Engineering & Consulting, Inc.

REPORT OF A
BOX CULVERT REPLACEMENT

FWC BULLFROG CREEK BOX CULVERT REPLACEMENT
HILLSBOROUGH COUNTY, FLORIDA

GSE PROJECT No. 16283

Prepared For:

CHW PROFESSIONAL CONSULTANTS

NOVEMBER 2023

GSE Engineering & Consulting, Inc.

November 7, 2023

Daniel Young
CHW Professional Consultants
11801 Research Drive
Alachua, Florida 32615

Subject: Report of a Box Culvert Replacement
FWC Bullfrog Creek Box Culvert
Hillsborough County, Florida
GSE Project No. 16283

Dear Mr. Young:

GSE Engineering & Consulting, Inc. (GSE) is pleased to submit this report of SPT borings for the proposed culvert replacement for the above referenced project. Presented herein are the findings and conclusions of our exploration.

We appreciate this opportunity to have assisted you on this project. If you have any questions or comments concerning this report, please contact us.

Sincerely,

GSE Engineering & Consulting, Inc.

This item has been digitally signed and sealed by

Printed copies of this document are not considered signed and sealed. The signature must be verified on any electronics documents.

Kenneth L. Hill, P.E.
Principal Engineer
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1.0 INTRODUCTION

1.1 General

GSE Engineering & Consulting, Inc. (GSE) has completed this soil exploration to assist in the reconstruction of the existing box culvert on FWC Bullfrog Creek in Hillsborough County, Florida. Our exploration was performed in accordance with GSE Proposal No. 2023-544 dated August 18, 2023.

1.2 Project Description

We understand the Fish and Wildlife Conservation (FWC) is reconstructing the existing culverts on Bullfrog Creek in Hillsborough County. The proposed improvement will be of a full reconstruction replacing the two existing 90-inch pipes below the roadway for a double barrel box culvert.

You provided information about the project. A recent site survey was also provided. In addition, the proposed alignment was overlaid onto an aerial photograph. We used the provided plans and aerial photograph in preparation of this report.

1.3 Purpose

The purpose of this geotechnical exploration was to determine the general subsurface conditions, evaluate these conditions with respect to the proposed construction, and prepare geotechnical recommendations to assist in the reconstruction of the existing culvert.

2.0 FIELD AND LABORATORY TESTS

2.1 General Description

The procedures used for field sampling and testing are in general accordance with industry standards of care, established geotechnical engineering practices for this geographic region. The location and depth of the borings is intended to FDOT guidelines for minimum explorations for drainage structures.

Our exploration consisted of performing two (2) Standard Penetration Test (SPT) borings to depths of 40 feet below existing grade on each side of the proposed box culvert. The soil borings were conducted at the approximate locations as shown on the Report of SPT Borings. We located the borings at the site using the provided site plan and obvious site features as reference. The locations should be considered approximate. The soil borings were performed on October 12, 2023.

2.2 Standard Penetration Test Borings

The soil borings were performed with a drill rig employing Standard Penetration Testing (SPT) in accordance with ASTM D 1586. The SPTs were performed continuously to 10 feet and at 5 feet on center thereafter. Soil samples were obtained at the depths where the SPTs were performed. The soil samples were classified in the field, placed in sealed containers, and returned to our laboratory for further evaluation.

The standard two-inch O.D. split-barrel sampler was seated by driving it 6 inches into the undisturbed soil. The sampler was driven an additional 18 inches for the first 10 feet and 12 inches for depths beyond 10 feet by blows of a 140-pound hammer falling 30 inches. The penetration resistance (N-value) was recorded as the number of blows required to produce the middle 12 inches of penetration for the top 10 feet and the additional 12 inches of penetration for depths beyond 10 feet. These values and the complete SPT boring logs are provided on the Report of SPT Borings in Section 5.1.

Upon completion of the sampling, the boreholes were abandoned in accordance with Water Management District guidelines.

2.3 Soil Laboratory Tests

The soil samples recovered from the soil borings were returned to our laboratory, and examined to confirm the field descriptions. Representative samples were then selected for laboratory testing. The laboratory tests consisted of four (4) percent fines passing the No. 200-sieve determinations, four (4) natural moisture content tests, one (1) Atterberg Limits test, and two (2) corrosion series test. A corrosion series test was also performed on a water sample. These tests were performed in order to aid in classifying the soils and to further evaluate their engineering properties. The laboratory results are indicated on the Report of SPT Boring provided in Section 5.1. The complete laboratory report is provided in Section 5.2.

