Geotechnical Exploration and Evaluation Report
Revision No. 01

William Burgess Blvd. from Harts Road to SR 200
Force Main and Reclaim Water Main
Nassau County, Florida

CSI Geo Project No.: 71-16-329-01
Client Project No.: JEA 09302-045-01

Prepared by

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Prepared for

Jones Edmunds & Associates, Inc.

November 22, 2016

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November 21, 2016

Mr. Gregory Perrine, P.E.
Jones Edmunds & Associates, Inc.
1100 Cesery Blvd, Second Floor
Jacksonville, FL 32211

RE: William Burgess from Harts Road to SR 200 Force Main and Reclaim Water Main
Nassau County, Florida

Subject: Geotechnical Exploration and Evaluation Report - Revision No. 01
CSI Geo Project No.: 71-16-329-01
Client Project No.: JEA 09302-045-01

Dear Mr. Perrine:

CSI Geo, Inc. has performed the authorized geotechnical exploration and laboratory testing program for the proposed force main and reclaim water main in Nassau County, Florida. Our last geotechnical report was prepared and submitted on June 15, 2016. Since that submittal we have performed two additional borings (B-29 and B-30) for the Horizontal Directional Drilling (HDD) entry and exit points at the intersection of William Burgess Road and Harts Road, and we have revised the report accordingly. This revised report (Revision No. 01) presents our understanding of the subsurface conditions along with our engineering evaluation and recommendations.

We have enjoyed working with you on this project and look forward to working with you on future projects. If you have any questions concerning this report, please contact our office.

Sincerely,

CSI Geo, Inc.

Bruce Khosrozadeh
2016.11.22
15:45:04-05'00'

Nader Amer, Ph.D
Geotechnical Engineer

Bruce Khosrozadeh, P.E.
Senior Geotechnical and Materials Engineer
Registered, Florida No. 45273

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APPENDIX

1.0 PROJECT INFORMATION

1.1 General Project Information

The purpose of this geotechnical exploration program was to develop information concerning the subsurface conditions in order to evaluate the site with respect to the proposed force main and reclaim water pipes along William Burgess Boulevard from Harts Road to SR 200 in Nassau County, Florida. This report describes the field and laboratory testing activities performed and presents the findings. Our last geotechnical report was prepared and submitted on June 15, 2016. Since that submittal we have performed two additional borings (B-29 and B-30) for the Horizontal Directional Drilling (HDD) entry and exit points at the intersection of William Burgess Blvd. and Harts Road, and we have revised the report accordingly. This revised report (Revision No. 01) presents our understanding of the subsurface conditions along with our engineering evaluation and recommendations. The subsurface soil and groundwater conditions are also presented in this report along with general site preparation recommendations and soil parameters for the proposed construction.

Information regarding this project was provided to CSI Geo, Inc. (CSI Geo) by Mr. Harold Bridges, PhD, P.E, and Mr. Greg Perrine, P.E. of Jones Edmunds & Associates, Inc. (Jones Edmunds), which included a set of CFG Gas Pipeline – Phase 3A plan and profile drawings prepared by P&A Consulting Engineers, dated January 2014, and William Burgess Blvd 16" Sewer Force Main Plan and Profile, prepared by Jones Edmunds, and dated September 30, 2016.

1.2 Existing Conditions and Project Description

The proposed 16-inch force main will extend along William Burgess Blvd. in Nassau County from the existing 16-inch force main stub at Harts Road to the existing 10-inch force main at SR 200. The proposed force main is located in the JEA Wastewater Service Area and will provide redundancy to the 10-inch force main along SR 200, which will be reserved and remain in place. The 16-inch reclaim water main will be installed along the same corridor with the 16-inch force main providing reclaimed water capacity for this area of Nassau County. The new pipes are proposed to be installed parallel to the existing 10-inch force main by means of open-cut pipe installation and horizontal directional drilling methods. The alignment of the new pipes is also proposed to cross underneath five future culvert extensions. In these areas, pipes will be installed deeper to provide proper vertical separation from possible future culvert extensions. Therefore, temporary sheet pile walls may be required to facilitate excavation, dewatering, and compaction processes. It is our understanding that pipe installation by means of horizontal directional drilling (HDD) may be considered at the culvert extension areas, based on the depth required below the culvert extensions. HDD is also considered for the pipes to be installed underneath William Burgess Blvd. at Harts Road crossing.

2.0 GEOTECHNICAL EXPLORATION

2.1 Field Exploration

The project was initially explored by means of a total of 28 Standard Penetration Test (SPT) borings (B-1 through B-28) drilled to depths of 15 to 20 feet below the existing ground surface. Additionally, two SPT borings (BC-1 and BC-2) were placed in the areas of culvert extensions and drilled to a depth of 30 feet below the existing ground surface. Following our initial submittal, two additional SPT borings (B-29 and B-30) were requested and drilled to a depth of 30 and 35 feet below the existing ground surface at the HDD entry and exit points at the intersection of William Burgess Blvd. and Harts Road. The field exploration also included a total of five pavement cores taken along the existing roadway crossings in order to evaluate the existing pavement system thicknesses.

The boring locations were spaced at approximately 500 feet along the proposed pipeline route, as per JEA requirements, and located in the field by personnel from CSI Geo. Soil samples collected were visually classified in the field and then transported to our laboratory for re-classification and testing. The approximate locations of the soil borings and pavement cores are shown on the Field Exploration Plan sheets included in the **Appendix**.

2.2 Laboratory Testing

Representative soil samples obtained during our field exploration program were visually classified using the American Association of State Highway and Transportation Officials (AASHTO) Soil Classification System. Quantitative laboratory testing was performed on representative soil samples to better define their composition. Laboratory tests performed were percent fines, natural moisture content, Atterberg limits, and organic content. A Summary of Laboratory Test Results, and Field and Laboratory Test Procedures are included in the **Appendix**.

3.0 GENERAL SUBSURFACE CONDITIONS

3.1 General

An illustrated representation of the subsurface conditions encountered in the proposed construction areas are shown on the General Subsurface Profiles sheets presented in the **Appendix**. The General Subsurface Profiles and the soil conditions outlined below highlight the major subsurface stratification. The General Subsurface Profiles in the **Appendix** should be consulted for a detailed description of the subsurface conditions encountered at each boring location. When reviewing the General Subsurface Profiles, it should be understood that soil conditions may vary outside of the explored area.

3.2 Soil Conditions

Open Cut Method of Pipe Installation

Review of test borings B-1 through B-28 indicates that the force main and reclaim water main alignment is generally underlain by inter-bedded deposits of very loose to very dense sands, slightly silty sands, and slightly clayey sands (A-3), silty sands (A-2-4), and soft to stiff plastic clayey sands (A-2-6) and sandy clays (A-6) until the boring termination depths of 15 to 20 feet below the existing grades. Test borings B-8, B-13, B-14, and B-28 were extended to a depth of 20 feet in order to penetrate beyond the very soft and/or clayey soils. Unsuitable organic soils (A-8) were encountered in the upper 1 foot of depth in test boring B-7.

Sheet Pile Walls and/or Horizontal Directional Drilling at Culvert Extension Areas

Review of test borings BC-1 and BC-2 indicates that the pipe alignment in the areas of culvert extensions is generally underlain by inter-bedded deposits of loose to very dense sands and slightly silty sands (A-3), silty sands (A-2-4), and firm plastic sandy clays (A-6) until the boring termination depth of 30 feet below the existing grades. Unsuitable organic soils (A-8) were encountered in the upper 2 feet of depth in test boring BC-1.

