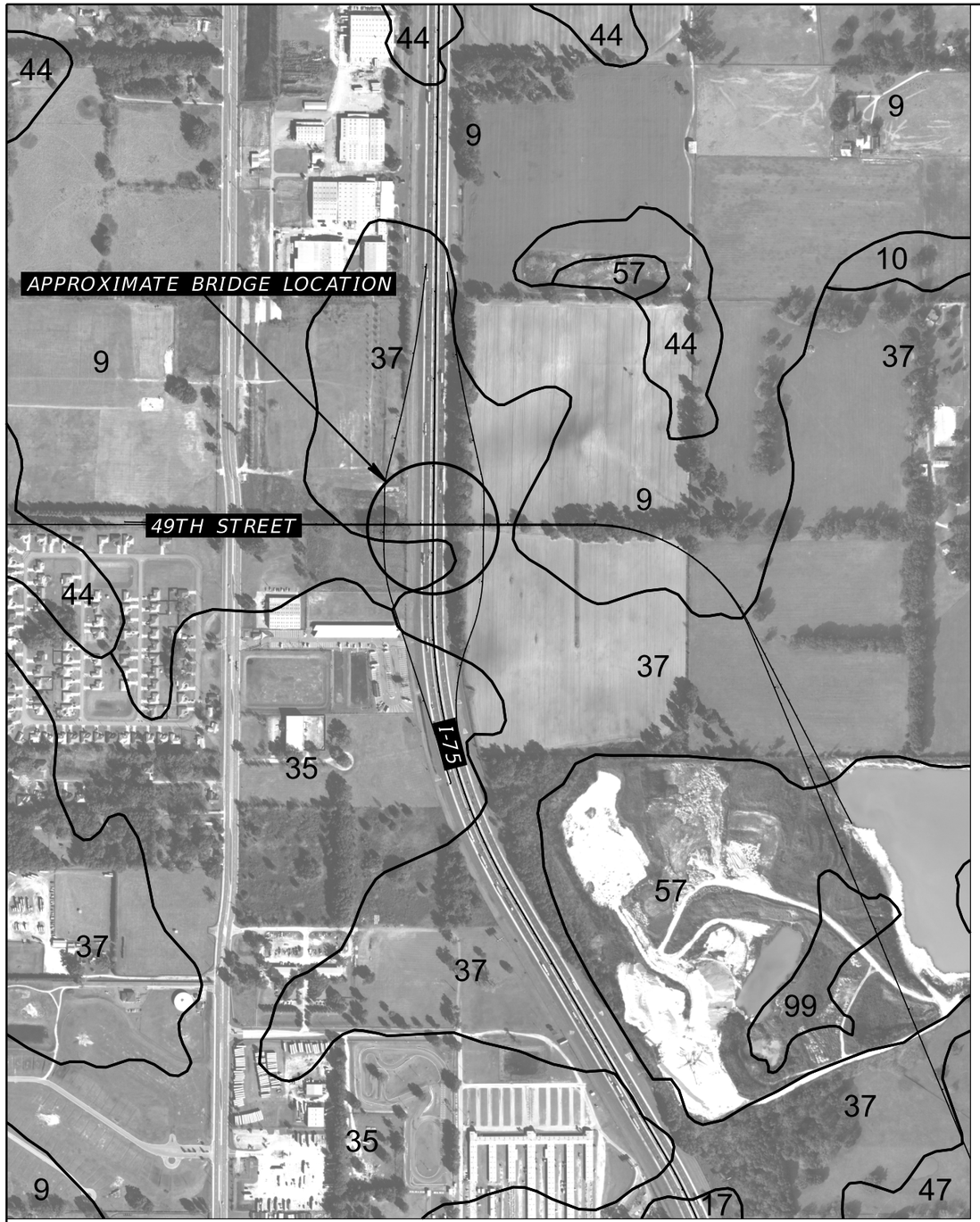
Jeremy A. Sewell, P.E.
Senior Geotechnical Engineer
Florida License No. 62951