3.0 FINDINGS

3.1 Surface Conditions

The existing culvert is located on Bullfrog Creek approximately 850 feet east of the gate at Paseo Al Mar Boulevard. Two pipes are situated beneath the roadway and the existing pipes will be replaced by a double barrel box culvert.

The roadway topography is relatively level to gently sloping toward the location of the culvert. The provided Topographic Survey indicates the ground surface elevations in the area of the site range from 31 to 35 feet[1] NAVD 88.

3.2 Subsurface Conditions

Complete logs for the SPT borings are shown in the Report of SPT Borings in Section 5.1. Descriptions for the soils encountered are accompanied by the Unified Soil Classifications (USC) and are based on visual examination of the recovered soil samples and the laboratory tests performed. Stratification boundaries between the soil types should be considered approximate, as the actual transition between soil types may be gradual.

The SPT borings generally encountered interbedded layer of loose to medium dense fine sand, fine sand with silt, and silty fine sand (SP, SP-SM, SM) to depths of 30 to 33.5 feet. This was followed by hard limestone with lime silt to the boring termination depths of 40 feet.

The groundwater table was initially encountered at depths from 5 feet below existing grade for borings B-1 and B-2, respectively.

3.3 Review of Published Data

3.3.1 Soil Survey

The Soil Conservation Service (SCS) Soil Surveys for Hillsborough County[2] maps one soil series in the general area where the borings were conducted. The following soil description is from the Soil Surveys.

Winder fine sand. This soil is nearly level and poorly drained. It is on low-lying sloughs on the flatwoods. The slope is 0 to 2 percent.

In 95 percent of the areas mapped as Winder fine sand, the Winder soil and similar soils make up 88 to 99 percent of the mapped areas. Dissimilar soils make 1 to 12 percent of the mapped areas.

Typically, this soil has a surface layer of very dark gray fine sand about 4 inches thick. The subsurface layer, to a depth of about 10 inches, is grayish brown fine sand. The upper part of the subsoil to a depth of about 14 inches, is dark grayish brown, mottled sandy loam and gray fine sand. The lower part of the subsoil, to a depth of about 30 inches, is gray sandy clay loam. The upper part of the substratum, to a depth of about 58 inches, is light gray, mottled sandy clay loam. Similar soils included in mapping, in some areas, have a subsoil at a depth of more than 20 inches.

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[1] United States Geological Survey, The National Map US Topo, Palatka Quadrangle, 2018.

[2] Soil Survey of Putnam County, Florida. Soil Conservation Service, U.S. Department of Agriculture.

Other similar soils, in some areas, have a thin, discontinuous strata of fragmented limestone in the upper part of the subsoil.

Dissimilar soils included in mapping are Basinger, Myakka, and Wabasso soils in small areas. Basinger soils are very poorly drained. Myakka soils have a dark color sandy subsoil. Wabasso soils have a dark color sandy subsoil above a loamy subsoil.

In most years, a seasonal high-water table fluctuates from the soil surface to a depth of about 10 inches for 2 to 6 months. Permeability is rapid in the surface and subsurface layers. It is slow or very slow in the subsoil and in the substratum. The available water capacity is moderate.

3.3.1 Regional Geology

The project area is located in southeast Hillsborough County. This area of Hillsborough County maps as Undifferentiated Sediment[3]. The following descriptions are from the Geological Survey.

Qu – Undifferentiated Sediment– Much of Florida's surface is covered by a varying thickness of undifferentiated sediments consisting of siliciclastics, organics and freshwater carbonates. Pleistocene sea levels reached a maximum of approximately 100 feet (30 meters) msl (Colquhoun, 1969).

The siliciclastics are light gray, tan, brown to black, unconsolidated to poorly consolidated, clean to clayey, silty, unfossiliferous, variably organic-bearing sands blue green to olive green, poorly to moderately consolidated, sandy, silty clays. Gravel is occasionally present in the panhandle. Organics occur as plant debris, roots, disseminated organic matrix, and beds of peat.

In southern Florida, freshwater carbonates are nearly ubiquitous in the Everglades. These sediments are buff colored to tan, unconsolidated to poorly consolidated, fossiliferous carbonate muds. Sand, silt and clay may be present in limited quantities. These carbonates often contain organics. The dominant fossils in the freshwater carbonates are mollusks.

