JEFFERSON COUNTY PURCHASING DEPARTMENT
Deborah L. Clark, Purchasing Agent

1149 Pearl Street
1st Floor, Beaumont, TX 77701

OFFICE MAIN: (409) 835-8593
FAX: (409) 835-8456

Addendum to IFB

IFB NUMBER: IFB 23-035/JW

IFB TITLE: Crane Bayou Pump Station Generators and Building – Community Development Block Grant-Disaster Recovery (CDBG-DR) Program Project for Jefferson County

IFB DUE BY: **11:00 AM, CT, WEDNESDAY, JUNE 21, 2023**

ADDENDUM NO.: **3**

ISSUED (DATE): June 16, 2023

To Bidder: This Addendum is an integral part of the IFB package under consideration by you as a Bidder in connection with the subject matter herein identified. Jefferson County deems all sealed bids to have been proffered in recognition and consideration of the entire IFB Specifications Package – *including all addenda*. For purposes of clarification, **receipt of this present Addendum by a Bidder should be evidenced by returning it (signed) as part of the Bidder's sealed bid submission.** If the bid submission has already been received by the Jefferson County Purchasing Department, Bidder should return this addendum in a separate sealed envelope, clearly marked with the IFB Title, IFB Number, and IFB Opening Date and Time, as stated above.

Reason for Issuance of this Addendum: CLARIFICATIONS, PAGE REPLACEMENT, WAGE RATES, AND GEOTECHNICAL REPORT

The information included herein is hereby incorporated into the documents of this present bid matter and supersedes any conflicting documents or portion thereof previously issued.

Receipt of this Addendum is hereby acknowledged by the undersigned Respondent:

ATTEST:

____
Authorized Signature (Respondent)

____
Witness

____
Title of Person Signing Above

____
Witness

____
Typed Name of Business or Individual

Approved by ____ Date: __________

____
Address

STATE OF TEXAS
JASON V. WARD
107836
LICENSED
PROFESSIONAL ENGINEER

6/16/2023

TBPE Firm F-2144

JEFFERSON COUNTY PURCHASING DEPARTMENT
Deborah L. Clark, Purchasing Agent

1149 Pearl Street **OFFICE MAIN: (409) 835-8593**
1st Floor, Beaumont, TX 77701 **FAX: (409) 835-8456**

IFB 23-035/JW
Crane Bayou Pump Station Generators and Building – Community Development Block Grant – Disaster Recovery (CDBG-DR) Program Project for Jefferson County

CLARIFICATIONS

Question: Per Addendum 01 – The Mitigation Measures- mentions that there is a USACE Consultation underway and that would need to be completed before construction can begin. Can we confirm that there will be no additional costs required to be by for the general contractor on this project and we would just be waiting for the consultation to be completed before commencing construction?

Answer: Correct. No additional costs are anticipated.

Question: Per Addendum 01 – The Mitigation Measures – Can we confirm that the *Hazards and Nuisances including site safety* section is just to clarify that any dumpsters we have on site will need to be 80' from the fuel pad location?

Answer: This is correct.

Question: The specifications have an asphalt paving spec section. Per review of the drawings there doesn't seem to be any asphalt paving that we are pouring. Can you please confirm that the Asphalt Paving isn't required?

Answer: No asphalt paving is required unless damaged by the Contractor's activities. Any damaged asphalt will need to be repaired/replaced to equal or better condition.

Question: On sheet C-2 it states we cannot park a vehicle larger than a 3/4" ton vehicle on the level or within the toe. Can you clarify the intent of this note as this will impact construction? Will we be able to bring concrete trucks on the levee? What about setting up a crane to set the generators and concrete roof panels? We will likely need large equipment within the toe for the majority of the project.

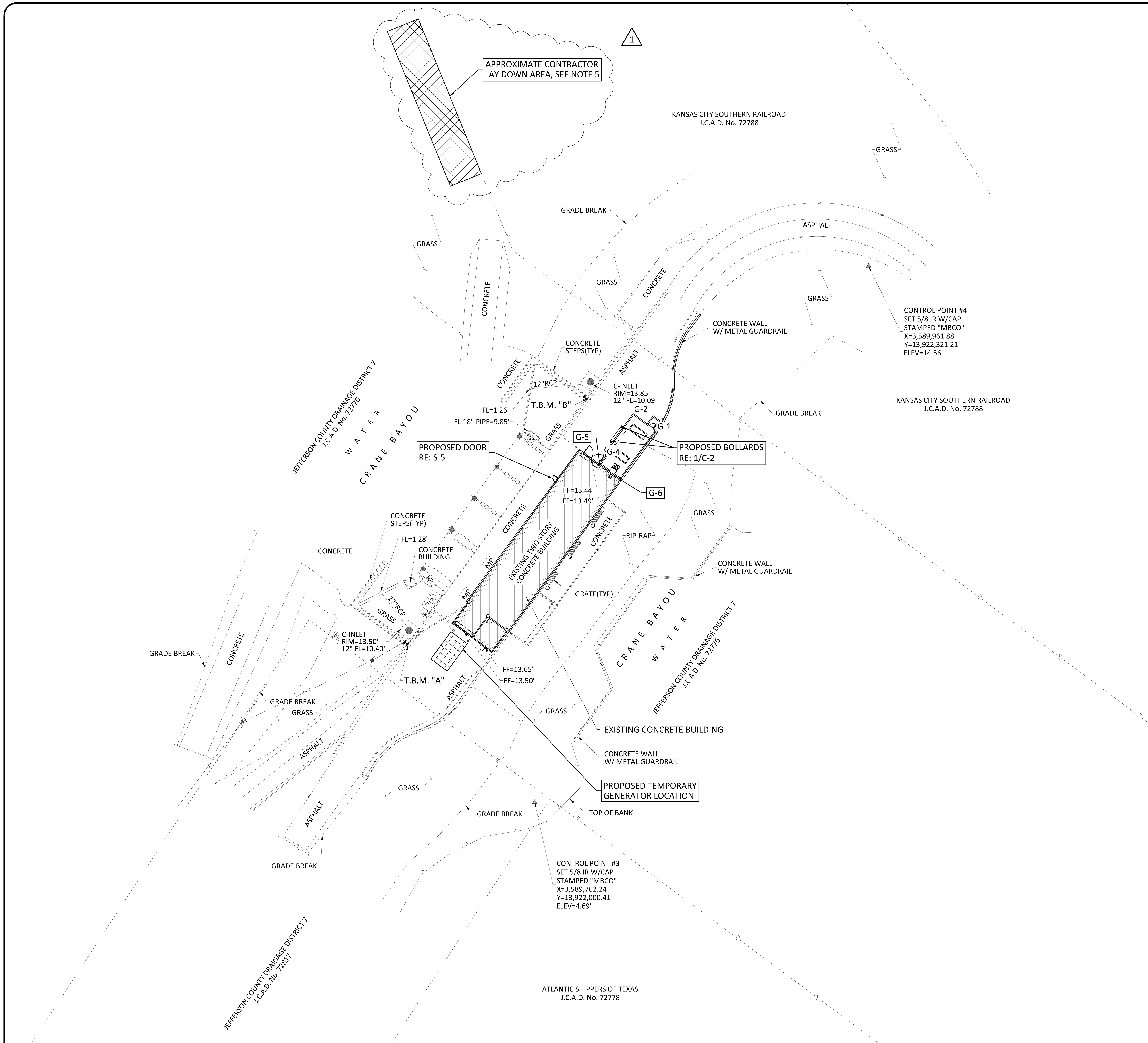
Answer: The intent of this requirement is to mat heavy loads. Specifically, heavy loads such as concrete trucks or tractor/trailers crossing the pump station intake will need to be matted. Cranes will also need to be matted.

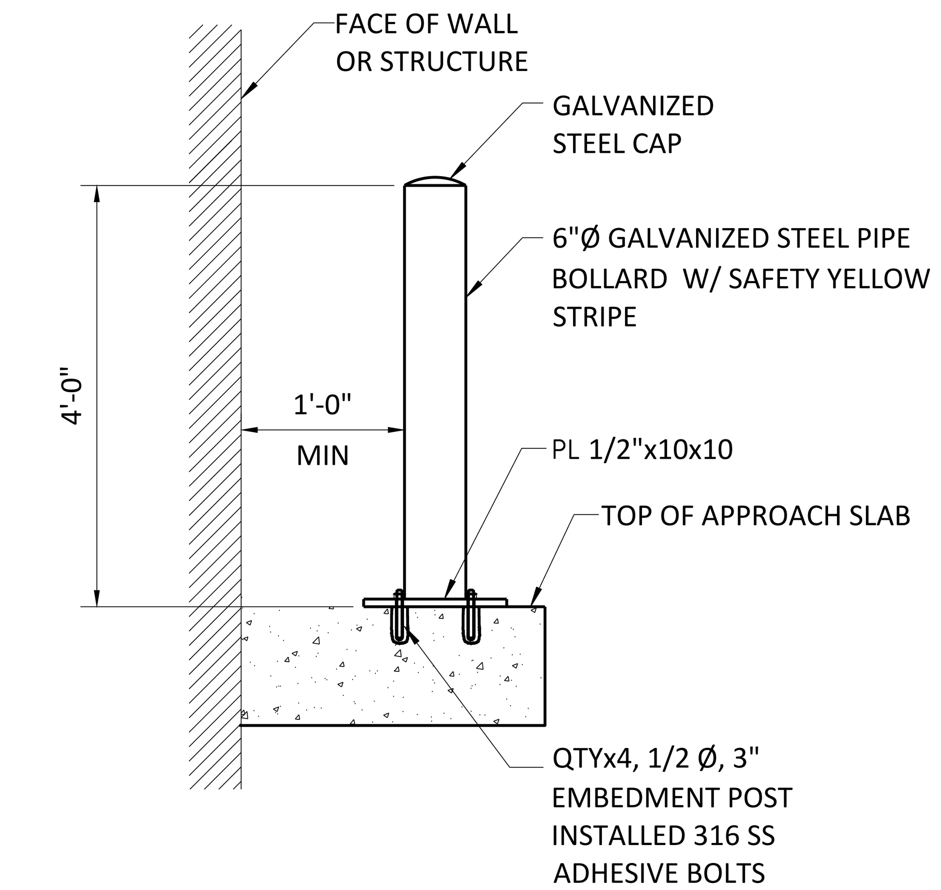
REPLACEMENTS

Replace sheet C-2 with the attached sheet C-2.

ADDITIONAL DOCUMENTATION

Geo-tecnical Report
Wage Determinations for the Project





1 BOLLARD DETAIL

NOT TO SCALE

NOTES:

1. CONTRACTOR SHALL NOT PARK ANY VEHICLE LARGER THAN A 3/4 TON TRUCK ON TOP OF THE LEVEE OR WITHIN THE TOE (INDICATED BY A GRADE BREAK ON THIS SHEET) WITHOUT WRITTEN APPROVAL FROM THE OWNER.
2. EQUIPMENT AND VEHICLES LARGER THAN A 3/4 TON TRUCK MAY STAGE ON THE LEVEE FOR THE PURPOSES OF LOADING AND UNLOADING ONLY.
3. CONTRACTOR IS CAUTIONED THAT THE OWNER WILL BE OPERATING THE PUMP STATION THROUGHOUT CONSTRUCTION AND SHALL KEEP ROADWAYS AND ACCESS POINTS CLEAR TO ALLOW FREE MOVEMENT FOR OWNER'S OPERATIONS AND MAINTENANCE STAFF.
4. TEMPORARY GENERATOR SHALL BE TRAILER MOUNTED. CONTRACTOR SHALL COORDINATE WITH OWNER IF GENERATOR NEEDS TO BE TEMPORARILY RELOCATED TO ALLOW ACCESS TO THE SOUTHWEST ROLL UP DOOR.
5. CONTRACTOR MAY USE JEFFERSON COUNTY DD7 PROPERTY FOR LAYDOWN AREA ABOVE ELEVATION 8 FEET.

