CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING
ENGINEERING AND CONSTRUCTION DIVISION

GEOTECHNICAL EXPLORATION
PROPOSED HYDRO-TANK AND CONCRETE PAD
METRO CENTRAL WASTEWATER TREATMENT PLANT (WWTP)
12815 GALVESTON ROAD
WEBSTER, TEXAS 77598
WBS NO. R-000265-0102-3

PROJECT NO. 15-216E

TO

FREESE AND NICHOLS, INC.
PEARLAND, TEXAS

BY

GEOTECH ENGINEERING AND TESTING

SERVICING

TEXAS, LOUISIANA, NEW MEXICO, OKLAHOMA

www.geotecheng.com

JUNE 2015

TEXAS BOARD OF PROFESSIONAL ENGINEERS
REGISTRATION NUMBER F-001183

GEOTECH ENGINEERING and TESTING

ACCREDITED

Geotechnical, Environmental, Construction Materials, and Forensic Engineering

Freese and Nichols, Inc.
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Project No. 15-216E
Report No. 1
Project Type 24/29/32/E/D/SP
June 18, 2015

Attention: Mr. Murali Erat, P.E.
Project Manager

GEOTECHNICAL EXPLORATION
PROPOSED HYDRO-TANK AND CONCRETE PAD
METRO CENTRAL WASTEWATER TREATMENT PLANT (WWTP)
12815 GALVESTON ROAD
WEBSTER, TEXAS 77598
WBS NO. R-000265-0102-3

Gentlemen:

Submitted here are the results of Geotech Engineering and Testing (GET) Geotechnical Study for the proposed hydro-tank and concrete pad at Metro Central Wastewater Treatment Plant (WWTP) at the above-referenced project site. The planned facilities were discussed in detail with Mr. Murali Erat, P.E., with Freese and Nichols, Inc. and Mr. Wade Parks, P.E., with KIT Professionals, Inc., in order to plan soils and foundation studies that would provide the necessary design and construction data. This study was conducted in general accordance with our Proposal No. P15-066, Revision I, dated March 31, 2015. Authorized to proceed with this study was received through a Transmittal Letter issued by Mr. Murali Erat, P.E., of Freese and Nichols, Inc. on April 23, 2015.

This report presents the results of our field exploration and laboratory testing together with design recommendations for the planned facilities at the above-referenced site.

We appreciate the opportunity to be of service. Should you have any questions or need additional assistance, please call.

Very truly yours,

GEOTECH ENGINEERING AND TESTING
TEXAS BOARD OF PROFESSIONAL ENGINEERS
REGISTRATION NUMBER F-001183

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TABLE OF CONTENTS

PAGE

1.0 EXECUTIVE SUMMARY 1

2.0 INTRODUCTION 2

3.0 FIELD EXPLORATION 2

4.0 LABORATORY TESTS 3
4.1 General 3
4.2 Classification Tests 3
4.3 Strength Tests 3
4.4 Soil Sample Storage 3

5.0 GENERAL SOILS AND DESIGN CONDITIONS 3
5.1 Site Conditions 3
5.2 Soil Stratigraphy 3
5.3 Design Conditions 4
5.4 Water-Level Measurements 4

6.0 HYDRO-TANK FOUNDATION RECOMMENDATION 5
6.1 General 5
6.2 Foundation Type 5
6.3 Spread Footings Foundation 5
6.3.1 Allowable Bearing Pressures 5
6.3.2 Lateral Capacity for Spread Footings 6
6.3.3 Uplift Capacity for Spread Footings 6
6.4 Foundation Settlement 6
6.5 Foundation Maintenance 6
6.6 Site Drainage 7

7.0 AIR COMPRESSOR FOUNDATION RECOMMENDATION 7
7.1 General 7
7.2 Concrete Pad Foundation 7

8.0 OTHER DESIGN CONSIDERATIONS 7

9.0 CONSTRUCTION CONSIDERATIONS 8
9.1 Surface Water Drainage 8
9.2 Site Preparation 8
9.3 Suitability of On-Site Soils for Use as Fill 9
9.3.1 General 9
9.3.2 Select Structural Fill 9
9.3.3 Structural Fill 9
9.3.4 General Fill 10
9.3.5 Use of On-Site Soils as Fill 10

9.4 Spread Footings Excavations 10
9.5 Earthwork 11
9.6 Construction Surveillance 11

10.0 RECOMMENDED ADDITIONAL STUDIES 12

11.0 STANDARD OF CARE 12

12.0 REPORT DISTRIBUTION 12

13.0 REFERENCE 12

ILLUSTRATIONS

	Plate
Site Vicinity Map	1
Plan of Boring	2
Uplift Capacity of Spread Footings	3

APPENDICES

Appendix A – Plan of Boring, Log of Boring, Key to Log Terms
Appendix B – Summary of Laboratory Test Results
Appendix C – Project Site Pictures

1.0 EXECUTIVE SUMMARY

It is planned to construct a hydro-tank and concrete pad at Metro Central Wastewater Treatment Plant (WWTP) at 12815 Galveston Road, Webster, Texas. A site vicinity plan is presented on Plate 1. The specific project information is as follows:

Facility	Remarks
Hydro-Tank	The facility consists of a 2,000 gallon carbon steel tank, 6-ft in diameter and 12-ft in length. The total empty vessel weight is approximately 6,400 pounds. We understand that the proposed hydro-tank will be supported on spread footings type foundation.
Air Compressor	We understand that the proposed air compressor will be supported on concrete pad type foundation.

The soil conditions were explored by conducting one (1) soil boring (B-1) to evaluate soil stratigraphy across the site and to obtain soil samples for laboratory testing. The soil boring was drilled to a depth of 25-ft below the existing grade. Results of field exploration, laboratory testing and our engineering analyses are summarized below:

1. In general, the soil stratigraphy at the project areas are as follows:

Stratum No.	Range of Depth, ft.	Soil Description*
I	0 – 2	FILL: FAT CLAY (CH)
II	2 – 25	FAT CLAY (CH)

2. Depth to groundwater/perched water will be important for design and construction of the proposed improvements. Water level observations were made during drilling and 24 hours after drilling. Our short-term field exploration at the subject site indicated that groundwater was encountered at a depth of 19-ft below the existing grade during drilling. Groundwater was encountered at a depth of 14-ft after 24 hours of drilling.