Horizontal Directional Drilling Area at Harts Road Crossing

Review of test borings B-29 and B-30 indicates that the pipe alignment in the area of HDD entry and exit points is generally underlain by inter-bedded deposits of loose to very dense sands and slightly silty sands (A-3), silty sands (A-2-4), and very soft to firm highly plastic clays (A-7) until the boring termination depth of 30 and 35 feet below the existing grades. Unsuitable sands due to the presence of some wood/roots (A-8) were encountered in boring B-30 between the depths of 5.5 and 8 feet below the existing ground surface (Elev. 24’ to 21.5’).

3.3 Groundwater Conditions

The groundwater level was measured and recorded as encountered at the time of drilling. The depths of the groundwater level and estimated seasonal high water level at the test location are marked on the General Subsurface Profiles sheets presented in the **Appendix**. The depth of groundwater level measured at the time of drilling ranged from 2 to 6 feet below the existing ground surface. The estimated seasonal high groundwater table for the borings performed ranged from 0.5 to 4.5 feet below the existing ground surface. However, it is anticipated that seasonal high groundwater will be at the surface or higher in the wetland areas. It should be anticipated that the groundwater level will fluctuate due to seasonal climate variations, surface water runoff patterns, construction operations, tidal effects, and other related factors.

3.4 Existing Pavement System Thickness

Five pavement cores were conducted to determine the existing pavement system thickness near pipe crossings on William Burgess Blvd., Harts Road, Cartesian Pointe Dr., Nicko Lane, and near an un-named road east of the Nassau County complex’s main entrance. The cores showed that the pavement section consisted of 1.5 to 2 inches of asphalt underlain by 7 to 9 inches of limerock. Complete results of the existing pavement system thickness are included in the **Appendix**.

4.0 DESIGN RECOMMENDATIONS

4.1 General

Our geotechnical evaluation of the site and the subsurface conditions is based on our understanding of the proposed project, our observations, and results of field and laboratory testing. The recommendations provided in this report present construction methods and techniques that are appropriate for the proposed construction. If the project location is changed or if field conditions encountered during construction are different from those presented in this report, the information should be provided to CSI Geo for evaluation. We also recommend that CSI Geo be given the opportunity to review the design plans and specifications to ensure that our recommendations have been properly included and implemented.

In general, we consider the subsurface soil conditions at the site to be favorable for support of the proposed pipes over a properly prepared and compacted subgrade, provided that the site preparation and earthwork construction recommendations in this report are performed.

4.2 Open Cut Excavations

The A-3 type soils are considered select material. Silty sands (A-2-4) can be treated as select material, however, they may contain excess moisture and may be difficult to dry and to compact.

Clayey sands (A-2-6) and sandy clays (A-6/A-7) should be considered plastic materials. Therefore, if these soils are encountered along the alignment of the pipes, they should be excavated to a minimum depth of one foot below the design invert elevations and replaced with suitable A-3 fill material. Organic soils (A-8) should be considered as muck and not suitable for use as backfill. If A-8 materials are encountered beneath the force main or the reclaim water main or other proposed structures they should be removed in their entirety.

It is cautioned that portions of the pipe alignment are underlain by plastic clayey sands (A-2-6) and sandy clays (A-6/A-7). These soils should be replaced with select A-3 material prior to the installation of the force main.

It is very likely that the excavated suitable soils will get mixed with plastic soils during construction. Therefore, it is our opinion that some of the excavated material should be regarded as unsuitable for backfill purposes. We recommend that allowance be made for overruns in quantities of subsoil removal and replacement with select backfill. It should be noted that plastic soils boundaries and limits are approximate and represent soil encountered at each boring location. Subsurface variance between borings may occur and should be anticipated.

We anticipate that the buried pipe lines will exert little downward pressure on the subgrade soils. In areas where the surrounding groundwater level is above the pipe invert elevation, the line should be designed to resist lateral earth pressures and hydrostatic uplift pressures appropriate to its depth below the existing grade and the seasonal high water level.

4.3 Design Soil Parameters for Sheet Pile Walls & Horizontal Directional Drilling at Existing Culverts

We understand that certain sections of the force main and reclaim water main will be installed deeper at areas with possible future culvert extensions to provide proper vertical separation. Due to the deeper installation, an open cut method is considered insufficient for excavation support and, therefore, temporary sheet pile walls and/or horizontal directional drilling may be required during construction at these areas. We recommend that soil parameters and assumptions for the temporary sheet pile walls and/or horizontal directional drilling design to be used for the project follow Tables 1 and 2 as follows:

TABLE 1 – RECOMMENDED SOIL PARAMETERS FOR DESIGN
Based on Boring BC-1

Soil Parameter	Loose Sand	Medium Dense Sand	Loose to Medium Dense Sand
Depth (ft)	0 to 4	4 to 11	11 to 30
Saturated unit weight (pcf)	110	120	105
Effective unit weight for input purposes (pcf)	48	58	43
Estimated friction angle ϕ (degrees)	32	37	28
At Rest Pressure Coefficient (K_o)	0.47	0.40	0.53
Active Pressure Coefficient (K_a)	0.31	0.25	0.36
Passive Pressure Coefficient (K_p)	3.25	4.02	2.77

TABLE 2 – RECOMMENDED SOIL PARAMETERS FOR DESIGN
Based on Boring BC-2

Soil Parameter	Loose Sand	Soft to Firm Clay	Loose Sand	Very Dense Sand
Depth (ft)	0 to 2	2 to 6	6 to 22	22 to 30
Saturated unit weight (pcf)	105	100	105	120
Effective unit weight for input purposes (pcf)	43	38	43	58
Estimated friction angle ϕ (degrees)	30	-	30	38
Cohesion (psf)	-	600	-	-
At Rest Pressure Coefficient (K_o)	0.50	1.00	0.50	0.38
Active Pressure Coefficient (K_a)	0.33	1.00	0.33	0.24
Passive Pressure Coefficient (K_p)	3.00	1.00	3.00	4.20

4.4 Design Soil Parameters for Horizontal Directional Drilling at Harts Road Crossing

We understand that this section of the force main and reclaim water main will be installed using HDD method of installation at William Burgess Blvd. and Harts Road. We recommend that soil parameters and assumptions for the horizontal directional drilling design to be used for the project follow Tables 3 and 4 as follows:

TABLE 3 – RECOMMENDED SOIL PARAMETERS FOR HDD DESIGN
Based on Boring B-29

Soil Parameter	Loose to Medium Dense Sand	Very Dense Sand	Firm Clay	Loose to Medium Dense Sand
Depth (ft)	0 to 6	6 to 13	13 to 18	18 to 30
Saturated unit weight (pcf)	115	120	95	105
Effective unit weight for input purposes (pcf)	53	58	33	43
Estimated friction angle ϕ (degrees)	33	35	---	30
Cohesion – C (psf)	---	---	800	---
At Rest Pressure Coefficient (K_o)	0.46	0.43	1.00	0.50
Active Pressure Coefficient (K_a)	0.29	0.27	1.00	0.33
Passive Pressure Coefficient (K_p)	3.39	3.69	1.00	3.00

TABLE 4 – RECOMMENDED SOIL PARAMETERS FOR HDD DESIGN
Based on Boring B-30

Soil Parameter	Loose Sand	Unsuitable Soils with wood	Medium Dense Silty Sand	Very Soft Clay	Medium Dense Sand	Very Loose Silty Sand	Dense Sand
Depth (ft)	0 to 5.5	5.5 to 8	8 to 13	13 to 18	18 to 22	22 to 25	25 to 35
Saturated unit weight (pcf)	110	100	120	90	115	95	120
Effective unit weight for input purposes (pcf)	48	38	58	25	53	33	58
Estimated friction angle ϕ (degrees)	32	29	35	---	33	25	36
Cohesion – C (psf)	---	---	---	200	---	---	---
At Rest Pressure Coefficient (K_o)	0.47	0.52	0.43	1.00	0.46	0.58	0.41
Active Pressure Coefficient (K_a)	0.31	0.35	0.27	1.00	0.29	0.41	0.26
Passive Pressure Coefficient (K_p)	3.25	2.88	3.69	1.00	3.39	2.46	3.85

5.0 SITE PREPARATION & EARTHWORK RECOMMENDATIONS

5.1 Existing Utilities

The locations of existing utilities should be established prior to construction. Provisions should be made to relocate utilities interfering with the proposed alignments and construction, as needed. Underground pipes that are not operational should be either removed or plugged otherwise they may become conduits for subsurface erosion and cause settlements.