BUILDING TABLE

POINT NO.	NORTHING	EASTING	POINT DESCRIPTION
G-1	13922222.70	3589835.09	GENERATOR RM
G-2	13922233.02	3589821.17	GENERATOR RM
G-3	13922208.76	3589803.18	GENERATOR RM
G-4	13922207.59	3589804.75	GENERATOR RM
G-5	13922202.67	3589801.10	GENERATOR RM
G-6	13922193.45	3589813.40	GENERATOR RM

ADDENDUM NO. 3 - 3 OF 47

NORTH

0 10' 20' 30' 60'
SCALE IN FEET

ISSUED FOR BID

Freese and Nichols, Inc.
Texas Registered Engineering Firm F-2144

STATE OF TEXAS
JASON V. WARD
107836
LICENSED PROFESSIONAL ENGINEER
5/25/2023

FREESE NICHOLS
10497 Town and Country Way, Suite 500
Houston, Texas 77024
Phone - (713) 600-6800
Web - www.freese.com

JEFFERSON COUNTY, TX
CRANE BAYOU PUMP STATION
GENERATORS AND BUILDING

CIVIL

SITE PLAN

F&N JOB NO.	JFF22292
DATE	05/15/2023
DESIGNED	LJB
DRAWN	JSG
REVISED	
CHECKED	JVW
FILE NAME	CV-PROP-SITE.dwg

NO.	ISSUE	BY	DATE
3	ADDENDUM 3	JVW	5/25/23

VERIFY SCALE 0 1
Bar is one inch on original drawing. If not one inch on this sheet, adjust scale.

SHEET C-2

SEQ. 4

ACAD Rel: 24.2s (LMS Tech)
Filename: N:\WTU\Drawings\CV-PROP-SITE.dwg
Last Saved: 5/25/2023 3:17 PM Saved By: 02690
Plot Date: 5/25/2023 3:18 PM Plot By: 02690 Filename: N:\WTU\Drawings\CV-PROP-SITE.dwg

"General Decision Number: TX20230256 05/05/2023

Superseded General Decision Number: TX20220256

State: Texas

Construction Type: Building

County: Jefferson County in Texas.

BUILDING CONSTRUCTION PROJECTS (does not include single family homes or apartments up to and including 4 stories).

Note: Contracts subject to the Davis-Bacon Act are generally required to pay at least the applicable minimum wage rate required under Executive Order 14026 or Executive Order 13658. Please note that these Executive Orders apply to covered contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but do not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(2)-(60).

If the contract is entered into on or after January 30, 2022, or the contract is renewed or extended (e.g., an option is exercised) on or after January 30, 2022:	. Executive Order 14026 generally applies to the contract. . The contractor must pay all covered workers at least $16.20 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract in 2023.
If the contract was awarded on or between January 1, 2015 and January 29, 2022, and the contract is not renewed or extended on or after January 30, 2022:	. Executive Order 13658 generally applies to the contract. . The contractor must pay all covered workers at least $12.15 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on that contract in 2023.

The applicable Executive Order minimum wage rate will be adjusted annually. If this contract is covered by one of the Executive Orders and a classification considered necessary for performance of work on the contract does not appear on this

wage determination, the contractor must still submit a
conformance request.

Additional information on contractor requirements and worker
protections under the Executive Orders is available at
http://www.dol.gov/whd/govcontracts.

Modification Number	Publication Date
0	01/06/2023
1	03/17/2023
2	05/05/2023

ASBE0022-009 06/01/2022

	Rates	Fringes
ASBESTOS WORKER/HEAT & FROST INSULATOR (Duct, Pipe and Mechanical System Insulation)....	$ 26.88	15.41

BOIL0074-003 01/01/2021

	Rates	Fringes
BOILERMAKER......................	$ 29.47	24.10

BRTX0005-006 06/01/2022

	Rates	Fringes
BRICKLAYER.......................	$ 27.05	3.54

ELEC0479-005 09/26/2022

	Rates	Fringes
ELECTRICIAN......................	$ 31.20	13.18

ENGI0450-002 04/01/2014

	Rates	Fringes
POWER EQUIPMENT OPERATOR		
Cranes......................	$ 34.85	9.85

IRON0084-011 06/01/2022

	Rates	Fringes
IRONWORKER, ORNAMENTAL...........	$ 26.76	7.88

IRON0135-002 09/01/2022

Rates Fringes

IRONWORKER, STRUCTURAL...........$ 34.35 14.44

PLUM0068-001 10/01/2022

Rates Fringes

PLUMBER..........................$ 33.81 11.63

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* PLUM0211-009 10/01/2022

Rates Fringes

PIPEFITTER.......................$ 38.03 12.66

SHEE0054-007 04/01/2020

Rates Fringes

SHEET METAL WORKER (Excludes
HVAC Duct Installation)..........$ 28.69 14.13

----

* SUTX2014-032 07/21/2014

Rates Fringes

CARPENTER........................$ 17.98 3.72

CEMENT MASON/CONCRETE FINISHER...$ 13.44 ** 0.00

FORM WORKER......................$ 13.02 ** 0.00

IRONWORKER, REINFORCING..........$ 12.95 ** 0.00

LABORER: Common or General......$ 12.04 ** 0.00

LABORER: Mason Tender - Brick...$ 12.90 ** 0.00

LABORER: Mason Tender -
Cement/Concrete..................$ 10.50 ** 0.00

LABORER: Pipelayer.............$ 13.47 ** 0.00

LABORER: Roof Tearoff...........$ 11.28 ** 0.00

LABORER: Landscape and
Irrigation.......................$ 11.04 ** 0.36

OPERATOR:
Backhoe/Excavator/Trackhoe.......$ 18.65 0.00

OPERATOR: Bobcat/Skid
Steer/Skid Loader................$ 13.93 ** 0.00

OPERATOR: Bulldozer.............$ 18.88 0.00

OPERATOR: Drill.................$ 16.22 0.34

OPERATOR: Forklift..............$ 17.69 0.00

OPERATOR: Grader/Blade..........$ 13.37 ** 0.00

OPERATOR: Loader................$ 13.55 ** 0.94

OPERATOR: Mechanic..............$ 17.52 3.33

OPERATOR: Paver (Asphalt,
Aggregate, and Concrete).........$ 16.03 ** 0.00

OPERATOR: Roller................$ 16.00 ** 0.00

PAINTER (Brush, Roller, and
Spray)...........................$ 16.75 4.51

ROOFER...........................$ 15.40 ** 0.00

SHEET METAL WORKER (HVAC Duct
Installation Only)...............$ 26.89 10.38

TILE FINISHER....................$ 12.00 ** 0.00

TILE SETTER......................$ 16.17 ** 0.00

TRUCK DRIVER: Dump Truck........$ 12.39 ** 1.18

TRUCK DRIVER: Flatbed Truck.....$ 19.65 8.57

TRUCK DRIVER: Semi-Trailer
Truck............................$ 12.50 ** 0.00

TRUCK DRIVER: Water Truck.......$ 12.00 ** 4.11

WELDERS - Receive rate prescribed for craft performing
operation to which welding is incidental.

==

** Workers in this classification may be entitled to a higher minimum wage under Executive Order 14026 ($16.20) or 13658 ($12.15). Please see the Note at the top of the wage determination for more information.

Note: Executive Order (EO) 13706, Establishing Paid Sick Leave for Federal Contractors applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2017. If this

contract is covered by the EO, the contractor must provide employees with 1 hour of paid sick leave for every 30 hours they work, up to 56 hours of paid sick leave each year. Employees must be permitted to use paid sick leave for their own illness, injury or other health-related needs, including preventive care; to assist a family member (or person who is like family to the employee) who is ill, injured, or has other health-related needs, including preventive care; or for reasons resulting from, or to assist a family member (or person who is like family to the employee) who is a victim of, domestic violence, sexual assault, or stalking. Additional information on contractor requirements and worker protections under the EO is available at
https://www.dol.gov/agencies/whd/government-contracts.

Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (ii)).

The body of each wage determination lists the classification and wage rates that have been found to be prevailing for the cited type(s) of construction in the area covered by the wage determination. The classifications are listed in alphabetical order of ""identifiers"" that indicate whether the particular rate is a union rate (current union negotiated rate for local), a survey rate (weighted average rate) or a union average rate (weighted union average rate).

Union Rate Identifiers

A four letter classification abbreviation identifier enclosed in dotted lines beginning with characters other than ""SU"" or ""UAVG"" denotes that the union classification and rate were prevailing for that classification in the survey. Example: PLUM0198-005 07/01/2014. PLUM is an abbreviation identifier of the union which prevailed in the survey for this classification, which in this example would be Plumbers. 0198 indicates the local union number or district council number where applicable, i.e., Plumbers Local 0198. The next number, 005 in the example, is an internal number used in processing the wage determination. 07/01/2014 is the effective date of the most current negotiated rate, which in this example is July 1, 2014.

Union prevailing wage rates are updated to reflect all rate changes in the collective bargaining agreement (CBA) governing this classification and rate.

Survey Rate Identifiers

Classifications listed under the ""SU"" identifier indicate that no one rate prevailed for this classification in the survey and the published rate is derived by computing a weighted average rate based on all the rates reported in the survey for that classification. As this weighted average rate includes all rates reported in the survey, it may include both union and non-union rates. Example: SULA2012-007 5/13/2014. SU indicates the rates are survey rates based on a weighted average calculation of rates and are not majority rates. LA indicates the State of Louisiana. 2012 is the year of survey on which these classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. 5/13/2014 indicates the survey completion date for the classifications and rates under that identifier.

Survey wage rates are not updated and remain in effect until a new survey is conducted.

Union Average Rate Identifiers

Classification(s) listed under the UAVG identifier indicate that no single majority rate prevailed for those classifications; however, 100% of the data reported for the classifications was union data. EXAMPLE: UAVG-OH-0010 08/29/2014. UAVG indicates that the rate is a weighted union average rate. OH indicates the state. The next number, 0010 in the example, is an internal number used in producing the wage determination. 08/29/2014 indicates the survey completion date for the classifications and rates under that identifier.

A UAVG rate will be updated once a year, usually in January of each year, to reflect a weighted average of the current negotiated/CBA rate of the union locals from which the rate is based.

WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

* an existing published wage determination
* a survey underlying a wage determination
* a Wage and Hour Division letter setting forth a position on a wage determination matter
* a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour National Office because National Office has responsibility for

the Davis-Bacon survey program. If the response from this
initial contact is not satisfactory, then the process described
in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal
process described here, initial contact should be with the
Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations
Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

2.) If the answer to the question in 1.) is yes, then an
interested party (those affected by the action) can request
review and reconsideration from the Wage and Hour Administrator
(See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

The request should be accompanied by a full statement of the
interested party's position and by any information (wage
payment data, project description, area practice material,
etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an
interested party may appeal directly to the Administrative
Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

4.) All decisions by the Administrative Review Board are final.