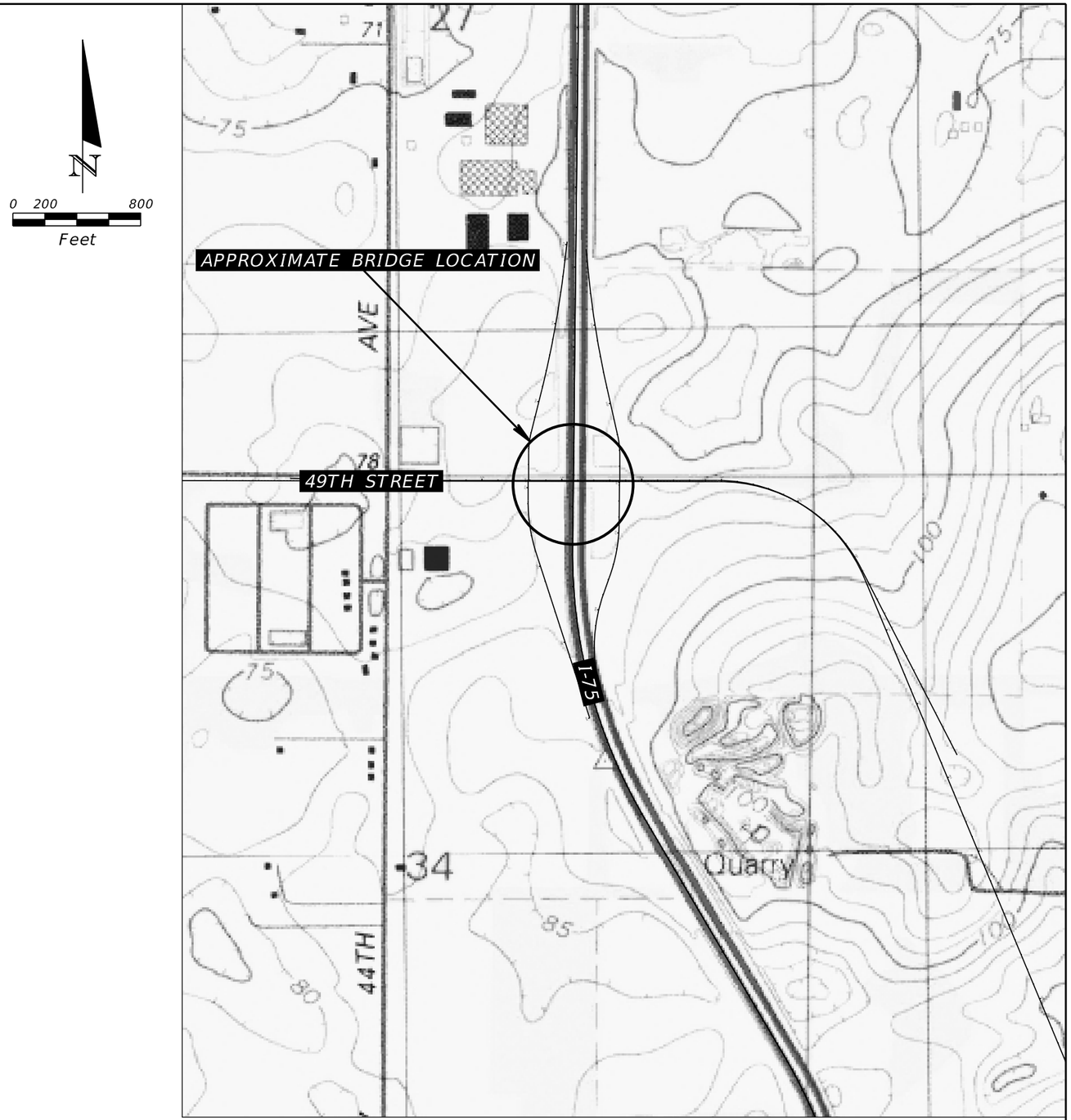
Appendix

Figure 2 | USDA Soil Survey & USGS Quadrangle Maps

Figures 3 - 4 | Report of Core Borings Sheets

Figures 5 - 8 | Driven Pile Axial Capacity Curves





0 200 800
Feet

REFERENCE: USDA SOIL SURVEY OF MARION COUNTY, FLORIDA

REFERENCE: USGS QUADRANGLE MAP OF "OCALA WEST, FLORIDA"

TOWNSHIP: 14S
RANGE: 21E
SECTIONS: 27 & 34

FIGURE 2

REVISIONS			
DATE	DESCRIPTION	DATE	DESCRIPTION

JEREMY A. SEWELL, P.E.
P.E. LICENSE NUMBER 62951
TIERRA, INC.
591 SUSAN B. BRITT COURT
WINTER GARDEN, FLORIDA 34787
CERTIFICATE OF AUTHORIZATION NO. 6486

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
SR 93	MARION	435209-1-22-01

USDA SOIL SURVEY & USGS QUADRANGLE MAPS

SHEET NO.

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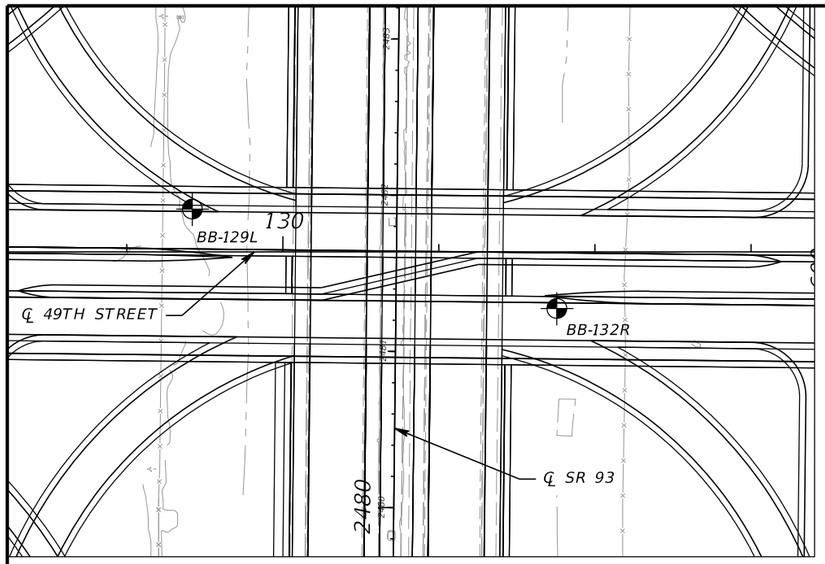