3.3.1 Hydrological Data

The Floridan Aquifer in the vicinity of the site has an elevation on the order of 10 to 20 feet NGVD 29[4]. This elevation is above land surface, indicating an upward or artesian hydraulic gradient occurs at the site. The Floridan Aquifer appears to be confined in this area with a surficial aquifer system encountered in the borings. The potentiometric map is included in Figure 2.

3.4 Laboratory Soil Analysis

Selected soil samples recovered from the soil borings were analyzed for natural moisture content, percent fines passing the No. 200 sieve, moisture content, Atterberg Limits, and corrosion series tests. Selected soil samples were collected from depths ranging from ground surface to 40 feet below existing grade. These tests were performed to confirm visual soil classification and evaluate

[3] Open-File Report 80, Thomas M. Scott, P.G. No. 99, Text to Accompany the Geological Map of Florida, Florida Geological Survey, 2001.

[4] Potentiometric Surface of the Upper Floridan Aquifer, September 2019, Florida Department of Environmental Protection.

their engineering properties. The laboratory results are indicated on the Report of SPT Borings in Section 5.1. The complete laboratory reports are provided in Section 5.2.

The laboratory tests indicate the near surface soils generally consist of poorly graded fine sand, fine sand with silt, and elastic silt.

The poorly graded fine sand and fine sand with silt (SP, SP-SM) tested had 4.3 to 7.5 percent soil fines passing the No. 200 sieve and natural moisture contents of 25 to 33 percent.

Tested silty fine sand (SM) had 12 to 21 percent soil fines passing the No. 200 sieve and natural moisture contents of 6.1 to 24 percent.

The elastic silt tested has 76 percent soil fines passing the No. 200 sieve, a natural moisture content of 50 percent. Atterberg Limits tests indicate the tested silt had a Liquid Limit of 79, Plastic Limit of 52, and a Plasticity Index of 27. This corresponds to a High Plastic (HP) material according to FDOT Index 120-001.

Two (2) bulk soil samples collected from depths of approximately 2 to 4 feet below grade at boring locations B-1 and B-2 were analyzed for corrosion series testing. The test results indicate the tested materials have resistivity values of 4,600 and 5,600 (ohms-cm). Chloride contents of the tested samples were Below Detectable Limits (BDL). The sulfate contents of the tested materials were Below Detectable Limits (BDL). The pH of the tested soils were 7.83 and 8.24. The soils at the site are considered slightly aggressive for concrete[5] and moderately to slightly aggressive for steel. One water sample was also tested for pH, chloride content, resistivity, and sulfate content. The pH of the water sample was 7.10. The resistivity of the water sample was 2,300 ohms-cm. The chloride content was 50 ppm. The sulfate content was 77 ppm. The water at the site is considered moderately aggressive for concrete and steel substructures. Results of the corrosion series test results are included in Sections 5.1 and 5.2.

[5] Structures Design Guidelines, FDOT Structures Manual, Volume 1, January 2018, Table 1.3.2-1, p.1-6.

4.0 EVALUATION AND RECOMMENDATIONS

4.1 General

The soil conditions at the site are fairly consistent and generally encountered surficial poorly graded fine sand, fine sand with silt, and silty fine sand (SP, SP-SM, SM) overlying limestone and lime silt to the 40 feet boring termination depths.

The following information is provided based upon our understanding of the proposed construction, a review of the attached soil borings and laboratory test data, and experience with similar projects and subsurface conditions. If plans or the location of proposed construction changes from those discussed previously, we request the opportunity to review and possibly amend our recommendations with respect to those changes.

4.2 Groundwater

The groundwater table was encountered at a depth of 5 feet below existing grade. We anticipated the seasonal high groundwater table to be approximately 2 feet below existing grade at the boring locations.

4.3 Culvert Recommendations

Soil Design Parameters

The following tables provide our recommended soil parameters for the box culvert replacement design. The parameters are based on the corrected N-value of the soil layers.