==

END OF GENERAL DECISIO"

TOLUNAY-WONG ENGINEERS

GEOTECHNICAL ENGINEERING REPORT
EMERGENCY GENERATOR BUILDING
CRANE BAYOU PUMPING STATION
JEFFERSON COUNTY DRAINAGE DISTRICT NO. 7
PORT ARTHUR, TEXAS

Prepared for:

Freese and Nichols, Inc.
10497 Town and Country Way, Suite 600
Houston, Texas 77024

Prepared by:

Tolunay-Wong Engineers, Inc.
2455 West Cardinal Drive, Suite A
Beaumont, Texas 77705

May 13, 2022

TWE Project No. 22.23.051 / Report No. 129545

Geotechnical Engineering
Construction Materials Testing
Geophysical Services
Deep Foundations Testing
Environmental Field Services

www.tweinc.com
1-888-887-9932

May 13, 2022

Freese and Nichols, Inc.
10497 Town and Country Way, Suite 600
Houston, Texas 77024

Attn: Mr. Lewis Bernard, P.E.
Lewis.Bernard@freese.com

Ref: Proposal for Geotechnical Services
Emergency Generator Building
Crane Bayou Pumping Station
Jefferson County Drainage District No. 7
Port Arthur, Texas
TWE Project No. 22.23.051 / Report No. 129545

Dear Mr. Bernard,

Tolunay-Wong Engineers, Inc. (TWE) is pleased to submit this report of our geotechnical engineering study performed for the above referenced project. This report contains a detailed description of the field and laboratory work performed for this study as well as a soil boring log including tabulated laboratory test results. Also included in this report are our geotechnical design and construction recommendations for the proposed emergency generator building.

We appreciate the opportunity to work with you on this phase of the project and look forward to the opportunity of providing additional services as the project progresses. If you have any questions regarding this report or if we can be of further assistance, please contact us.

Sincerely,

TOLUNAY-WONG ENGINEERS, INC.
TBPELS Firm Number F-124

Trey O'Connor, E.I.T.
Project Geotechnical Engineer

Tyler G. Henneke, P.E.
Vice President

STATE OF TEXAS
TYLER G. HENNEKE
115724
LICENSED
PROFESSIONAL ENGINEER
05/13/2022

TO/TGH/to

TABLE OF CONTENTS

TABLES AND APPENDICES

TABLES

APPENDICES

1 INTRODUCTION AND PROJECT DESCRIPTION

1.1 Introduction

This report presents the results of our geotechnical engineering study performed for the proposed emergency generator building at the Crane Bayou Pumping Station operated by Jefferson County Drainage District No. 7 (DD7) in Port Arthur, Texas. Our study was performed in general accordance with TWE Proposal No. P21-B327 and authorized by Freese & Nichols, Inc. (FNI) Subconsultant Authorization executed on March 30, 2022.

1.2 Project Description

The pump station is situated near Station 310+00 of the U.S. Army Corps of Engineers (USACE) Hurricane Flood Protection Levee System (HFPLS) operated and maintained by DD7. We understand the precast concrete building will be approximately 30-ft square in plan with a height of about 15-ft and will exert a uniform ground bearing pressure of no more than 700-psf. We understand a stiffened slab-on-grade is anticipated for foundation support at this time but both shallow and deep foundations are under consideration.

2 PURPOSE AND SCOPE OF SERVICES

The purposes of our geotechnical engineering study were to investigate the soil and groundwater conditions within the project site and to provide geotechnical design and construction recommendations for the proposed emergency generator building. Our scope of services for this study consisted of:

1. Conducting one (1) soil boring to a depth of 80-ft below existing grade to evaluate general subsurface stratigraphy and groundwater conditions at the site;

2. Performing geotechnical laboratory tests on the recovered soil samples to evaluate the physical and engineering properties of the strata encountered;

3. Providing geotechnical design recommendations for shallow foundation systems including suitable type and depth, allowable soil bearing capacity, uplift resistance, lateral resistance and settlement estimates;

4. Providing geotechnical design recommendations for deep foundation systems including ultimate axial compression and tension capacities, input parameters for lateral response analysis and pile group considerations; and,

5. Providing geotechnical construction recommendations including site and subgrade preparation, excavation considerations, fill and backfill types and placement requirements, compaction guidelines, foundation installation and overall quality control monitoring, inspection and testing procedures.

Our scope of services did not include any environmental assessment for the presence or absence of wetlands or of hazardous or toxic materials within or on the soil, air or water at the site. Any statements in this report or on the boring log regarding odors, colors, unusual items and conditions are strictly for the information of the Client. A geological fault study was also beyond the scope of this study.

3 FIELD PROGRAM

3.1 Soil Borings

TWE conducted an exploration of subsurface soil conditions on April 15th, 2022 which included one (1) soil boring to a depth of 80-ft below existing grade. TWE coordinated the field activities, drilled, sampled and logged the borehole during the field program. The location of the test boring performed for this study is presented on TWE Drawing No. 22.23.051-1 in Appendix A of this report.

3.1.1 Drilling Methods

The soil boring was performed by TWE in general accordance with the Standard Practice for Soil Investigation and Sampling by Auger Borings (ASTM D1452) using conventional highland buggy-mounted drilling equipment. The borehole was advanced using dry-auger drilling methods until groundwater was encountered. Following groundwater level measurements over a 15-min hold period, the borings were completed to depth using wash-rotary drilling techniques. Soil samples were obtained continuously to a depth of 12-ft, at 13-ft to 15-ft and at 5-ft depth intervals thereafter until the boring completion depth of 80-ft was reached.

3.1.2 Soil Sampling

Fine-grained, cohesive soil samples were recovered from the soil boring by hydraulically pushing a 3-in diameter, thin-walled tube a distance of about 24-in. The field sampling procedures were conducted in general accordance with the Standard Practice for Thin-Walled Tube Sampling of Soils (ASTM D1587). Our Geotechnician visually classified the recovered soils and obtained field strength measurements of the recovered soils using a calibrated pocket penetrometer or hand-held torvane. The tube samples were extruded in the field, wrapped in foil, placed in moisture-sealed plastic bags and protected from disturbance prior to transport to the laboratory. The recovered soil sample depths and field strength measurements are shown on the project boring log in Appendix B.

Cohesionless or semi-cohesionless soils were collected with the Standard Penetration Test (SPT) sampler driven 18-in by blows from a 140-lb hammer falling 30-in in accordance with the Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils (ASTM D1586). The number of blows required to advance the sampler three (3) consecutive 6-in depths are recorded for each corresponding sample on the boring log. The N-value, in blows per foot, is obtained from SPTs by adding the last two (2) blow count numbers. The consistency of cohesive soils and the relative density of cohesionless and semi-cohesionless soils can be inferred from the N-value. The samples obtained from the split-barrel sampler were visually classified, placed in moisture-sealed plastic bags and transported to our laboratory. SPT sampling intervals and blow counts are presented on the project boring log in Appendix B. The SPT tests were performed using an automatic hammer with an energy transfer ratio (ETR) of 84.1%. Corrected N60 values are presented on the test boring log in Appendix B.

3.1.3 Boring Log

Our interpretations of general subsurface soil and groundwater conditions at the boring locations are included on the project boring log in Appendix B. The interpretations of the soil types throughout the boring depths and the locations of strata changes were based on visual classifications during field sampling and laboratory testing using the Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System) [ASTM D2487] and the Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) [ASTM D2488]. A key to terms and symbols used on boring log is also included in Appendix B.

3.1.4 Groundwater Measurements

Groundwater level measurements were attempted in the open borehole during dry-auger drilling. Measurements were taken initially during dry-auger drilling when groundwater was first encountered and at 5-min intervals thereafter over a 15-min time period. The groundwater measurements observed within the test boring are described in Section 5.3.

4 LABORATORY SERVICES

A laboratory testing program was conducted on selected samples to assist in classification and evaluation of the physical and engineering properties of the soils encountered in the project boring. Laboratory tests were performed in general accordance with ASTM International standards. The types and brief descriptions of the geotechnical laboratory tests performed are presented in Table 4-1 below.

Table 4-1: Laboratory Testing Program	
Test Description	**Test Method**
Particle Size Analysis of Soils – Sieve Analysis	ASTM D422
Amount of Material in Soils Finer than No. 200 Sieve	ASTM D1140
Water (Moisture) Content of Soil	ASTM D2216
Unconsolidated-Undrained Triaxial Compression on Cohesive Soils	ASTM D2850
Liquid Limit, Plastic Limit and Plasticity Index of Soils	ASTM D4318
Density (Unit Weight) of Soil Specimens	ASTM D7263

Standard geotechnical laboratory test results are presented on the soil boring log in Appendix B. A mechanical sieve analysis report on the existing fill material sample from the upper 2-ft depth range is also provided in Appendix B for reference.

5 PROJECT SITE CONDITIONS

Our interpretations of soil and groundwater conditions within the project site are based on information obtained at the location of the soil boring performed for this project. This information has been used as the basis for our conclusions and recommendations presented in this report. Subsurface conditions could vary at areas not explored by the test boring. If encountered during construction, significant variations at areas within the project site not explored by the soil boring could require reassessment of our recommendations.

5.1 Site Description and Surface Conditions

The proposed building will be located adjacent to the existing DD7 Crane Bayou Pumping Station structure. At the time of our field program, the ground surface at the test boring locations was relatively flat and consisted of 2-in thick asphalt paving over 22-in of stabilized sand/shell fill material. Site drainage appeared to be adequate at the time of drilling.

5.2 Subsurface Soil Stratigraphy & Design Soil Parameters

The generalized subsurface soil conditions within the project site were interpreted from the soil boring performed for this study. The general subsurface stratigraphy at the project site consists of approximately 2-ft of existing pavement and stabilized fill material underlain by firm to stiff clays to a depth of 21-ft below grade. A medium dense sand layer is present from the 21-ft to 33-ft depth range and is underlain by stiff to very stiff clays to the boring completion depth of 80-ft. Detailed soil type and layer stratification are shown on the boring log in Appendix B of this report.

5.2.1 Design Soil Parameters

Design soil parameters for engineering analyses were developed based on field and laboratory measurements, published literature and our experience with soils in the project area. A ratio of undrained cohesion to effective overburden pressure (c/p) equaling 0.22 was used to determine minimum undrained shear strength values with depth according to the SHANSEP (Soil Stress History and Normalized Soil Engineering Properties) relation (Ladd and Foote, 1974). The design soil parameters developed for the project are presented in Appendix C.

Please note the generalized design soil stratification and soil types along with depth, assumed for engineering analyses purposes, can vary from the soil types and conditions encountered in the individual soil borings. Details of the soil conditions encountered in the soil boring can be found on the corresponding soil boring log presented in Appendix B.

5.3 Groundwater Measurements

Groundwater level measurements were attempted in the open borehole when groundwater was first encountered during dry-auger drilling and at 5-min intervals over a 15-min time period. Groundwater was first measured at a depth of 21.3-ft and rose to a depth of 21.2-ft after the 15-min hold period.

Groundwater levels at the project site could fluctuate with climatic and seasonal variations and should be verified before construction. Accurate determination of static groundwater levels is typically made with standpipe piezometers. Installation of standpipe piezometers to evaluate long-term groundwater conditions within the project site was not included in our scope of services for this project.

5.4 Soil Shrink/Swell Potential

The tendency for soils to shrink and swell with change in moisture content is a function of clay content and type. These properties are generally defined by the Atterberg Limits. A generalized relationship between shrink/swell potential and the soil plasticity index is shown in Table 5-1 below.