5.2 Temporary Groundwater Control

Groundwater level was encountered at the time of drilling at a depth ranging from 2 to 6 feet below the existing ground surface. Therefore, groundwater control should be anticipated. The groundwater level should be maintained at a minimum of two feet below the subgrade of the proposed inverts. Dewatering may be achieved by conventional open pumping using ditches graded to a sump or by using a well point system. Dewatering should continue until sufficient weight is placed over the proposed pipes to resist uplift.

5.3 Excavation Protection

All excavations should meet OSHA Excavation Standard Subpart P regulations for Type C soils. Temporary sheet pile walls are proposed in some areas where deep installation is required, but a trench box or braced sheet pile structures may also be required in other areas to support the open excavations. The soil support system shall be designed by a Florida registered Professional Engineer.

5.4 Pipe Backfill and Compaction of Pipe Backfill

Some of the excavated soils during pipe installations are anticipated to consist of silty sands (A-2-4), plastic clayey sands (A-2-6), sandy clays (A-6/A-7), and organic soils (A-8), which should be considered unsuitable for backfilling and compaction purposes. As mentioned earlier, the excavated suitable soils will likely get mixed with plastic soils during construction. Therefore, some of the excavated material should be regarded as unsuitable for backfill purposes. We recommend that allowance be made for overruns in quantities of subsoil removal and replacement with select (A-3) backfill.

The backfill material within the excavation should be placed in thin loose lifts not exceeding 6 or 12 inches in thickness as required by JEA. The backfill material shall be compacted by the use of hand-operated equipment. The backfill material shall be granular (A-3) fill with less than 10 percent material passing the no. 200 mesh sieve and containing less than 3 percent organic matter. The backfill material should be compacted to a minimum density of 98% or 95% of maximum dry density obtained from the Modified Proctor compaction test (ASTM D1557), as required by JEA. The moisture content during compaction shall be maintained within ± 3 percent of the optimum moisture content as obtained from the Modified Proctor compaction test.

Hand held compaction equipment shall be used for the backfill placed around the pipe and to a height of 2 feet above the pipe. Heavier equipment may be used on the remaining backfill lifts placed above the 2 feet above the pipe. However, care shall be taken not to damage the pipe below. The pipe shall be designed to withstand the anticipated dead (overburden) and live loads.

6.0 REPORT LIMITATIONS

The subsurface exploration program including our evaluation and recommendations was performed in general accordance of accepted geotechnical engineering principles and standard practices. CSI Geo is not responsible for any independent conclusions, opinions, or interpretations made by others based on the data presented in this report.

This report does not reflect any variations that may occur adjacent or between soil borings. The discovery of any site or subsurface condition during construction that deviates from the findings and data as presented in this report should be reported to CSI Geo for evaluation. If the locations of the proposed reclaim water and/or force main are changed, our office should be contacted so our recommendations can be re-evaluated. We recommend that CSI Geo be given the opportunity to review the final design drawings and specifications to ensure that our recommendations are properly included and implemented.

APPENDIX

Site Location Map

Field Exploration Plan

General Subsurface Profiles

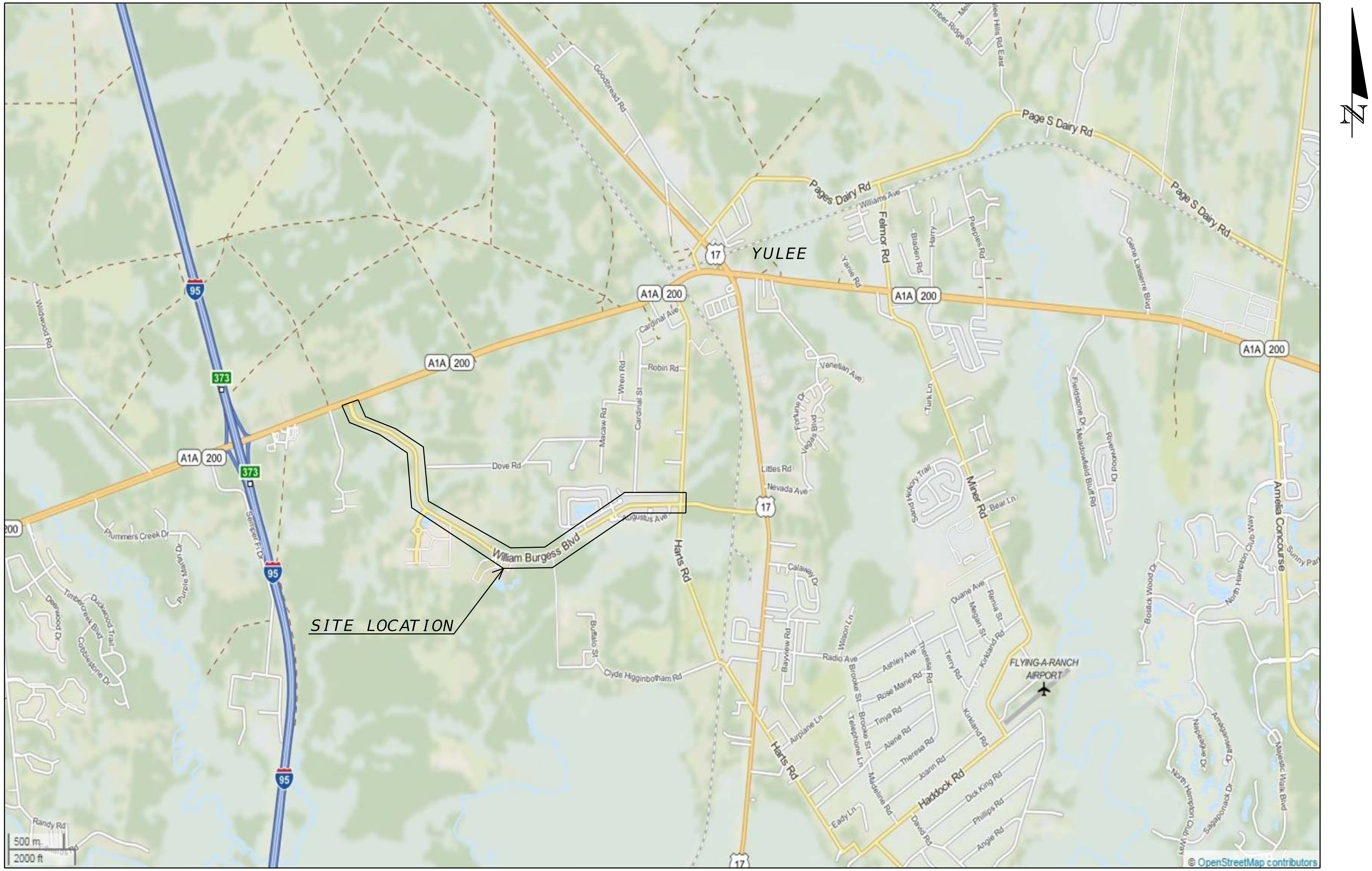
Summary of Laboratory Testing Results

Existing Pavement System Thickness

Key to Soil Classification

Field and Laboratory Test Procedures

Site Location Map



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SITE LOCAION MAP
WILLIAM BURGESS BLVD. FROM HARTS RD TO SR 200
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Field Exploration Plan