BORING LOCATION PLAN

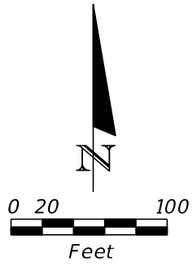
TOWNSHIP:	14 S
RANGE:	21 E
SECTION:	27 & 34

ENVIRONMENTAL CLASSIFICATION:

SUBSTRUCTURE	CONCRETE: MODERATELY AGGRESSIVE (pH = 6.0)
SUBSTRUCTURE	STEEL: MODERATELY AGGRESSIVE (pH = 6.0)
SUPERSTRUCTURE	SLIGHTLY AGGRESSIVE

SOIL TEST RESULTS:

RESISTIVITY	28,000 TO 29,000 OHM-CM
CHLORIDES	30 TO 45 PPM
SULFATES	<5 TO 30 PPM
pH	6.0 TO 6.9



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DATE 4/26/2018
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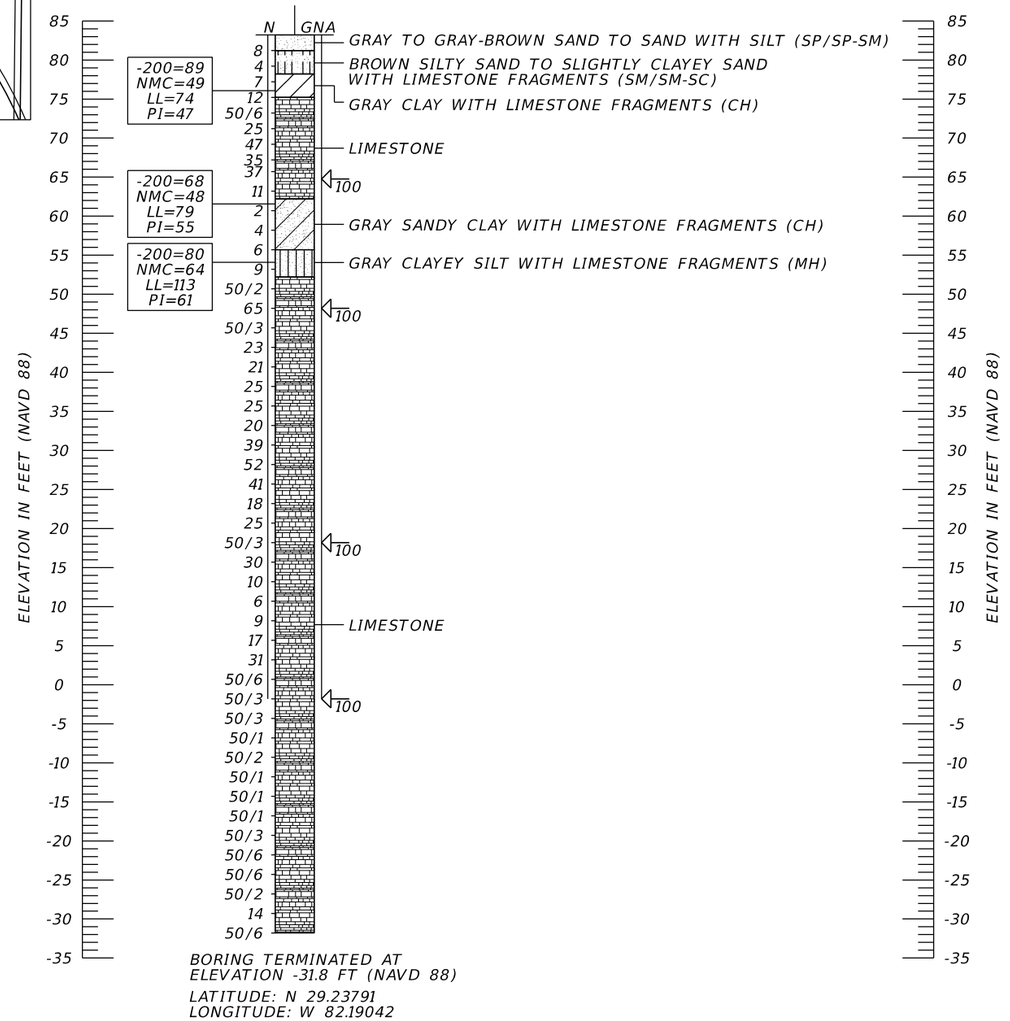
HAMMER AUTOMATIC
RIG D-25