Table 5-1: Relationship Between Plasticity Index and Shrink/Swell Potential

Plasticity Index Range	Shrink/Swell Potential
0 – 10	Very Low
10 – 15	Low
15 – 25	Medium
25 – 35	High
> 35	Very High

Based on Table 12-2 of the International Code Council (ICC) Geotechnical Engineers Handbook (2nd Edition).

The amount of expansion that could occur with increase in moisture content is inversely related to the overburden pressure. Therefore, the larger the overburden pressure, the smaller the amount of expansion. Near-surface soils are thus susceptible to shrink/swell behavior because they experience low amounts of overburden. The zone of seasonal moisture variation (active zone) at the location of this project site is believed to be limited to the upper 6-ft depth range of existing grade.

Considering the plasticity characteristics of existing site subgrade soils, the site soils appear to possess very low to low shrink/swell potential. We estimate potential shrink/swell movements of of the existing site soils encountered at the boring location are well below 1-in which is typically considered as a maximum threshold value for permanent foundation systems of this type. Our estimate is based on TxDOT Method TEX-124-E for determination of Potential Vertical Rise (PVR). This estimation is based on existing site grade without consideration of any removal or replacement of existing soils with select non-expansive fill or site grade raise with non-expansive fill.

6 SHALLOW FOUNDATION SYSTEMS

We understand the shallow foundation system being considered at this time includes a 30-ft wide by 30-ft long, stiffened slab-on-grade foundation with the grade beams and slab supported by structural select fill or the existing low plasticity site soils near surface. We assume existing grade is similar to final design grade for the proposed building. If geotechnical recommendations for additional shallow foundations, such as spread footings or shallow dry-augered drilled piers are needed, TWE can provide recommendations for these foundation types upon request.

Shallow foundation systems must satisfy two (2) independent design criteria with respect to soil conditions. The first criterion is that the system be designed with an appropriate factor of safety against bearing capacity failure of the soils underlying the foundations. The second criterion is that movement beneath the foundation system due to compression (consolidation) or expansion (swell) of the underlying soils must be within tolerable limits for the structure.

6.1 Stiffened Slab-On-Grade Foundation

A stiffened slab-on-grade foundation, which utilizes a perimeter grade beam and interior grade beams, is considered suitable for support of the proposed generator building. The slab-on-grade foundation should provide uniform pressure distribution and thereby reduce the magnitude of differential settlement.

6.1.1 Embedment Depth and Allowable Net Bearing Pressure

We recommend exterior grade beams (turned down edges) and interior grade beams be used to stiffen the slab and transfer loads to the underlying soils. The spacing and depth of grade beams can vary depending on the structural requirements of the slab. We recommend exterior grade beams extend to an embedment of at least 2-ft below final site grade and bear on the native firm to stiff, low plasticity clay soils encountered in the soil boring. Interior grade beams should be embedded at least 1-ft within properly-compacted structural select fill. The grade beams can be designed using a net allowable bearing capacity of 1,500-psf which includes a safety factor of 3.0 against shear failure.

6.1.2 Settlement

Settlement analysis of the proposed 30-ft square stiffened slab-on-grade was performed using the computer program Settle3 by Rocscience, Inc. (Toronto, Canada) using empirical compressibility parameters derived from the soil boring data. Our analysis considered a maximum applied uniform pressure of 700-psf.

Total settlement of the proposed foundation is estimated to be less than 1.5-in with 0.25-in to 0.50-in contributed to immediate undrained distortion during construction, or immediately after loading, and 1-in to 1.25-in contributed to long-term consolidation (10+ years or longer after construction) of the underlying clay soils. Consolidation settlements were corrected for three-dimensional pore water pressure dissipation effects. Differential settlement could be on the order of about 50% of the total settlement. Actual settlement could vary ±20%.

6.1.3 Coefficient of Subgrade Reaction of Mat Foundation

Typical analyses for design of large slab-on-grade foundations require a coefficient of subgrade reaction, k, which is defined as the ratio between the pressure at any given point on the surface of contact and the deformation produced by the load application at that point. A subgrade modulus obtained from a 1-ft by 1-ft plate load test (k_1) is typically applicable to the design of pavements and lightly-loaded slabs where the stress influence from loading occurs at a relatively shallow depth. For larger foundations with increased loading conditions, the stress influence will be deeper whereby k_1 is adjusted to k_f based on the foundation dimensions, bearing pressure and predicted settlement.

The modulus of subgrade reaction is a function of soil properties as well as the actual foundation size. Computed settlements and respective loading pressures should be used to compute the modulus of subgrade reaction for slab design by simply dividing loading pressure by settlement. For example, assuming the 30-ft by 30-ft mat with a sustained net loading pressure of 700-psf and an average estimated consolidation settlement of 1.25-in at the center, the resulting k_f value will be about 4-pci [k_f = 700-lbs/ft^2 / (1.25-in x 144-in^2/ft^2)]. Based on our experience with large concrete slabs on cohesive soils, subgrade modulus values of 5-pci to 20-pci are typical for design.

6.1.4 Lateral Resistance

Horizontal loads acting on the stiffened slab-on-grade, if applicable, can also be resisted by passive earth pressure acting on one (1) side of the perimeter grade beam. An allowable passive pressure of 750-psf can be used for properly-compacted fill material used as backfill around the foundation. This value should provide a factor of safety of 2.0 with respect to the ultimate value.

7 DEEP FOUNDATION SYSTEMS

This section applies to deep foundation recommendations for support of the proposed building at the project site as an alternate to shallow foundations. Deep foundation systems considered herein consist of augered cast-in-place (ACIP) piles as well as driven precast concrete piles (PCPs) and timber piles. Geotechnical recommendations for these foundation types are provided in the following sections.

7.1 Axial Capacity

We used the computer program SHAFT Version 2017 (Ensoft, Inc.) to compute the axial capacities of ACIP piles with diameters of 16-in, 18-in and 24-in. The ultimate axial capacity curves for these specified pile sizes are provided on Figure 1 of Appendix D.

For driven piles, we computed ultimate compression and tension capacities of a single pile using the static method of analysis recommended by American Petroleum Institute (API RP 2A - WSD, 2002). The analyses were performed using the computer code APILE Plus, Version 2019 (Ensoft, Inc.) for square precast concrete piles with widths ranging from 12-in to 20-in and for 13-in (measured 3-ft from the butt) Class B tapered timber piles. Ultimate axial pile capacity curves for the driven piles considered are provided on Figures 2 and 3 in Appendix D. Please note on the driven pile capacity curves, a medium dense sand layer is shown from 21-ft to 33-ft below grade which can provide increased driving resistance, and/or possible refusal, during pile installation.

Ultimate axial pile capacities obtained from the curves in Appendix D should be reduced by an appropriate factor of safety to compute the allowable axial pile capacity. A factor of safety of 2.5 is recommended to compute allowable compression capacity. A factor of safety of 3.0 is recommended to compute allowable tension capacity. If load testing will be conducted as part of the construction scope, reduced factors of safety as low as 2.0 could be considered.

Please note the tension capacities in Appendix D are based solely on soil/pile interaction. Piles and pile cap connections should be structurally capable of resisting design uplift loads. Also, the buoyant weight of the pile can be added to the tension capacity shown on the curves in Appendix D. The computed weight of the pile should be reduced by a factor of 1.2 for design. It should also be noted that we discounted frictional resistance of the soils to 5-ft below existing grade to account for pile cut-off elevation and possible disturbances during construction.

7.2 Individual Pile Settlement

A detailed analysis of axial load versus settlement for deep foundations was beyond the scope of this investigation. However, for single-isolated piles designed in accordance with the computed capacity values in Appendix D, individual pile settlements should be less than about 0.5-in.

7.3 Lateral Pile Response

For deep foundations, lateral loads are resisted by the soil as well as the rigidity of the pile. Lateral capacity will vary with pile type and properties, degree of fixity and pile spacing. Typically, lateral loads are analyzed using the p-y method in which the soil is modeled as a series of non-linear springs. This procedure with appropriate computer codes (i.e., LPILE by Ensoft, Inc.) has the advantage that major factors influencing soil resistance are inherently included in the semi-empirical p-y design criteria.

For the subsurface conditions observed at the project site, we developed the soil design parameters in Appendix E for use with lateral analyses of pile foundations associated with this project. Horizontal loads acting on pile caps, if applicable, can also be resisted by passive earth pressure acting on one (1) side of the pile cap. An allowable passive pressure of 750-psf can be used for properly-compacted fill material used as backfill around pile caps. This value should provide a factor of safety of 2.0 with respect to the ultimate value.

7.4 Pile Groups

7.4.1 Axial Group Efficiency

The overall axial compression capacity of a pile group depends on several factors including soil type, pile type and spacing as well as the number of piles in the group. Therefore, groups of piles having a center-to-center spacing of less than three (3) diameters/widths should be analyzed for group efficiency considering both block and individual modes of failure. If pile groups are planned for this project, TWE should be contacted to analyze group capacities once the final pile size, depth and group configurations are selected.

7.4.2 Lateral Group Effects

The effects of close pile spacing results primarily in a reduction in the maximum soil resistance which can be mobilized as compared to the sum of the lateral resistances of individual piles within the group. This leads to the concept of a “p-multiplier” or the Pm factor. If pile groups are planned for this project, TWE should be contacted to analyze lateral group effects and appropriate Pm factors once the final pile size, depth and group configurations are selected.

7.4.3 Pile/Shaft Group Settlement

Pile group design is typically governed by group settlement rather than axial group capacity or lateral group response. The settlement of a group of piles is significantly influenced by the size of the pile group and the compressibility of the soils below the pile tips. For typical spacing of about three (3) diameters/widths center-to-center, settlement estimates of pile groups (4 x 4 or larger) should be determined.

8 CONSTRUCTION CONSIDERATIONS

The performance of the foundation systems associated with the project will be highly dependent upon the quality of construction. Thus, we recommend foundation construction be monitored by TWE to evaluate construction activities in accordance with this report. This section provides our geotechnical recommendations pertaining to site preparation, excavation considerations, groundwater control, proofrolling, fill material placement and compaction, foundation installation and overall construction monitoring and quality control.

8.1 Site Preparation

Areas designated for new construction should be stripped of the existing pavement and other deleterious fill materials to the depth of competent subgrade capable of supporting proofrolling activities. Unsuitable soils, such as the upper 2-ft depth range as indicated by the project boring, should be removed prior to proofrolling. After stripping, areas designated for construction should be graded to establish positive drainage across the site so that ponding of surface water does not collect and inhibit site access or construction activities.

8.2 Excavation Considerations

Excavations for construction of foundations could be either open-cut and formed or neatly-excavated. Excavations for foundations should be made with a smooth-mouthed bucket or hand labor. Foundation excavation bottoms should be level, suitably benched and free of any loose, wet or weak soils that have been impacted by surface runoff, groundwater seepage or the construction process.

The sides of open excavations are susceptible to deterioration upon exposure and could become unstable. The Contractor's competent Supervisor should inspect all excavations and take appropriate safety measures including the use of trench shields and sloped excavations. We recommend Occupational Safety and Health Administration (OSHA) standards be observed with all excavations.

Positive drainage should be established and maintained across the project site so that ponding of surface water does not collect near foundation excavations or inhibit construction activities. If the subgrade soils are exposed to excess moisture, the bearing soils will likely soften and lose capacity. Once this occurs, it generally becomes necessary to either consider drying efforts or removal and replacement of the saturated material with select structural fill.