3. We understand that the structural loads for the proposed hydro-tank will be supported on spread footings type foundation. Furthermore, we understand that a concrete pad will be used to support a light mechanical structure. Our recommendations for these foundation types along with the allowable bearing capacities are presented in this report.

2.0 INTRODUCTION

It is planned to construct a hydro-tank and concrete pad at Metro Central Wastewater Treatment Plant (WWTP) at 12815 Galveston Road, Webster, Texas. A site vicinity plan is presented on Plate 1. The specific project information is as follows:

Facility	Remarks
Hydro-Tank	The facility consists of a 2,000 gallon carbon steel tank, 6-ft in diameter and 12-ft in length. The total empty vessel weight is approximately 6,400 pounds. We understand that the proposed hydro-tank will be supported on spread footings type foundation.
Air Compressor	We understand that the proposed air compressor will be supported on concrete pad type foundation.

The purpose of our study was to evaluate soils and foundation conditions at the project site and use the information obtained to develop recommendations to guide design and construction of the proposed facilities. This report briefly describes the field exploration and laboratory testing followed by our engineering analysis and foundation recommendations for the proposed facilities. A detailed settlement analysis for the proposed facilities was outside the scope of our services.

3.0 FIELD EXPLORATION

At the request of the client, the soil conditions were explored by conducting one (1) soil boring (B-1), located approximately as shown on Plate 2. The number of boring and depth were specified by the client. Soil samples were obtained continuously from the ground surface to a depth of 20-ft and at 5-ft intervals thereafter to the completion depth of boring at 25-ft. The cohesive soils were sampled in general accordance with the ASTM D 1587.

Soil samples were examined and classified in the field, and cohesive soil strengths were estimated using a calibrated hand penetrometer. This data, together with a classification of the soils encountered and strata limits, is presented on the log of boring in Appendix A. The key to the log terms and symbols are also presented on Appendix A.

Depth to groundwater is important for design and construction of the proposed facilities. Borings were drilled dry, without the aid of drilling fluids, to more accurately estimate the depth to groundwater. Water level observations made during and 24-hour after drilling in the borehole are indicated at the bottom portion of the boring log. The borehole was grouted with non-shrink grout using Tremie method after the completion of the field work.

4.0 LABORATORY TESTS

4.1 General

Soil classifications and shear strengths were further evaluated by laboratory tests on representative samples of the major strata. The laboratory tests were performed in general accordance with ASTM Standards. Specifically, ASTM D 2487 is used for classification of soils for engineering purposes. Furthermore, summary of test results are presented in Appendix B on Plate B-1.

4.2 Classification Tests

As an aid to visual soil classifications, physical properties of the soils were evaluated by classification tests. The tests were conducted in general accordance with ASTM standards. These tests consisted of natural moisture content tests (ASTM D 4643), percent finer than the No. 200 sieve tests (ASTM D 1140), dry unit weight and Atterberg limit determinations (ASTM D 4318, Method A). Similarity of these properties is indicative of uniform strength and compressibility characteristics for soils of essentially the same geological origin. Results of these tests are tabulated on the boring logs at respective sample depths.

4.3 Strength Tests

Undrained shear strengths of the cohesive soils, measured in the field, were verified by calibrated hand penetrometer tests, unconfined compressive strength tests (ASTM D 2166) and torvane tests. Natural water content and dry unit weight were determined routinely for each unconfined compressive strength test. These test results are also presented on the boring log.

4.4 Soil Sample Storage

Soil samples tested or not tested in the laboratory will be stored for a period of seven days subsequent to submittal of this report. The samples will be discarded after this period, unless we are instructed otherwise.

5.0 GENERAL SOILS AND DESIGN CONDITIONS

5.1 Site Conditions

The project site is located inside the Metro Central Wastewater Treatment Plant (WWTP) at 12815 Galveston Road, Webster, Texas. The project site and the surrounding areas are generally flat and exhibit topographic variation of less than three-feet. Currently, several structures are located on the project site. The remaining area is covered with grass. Project site pictures were taken during our site visit. These pictures are presented in Appendix C.

5.2 Soil Stratigraphy

In general, the soils can be grouped into two (2) major strata with depth limits and characteristics as follows:

Stratum No.	Range of Depth, ft.	Soil Description*
I	0 – 2	FILL: FAT CLAY (CH), very stiff, brown, dark gray, with root fibers, calcareous nodules, moist
II	2 – 25	FAT CLAY (CH), firm to very stiff, brown, reddish brown, gray, dark gray, brownish yellow, with root fibers to 6', ferrous and calcareous nodules, moist

*Classification in general accordance with the Unified Soil Classification System (ASTM D 2487)

5.3 Design Conditions

Soil strength and index properties and how they relate to foundation designs are summarized below:

Stratum No.	Soil Type	PI(s)	Soil Expansivity	Soil Shear Strength, tsf
I	Fill: Fat Clay (CH)	49	Expansive	1.08
II	Fat Clay (CH)	44	Expansive	0.31 – 1.13

Legend: PI = Plasticity Index

5.4 Water-Level Measurements

The soil boring was dry augered to evaluate the presence of perched or free-water conditions. The level where free water was encountered in the open boreholes during the time of our field exploration is shown on the boring logs. Our groundwater measurements are as follows:

Boring No.	Groundwater Depth, ft. at the Time of Drilling	Groundwater Depth, ft. at 0.33 Hour Later
B-1	19	14

Fluctuations in groundwater generally occur as a function of seasonal moisture variation, temperature, groundwater withdrawal and future construction activities that may alter the surface drainage and subdrainage characteristics of this site.

An accurate evaluation of the hydrostatic water table in the relatively impermeable clays and low permeable silts/sands requires long term observation of monitoring wells and/or piezometers. It is not possible to accurately predict the pressure and/or level of groundwater that might occur based upon short-term site exploration. The installation of piezometers/monitoring wells was beyond the scope of our study. We recommend that the groundwater level be verified just before construction if any excavations such as construction of underground utilities, etc. are planned.

We recommend that GET be immediately notified if a noticeable change in groundwater occurs from that mentioned in our report. We would be pleased to evaluate the effect of any groundwater changes on our design and construction sections of this report.