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LONGITUDE: W 82.19042

LEGEND

SAND
SILTY SAND
SANDY SILT
SANDY CLAY
CLAY
LIMESTONE

SP	UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2487) GROUP SYMBOL AS DETERMINED BY VISUAL REVIEW AND LABORATORY TESTING ON SELECTED SAMPLES FOR CONFIRMATION OF VISUAL REVIEW.
N	NUMBERS TO THE LEFT OF BORINGS INDICATE SPT VALUE FOR 12 INCHES OF PENETRATION (UNLESS OTHERWISE NOTED).
50/4	NUMBER OF BLOWS FOR 4 INCHES OF PENETRATION
HA	HAND AUGERED TO VERIFY UTILITY CLEARANCE
-200	PERCENT PASSING #200 SIEVE
NMC	NATURAL MOISTURE CONTENT (%)
LL	LIQUID LIMIT
PI	PLASTICITY INDEX
NAVD 88	NORTH AMERICAN VERTICAL DATUM OF 1988
	APPROXIMATE SPT BORING LOCATION
	CASING
100	LOSS OF CIRCULATION OF DRILLING FLUID (%)
GNA	GROUNDWATER NOT APPARENT DUE TO THE INTRODUCTION OF DRILLING FLUID.
℄ 49TH STREET	CENTERLINE CONSTRUCTION OF 49TH STREET

	SAFETY HAMMER	AUTOMATIC HAMMER
GRANULAR MATERIALS- RELATIVE DENSITY	SPT N-VALUE (BLOWS/FT.)	SPT N-VALUE (BLOWS/FT.)
VERY LOOSE	LESS THAN 4	LESS THAN 3
LOOSE	4 to 10	3 to 8
MEDIUM DENSE	10 to 30	8 to 24
DENSE	30 to 50	24 to 40
VERY DENSE	GREATER THAN 50	GREATER THAN 40
SILTS AND CLAYS CONSISTENCY	SPT N-VALUE (BLOWS/FT.)	SPT N-VALUE (BLOWS/FT.)
VERY SOFT	LESS THAN 2	LESS THAN 1
SOFT	2 to 4	1 to 3
FIRM	4 to 8	3 to 6
STIFF	8 to 15	6 to 12
VERY STIFF	15 to 30	12 to 24
HARD	GREATER THAN 30	GREATER THAN 24

FIGURE 3

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REVISIONS

DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

JEREMY A. SEWELL, P.E.
P.E. LICENSE NUMBER 62951
TIERRA, INC.
591 SUSAN B. BRITT COURT
WINTER GARDEN, FLORIDA 34787
CERTIFICATE OF AUTHORIZATION NO. 6486

DRAWN BY: BJS
CHECKED BY: LA
DESIGNED BY: BJS
CHECKED BY: JAS

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
SR 93	MARION	435209-1-22-01

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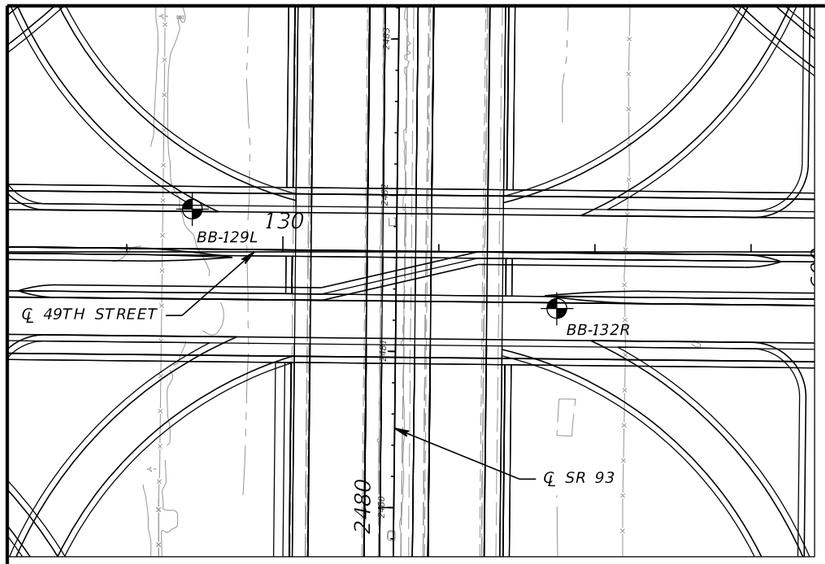
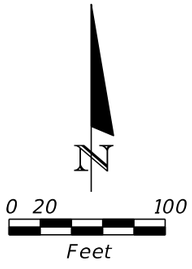
REF. DWG. NO.
PROJECT NAME: I-75 @ 49TH STREET PD&E STUDY
SHEET NO.





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SULFATES	<5 TO 30 PPM
pH	6.0 TO 6.9