Reference Boring	B-1
Approximate Groundwater Table Depth (feet)	5

Layer No.	1	2	3	4	5
Soil Type	SM	SP	SM	SP-SM	LS
Top Boundary Depth (feet)	0	4	6	10	30
Thickness of Layer (feet)	2	6	10	30	40
Average Corrected SPT N-Value (Blows/Foot)	N/A	10	12	14	40

Soil Model	Sand	Sand	Sand	Sand	LS
Internal Friction Angle (degrees), ϕ	23	30	31	32	39
Unit Weight (pcf), γ_t	105	108	110	112	130
Unconfined Compression (ksf), q_u	*	*	*	*	500
Modulus of Subgrade Reaction (pci), k_{bw}	10	20	40	50	175

Cohesion (ksf), c	*	*	*	*	250

Reference Boring	B-2
Approximate Groundwater Table Depth (feet)	5

Layer No.	1	2	3	4
Soil Type	SP	SP-SM	SP-SC	SP-SM
Top Boundary Depth (feet)	0	2	6	33.5
Thickness of Layer (feet)	2	6	33.5	40
Average Corrected SPT N-Value (Blows/Foot)	N/A	9	10	39

Soil Model	Sand	Sand	Sand	LS
Internal Friction Angle (degrees), ϕ	23	30	30	39
Unit Weight (pcf), γ_t	105	108	109	130
Unconfined Compression (ksf), q_u	*	*	*	500
Modulus of Subgrade Reaction (pci), k_{bw}	10	20	23	175
Cohesion (ksf), c	*	*	*	250

The soils at the site are considered slightly aggressive for concrete and moderately to slightly aggressive for steel. The water at the site is considered moderately aggressive for concrete and steel substructures.

Culvert Replacement Evaluation

Based on the plans provided and assuming that construction and subgrade preparation is in accordance with FDOT Standard Specifications for Road and Bridge Construction (SSRBC), the following design and construction criteria should be observed for the culvert extension foundation system. GSE evaluated a 12 feet 10-inch wide by 7 feet 10-inch tall double barrel box culvert for bearing capacity and settlement using AASHTO LRFD Design Specifications. Our evaluation considers a 46 feet long effective length based on the provided Geotechnical Detail sheet No. Plan Only and assuming a 1.5 feet embedment depth and 2 feet of cover soil over the box culvert. Our settlement calculations and assumptions are provided in Section 5.3. The following Table provides the anticipated nominal and allowable bearing capacity for the analyzed section of precast double barrel box culvert.

Nominal Bearing Capacity (psf)	AASHTO LRFD ϕ factor	Allowable Bearing Capacity (psf)
10,481	0.45	4,716

GSE recommends you consider the following soil parameters for design of the box culvert replacement.

Design Soil Property	Recommended Value
Modulus of Subgrade Reaction, K_s, (lbs/ft^3)	20
Nominal Bearing Capacity, q_{nom}, (lbs/ft^2)	10,481
Soil Friction Angle, ϕ, (degrees)	30
Density of Soil, γ_{soil}, (lbs/ft^3)	120*
Depth of Soil Above Top of Slab	TBD
Environmental Classification	Moderately Aggressive
Long Term Differential Settlement, ΔY, (ft)	0.03

*Minimum design value for use above the top of slab

Concrete End-Wall Evaluation

It is our understanding that the box culvert replacement will utilize concrete end-walls. The end walls/retaining walls must be designed to resist the lateral stress of the existing and fill soils. We anticipate the retaining walls will be cantilever-type walls. For this condition, we recommend the retaining walls be designed assuming the retained soil will exert a lateral stress equivalent to a fluid having a unit weight of 38 pcf. This assumes a soil unit weight of 110 pcf, and a coefficient of lateral earth pressure for the active condition, K_a, of 0.34. GSE recommends the designer consider hydrostatic pressure for the full height of the wall.

Construction Considerations

Footings should have adequate cover to protect from scour. Any loose or disturbed soils encountered at foundation elevation should be removed. It may be desired to place a layer of washed gravel in the bottom of the excavation in order to provide a working platform in the