6.0 HYDRO-TANK FOUNDATION RECOMMENDATION

6.1 General

It is planned to construct a hydro-tank at Metro Central WWTP at 12815 Galveston Road, Webster, Texas. We understand that the proposed hydro-tank will be a 2,000 gallon carbon steel tank, 6-ft in diameter and 12-ft in length. Furnished information indicated that the total empty vessel weight is approximately 6,400 lb.

6.2 Foundation Type

Foundations for the proposed structure should satisfy two independent design criteria. First, the maximum design pressure exerted at the foundation level should not exceed allowable net bearing pressure based on an adequate factor of safety with respect to soil shear strength. Secondly, the magnitude of total and differential settlements or heave under sustained foundation loads must be such that the structure is not damaged or its intended use impaired.

We understand that the proposed structural loads will be supported on spread footings type foundation. Our recommendations for this foundation type are presented in the following report sections.

6.3 Spread Footings Foundation

6.3.1 Allowable Bearing Pressures

Based on the results of field exploration, laboratory test data and bearing capacity theory, the allowable bearing pressures for spread footings for the proposed hydro-tank will be as follows:

Foundation Type	Minimum Depth, ft. (1), (2)	Soil Type	Allowable Net Bearing Pressures, psf	
			Dead Load (3)	Total Load (Dead + Live)
Spread Footings:				
Square or Circle	3	Stiff Clay	2,000 (1+0.2D/B)	3,000 (1+0.2D/B)
Rectangle	3	Stiff Clay	1,500 (1+0.2D/B) × (1+0.2B/L)	2,250 (1+0.2D/B) × (1+0.2B/L)
Strip	3	Stiff Clay	1,500 (1+0.2D/B)	2,250 (1+0.2D/B)

Where: D = Footing depth, ft.
B = Footing width, ft.
L = Footing length, ft.

Notes:
1. With respect to existing grade.
2. The actual depth of the spread footings should be determined on the basis of compression, lateral and uplift loads by the structural engineer.
3. Dead + sustained live loading.

Footings proportioned in accordance with these values will have a factor of safety of 3.0 and 2.0 with respect to shearing failure for dead and total loading, respectively. This assumes that the footings will be seated in a compacted select structural fill, as discussed above. Footing weight below final grade can be neglected in determination of design loading.

Based on our current groundwater observations, footing excavations may probably not encounter groundwater. Any water inflow must be pumped out using a sump-pump. The footing excavations should be free of loose material and water prior to concrete placements, and concrete should be poured as soon as possible.

Detailed observations of spread footings construction should be required by a qualified engineering technician to assure that the footings are (a) founded in the proper bearing stratum, (b) have the proper depth, (c) have the correct size, and (d) that all loose materials have been removed prior to concrete placement.

6.3.2 Lateral Capacity for Spread Footings

Lateral loads on spread footings may be resisted by soil friction and by the passive resistance of the soils. An allowable friction resistance of 200 psf may be used between the foundation bottom or concrete slabs and the supporting soils. A factor of safety of 2.0 was used in the design. The allowable net passive resistance of natural soils or properly compacted fill may be assumed to be equal to 500 psf per feet of footing depth. A one-third increase in the passive value may be used for wind loads. The passive pressure and the frictional resistance of the soils may be combined without reduction in determining the total lateral resistance.

6.3.3 Uplift Capacity for Spread Footings

The ultimate uplift capability of a single spread footing can be estimated using the information shown on Plate 8 and the following empirical equation:

$$Q_T = W_F + W_S$$

Where: W_F = Weight of Foundation, pounds
W_S = Weight of Soil Wedge, pounds; Use Soil Unit Weight, γ' = 60 pcf
Q_T = Ultimate capacity of a footing, Pounds; Use factor of safety = 1.5

6.4 Foundation Settlement

A detailed settlement analysis was not within the scope of this study. It is anticipated that the foundation designed using our recommendations will experience small settlements that will be within the tolerable limit for the proposed structure.

6.5 Foundation Maintenance

Long term performance of structures depends not only on the proper design and construction, but also on the proper foundation maintenance program.

A properly designed and constructed foundation may still experience distress from the vegetation and expansive soil which will undergo volume change when correct drainage is not established or incorrectly controlled water source, such as plumbing/sewer leaks, excessive irrigation, and water ponding near the foundation becomes available.

6.6 Site Drainage

It is recommended that site drainage be well developed to provide for suitable dry working conditions. Surface water should be directed away from the foundation soils (use a slope of about 5% in the grass within 10-ft of foundation). No ponding of surface water should be allowed near the foundations during all phases of construction and during its life. Ponded water next to the foundations will result in softening of foundation soils and corresponding settlement and possible bearing capacity failure.

7.0 AIR COMPRESSOR FOUNDATION RECOMMENDATION

7.1 General

It is planned to construct an air-compressor at Metro Central WWTP at 12815 Galveston Road, Webster, Texas. We understand that the proposed air compressor will be supported on a concrete pad type foundation.

7.2 Concrete Pad Foundation

We understand that concrete pad foundation will be used to support the proposed air compressor. The estimated ultimate bearing capacity at the foundation location is as follows:

Depth, inches [(1), (2)]	Bearing Soil Type	Allowable Net Bearing Capacity, psf
8	Very Stiff Clay	2,000

Notes: 1. The concrete should have a minimum compressive strength of 4000 psi at 28 days, using the ASTM method C39. The maximum allowable slump should be 5-inch. Steel used as reinforcement should be Grade 60 and conforms to ASTM A615.
2. With respect to existing grade.

8.0 OTHER DESIGN CONSIDERATIONS

The potential foundation problems can be reduced by the incorporation of additional design features. Recommended items for consideration are outlined below:

1. Positive drainage should be maintained away from the foundation and pavement areas, both during and after construction.

2. Paving, if possible, should commence at the perimeter of the structural walls to limit moisture content change in floor slab areas.

3. Sand bedding should be specifically prohibited in pavement areas since these more porous soils can allow water inflow which can cause heave and strength loss in the subgrade soils.

4. Long term performance of structures depends not only on the proper design and construction, but also on the proper foundation maintenance program. A properly designed and constructed structure may still experience distress from vegetation and expansive soils which will undergo volume change when correct drainage is not established or an incorrectly controlled water source, such as plumbing/sewer leaks, excessive irrigation, water ponding near the foundation becomes available.

9.0 CONSTRUCTION CONSIDERATIONS

9.1 Surface Water Drainage

In order to minimize ponding of surface water, site drainage should be established early in project construction so that this condition will be controlled.