8.3 Groundwater Control/Dewatering

Based on the subsurface soil and groundwater conditions encountered in the project boring, excavations for foundations should be able to be performed in the dry. In the event groundwater, perched water or seepage is encountered, provisions should be made to remove any water that accumulates within excavations to maintain a dry bottom. Provisions should also be made to divert surface water runoff from open excavations. If encountered, any water accumulations within foundation excavations should be pumped out immediately and not allowed to deteriorate the foundation soils.

8.4 Subgrade Proofrolling

If applicable, the exposed subgrade within the foundation area should be proofrolled to detect areas of weak or compressible soils. The effective depth of proofrolling will depend on the vehicle weight and tire pressures. We recommend proofrolling be performed using a rubber-tired pneumatic roller, partially or fully-loaded dump truck or water truck with a weight of at least 20-tons and tire pressures of at least 70-psi. We do not recommend using off-road earthmoving equipment (e.g. loaders and scrapers), compactors or tracked vehicles (e.g. bulldozers) for proofrolling.

Proofrolling should extend at least 5-ft beyond the foundation limits and specifications should provide acceptance criteria such as rut depths less than 2-in and no visual evidence of pumping. TWE should be present to observe and document proofrolling and to delineate areas of weak or compressible soils, if encountered. Weak and/or compressible soils as well as soils not in compliance with the proofrolling specifications should be excavated and replaced with properly-compacted select structural fill. Recommendations for select structural fill are provided in Section 8.1.4 below.

The exposed subgrade soils within foundation excavations should then be protected from disturbance prior to and during foundation construction. A relatively thin seal slab of lean concrete or flowable fill should be placed over the exposed subgrade if excavations are expected remain open for more than one (1) working day.

8.5 Select Structural Fill

Structural select fill for the project should consist of clean lean clay (CL) or lean clay with sand (CL) material with a liquid limit (LL) less than 40 and a plasticity index (PI) between 10 and 20. Structural clay fill should be placed in thin lifts (maximum 8-in loose lifts), moisture conditioned between -2% to +3% of optimum moisture content and compacted to a minimum 95% of the maximum dry density as determined by ASTM D698 (standard Proctor).

Prior to use, samples of the proposed select fill material should be obtained by TWE for laboratory classification (Atterberg limits and percent passing the No. 200 sieve) and moisture-density relationship (standard Proctor) testing. These tests will provide a basis for fill acceptance and evaluation of fill compaction by in-place density testing. TWE should be retained to perform sufficient in-place density tests during placement to verify compaction requirements are met.

Maximum loose lift thicknesses for fill placement will depend on the type of compaction equipment used. Recommended fill layers are summarized in Table 8-1 below.

Table 8-1: Compaction Equipment and Maximum Lift Thickness

Compaction Equipment	Maximum Lift Thickness
Mechanical Hand Tamper	4-in
Pneumatic-Tired Roller	6-in
Tamping Foot Roller	8-in
Sheepsfoot Roller	8-in

8.6 Deep Foundation Installation

Performance of project structures supported on deep foundation systems will be directly related to the Contractor's adherence to the recommendations in this report and the project plans and specifications. Therefore, we recommend pile installation monitoring services be provided by TWE for this project. Pile installation monitoring services will provide verification the piles are installed in accordance with the intentions of this report and the project driving or installation criteria.

8.6.1 Augered Cast-In-Place (ACIP) Piles

The proper installation of ACIP piles in dependent on Contractor experience, construction procedure and equipment. The Contractor should have relevant experience with augering and pumping equipment, installing ACIP piles in similar subsurface conditions and placing of reinforcing steel. Key personnel including the crane operator, grout pump operator and full-time field supervisor should have a minimum of three (3) years of experience with installing ACIP piles of similar size and depth in the local area.

We recommend a pile installation monitoring program be implemented and performed by TWE. Several aspects to monitor during ACIP pile installation are viscosity of the pumped grout mixture, initial grout placement prior to raising the augers, resulting grout head observed at pile completion, incremental grout factors computed over 5-ft intervals during auger withdrawal, uniformity of grout placement; computed grout factor along completed pile length, continuous grout placement, auger withdrawal without delays or grout pressure fluctuations and reinforcing steel placement.

A grout mix should be furnished to meet the requirements of the project and tested TWE. A minimum of six (6) 2-in square grout cubes should be cast each day during which piles are installed. Two (2) grout cubes should be tested in compression at seven (7) days and twenty-eight (28) days after placement. The remaining grout cubes should be held for additional testing, if necessary.

The required grout volume to obtain a uniform pile will vary depending on subsurface soil conditions. Installation of piles with inappropriate grout volumes will affect the performance of the foundation system. Therefore, the Contractor should calibrate the grout pump before ACIP pile installation commences. Grout should be pumped with sufficient pressure typically ranging from 300-psi to 400-psi. The auger should be withdrawn slowly enough to keep the hole filled to prevent collapse and lateral penetration of grout into soft or porous zone surrounding the pile.

The auger withdrawal rate should be constant and not exceed 10-ft per minute. Pumped grout volumes typically range from 115% to 150% of the theoretical volume of the pile. A pressure head of at least 10-ft of grout above the injection point should be maintained at all times during auger withdrawal so that the grout exhibits a displacing action and resists the movement of loose material into the hole. The Contractor should determine the appropriate pressure head requirement during construction. Specific criteria regarding the minimum curing time before drilling adjacent piles and the minimum distance between new and previously installed, freshly grouted piles should be established in the project specifications. These criteria are necessary to protect newly completed piles from damage during the installation of adjacent piles.

8.6.2 Driven Piles

Pile driving hammers should be selected according to pile type, length, size and weight of pile, as well as potential vibrations resulting from pile driving operations. Care should be taken to assure the hammer selected is capable of achieving the desired penetration without causing damage to the piles or causing excessive vibrations which could cause damage to nearby structures.

We recommend the Contractor submit a pre-construction wave equation analysis (GRLWEAP or equivalent) prior to mobilization to appropriately size the hammer for the planned pile size and the site subsurface profile. It should be noted the piles could be driven through alternating clay and sand soil layers whereby compression and tension stresses could be of concern during driving. Each pile should be driven to the desired tip elevation and driving resistance without interruption in the driving operations. Pile driving records should be maintained by TWE on-site throughout the duration of pile driving.

It should be noted a medium dense sand strata was encountered at 21-ft to 33-ft depth range whereby driven piles will be driven through alternating clay and sand layers. The sand strata encountered within the site could impact the installation of driven piles whereby increased driving resistance and/or possible refusal could be encountered. We recommend WEAPs and driveability studies be performed to estimate driving resistance and required hammer energy for driven piles installed for this project.

Some pile heaving could be experienced during installation of adjacent displacement type piles. We recommend tip elevations of piles be recorded and if significant heave is noted after driving of subsequent piles, provisions should be made for reseating them by the Contractor.

8.7 Pile Integrity and Load Testing

TWE would be pleased to develop a detailed integrity and load testing program for the deep foundations being considered for this project. The purpose of the integrity and load tests would be to evaluate the as-built conditions of the piles, loading/unloading versus displacement response, evaluate ultimate axial compression, axial tension and lateral capacity of the piles, compare measured capacities and deflections with design criteria and develop installation guidelines for the remaining deep foundations to be installed for the project.

The load testing program could include a combination of static pile testing and high-strain dynamic testing to investigate a variety of pile types, sizes and depths. Refined WEAP analyses could also be performed for driven piles utilizing the data obtained from the static and dynamic tests. Using this information, pile driving criteria can be developed to establish a reliable relationship between hammer blow count and pile capacity and to establish pile driving and refusal criteria.

9 LIMITATIONS AND DESIGN REVIEW

9.1 Design Review and Cons truction Monitoring

9.1.1 Geotechnical Design Review

Geotechnical review of the design drawings and specifications should be performed prior to construction. This review is recommended to check the geotechnical recommendations and construction guidelines presented herein have been properly interpreted and incorporated into the construction documents.

9.1.2 Construction Monitoring

The performance of the foundations for this project will be highly dependent on the quality of construction. Thus, we recommend construction activities be monitored by TWE. TWE would be pleased to assist in the development of a plan for construction monitoring to be incorporated in the overall quality control program.

Construction surveillance by TWE is recommended and has been assumed in preparing our recommendations. These field services are required to check for changes in conditions which could result in modifications to our recommendations. Performance of the foundations will be directly related to the Contractor's adherence to the recommendations in this report and the project plans and specifications. Testing should be provided for all site preparation, foundation installations, concrete pours and other pertinent construction activities. TWE would be pleased to provide these services to verify construction is performed in accordance with the intentions of this report upon request.

9.2 Limitations

9.2.1 Scope of Study

The scope of this study, as well as the conclusions and recommendations provided herein, were developed based on our understanding of the project. Assumptions were made when specific information was unknown. Revisions to our conclusions and recommendations could be necessary as a result of any significant project changes or if our assumptions are incorrect. Construction dewatering design, earth retention design and construction site safety are the responsibility of the Contractor and have not been addressed herein. The scope of our study did not include evaluation of areal fill conditions or geologic faults. In addition, assessment of environmental conditions, including investigation for hazardous materials/pollutants/wastes, regulatory compliance, threatened or endangered species, cultural resources, floodplains and jurisdictional wetlands were also beyond the scope of our study.

9.2.2 Warranty

The professional services which form the basis for this report have been performed using a degree of care and skill ordinarily exercised, under similar circumstances, by reputable geotechnical engineers practicing in the same locality. No warranty, expressed or implied, is made as to the professional advice set forth.

9.2.3 Subsurface Variations

Our interpretations of subsurface conditions are based on data obtained at the exploration location only and only at the time of our field exploration. Subsurface variations could exist between the boring location and at areas not explored. The validity of our recommendations is based, in part, on assumptions made about subsurface conditions in areas not explored. Such assumptions can only be confirmed during construction. Therefore, construction observations by TWE are recommended to check for variations in subsurface conditions. Significant changes from our assumptions could require modification to our findings and recommendations.

9.2.4 Report Reliance

This report was prepared as an instrument of service for the sole and exclusive use by Freese and Nichols, Inc. and their project team subject to the limitations stated herein and with specific application to the referenced project. This report should not be applied for any other purpose or project, expect as described herein.

This report shall remain the property of TWE. No third party may use or rely upon the information provided herein without our express written consent. If any party other than Freese and Nichols, Inc. chooses to rely on this instrument without our consent, said party expressly waives any rights it may otherwise have to claim its reliance on this instrument of professional service that resulted in injury, loss, or damage of any kind and will defend and indemnify TWE, from any such claim.

9.2.5 Report Distribution

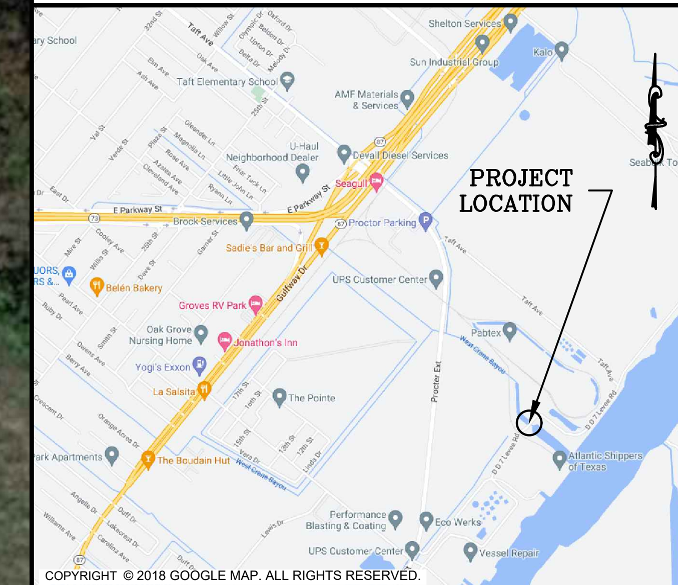
This report is intended to be used in its entirety. This report should be considered in whole and should not be distributed or made available in partial form.