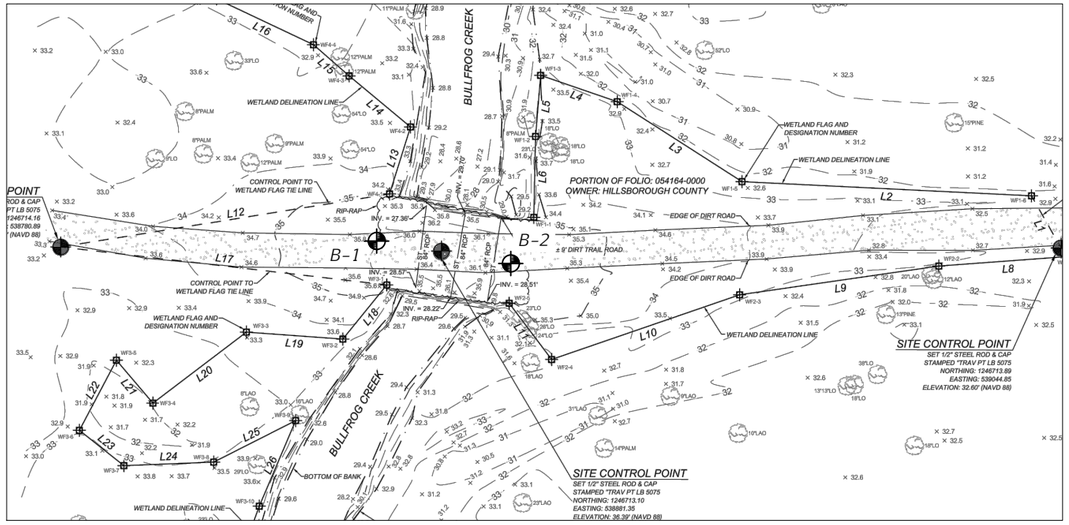
anticipated wet conditions. Foundation excavation should be observed by the geotechnical engineer to confirm the subsurface conditions and foundation recommendations.

Excavation will likely extend below the existing water level. The Contractor should determine actual groundwater levels at the time of construction. It is anticipated that the presence of groundwater will require dewatering to control groundwater during construction. The design and implementation of a dewatering system is recommended to maintain a dry, undisturbed subgrade. To avoid disturbing the subgrade, the groundwater elevation should be maintained at least 2 feet below the subgrade level and over-excavation areas during the entire period of exaction, compaction and fill placement. Dewatering should consist of pumps, wells or well points capable of lowering the groundwater below the lowest level of the exaction. It may be necessary to divert the flow of water from upstream to some location downstream away from the proposed construction area. This should also be considered by the Contractor. Detailed design of dewatering systems may require additional subsurface testing and determination of subsurface hydraulic conductivity and should be performed by a Florida registered engineer.

Removal of grass, roots, sediments, and organic material located within the proposed construction area shall be considered as standard clearing and grubbing in accordance with FDOT Standard Specifications.

5.0 FIELD DATA

5.1 Report of SPT Borings



LEGEND:

SPT BORING

NORTH

0 40

SCALE: 1"=40' APPROX.

LEGEND

HA	HAND AUGER
MC	MOISTURE CONTENT (%)
-200	PERCENT PASSING THE No. 200 SIEVE
LL	LIQUID LIMIT
PL	PLASTIC LIMIT
PI	PLASTICITY INDEX
ORG	ORGANIC CONTENT
NP	NOT PLASTIC
N	STANDARD PENETRATION RESISTANCE (BLOWS / FOOT)
WOH	WEIGHT-OF-HAMMER
	ESTIMATED SEASONAL HIGH GROUNDWATER
	ENCOUNTERED GROUNDWATER TABLE
GNE	GROUNDWATER NOT ENCOUNTERED
	100% LOSS OF CIRCULATION
*	* - CORROSION SERIES TEST
pH	$-LOG_{10}(a_H)$
R	RESSISTIVITY (OHM-CM)
Cl	CHLORIDE CONTENT (PPM)
S	SULFATE CONTENT (PPM)
BDL	BELOW DETECTABLE LIMITS
B.T.	BORING TERMINATED

	(SP) SAND
	(SC) CLAYEY TO VERY CLAYEY SAND
	(SM) SILTY SAND
	(SP-SC) SAND WITH CLAY
	(SP-SM) SAND WITH SILT
	(ML) SILT
	(SM-SC) SILTY SAND WITH CLAY
	(CH) CLAY
	(CH) SANDY CLAY
	(CH) CLAY WITH SAND
	LIMESTONE