9.2 Site Preparation

Site preparation should be conducted in accordance with the "City of Houston Standard Specifications (Ref. 1), Section 02221 – Removing Existing Pavements and Structures, and Section 02233 – Clearing and Grubbing". In general, subgrade preparation should be as follows:

1. In general, remove all vegetation, tree roots, organic topsoil, existing foundations, paved areas and any undesirable materials from the construction area. Tree trunks and roots under the proposed structures should be removed to a root size of less than 0.5-inch. We recommend that the stripping depth be evaluated at the time of construction by a soil technician.

2. Any on-site fill soils, encountered in the pavement areas during construction, must have records of successful compaction tests signed by a licensed professional engineer that confirms the use of the fill and record of construction and earthwork testing. These tests must have been performed on all the lifts for the entire thickness of the fill. In the event that no compaction test results are available, the fill soils must be removed, processed and recompacted in accordance with our site preparation recommendations. Excavation should extend at least two-feet beyond the pavement area. Alternatively, the existing fill soils should be tested comprehensively to evaluate the degree of compaction in the fill soils.

3. The subgrade areas should then be proofrolled with a loaded dump truck or similar pneumatic-tired equipment with loads ranging from 25- to 50-tons. The proofrolling serves to compact surficial soils and to detect any soft or loose zones. The proofrolling should be conducted in accordance with TxDOT Standard Specification Item 216. Any soils deflecting excessively under moving loads should be undercut to firm soils and recompacted. Any subgrade stabilization should be conducted after site proofrolling is completed and approved by the geotechnical engineer. The proofrolling operations should be observed by an experienced geotechnician.

4. Off-site borrow for fill should consist of lean clays with a liquid limit not exceeding 40 and a PI between 8 and 20. These soils should be placed in loose lifts not exceeding eight-inches and compacted to at least 95% of maximum standard Proctor density (ASTM D 698) at moisture contents between optimum and +3% of optimum. Bank sands should not be used as select structural fill. On-site soils, free of organics, (with the exception of sands and silts) are also suitable for use as structural fill.

5. Scarify the subgrade, add moisture, or dry if necessary, and recompact to 95% of the maximum dry density as determined by ASTM D 698 (Standard Proctor). The moisture content at the time of compaction of subgrade soils should be between optimum and + 3% of the Proctor optimum value. We recommend that the degree of compaction and moisture in the subgrade soils be verified by field density tests at the time of construction.

6. In cut areas, the soils should be excavated to grade and the surface soils proofrolled and scarified to a minimum depth of six-inches and recompacted to the previously mentioned density and moisture content.

7. The subgrade and fill moisture content and density must be maintained until the proposed structure and paving are completed. We recommend that these parameters be verified by field moisture and density tests at the time of construction.

8. We recommend that the site and soil conditions used in the structural design of the foundation be verified by the engineer's site visit after all of the earthwork and site preparation has been completed and prior to the concrete placement.

9.3 Suitability of On-Site Soils for Use as Fill

9.3.1 General

Fill requirements should be in accordance with the ‘City of Houston Standard Specifications (Ref. 1), Section 02316 –Excavation and Backfill for Structures, Section 02317 – Excavation and Backfill for Utilities, and Section 02320 – Utility Backfill Materials”. The on-site soils can be used as fill materials as described in the following report sections. There are typically three types of fill at a site. These fills can be classified as described in the following report sections.

9.3.2 Select Structural Fill

This is the type of fill that can be used for the structures. These soils should consist of lean clays with liquid limit of less than 40 and plasticity indices between 8 and 20.

9.3.3 Structural Fill

This type does not meet the Atterberg limit requirements for select structural fill. This fill should consist of lean clays or fat clays. They can be used under a paving.

9.3.4 General Fill

This type of fill consists of silts, sands and clays. However, the silts and sands are moisture sensitive and are difficult to compact in a wet condition (they may pump). Furthermore, these soils can erode easily. Their use is not recommended as backfill materials. They can be used for site grading and in unimproved areas.

9.3.5 Use of On-Site Soils as Fill

The on-site soils can be used as fill materials as described below:

		Use as Fill			
Stratum No.[1]	Soil Type	Select Structural Fill	Structural Fill	General Fill	Notes
I	Fill: Fat Clay (CH)	–	✓	✓	2, 3
II	Fat Clay (CH)	–	✓	✓	2, 4

Notes: 1. See soil stratigraphy and design conditions sections of this report for strata description.
2. All fill soils should be free of organics, roots, etc.
3. These soils, once lime modified (5% by dry weight), can be used as select structural fill.
4. These soils, once lime modified (6% by dry weight), can be used as select structural fill.

9.4 Spread Footings Excavations

Each side of an excavation or trench which is five-ft or deeper must be protected by sheeting/bracing shoring or sloped. Based on soil strength data, temporary (less than 24 hours) open-trenched, non-surcharged, and unsupported excavations should be made on slopes of flatter than 1.5 (h):1 (v). Vertical cuts can be constructed, provided shoring and bracing are used for the excavation wall stability. Benched excavation can also be used with average slopes of about 1(h):1(v) and steps should not be higher than five-ft. In all cases, excavations should conform to OSHA guidelines. Flatter slopes may have to be used if large amounts of sand need to be excavated for deep installations. Specifications should require that no water be allowed to pond in the excavations. The surface slopes should be protected from deterioration and weathering if they are to be left open for more than 24 hours.

Excavations should be performed with equipment capable of providing a relatively clean bearing area. Excavation equipment should not disturb the soil beneath the design excavation bottom and should not leave large amounts of loose soil in the excavation.

Foundation excavations should be protected against any significant change in soil moisture content and disturbance by construction activity. If concrete is not poured the same day, the excavation is completed, we recommend placement of a thin seal slab over the base of the excavation.

9.5 Earthwork

Difficult access and workability problems can occur in the surficial fat clay fill soils due to poor site drainage, wet season, or site geohydrology. Should this condition develop, drying of the soils may be improved by the addition of 5% lime by dry weight. The application rate corresponding to this additive amount would be approximately 30 pounds per square yard for each eight-inch of compacted thickness.

City of Houston Standard Specifications 02336 shall be used as procedural guides for placing, mixing, and compacting lime stabilizer and the soils.