If any changes in the nature, design or location of the project are planned, the conclusions and recommendations contained in this report should not be considered valid unless the changes are reviewed and the conclusions modified or verified in writing by TWE. TWE is not responsible for any claims, damages or liability associated with interpretation or reuse of the subsurface data or engineering analyses without the expressed written authorization of TWE.

APPENDIX A

EXPLORATION LOCATION PLAN

VICINITY MAP



TEST BORING COORDINATES

BORING	DEPTH	LATITUDE	LONGITUDE
TB–1	80'	29° 55' 47.25" N	93° 52' 50.58" W

LEGEND

SYMBOL	DESCRIPTION
⊕	TEST BORING LOCATION

Tolunay-Wong Engineers, Inc.

TEST BORING LOCATION PLAN
CRANE BAYOU PUMP STATION
EMERGENCY GENERATOR BUILDING
JEFFERSON COUNTY, TEXAS

Drawn	*T.T.*	*05–09–2022*
Checked	*T.O.*	*05–09–2022*
Approved	*T.G.H.*	*05–09–2022*
Scale	*N.T.S.*	

TWE DRAWING NO. *22.23.051–1*

APPENDIX B

SOIL BORING LOG AND KEY TO SYMBOLS AND TERMS

LOG OF BORING TB-1

PROJECT: Emergency Generator Building
Crane Bayou Pumping Station

CLIENT: Freese & Nichols, Inc.
Fort Worth, Texas

COORDINATES: N 29° 55° 47.25°
W 93° 52° 50.58°

SURFACE ELEVATION: --

DRILLING METHOD:
Dry Augered: 0' to 25'
Wash Bored: 25' to 80'

DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LAB MINI VANE SHEAR (tsf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
0	ASPHALTIC CONCRETE (2")													
	FILL: Gray STABILIZED SAND, with shell fragments				21		26	5					33	SA
	Stiff, brown and gray SANDY LEAN CLAY (CL), with sand seams and silt seams	(T)0.30			20	105				1.09	15	5		
	-firm from 4' to 6'	(T)0.40			19		30	10					62	
		(T)0.50			22	105				0.93	14	6		
	firm from 8' to 10'	(T)0.45			21		31	13					61	
10		(T)0.50												
	Stiff gray FAT CLAY (CH) -with calcareous nodules and silt seams at 13'	(P)1.50			34	93	52	28		1.07	15	12		
	Stiff, gray and tan LEAN CLAY (CL), with ferrous nodules	(P)2.25			23		38	17						
	Gray CLAYEY SAND (SC)													
	-becomes medium dense at 23.5'		1/6" 2/6" 6/6"	11	26								20	
			4/6" 8/6" 12/6"	28	23								16	
	Firm, gray and tan LEAN CLAY (CL), with sand seams and ferrous nodules	(T)0.25			29		39	12					88	
35														

COMPLETION DEPTH: 80 ft
DATE BORING STARTED: 04/18/22
DATE BORING COMPLETED: 04/18/22
LOGGER: P. Taylor
PROJECT NO.: 22.23.051

NOTES: Free Water Depth = 21.3-ft. 15-min Static Water Depth = 21.2-ft. 15-min Total Hole Depth = 25.0-ft. Borehole was backfilled with cement-bentonite grout.

LOG OF BORING TB-1

PROJECT: Emergency Generator Building
Crane Bayou Pumping Station

CLIENT: Freese & Nichols, Inc.
Fort Worth, Texas

COORDINATES: N 29° 55° 47.25°
W 93° 52° 50.58°

SURFACE ELEVATION: --

DRILLING METHOD:
Dry Augered: 0' to 25'
Wash Bored: 25' to 80'

DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LAB MINI VANE SHEAR (tsf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
35	Firm, gray and tan LEAN CLAY (CL), with sand seams and ferrous nodules													
	-becomes stiff at 38'	(P)2.50												
40														
	Stiff gray FAT CLAY (CH), with slickensides	(P)2.50			35	84	66	33		1.81	7	37		
45														
	-very stiff from 48' to 50'	(P)3.25												
50														
	-with shell fragments from 53' to 55'	(P)1.75												
55														
	Stiff gray LEAN CLAY (CL), with sand pockets	(P)3.00			18	110	35	15		1.70	6	49		
60														
	Stiff gray FAT CLAY (CH), with sand pockets	(P)2.00			31								89	
65														
	Stiff, gray and brown LEAN CLAY (CL)	(P)2.00			26		37	16						
70														

COMPLETION DEPTH: 80 ft
DATE BORING STARTED: 04/18/22
DATE BORING COMPLETED: 04/18/22
LOGGER: P. Taylor
PROJECT NO.: 22.23.051

NOTES: Free Water Depth = 21.3-ft. 15-min Static Water Depth = 21.2-ft. 15-min Total Hole Depth = 25.0-ft. Borehole was backfilled with cement-bentonite grout.

LOG OF BORING TB-1

PROJECT: Emergency Generator Building
Crane Bayou Pumping Station

CLIENT: Freese & Nichols, Inc.
Fort Worth, Texas

COORDINATES: N 29° 55° 47.25°
W 93° 52° 50.58°

SURFACE ELEVATION: --

DRILLING METHOD:
Dry Augered: 0' to 25'
Wash Bored: 25' to 80'

ELEVATION (FT) / DEPTH (FT)	SAMPLE TYPE	SYMBOL	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LAB MINI VANE SHEAR (tsf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
			Stiff, gray and brown LEAN CLAY (CL)													
			-becomes firm at 73'	(T)0.30			28								96	
75																
			Very stiff gray FAT CLAY (CH), with slickensides and calcareous nodules	(P)3.50			34		69	35						
80			Bottom @ 80'													
85																
90																
95																
100																
105																

COMPLETION DEPTH: 80 ft
DATE BORING STARTED: 04/18/22
DATE BORING COMPLETED: 04/18/22
LOGGER: P. Taylor
PROJECT NO.: 22.23.051

NOTES: Free Water Depth = 21.3-ft. 15-min Static Water Depth = 21.2-ft. 15-min Total Hole Depth = 25.0-ft. Borehole was backfilled with cement-bentonite grout.

Tolunay-Wong Engineers, Inc.

KEY TO SYMBOLS AND TERMS USED ON BORING LOGS FOR SOIL

Most Common Unified Soil Classifications System Symbols

- Lean Clay (CL)
- Lean Clay w/ Sand (CL)
- Sandy Lean Clay (CL)
- Fat Clay (CH)
- Fat Clay w/ Sand (CH)
- Sandy Fat Clay (CH)
- Silty Clay (CL-ML)
- Sandy Silty Clay (CL-ML)
- Silty Clayey Sand (SC-SM)
- Clayey Sand (SC)
- Sandy Silt (ML)
- Silty Sand (SM)
- Silt w/ Sand (ML)
- Well Graded Sand (SW)
- Well Graded Sand w/ Gravel (SW-GM)
- Poorly Graded Sand (SP)
- Poorly Graded Sand w/ Silt (SP-SM)
- Silt (ML)
- Elastic Silt (MH)
- Elastic Silt w/ Sand (MH-SP)
- Silty Gravel (GM)
- Clayey Gravel (GC)
- Well Graded Gravel (GW)
- Well Graded Gravel w/ Sand (SP-GM)
- Poorly Graded Gravel (GP)
- Peat

Miscellaneous Materials

- Fill
- Concrete
- Asphalt and/or Base

Sampler Symbols	Meaning
	Pavement core
	Thin - walled tube sample
	Standard Penetration Test (SPT)
	Auger sample
	Sampling attempt with no recovery
	TxDOT Cone Penetrometer Test

Field Test Data

2.50	Pocket penetrometer reading in tons per square foot
(T)1.13	Torvane Measurement in tons per square foot
8/6"	Blow count per 6 - in. interval of the Standard Penetration Test
	Observed free water during drilling
	Observed static water level

Laboratory Test Data

Wc (%)	Moisture content in percent
Dens. (pcf)	Dry unit weight in pounds per cubic foot
Qu (tsf)	Unconfined compressive strength in tons per square foot
UU (tsf)	Compressive strength under confining pressure in tons per square foot
Str. (%)	Strain at failure in percent
LL	Liquid Limit in percent
PI	Plasticity Index
#200 (%)	Percent passing the No. 200 mesh sieve
( )	Confining pressure in pounds per square inch
*	Slickensided failure
**	Did not fail @ 15% strain

RELATIVE DENSITY OF COHESIONLESS & SEMI-COHESIONLESS SOILS

The following descriptive terms for relative density apply to cohesionless soils such as gravels, silty sands, and sands as well as semi-cohesive and semi-cohesionless soils such as sandy silts, and clayey sands.

Relative Density	Typical N_{60} Value Range*
Very Loose	0-4
Loose	5-10
Medium Dense	11-30
Dense	31-50
Very Dense	Over 50

* N_{60} is the number of blows from a 140-lb weight having a free fall of 30-in. required to penetrate the final 12-in. of an 18-in. sample interval, corrected for field procedure to an average energy ratio of 60% (Terzaghi, Peck, and Mesri, 1996).