ENGINEERING CLASSIFICATION

GRANULAR MATERIALS

No. OF BLOWS, N	RELATIVE DENSITY
0 - 4	VERY LOOSE
5 - 10	LOOSE
11 - 30	MEDIUM DENSE
31 - 50	DENSE
OVER 50	VERY DENSE

SILTS AND CLAYS

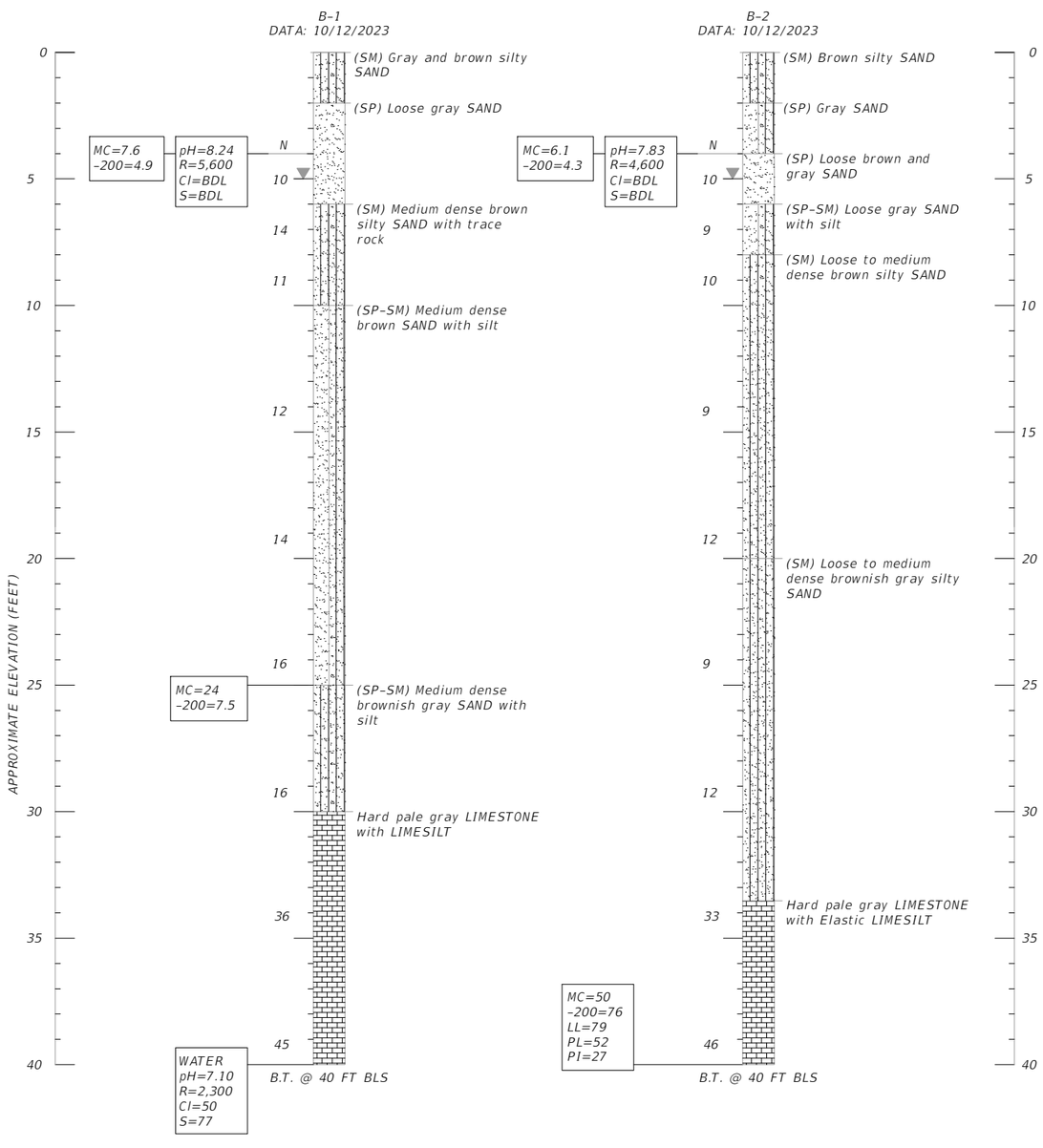
No. OF BLOWS, N	CONSISTENCY
0 - 2	VERY SOFT
3 - 4	SOFT
5 - 8	FIRM
9 - 15	STIFF
16 - 30	VERY STIFF
31 - 50	HARD
OVER 50	VERY HARD