Depending on the major type of soils encountered along the project alignment, lime stabilization of the subgrade soils should most likely be performed. The subgrade soils should be stabilized, using lime based on the "City of Houston Standard Specifications, Section 02336 – Lime Stabilized Subgrade". Use 5% lime by dry weight to stabilize the subgrade soils. This results in application rates of 30 pounds of lime, per square yard per eight-inch of compacted thickness.

Provided the site work is performed during dry weather and/or project schedules permit aeration of wet soils, the subgrade will be suitable for floor slab and pavement support.

9.6 Construction Surveillance

Construction surveillance and quality control tests should be planned to verify materials and placement in accordance with the specifications. The recommendations presented in this report were based on a discrete number of soil test borings. Soil type and properties may vary across the site. As a part of quality control, if this condition is noted during the construction, we can then evaluate and revise the design and construction to minimize construction delays and cost overruns. We recommend the following quality control procedures be followed by a qualified engineer or technician during the construction of the facility:

- Observe all phases of excavation.
- Observe the site stripping and proofrolling.
- Verify the type, depth and amount of stabilizer.
- Verify the compaction of subgrade soils.
- Evaluate the quality of fill and monitor the fill compaction for all lifts.
- Monitor and test the excavations for strength, cleanness, depth, size, etc.
- Observe the foundation make-up prior to concrete placement.
- Monitor concrete placement, conduct slump tests and make concrete cylinders.
- Monitor the construction of spread footings.

It is the responsibility of the client to notify GET of when each phase of the construction is taking place so that proper quality control and procedures are implemented.

10.0 RECOMMENDED ADDITIONAL STUDIES

This report has been based on assumed conditions/characteristics of the proposed development where specific information was not available. It is recommended that the architect, civil engineer and structural engineer along with any other design professionals involved in this project carefully review these assumptions to ensure they are consistent with the actual planned development. When discrepancies exist, they should be brought to our attention to ensure they do not affect the conclusions and recommendations provided herein. We recommend that GET be retained to review the plans and specifications to ensure that the geotechnical related conclusions and recommendations provided herein have been correctly interpreted as intended.

11.0 STANDARD OF CARE

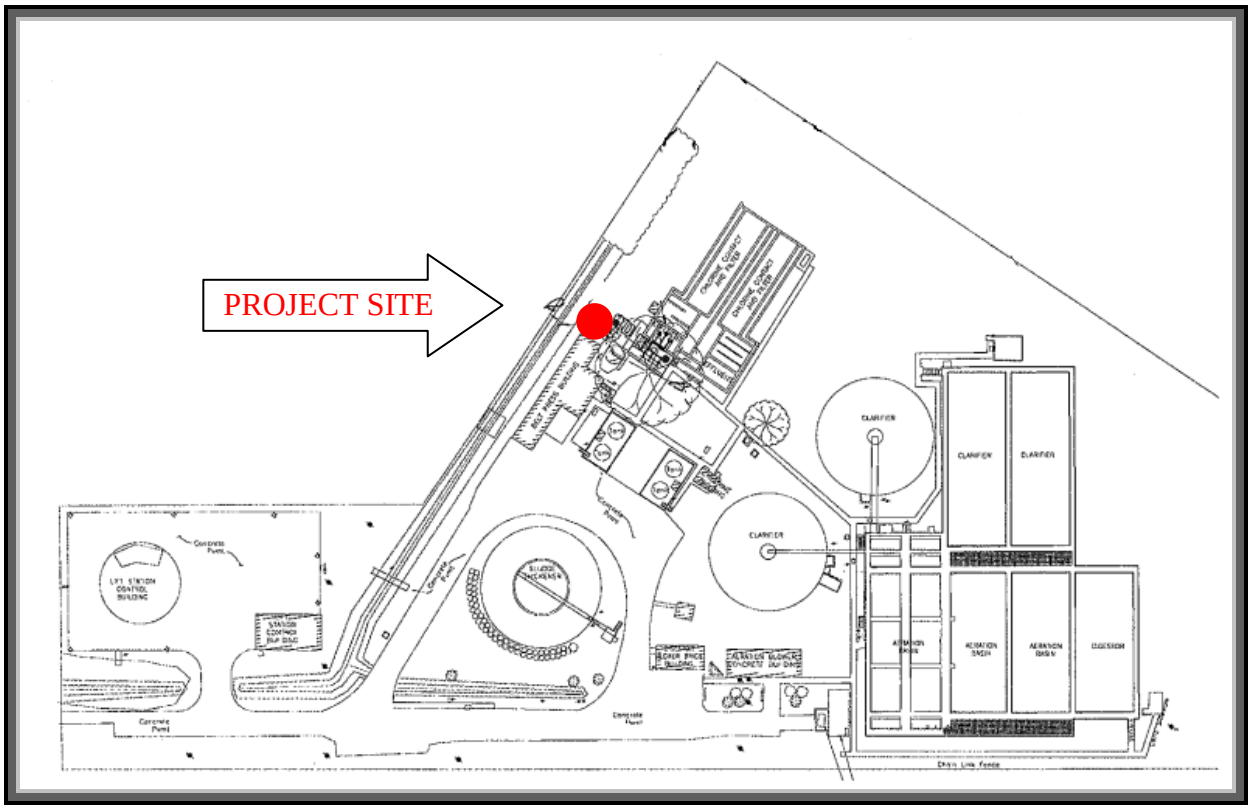
The recommendations described herein were conducted in a manner consistent with the level of care and skill ordinarily exercised by members of the geotechnical engineering profession practicing contemporaneously under similar conditions in the locality of the project. No other warranty or guarantee, expressed or implied, is made other than the work was performed in a proper and workmanlike manner.

12.0 REPORT DISTRIBUTION

This report was prepared for the sole and exclusive use by our client, based on specific and limited objectives. All reports, boring logs, field data, laboratory test results, maps and other documents prepared by GET as instruments of service shall remain the property of GET. Reuse of these documents is not permitted without written approval by GET. GET assumes no responsibility or obligation for the unauthorized use of this report by other parties and for purposes beyond the stated project objectives and work limitations.

13.0 REFERENCE

1. "Standard Construction Specifications for Wastewater Collection Systems, Waterlines, Storm Drainage, Street Paving and Traffic," City of Houston Department of Public Works, 2012.