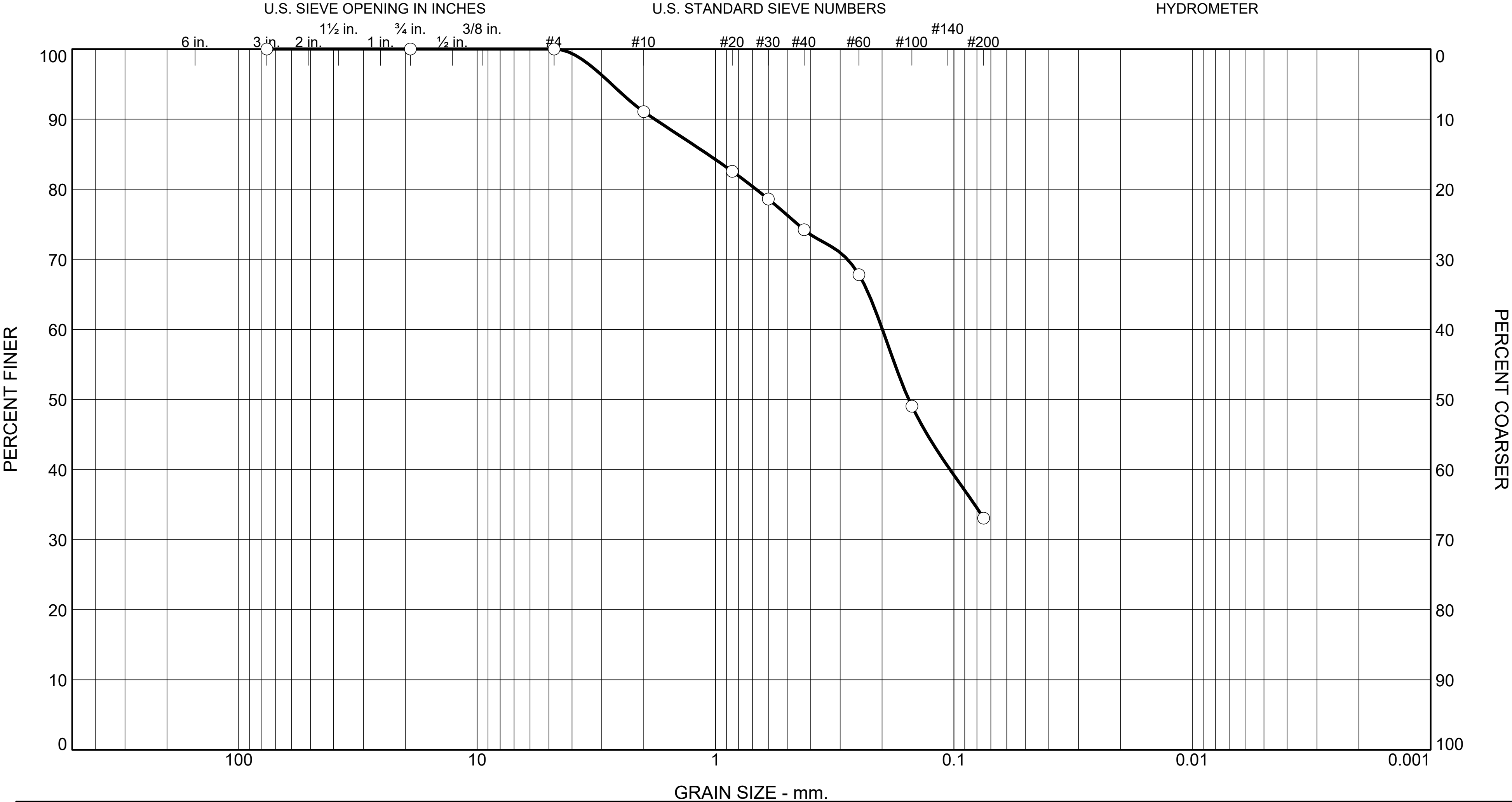
CONSISTENCY OF COHESIVE SOILS

The following descriptive terms for consistency apply to cohesive soils such as clays, sandy clays, and silty clays.

Typical Compressive Strength (tsf)	Consistency	Typical SPT "N_{60}" Value Range**
$q_u < 0.25$	Very soft	≤ 2
$0.25 \leq q_u < 0.50$	Soft	3-4
$0.50 \leq q_u < 1.00$	Firm	5-8
$1.00 \leq q_u < 2.00$	Stiff	9-15
$2.00 \leq q_u < 4.00$	Very Stiff	16-30
$q_u \geq 4.00$	Hard	≥ 31

** An "N_{60}" value of 31 or greater corresponds to a hard consistency. The correlation of consistency with a typical SPT "N_{60}" value range is approximate.

ASTM D6913



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	8.9	16.9	41.2	33.0	

Identification	Date Sampled	Date Received	Date Tested
Source of Sample: TB-1 Depth: 0.1666667			

Client Freese & Nichols, Inc.

Project Emergency Generator Building

Crane Bayou Pumping Station

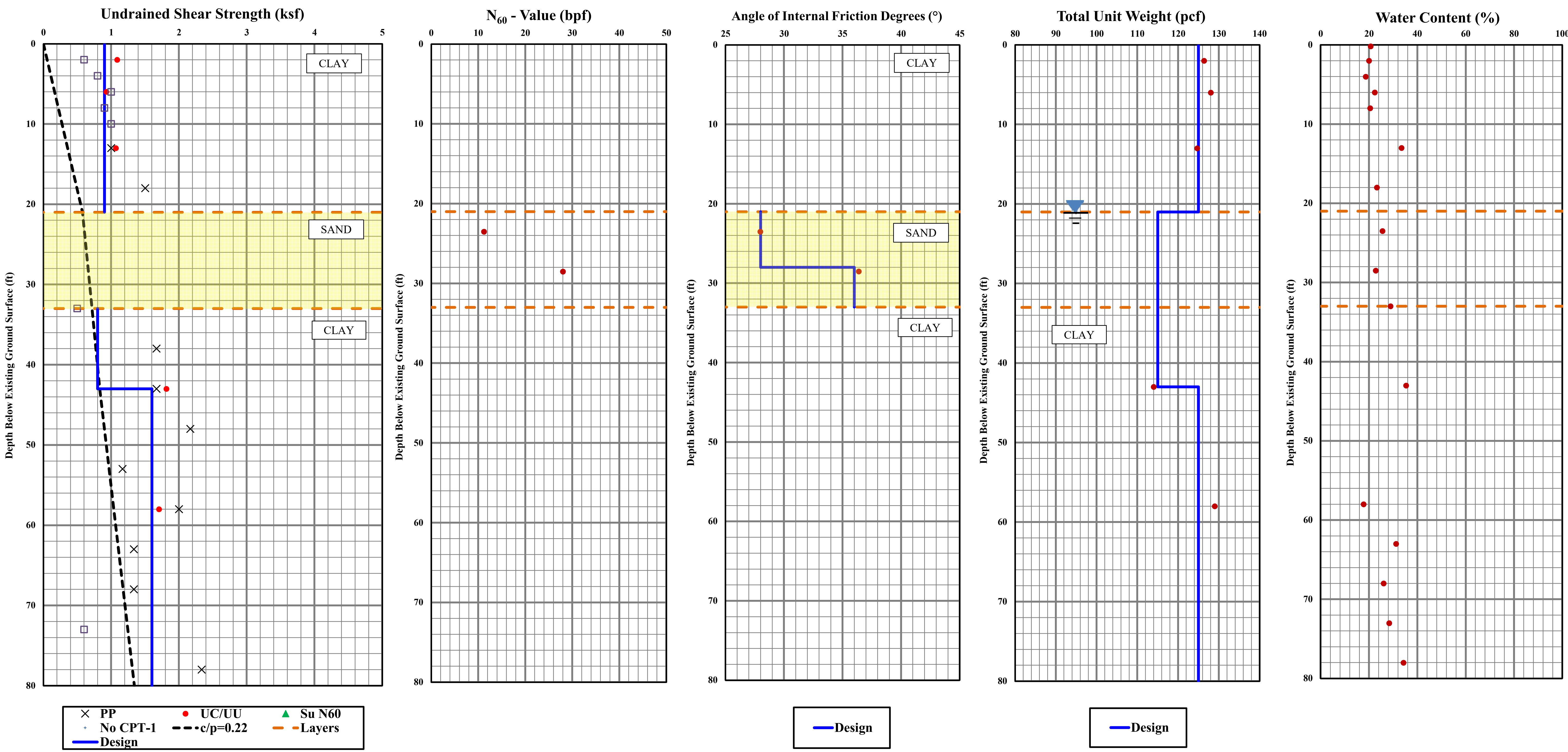
Project No. 22.23.051 Figure

Tolunay-Wong Engineers, Inc.

Beaumont, TX

APPENDIX C

DESIGN SOIL PARAMETERS

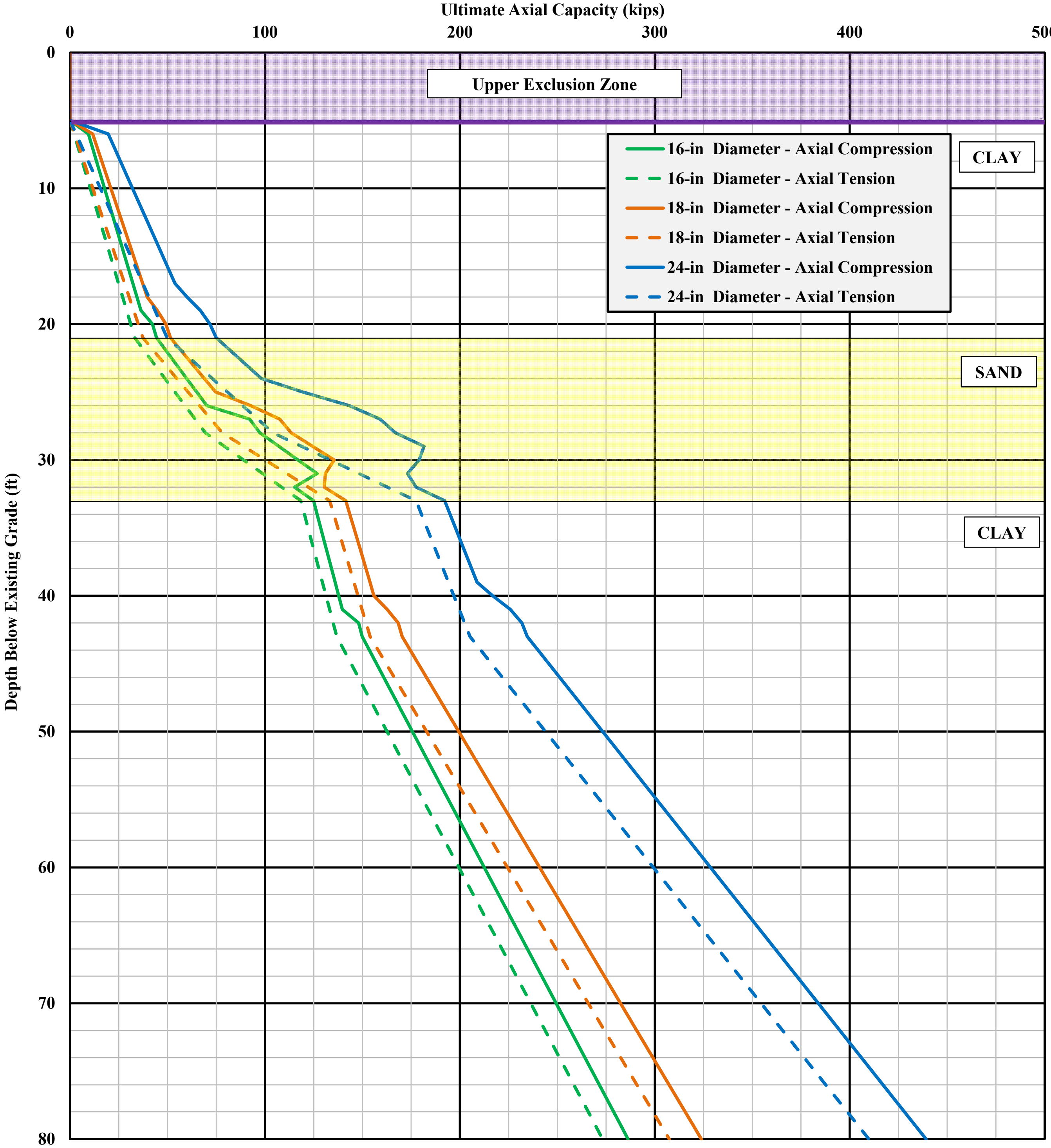


Emergency Generator Building Crane Bayou Pumping Station	Tolunay-Wong Engineers, Inc.	Project Number: 22.23.051 Report Number: 129545
Freese & Nichols, Inc. Fort Worth, Texas	**Design Soil Parameters**	Appendix C Figure 1