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FIELD EXPLORATION PLAN

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NASSAU COUNTY, FLORIDA

General Subsurface Profiles

LEGEND

(pattern)	FINE SAND (A-3); SLIGHTLY SILTY FINE SAND (A-3); SLIGHTLY CLAYEY FINE SAND (A-3)
(pattern)	SILTY FINE SAND (A-2-4)
(pattern)	CLAYEY FINE SAND (A-2-6)
(pattern)	SANDY CLAY (A-6)
(pattern)	SILTY FINE SAND WITH SOME TO MANY ORGANICS; FINE SAND WITH SOME WOOD (A-8)
(pattern)	CLAY (A-7)

(A-3)	AASHTO SOIL CLASSIFICATION SYSTEM
B.T.	STANDARD PENETRATION TEST BORING TERMINATION
W	NATURAL MOISTURE CONTENT (%)
-200	FINES PASSING NO. 200 SIEVE (%)
LL	LIQUID LIMIT
PI	PLASTICITY INDEX
OC%	ORGANIC CONTENT PERCENT (%)
W.O.H.	WEIGHT OF HAMMER
▼	GROUND WATER LEVEL AT TIME OF DRILLING
▽	ESTIMATED SEASONAL HIGH GROUND WATER LEVEL
N	STANDARD PENETRATION RESISTANCE IN BLOWS PER FT UNLESS OTHERWISE NOTED, NUMBERS TO THE LEFT OF BORING INDICATE N-VALUES.

GRANULAR MATERIALS

RELATIVE DENSITY	AUTOMATIC HAMMER SPT N-VALUE (BLOWS/FT)
VERY LOOSE	LESS THAN 3
LOOSE	3-8
MEDIUM DENSE	8-24
DENSE	24-40
VERY DENSE	GREATER THAN 40

SILT AND CLAYS

CONSISTENCY	AUTOMATIC HAMMER SPT N-VALUE (BLOWS/FT)
VERY SOFT	LESS THAN 1
SOFT	1-3
FIRM	3-6
STIFF	6-12
VERY STIFF	12-24
HARD	GREATER THAN 24

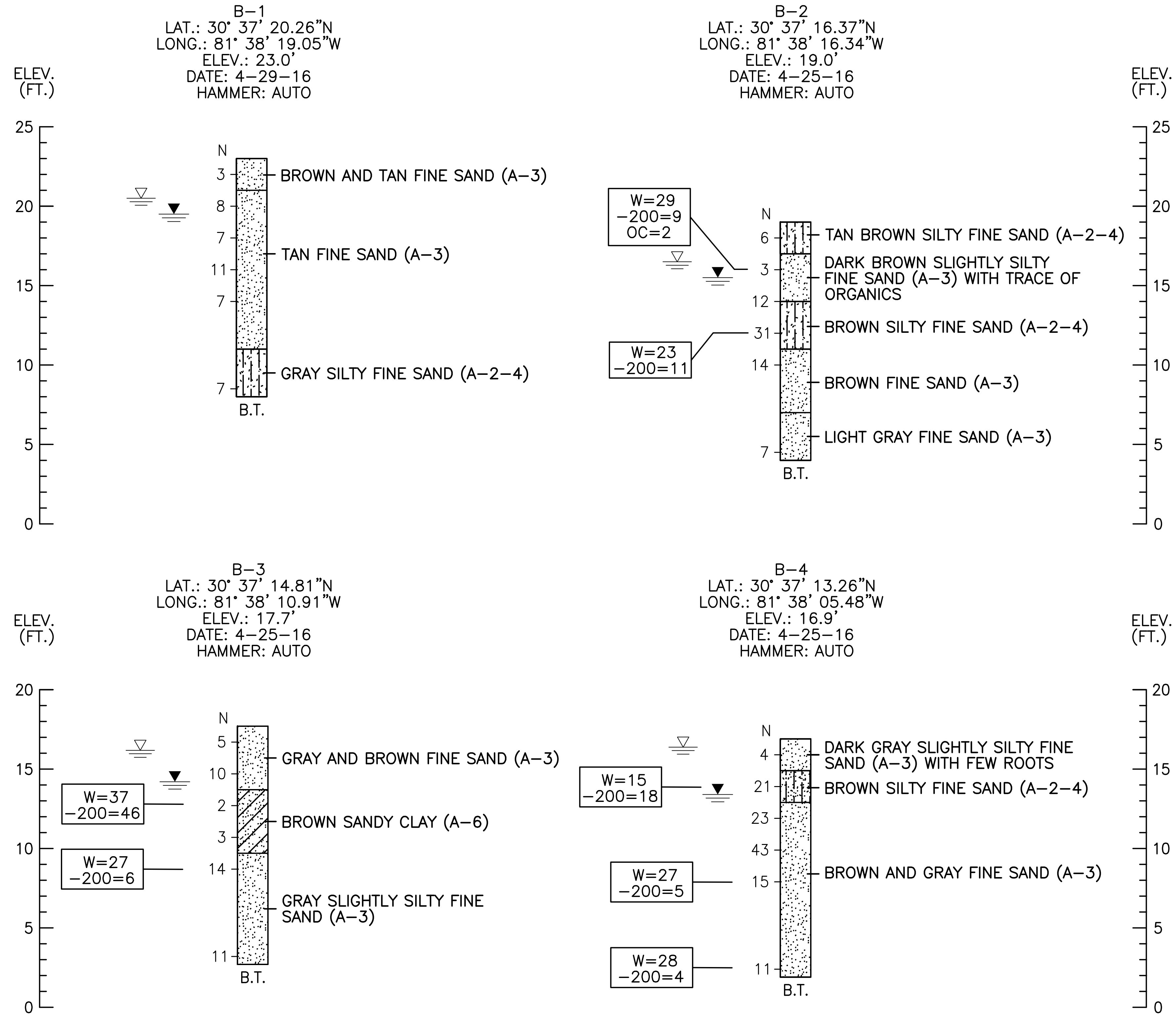
STANDARD PENETRATION TEST DATA

SPOON INSIDE DIA.	1.44 INCHES
SPOON OUTSIDE DIA.	2.0 INCHES
ASTM STANDARD DROP HAMMER, MANUAL.	
AVG. HAMMER DROP	30.0 INCHES
HAMMER WEIGHT	140.0 LBS

NOTES:

1) DRILL AND PENETRATION TESTING WAS PERFORMED IN ACCORDANCE WITH ASTM D-1586.

2) LAYER BOUNDARIES ARE APPROXIMATE AND MAY VARY BETWEEN OR AWAY FROM BORING LOCATIONS.