LIMESTONE

No. OF BLOWS, N	CONSISTENCY
0 - 8	VERY SOFT
9 - 18	SOFT
19 - 32	MODERATELY HARD
33 - 50	HARD
OVER 50	VERY HARD

ENVIRONMENTAL CLASSIFICATION

SUPERSTRUCTURE:	SLIGHTLY AGGRESSIVE
SUBSTRUCTURE:	SLIGHTLY AGGRESSIVE
WATER:	MODERATELY AGGRESSIVE R<3,000



REVISIONS			
DATE	DESCRIPTION	DATE	DESCRIPTION

JASON E. GOWLAND P.E. 66467
GSE ENGINEERING & CONSULTING, INC.
5590 SW 64TH STREET, SUITE B
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CHW PROFESSIONAL CONSULTANTS, INC.

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
NA	HILLSBOROUGH	N/A

REPORT OF SPT BORINGS

SHEET NO. 1

5.2 Summary of Laboratory Test Results

GSE Engineering & Consulting, Inc.

SUMMARY REPORT OF LABORATORY TEST RESULTS

Project Number: 16283

Project Name: FWC Bullfrog Creek Culvert Replacement

Boring Number	Depth (ft)	Soil Description	pH	Resistivity (ohm-cm)	Chloride Content (ppm)	Sulfate Content (ppm)
Water			7.10	2300	50	77
B-1	4-6	Gray SAND	8.24	5600	BDL	BDL
B-2	4-6	Brown and Gray SAND	7.83	4600	BDL	BDL

GSE Engineering & Consulting, Inc.

SUMMARY REPORT OF LABORATORY TEST RESULTS

Project Number: 16283

Project Name: FWC Bullfrog Creek Culvert Replacement

Boring Number	Depth (ft)	Soil Description	Natural Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Percent Passing No. 200 Sieve	Organic Content (%)	Hydraulic Conductivity (ft/day)	Unified Soil Classification
Water										
B-1	4-6	Gray SAND	7.6				4.9			SP
B-2	4-6	Brown and Gray SAND	6.1				4.3			SP
B-1	23.5-25	Brownish Gray SAND with Silt	24				7.5			SP-SM
B-2	38.5-40	Pale Gray Elastic SILT	50	79	52	27	76			MH

6.0 LIMITATIONS

6.1 SPT Borings

The determination of soil type and conditions was performed from the ground surface to the maximum depth of the borings, only. Any changes in subsurface conditions that occur between or below the borings would not have been detected or reflected in this report.

Soil classifications that were made in the field are based upon identifiable textural changes, color changes, changes in composition or changes in resistance to penetration in the intervals from which the samples were collected. Abrupt changes in soil type, as reflected in boring logs and/or cross sections may not actually occur, but instead, be transitional.

Depth to the water table is based upon observations made during the performance of the borings. This depth is an estimate and does not reflect the annual variations that would be expected in this area due to fluctuations in rainfall and rates of evapotranspiration.

6.2 Site Figures

The measurements used for the preparation of the figures in this report were made with a fiberglass tape and by estimating distances from existing structures and site features. Figures in this report were not prepared by a licensed land surveyor and should not be interpreted as such. Some of the boring locations were surveyed after completion. It is possible that the staked locations that were surveyed were not representative of the actual boring location and should be considered for estimating purposes.

6.3 Unanticipated Soil Conditions

The analysis and recommendations submitted in this report are based upon the data obtained from soil borings performed at the locations indicated on the Boring Location Plan. This report does not reflect any variations that may occur between these borings.

The nature and extent of variations between borings may not become known until excavation begins. If variations appear, we may have to re-evaluate our recommendations after performing on-site observations and noting the characteristics of any variations.

6.4 Misinterpretation of Soil Engineering Report

GSE Engineering & Consulting, Inc. is responsible for the conclusions and opinions contained within this report based upon the data relating only to the specific project and location discussed herein. If others make the conclusions or recommendations based upon the data presented, those conclusions or recommendations are not the responsibility of GSE.

FIGURE

LEGEND:

60 WINDER FINE SAND, FREQUENTLY FLOODED

NORTH

NOT TO SCALE

FWC BULLFROG CREEK CULVERT REPLACEMENT
HILLSBOROUGH COUNTY, FLORIDA
GSE PROJECT NO. 16283

PROJECT SITE LOCATION MAP

DESIGNED BY: JEG
CHECKED BY : JEG
DRAWN BY : EEW

GSE Engineering & Consulting, Inc.

FIGURE 1