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STA. 131+76
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ELEV. 76.8
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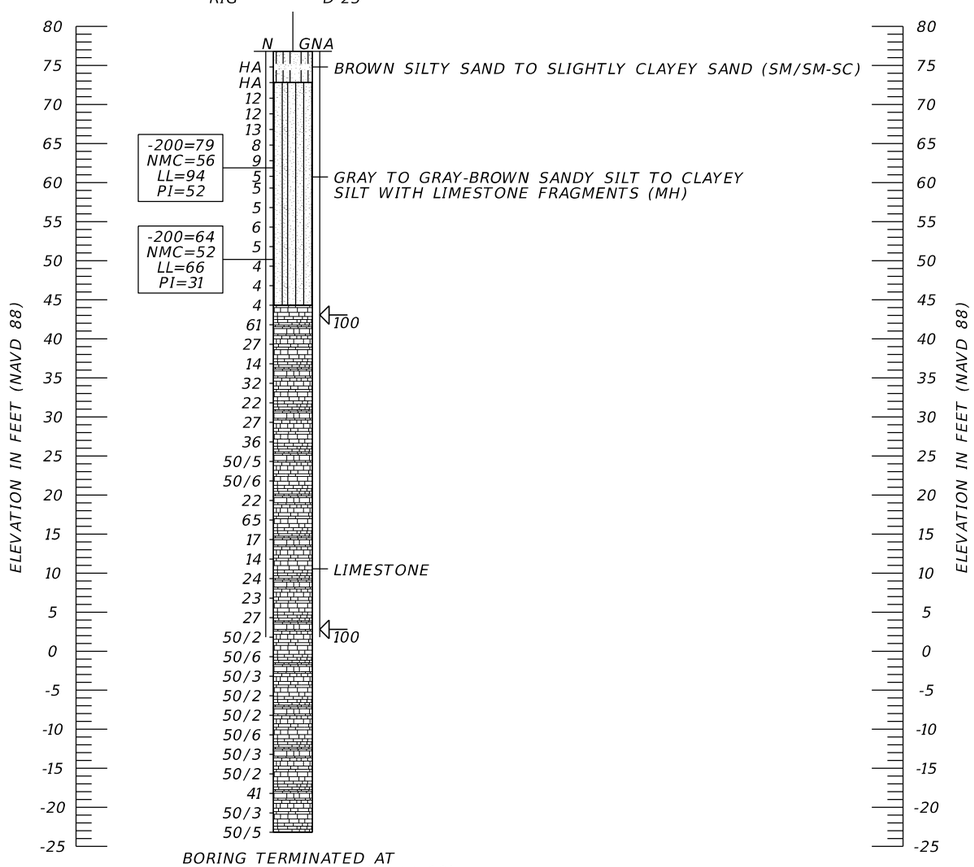
HAMMER AUTOMATIC
RIG D-25



BORING TERMINATED AT
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LATITUDE: N 29.23773
LONGITUDE: W 82.18969

LEGEND

SAND — SANDY CLAY
SILTY SAND — CLAY
SANDY SILT — LIMESTONE

SP	UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2487) GROUP SYMBOL AS DETERMINED BY VISUAL REVIEW AND LABORATORY TESTING ON SELECTED SAMPLES FOR CONFIRMATION OF VISUAL REVIEW.
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HARD	GREATER THAN 30	GREATER THAN 24

FIGURE 4

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SR 93	MARION	435209-1-22-01

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PROJECT NAME: I-75 @ 49TH STREET PD&E STUDY
SHEET NO.

bsawaska 6/26/2018 11:55:13 AM L:\5511\2016\2016 Projects\5511-16-033 I75 at 49th PD&E\Microstation\B1Boring02.dgn