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GENERAL SUBSURFACE PROFILES

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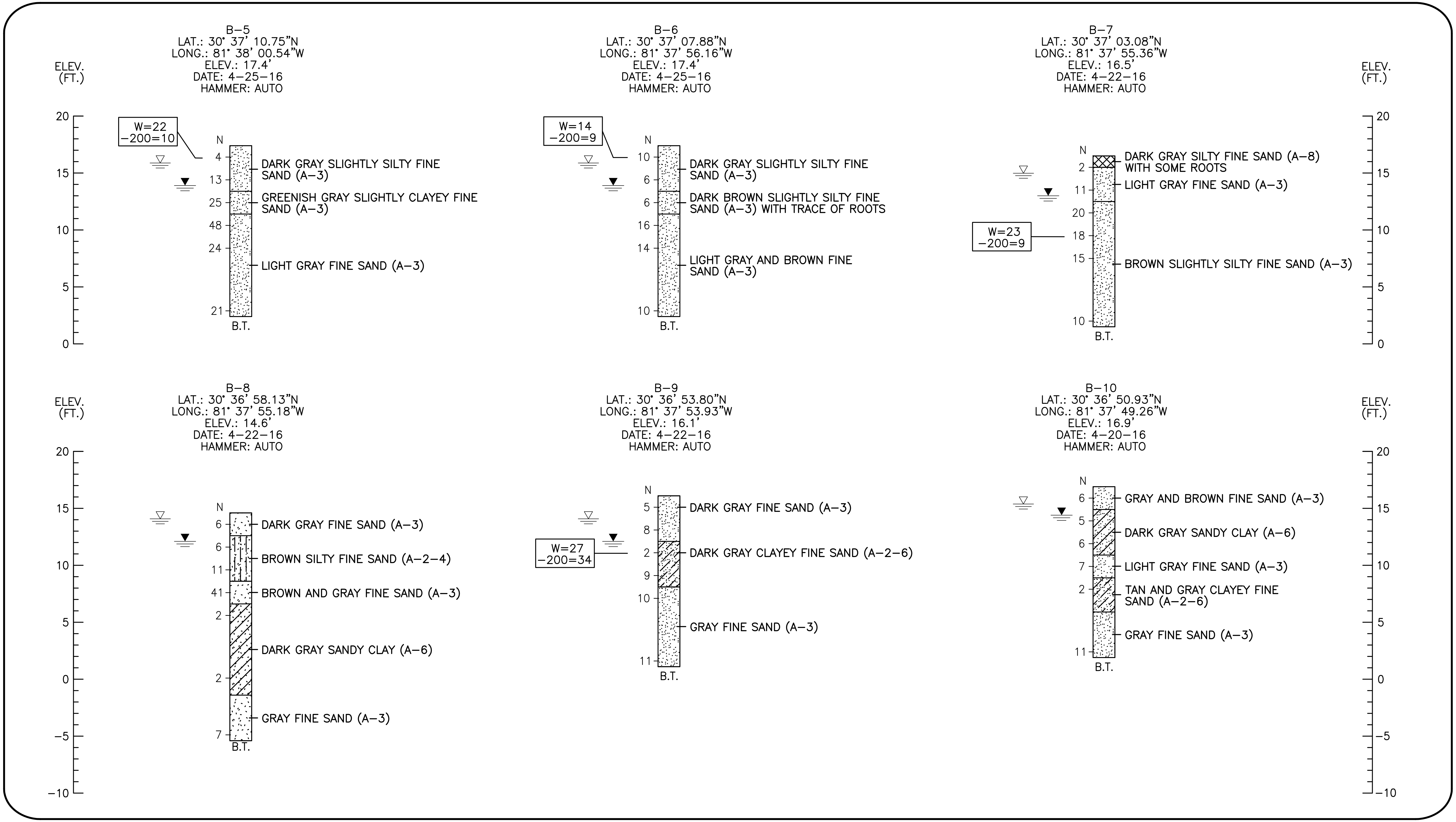

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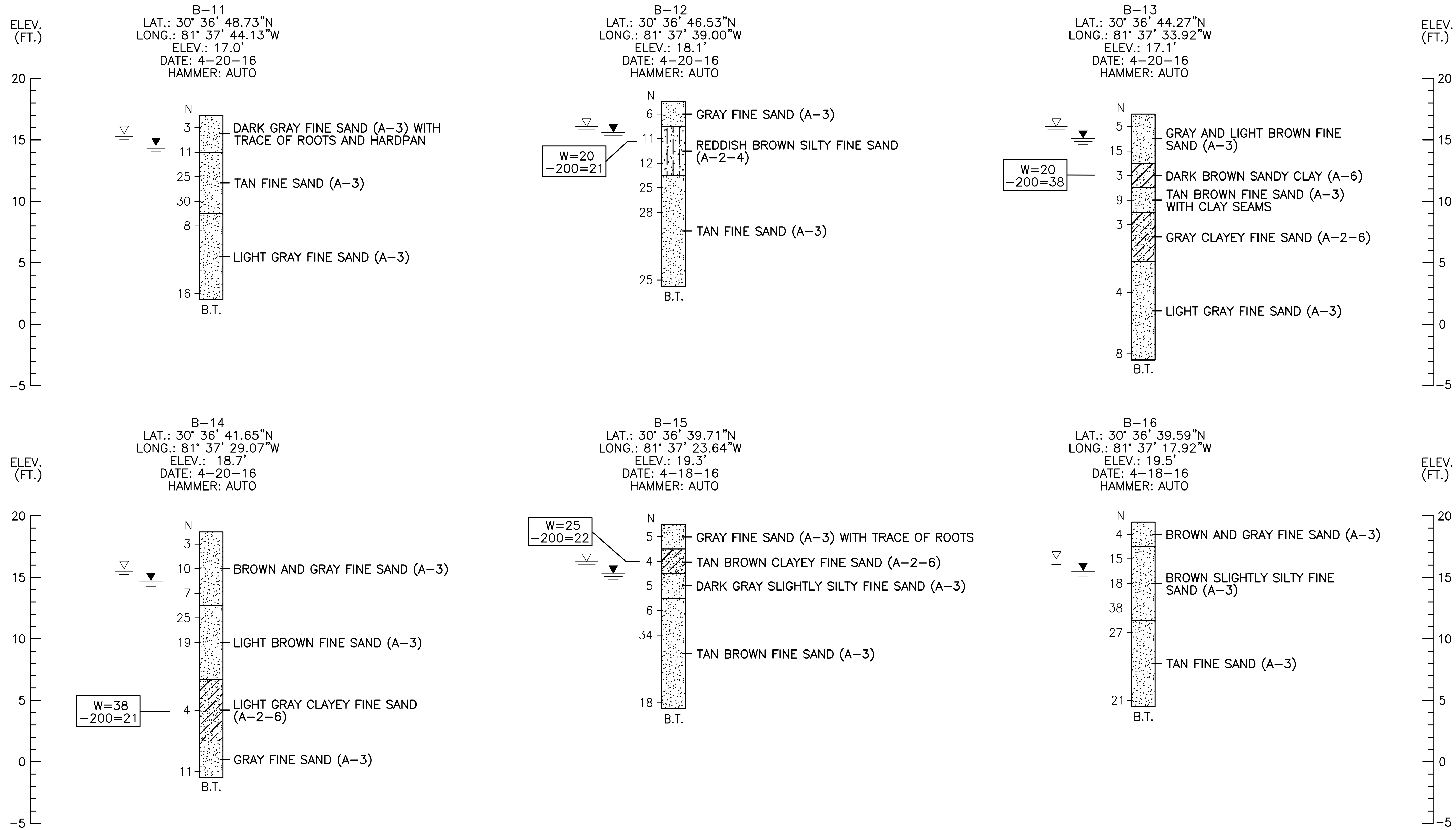