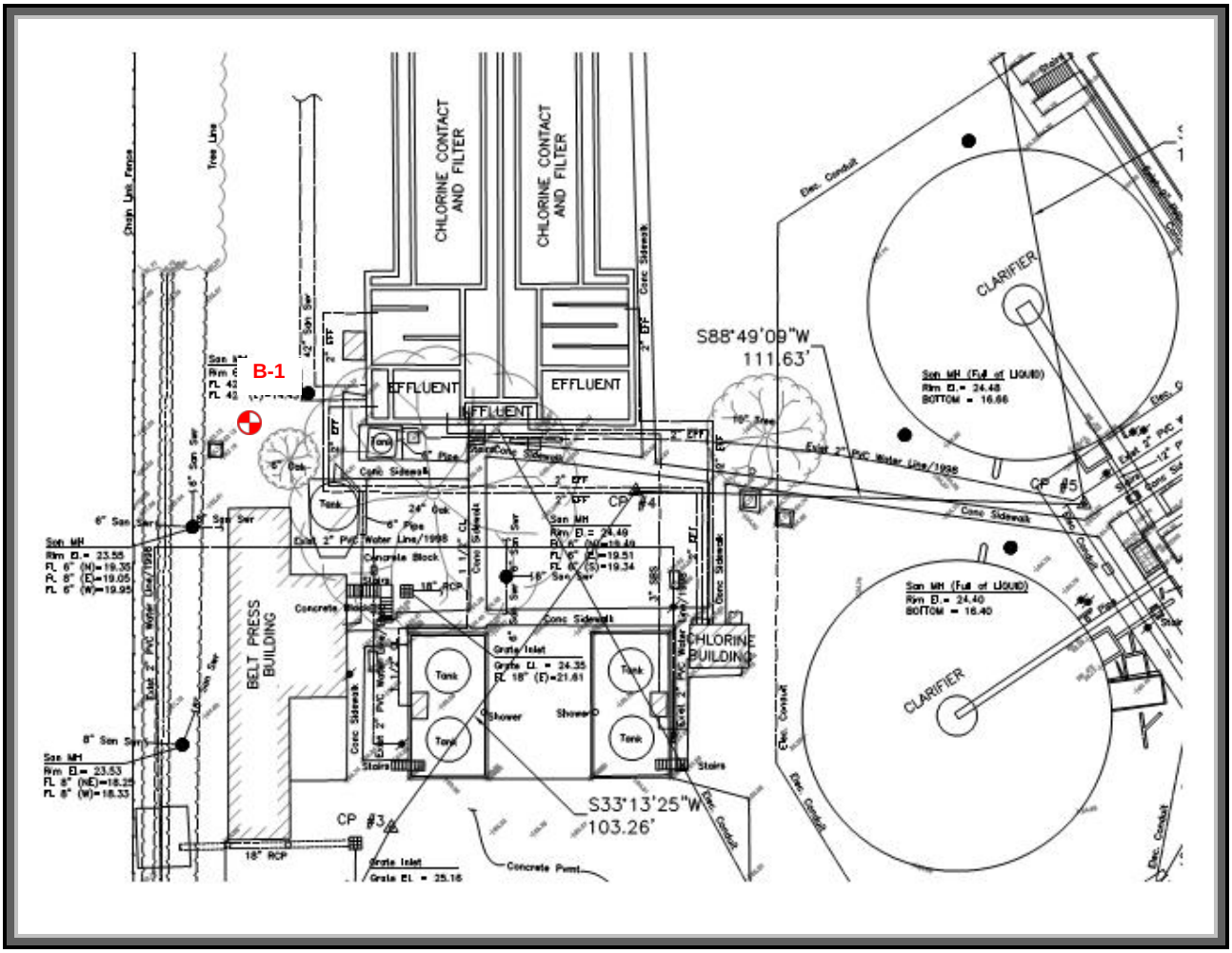


SITE VICINITY MAP

PROJECT: Geotechnical Exploration, Hydro-Tank and Concrete Pad, Metro Central WWTP, 12815 Galveston Road
WBS No. R-000265-0102-3, Webster, Texas

1 INCH = 125 FT	DATE: JUNE 2015	PROJECT NO.: 15-216E

NORTH



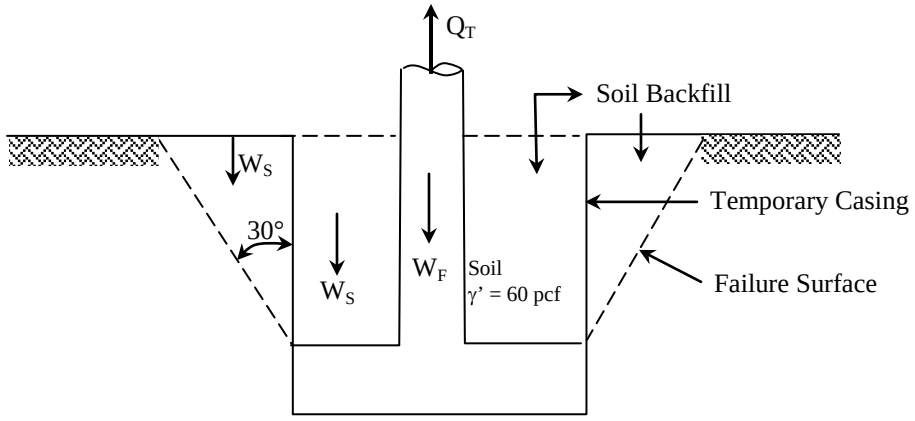
PLAN OF BORING

PROJECT: Geotechnical Exploration, Hydro-Tank and Concrete Pad, Metro Central WWTP, 12815 Galveston Road, WBS No. R-000265-0102-3, Webster, Texas