I-75 at NW 49th Street PD&E
18-inch Pre-Stressed Square Concrete Pile

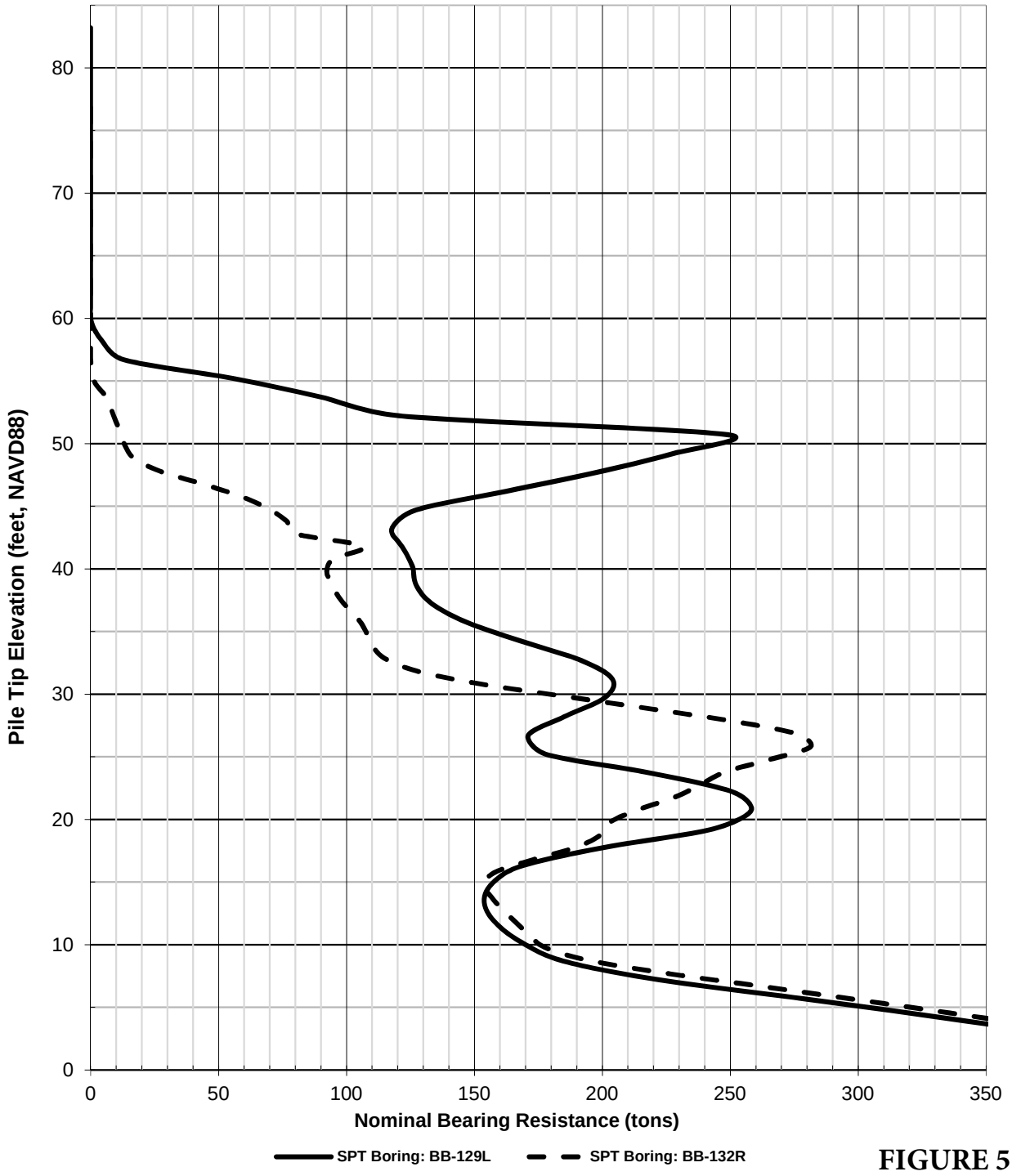

FIGURE 5

TIERRA
GEOTECHNICAL • MATERIALS
ENVIRONMENTAL • ENGINEERING

DRAWN BY:	SCALE:	PROJECT NO.
LAA	Noted	5511-16-033
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JAS	June 2018	