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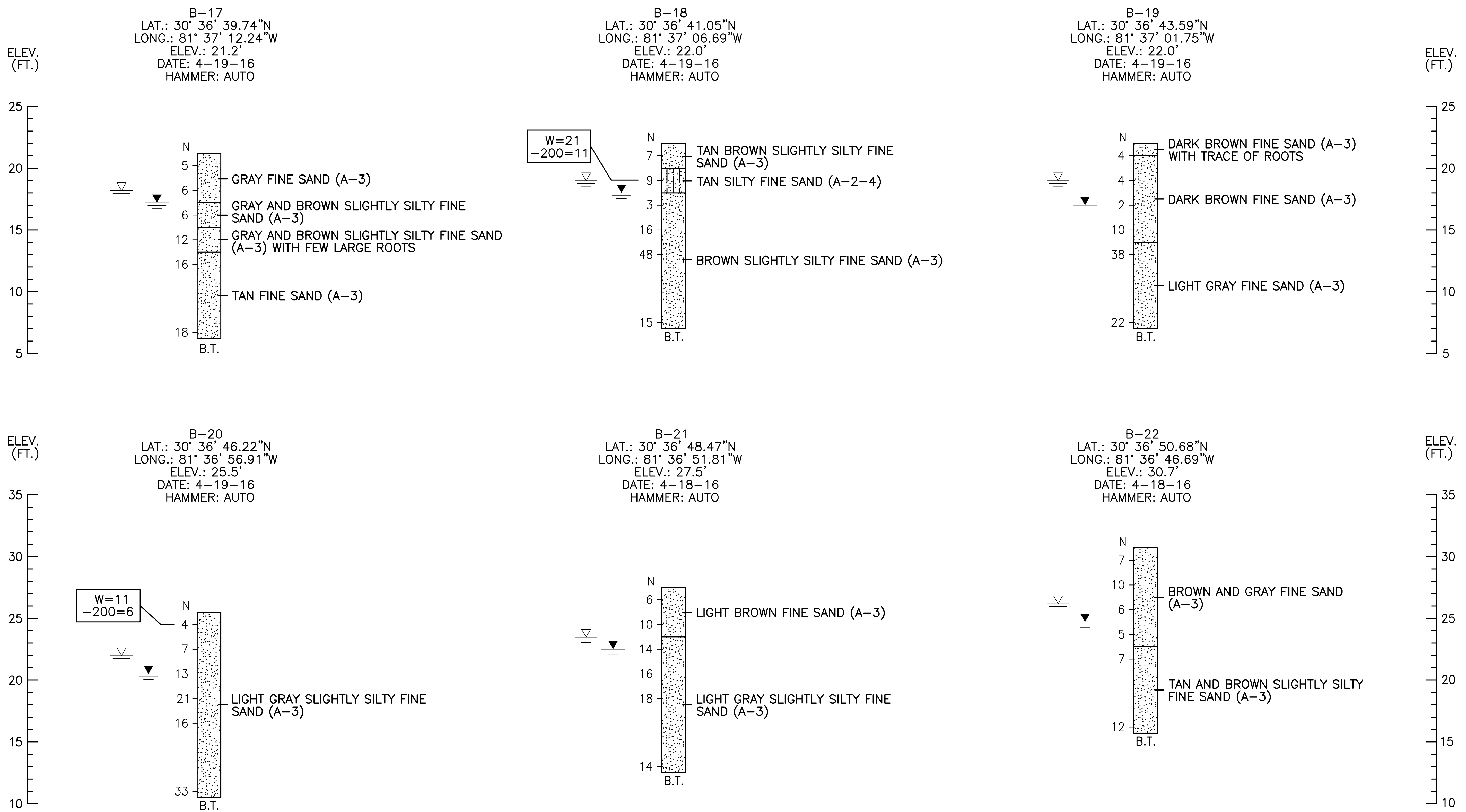

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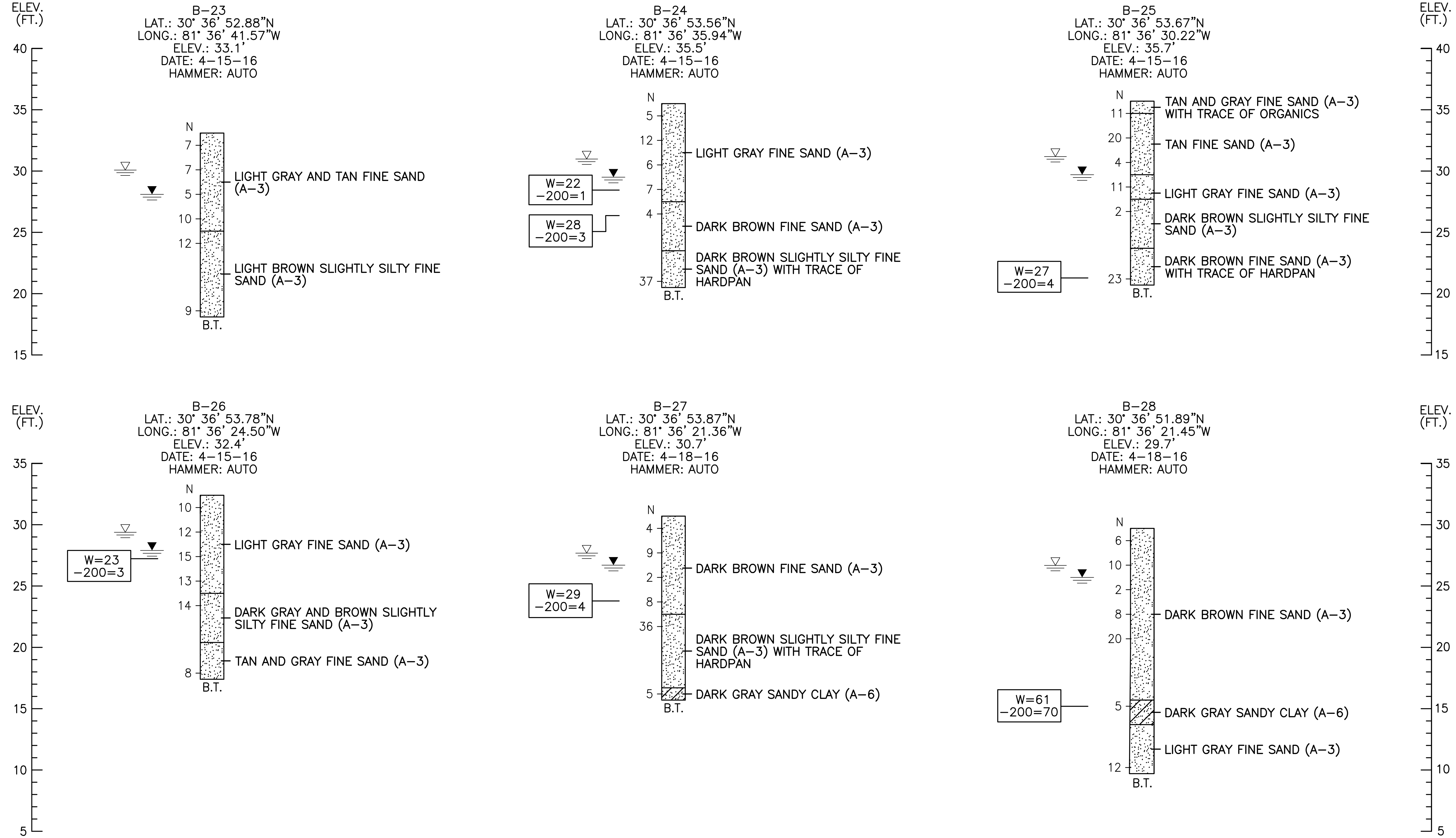
CONSTRUCTION ENGINEERING INSPECTION