APPENDIX D

ULTIMATE AXIAL PILE CAPACITY PLOTS

ULTIMATE AXIAL CAPACITY VERSUS DEPTH
AUGERED CAST-IN-PLACE CONCRETE PILES

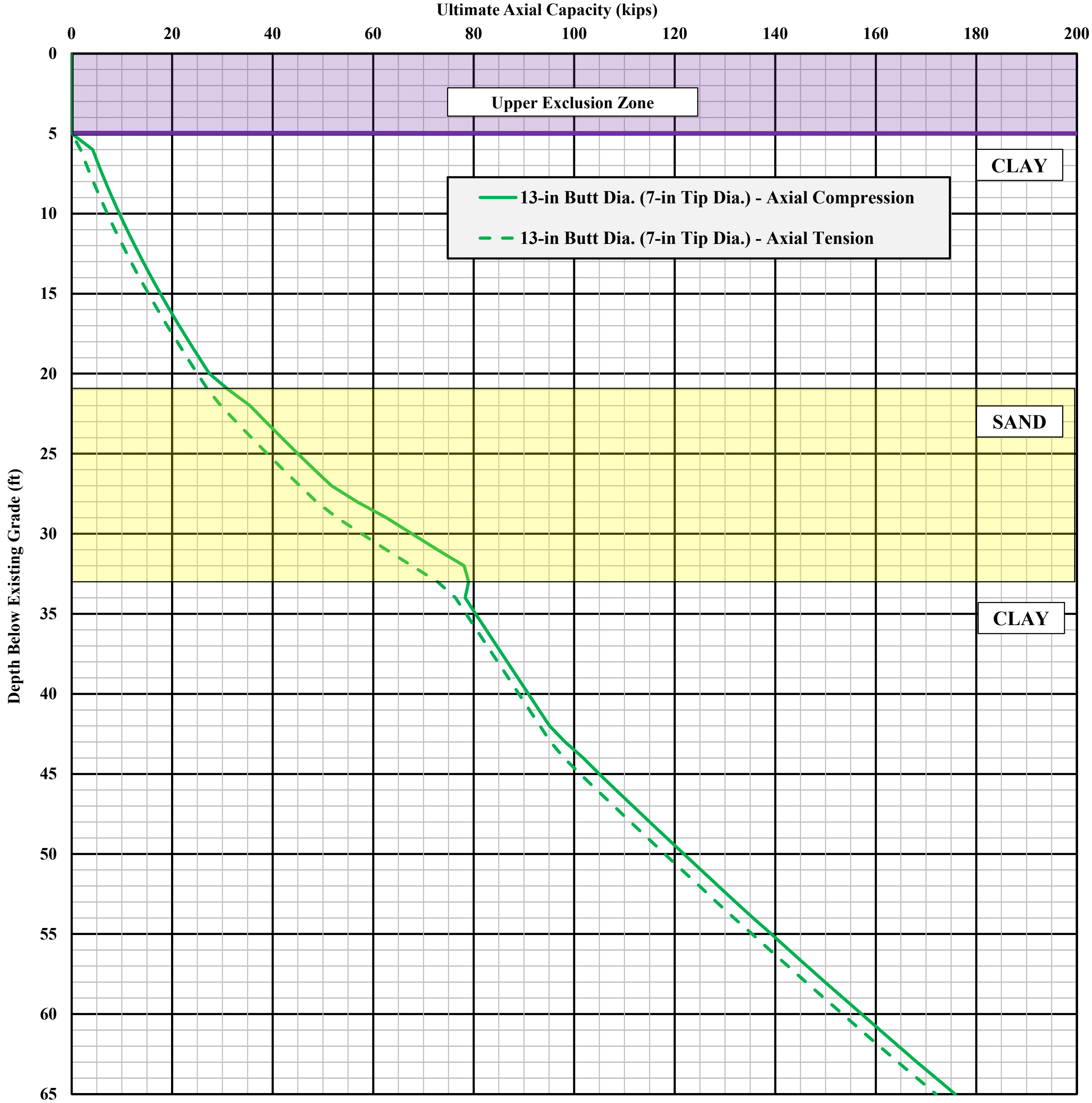


NOTES:

1) Center-to-center spacing of the pile should be at least three (3) times the pile/shaft diameter.
2) A factor of safety of 2.5 is recommended for allowable compression loads.
3) A factor of safety of 3.0 is recommended for allowable tension loads (does not include the weight of pile).
4) Reduced factors of safety can be considered if a pile load testing program (static, dynamic or combination) is performed. (See Report Section 7.1).

Project Emergency Generator Building Crane Bayou Pumping Station	Tolunay-Wong Engineers, Inc.	**Project No.** 22.23.051 **Report No.** 129545
Client Freese & Nichols, Inc. Fort Worth, Texas	**Ultimate Axial Capacity vs. Depth** **Augered Cast-In-Place Concrete Piles**	**Appendix** D **Figure** 1

ULTIMATE AXIAL CAPACITY VERSUS DEPTH
CLASS B TIMBER PILES

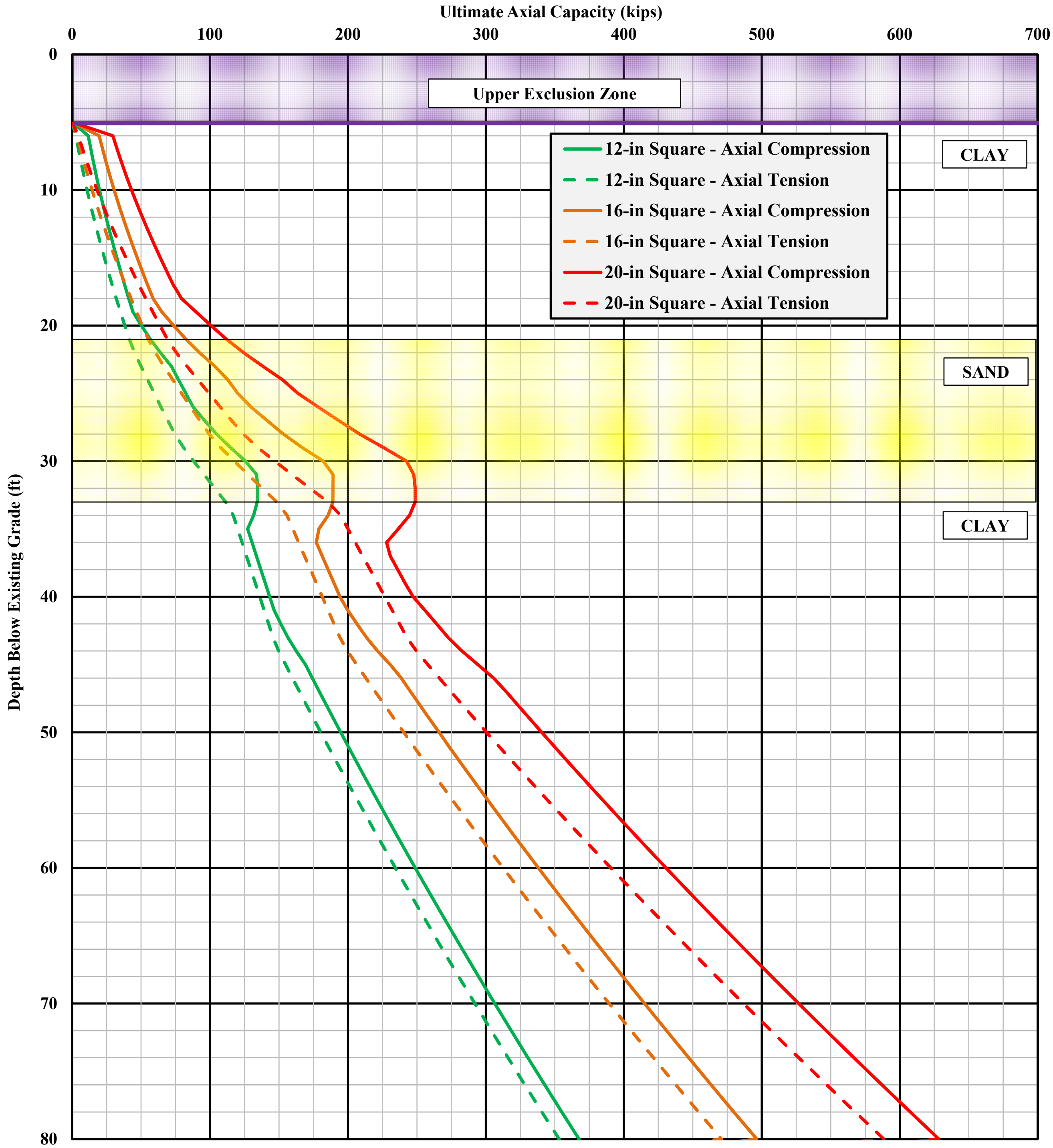


NOTES:

1) Center-to-center spacing of the pile should be at least three (3) times the butt diameter.
2) A factor of safety of 2.5 is recommended for allowable compression loads.
3) A factor of safety of 3.0 is recommended for allowable tension loads (does not include the weight of pile).
4) Reduced factors of safety can be considered if a pile load testing program (static, dynamic or combination) is performed. (See Report Section 7.1)
5) Embedment depths for Class B timber pile sizes can be determined by commonly available Southern Pine Timber Pile lengths as presented in the Timber Piling Council (TPC) Timber Pile Design Manual (updated 2015).
6) Increased driving resistance and/or refusal could be encountered within the sand strata shown.

Project Emergency Generator Building Crane Bayou Pumping Station	Tolunay-Wong Engineers, Inc.	**Project No.** 22.23.051 **Report No.** 129545
Client Freese & Nichols, Inc. Fort Worth, Texas	**Ultimate Axial Capacity vs. Depth** **Class B Timber Piles**	**Appendix:** D **Figure:** 2

ULTIMATE AXIAL CAPACITY VERSUS DEPTH
SQUARE PRECAST CONCRETE PILES



NOTES:

1) Center-to-center spacing of the pile should be at least three (3) times the pile width.
2) A factor of safety of 2.5 is recommended for allowable compression loads.
3) A factor of safety of 3.0 is recommended for allowable tension loads (does not include the weight of pile).
4) Reduced factors of safety can be considered if a pile load testing program (static, dynamic or combination) is performed. (See Report Section 7.1).
5) Increased driving resistance and/or refusal could be encountered within the sand stara shown.

Project Emergency Generator Building Crane Bayou Pumping Station	Tolunay-Wong Engineers, Inc.	**Project No.** 22.23.051 **Report No.** 129545
Client Freese & Nichols, Inc. Fort Worth, Texas	**Ultimate Axial Capacity vs. Depth** **Square Precast Concrete Piles**	**Appendix** D **Figure** 3

APPENDIX E

LPILE SOIL DESIGN PARAMETERS

Lateral Pile Analysis Soil Design Parameters							
LPILE Soil Type	Depth (ft)		Effective Unit Weight, γ' (pcf)	Cohesion, c (psf)	Friction Angle (°)	Static Lateral Modulus, *k* (pci)	Strain Factor, ε_{50}
	Top	Bottom					
Stiff Clay without Free Water	0	21	126	900	--	100	0.010
Sand (Reese)	21	28	53	--	28	60	--
Sand (Reese)	28	33	53	--	36	60	--
Stiff Clay without Free Water	33	43	53	800	--	100	0.010
Stiff Clay without Free Water	43	80	63	1,600	--	500	0.007

Emergency Generator Building Crane Bayou Pumping Station	Tolunay-Wong Engineers, Inc.	Project Number: 22.23.051 Report Number: 129545
Freese & Nichols, Inc. Fort Worth, Texas	**Lateral Pile Analysis Soil Design Parameters**	Appendix E Figure 1