I-75 at NW 49th Street PD&E Study
Marion County, FL
FPID No. 435209-1-22-01

I-75 at NW 49th Street PD&E
24-inch Pre-StressedSquare Concrete Pile

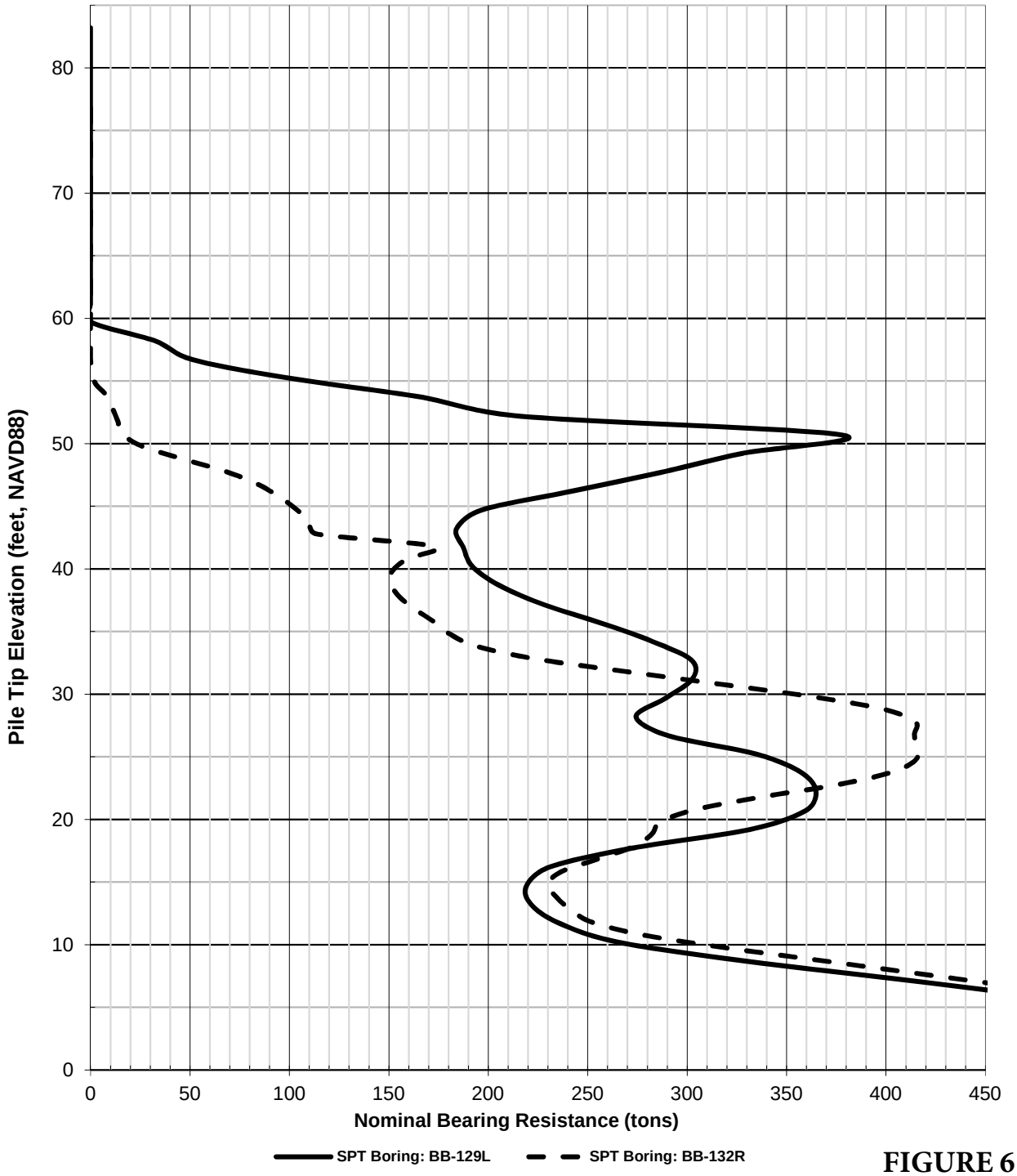

FIGURE 6

TIERRA
GEOTECHNICAL • MATERIALS
ENVIRONMENTAL • ENGINEERING

DRAWN BY:	SCALE:	PROJECT NO.
LAA	Noted	5511-16-033
CHECKED BY:	DATE:	
JAS	June 2018	

I-75 at NW 49th Street PD&E Study
Marion County, FL
FPID No. 435209-1-22-01

I-75 at NW 49th Street PD&E
20X0.5-inch Open Ended Steel Pipe Pile

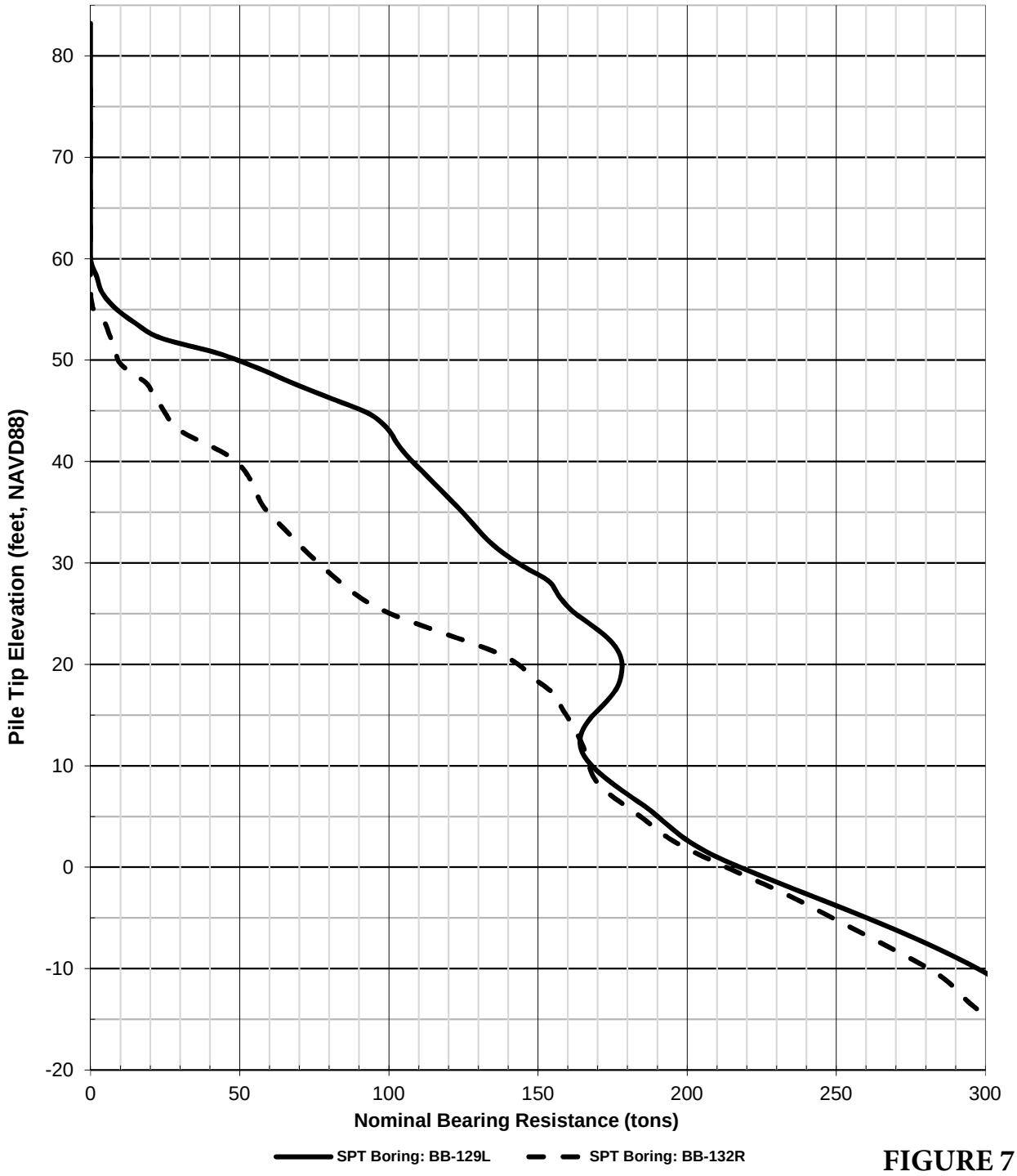

FIGURE 7