GENERAL SUBSURFACE PROFILES

WILLIAM BURGESS BLVD. FROM HARTS ROAD TO SR 200
FORCE MAIN AND RECLAIM WATER MAIN
NASSAU COUNTY, FLORIDA



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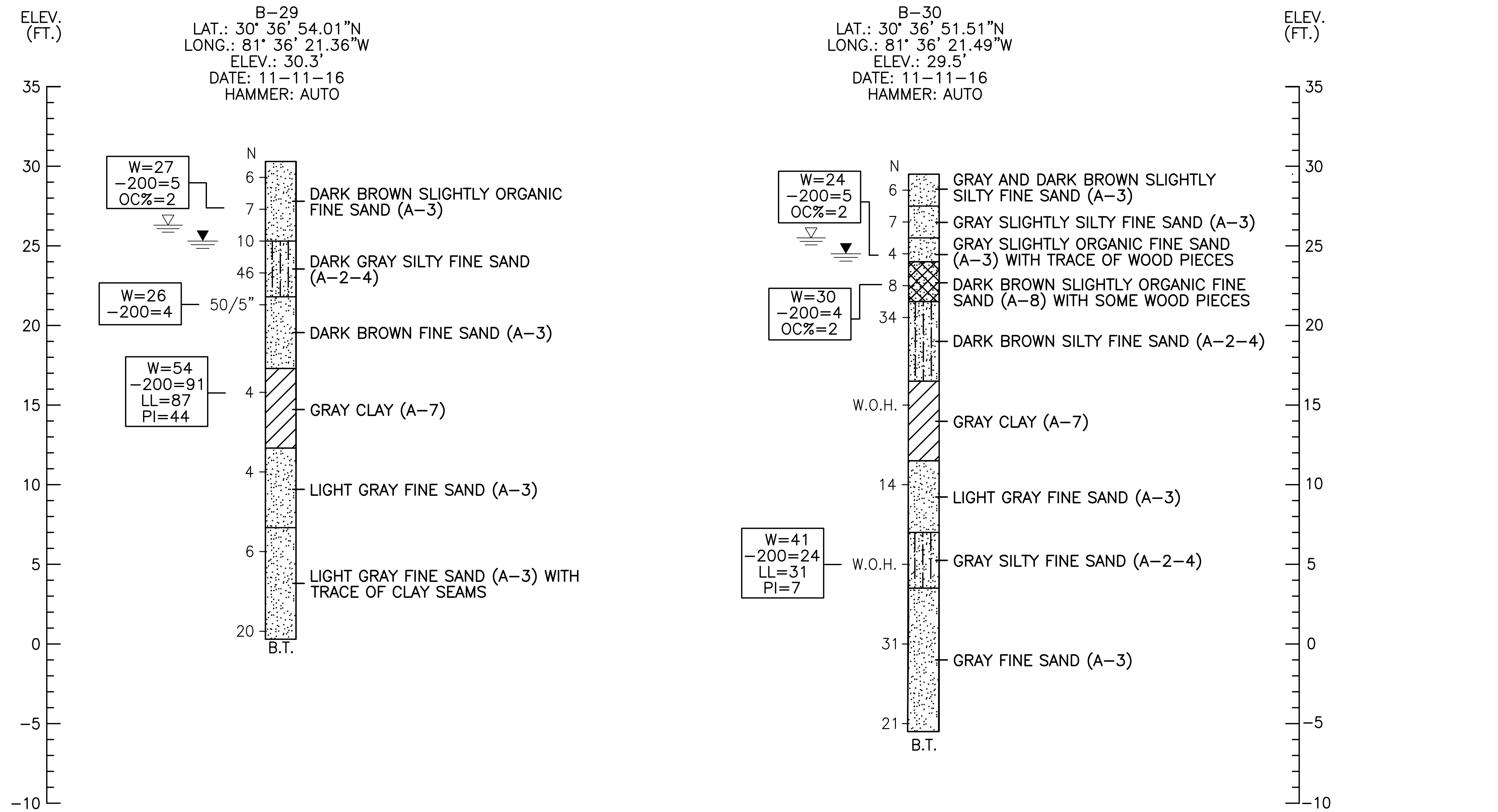

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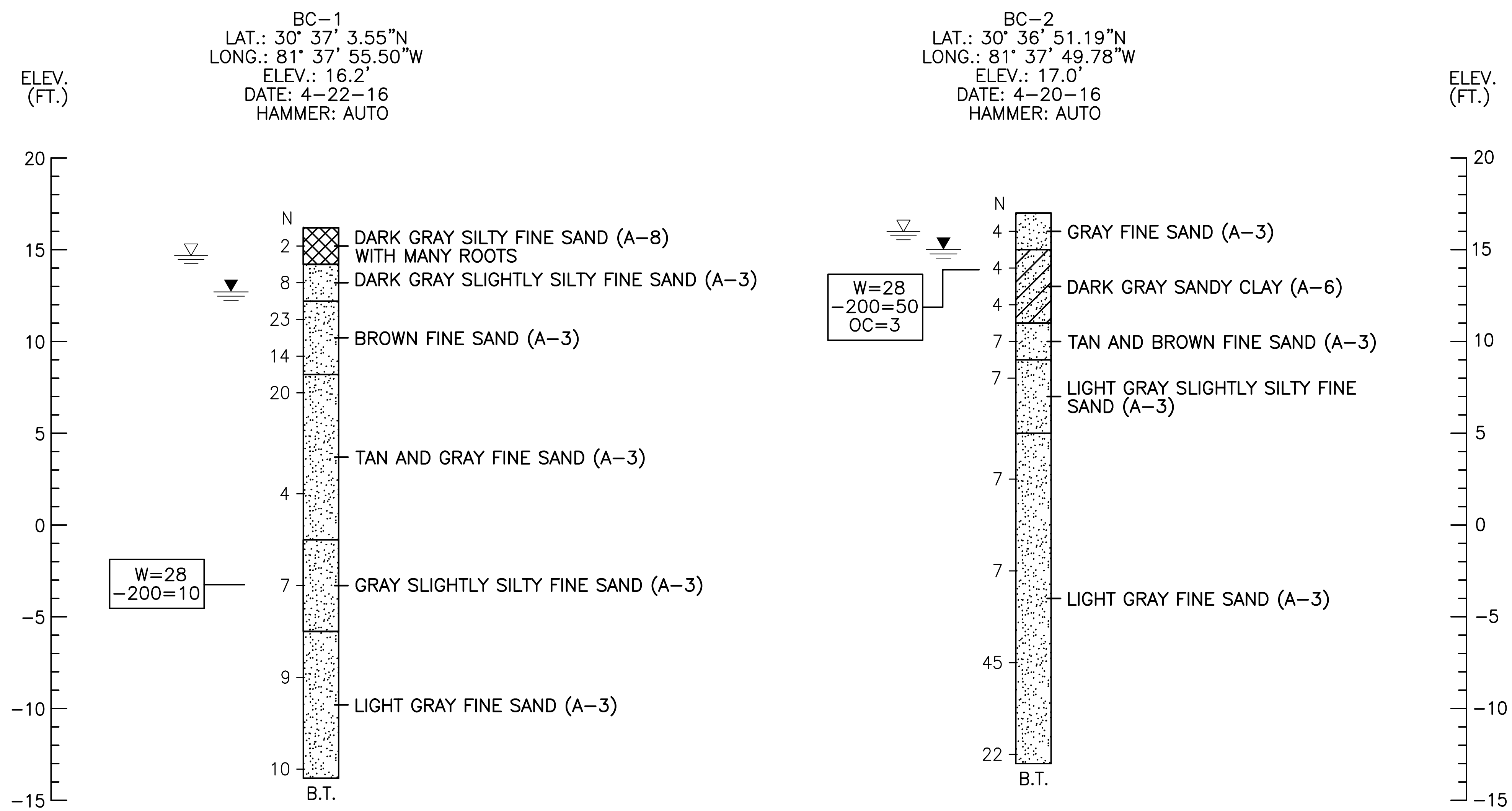

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Summary of Laboratory Testing Results

SUMMARY OF LABORATORY TEST RESULTS

William Burgess from Harts Road to SR 200 Force Main & Reclaim Water Main
Nassau County, Florida