SCALE: 1 INCH = 45 FT	DATE: JUNE 2015	PROJECT NO.: 15-216E

NORTH

UPLIFT CAPACACITY OF SPREAD FOOTING



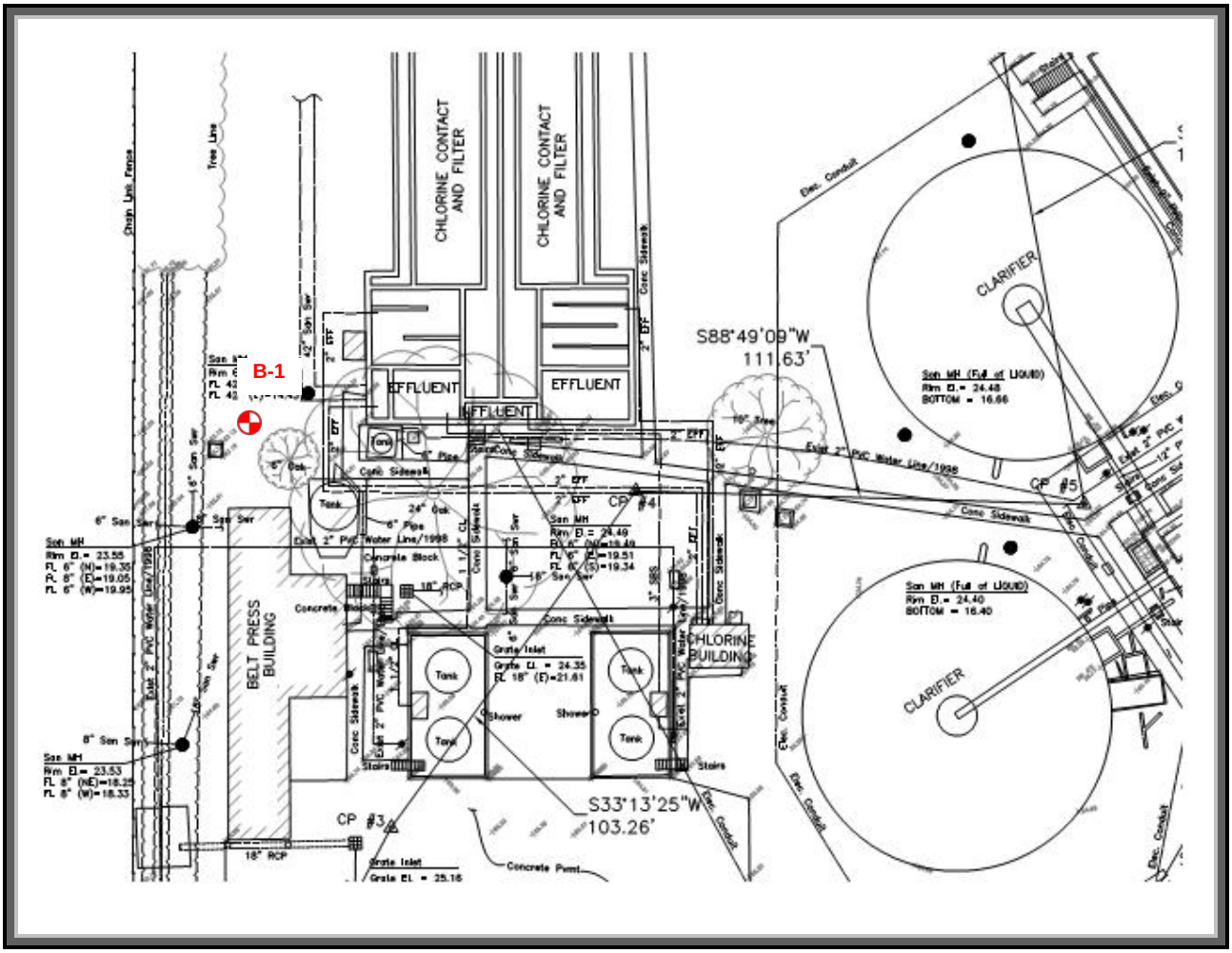
Where, $Q_T = W_F + W_S$ (Use F.S = 1.5)

W_F = Weight of Foundation (Submerged)

W_s = Weight of Soil Wedge (Use Soil Unit Weight, γ' = 60 pcf)

APPENDIX A

Plan of Boring
Log of Boring
Key to Log Terms and Symbols



PLAN OF BORING

PROJECT: Geotechnical Exploration, Hydro-Tank and Concrete Pad, Metro Central WWTP, 12815 Galveston Road, WBS No. R-000265-0102-3, Webster, Texas

SCALE: 1 INCH = 45 FT	DATE: JUNE 2015	PROJECT NO.: 15-216E

NORTH

LOG OF BORING B-1

PROJECT: Proposed Hydro-Tank and Concrete Pad, Metro Central Wastewater Treatment Plant (WWTP), 12815 Galveston Road

PROJECT NO.: R-000265-0102-3

LOCATION: N 13782428.16; E 3190053.59
Metro Central Wastewater Treatment Plant

COMPLETION DEPTH: 25 FT

SURFACE ELEVATION: 24.9 FT

DATE: 05/07/2015

SAMPLER: Shelby Tube/Split Spoon

DRY AUGER: 0 TO 25 FT

WET ROTARY: TO FT

UNDRAINED SHEAR STRENGTH, TSF: ○ HAND PENETROMETER ● UNCONFINED COMPRESSION ■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION △ TORVANE

ELEVATION, FT	DEPTH, FT	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
	0	FILL: FAT CLAY (CH), very stiff, brown, dark gray, with root fibers, calcareous nodules, moist				27	57	20	37
		FAT CLAY (CH), stiff, gray, dark gray, with root fibers to 6', calcareous nodules, moist				33			
20	5	- firm 4' to 6'		94		33			
		- brownish yellow 6' to 10', with ferrous nodules 6' to 12'				25			
15	10					24	64	21	43
		- very stiff 10' to 16', brown 10' to 12'			102	24			
		- reddish brown 12' to 25'				24			
10	15			97		25			
					104	23			
		- brown 18' to 25', with ferrous nodules 18' to 20'				30			
5	20								
0	25					21			

DEPTH TO WATER IN BORING:

▽ FREE WATER 1ST ENCOUNTERED AT 19.0 FT. DURING DRILLING; AFTER 24-HR AT 14.0 FT.