TIERRA
GEOTECHNICAL • MATERIALS
ENVIRONMENTAL • ENGINEERING

DRAWN BY:	SCALE:	PROJECT NO.
LAA	Noted	5511-16-033
CHECKED BY:	DATE:	
JAS	June 2018	

I-75 at NW 49th Street PD&E Study
Marion County, FL
FPID No. 435209-1-22-01

I-75 at NW 49th Street PD&E
14X89 Steel H-Pile

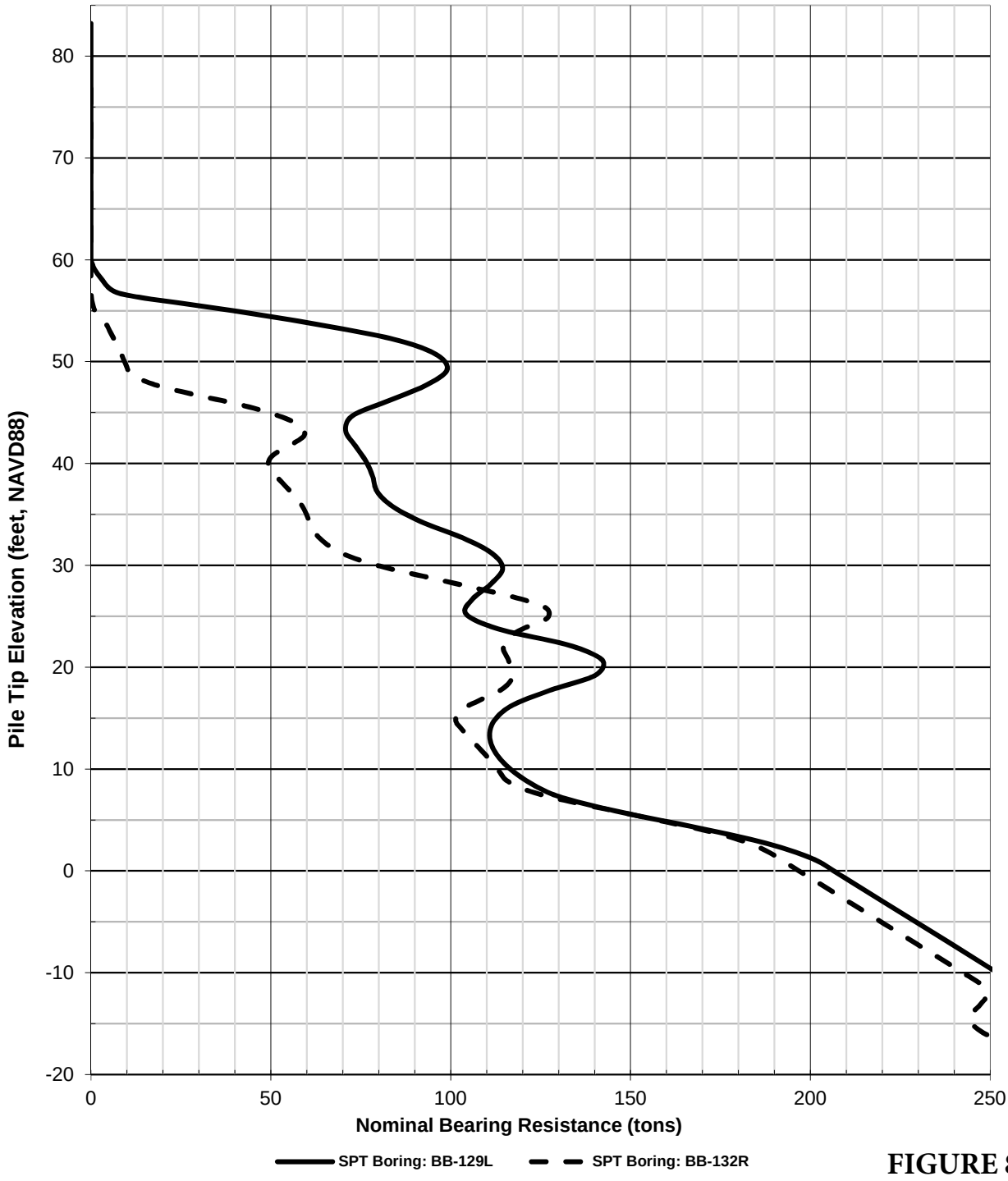

FIGURE 8

TIERRA
GEOTECHNICAL • MATERIALS
ENVIRONMENTAL • ENGINEERING

DRAWN BY:	SCALE:	PROJECT NO.
LAA	Noted	5511-16-033
CHECKED BY:	DATE:	
JAS	June 2018	

I-75 at NW 49th Street PD&E Study
Marion County, FL
FPID No. 435209-1-22-01