Boring No.	Sample No.	Approximate Depth (ft)			Natural Moisture Content (%)	Organic Content (%)	Percent Passing Sieve Size (%)						Atterberg Limits		Soil Classification Symbol
							#4	#10	#40	#60	#100	#200	LL	PI	
B-2	2	2.0	-	4.0	29	2						9			A-3
B-2	4	6.0	-	8.0	23							11			A-2-4
B-3	3	4.0	-	6.0	37							46			A-6
B-3	5	8.0	-	10.0	27							6			A-3
B-4	2	2.0	-	4.0	15							18			A-2-4
B-4	5	8.0	-	10.0	27							5			A-3
B-4	6	13.5	-	15.0	28							4			A-3
B-5	1	0.0	-	2.0	22							10			A-3
B-6	1	0.0	-	2.0	14							9			A-3
B-7	4	6.0	-	8.0	23							9			A-3
B-9	3	4.0	-	6.0	27							34			A-2-6
B-12	2	2.0	-	4.0	20							21			A-2-4
B-13	3	4.0	-	6.0	20							38			A-6
B-14	6	13.5	-	15.0	38							21			A-2-6
B-15	2	2.0	-	4.0	25							22			A-2-6
B-18	2	2.0	-	4.0	21							11			A-2-4
B-20	1	0.0	-	2.0	11							6			A-3
B-24	4	6.0	-	8.0	22							1			A-3
B-24	5	8.0	-	10.0	28							3			A-3
B-25	6	13.5	-	15.0	27							4			A-3
B-26	3	4.0	-	6.0	23							3			A-3
B-27	4	6.0	-	8.0	29							4			A-3
B-28	6	13.5	-	15.0	61							70			A-6
B-29	2	2.0	-	4.0	27	2						5			A-3
B-29	5	8.0	-	10.0	26							4			A-3
B-29	6	13.5	-	15.0	54							91	87	44	A-7-5
B-30	3	5.0	-	7.0	24	2						5			A-3
B-30	4	7.0	-	8.0	30	2						4			A-8*
B-30	8	23.5	-	25.0	41							24	31	7	A-2-4
BC-1	7	18.5	-	20.0	28							10			A-3
BC-2	2	2.0	-	4.0	28	3						50			A-6

* Soil classified as A-8 due to the presence of some wood pieces in the sample

Existing Pavement System Thickness

EXISTING PAVEMENT SYSTEM THICKNESS

William Burgess Blvd. from Harts Rd to SR 200 Force Main and Reclaim Water Main
Nassau County, Florida

Road Name	Core No.	Location		Material Layer Thickness		Description & AASHTO Classification of Soil Beneath Pavement / Base
		Lat.	Long.	Asphalt (in)	Limerock (in)	
Un-named Road Near Nassau Co. Entrance	C-1	30°36'47.44"N	81°37'43.98"W	2	8	Gray Brown Fine SAND (A-3)
Nicko Lane	C-2	30°36'46.71"N	81°36'55.32"W	1 1/2	7	Brown Fine SAND (A-3)
Cartesian Pointe Dr	C-3	30°36'51.28"N	81°36'45.46"W	2	9	Gray Slightly Silty Fine SAND (A-3)
Harts Road	C-4	30°36'53.85"N	81°36'21.65"W	2	7	Gray Brown Fine SAND (A-3)
William Burgess at Harts Road	C-5	30°36'53.25"N	81°36'20.94"W	2	8 1/2	Gray Brown Fine SAND (A-3)

Key to Soil Classification

KEY TO SOIL CLASSIFICATION

Correlation of Penetration Resistance with Relative Density and Consistency

Granular Materials

Relative Density	**Auto Hammer SPT N-Value (Blows/foot)**
Very Loose	Less than 3
Loose	3 – 8
Medium Dense	8 - 24
Dense	24 - 40
Very Dense	Greater than 40

Silts and Clays

Consistency	**Auto Hammer SPT N-Value (Blows/foot)**
Very Soft	Less than 1
Soft	1 – 3
Firm	3 - 6
Stiff	6 - 12
Very Stiff	12 - 24
Hard	Greater than 24

Particle Size Identification (Unified Soil Classification System)

Boulders:	Diameter exceeds 8 inches
Cobbles:	3 to 8 inches diameter
Gravel:	Coarse - 3/4 to 3 inches in diameter
	Fine - 4.76 mm to 3/4 inch in diameter
Sand:	Coarse - 2.0 mm to 4.76 mm in diameter
	Medium - 0.42 mm to 2.0 mm in diameter
	Fine - 0.074 mm to 0.42 mm in diameter

Modifiers

These modifiers provide our estimate of the amount of fines (silt or clay size particles) in soil samples.

Approximate Fines Content	Modifiers
5% Fines 12%	Slightly silty or slightly clayey
12% Fines 30%	Silty or clayey
30% Fines 50%	Very silty or very clayey

These modifiers provide our estimate of shell, rock fragments, or roots in the soil sample.

Approximate Content, By Weight	Modifiers
< 5%	Trace
5% to 10%	Few
15% to 25%	Little
30% to 45%	Some
50% to 100%	Mostly

These modifiers provide our estimate of organic content in the soil sample.

Organic Content	Modifiers
1% to 3%	Trace
3% to 5%	Slightly Organic
5% to 20%	Organic
20% to 75%	Highly Organic (Muck)
> 75%	Peat

Field and Laboratory Test Procedures

FIELD AND LABORATORY TEST PROCEDURES

FIELD TEST PROCEDURES

Standard Penetration Test (SPT) Borings – The soil penetration test borings were made in general accordance with ASTM D1586, "Penetration Test and Split-Barrel Sampling of Soils". The borings were advanced by continuous driving the split spoon sampler to a depth of 10 feet below the existing ground surface. Below 10 feet and until boring termination depths, split spoon sampling was performed at a spacing of 5 feet. Bentonite drilling fluid was used below the ground water level to stabilize the sides and to flush the cuttings. At the sampling intervals, the drilling tools were removed and soil samples were obtained with a standard 1.4 inch I.D., 2.0 inch O.D., split-tube sampler. The sampler was first seated six inches and then driven an additional foot with blows of a 140 pound hammer falling 30 inches. The number of hammer blows required to drive the sampler the final foot is designated the "Penetration Resistance". The penetration resistance, when properly interpreted, is an index to the soil strength and density.

Representative portions of the soil samples, obtained from the sampler, were placed in glass jars and transported to our laboratory. The samples were then examined by a geotechnical engineer to confirm the field classifications.

LABORATORY TEST PROCEDURES

Percent Organic Content – This test is based on the percent of organics by weight of the total sample. This test was conducted in accordance with FM I - T 267.

Percent Fines Content – To determine the percentage of soils finer than No. 200 sieve, the dried samples were washed over a 200 mesh sieve. The material retained on the sieve was oven dried and then weighed and compared with the unwashed dry weight in order to determine the weight of the fines. The percentage of fines in the soil sample was then determined as the percentage of weight of fines in the sample to the weight of the unwashed sample. This test was conducted in accordance with ASTM D 1140.

Natural Moisture Content – The water content is the ratio, expressed as a percentage, of the weight of water in a given mass of soil to the weight of the solid particles. This test was conducted in the general accordance with FM 1-T 265.

Plasticity (Atterberg Limits) – The soil's Plastic Index (PI) is bracketed by the Liquid Limit (LL) and Plastic Limit (PL). The LL is the moisture content at which the soil flows as a heavy viscous fluid and is determined in general accordance with FM 1-T 089. The PL is the moisture content at which the soil begins to crumble when rolled into a small thread and is also determined in general accordance with FM 1-T 090. The water-plasticity ratio is computed from the above test data. This ratio is an expression comparing the relative natural state of soil with its liquid and plastic consolidation characteristics.

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