▼ WATER DEPTH AT 14.0 FT., HOLE OPEN TO 25.0 FT. ON 5/8/2015

Drilled By: Abraham Logged By: Colby

Geotech Engineering & Testing

KEY TO LOG TERMS AND SYMBOLS

UNIFIED SOIL CLASSIFICATIONS

Symbol	Material Descriptions
GW	WELL GRADED-GRAVELS, GRAVEL-SAND MIXTURES LITTLE OR NO FINES
GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
GM	SILTY GRAVELS, GRAVEL-SAND SILT MIXTURES
GC	CLAY GRAVELS, GRAVEL-SAND CLAY MIXTURES
SW	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
SP	POORLY GRADED SANDS, OR GRAVELLY SANDS, LITTLE OR NO FINES
SM	SILTY SANDS, SAND-SILT MIXTURES a
SC	CLAYEY SANDS, SAND-SILT MIXTURES b
ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, LEAN CLAYS
OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS
CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENT
	FILL SOILS

TERMS CHARACTERIZING SOIL STRUCTURE

Slickensided	-	Having incline planes of weakness that are slick and glossy in appearance.
Fissured	-	Containing shrinkage cracks frequently filled with fine sand or silt: usually vertical.
Laminated	-	Composed of thin layers of varying colors and soil sample texture.
Interbedded	-	Composed of alternate layers of different soil types.
Calcareous	-	Containing appreciable quantities of calcium carbonate.
Well Graded	-	Having wide range in grain sizes and substantial amounts of all intermediate particle sizes.
Poorly Graded	-	Predominantly of one grain size, or having a range of sizes with some intermediate sizes missing.
Pocket	-	Inclusion of material of different texture that is smaller than the diameter of the sample.
Parting	-	Inclusion less than ⅛-inch thick extending through the sample.
Seam	-	Inclusion ⅛- to 3-inch thick extending through the sample.
Layer	-	Inclusion greater than 3-inch thick extending through the sample.
Interlayered	-	Soils sample composed of alternating layers of different soil types.
Intermixed	-	Soil samples composed of pockets of different soil type and layered or laminated structure is not evident.

COARSE GRAINED SOILS (major portion retained on No. 200 Sieve): Includes (1) clean gravels and sands, and (2) silty or clayey gravels and sands. Conditions rated according to standard penetration test (SPT)* as performed in the field.

Descriptive Terms	Blows Per Foot*
Very Loose	0 – 4
Loose	5 – 10
Medium Dense	11 – 30
Dense	31 – 50
Very Dense	over 50

* 140 pound weight having a free fall of 30-inch

FINE GRAINED SOILS (major portion passing No. 200 Sieve): Include (1) inorganic or organic silts and clays, (2) gravelly, sandy, or silty clays, and (3) clayey silts. Consistency is rated according to shearing strength as indicated by hand penetrometer readings or by unconfined compression tests.

Descriptive Term	Undrained Shear Strength Ton/Sq. Ft.
Very Soft	Less than 0.13
Soft	0.13 to 0.25
Firm	0.25 to 0.50
Stiff	0.50 to 1.00
Very Stiff	1.00 to 2.00
Hard	2.00 or higher

NOTE: Slickensided and fissured clays may have lower unconfined compressive strengths than shown above because of weakness or cracks in the soil. The consistency ratings of such soils are based on hand penetrometer readings.

SOIL SAMPLERS

- SHELBY TUBE SAMPLER
- STANDARD PENETRATION TEST
- AUGER SAMPLING

TERMS CHARACTERIZING ROCK PROPERTIES

VERY SOFT OR PLASTIC	Can be remolded in hand: corresponds in consistency up to very stiff in soils.
SOFT	Can be scratched with fingernail.
MODERATELY HARD	Can be scratched easily with knife; cannot be scratched with fingernail. Difficult to scratch with knife.
VERY HARD	Cannot be scratched with knife.
POORLY CEMENTED OR FRIABLE	Easily crumbled.
CEMENTED	Bounded Together by chemically precipitated materials.
UNWEATHERED	Rock in its natural state before being exposed to atmospheric agents.
SLIGHTLY WEATHERED	Noted predominantly by color change with no disintegrated zones.
WEATHERED	Complete color change with zones of slightly decomposed rock.
EXTREMELY WEATHERED	Complete color change with consistency, texture, and general appearance or soil.

APPENDIX B

Summary of Laboratory Test Results

SUMMARY OF LABORATORY TEST RESULTS

Geotechnical Consultant's Name: Geotech Engineering and Testing

PROJECT NAME: HYDRO-TANK AND CONCRETE PAD, METRO CENTRAL WWTP, 12815 GALVESTON ROAD, WEBSTER, TX

COH WBS NUMBER: R-000265-0102-3

CONSULTANT PROJECT NUMBER: 15-216E

BORING NO.	SAMPLE NO.	DEPTH (FT) Top	DEPTH (FT) Bottom	TYPE	SPT	WATER CONTENT(%)	DRY DENSITY (pct)	ATTERBERG LIMITS LL (%)	ATTERBERG LIMITS PL (%)	ATTERBERG LIMITS PI (%)	PERCENT PASSING SIEVE 200 (%)	SHEAR STRENGTH (TSF) UNCONFINED COMPRESSION TEST	SHEAR STRENGTH (TSF) UU TEST (CONFINING PRESSURE, TSF)	SHEAR STRENGTH (TSF) TORVANE	SHEAR STRENGTH (TSF) POCKET PENETRO METER	TYPE OF MATERIAL
B-1	1	0	2	UD		21		57	20	37				1.12	1.08	Fat Clay (CH)
	2	2	4	UD		33								0.75	0.62	Fat Clay (CH)
	3	4	6	UD		33					94.1			0.38	0.31	Fat Clay (CH)
	4	6	8	UD		25								0.75	0.69	Fat Clay (CH)
	5	8	10	UD		24		64	21	43				0.88	0.78	Fat Clay (CH)
	6	10	12	UD		24	101.82					1.13		1	0.93	Fat Clay (CH)
	7	12	14	UD		24								1.12	1.08	Fat Clay (CH)
	8	14	16	UD		25					96.8			1.12	1.08	Fat Clay (CH)
	9	16	18	UD		23	104.44					0.92		0.88	0.78	Fat Clay (CH)
	10	18	20	UD		30								1	0.93	Fat Clay (CH)
	11	23	25	UD		21								1	0.93	Fat Clay (CH)

LEGEND:

UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD

SS = SPLIT SPOON SAMPLE

AG = AUGER CUTTINGS

SPT = STANDARD PENETRATION TEST

LL = LIQUID LIMIT

PL = PLASTIC LIMIT

PI = PLASTIC INDEX

UU = TRIAXIAL COMPRESSION

NOTES:

APPENDIX C

Project Site Pictures

PROJECT PICTURES
Project No. 15-216E

P-1

P-2

PROJECT PICTURES
Project No. 15-216E

P-3

P-4