ADDENDUM NO. 1

MARCH 15, 2019

CITY OF LUCAS

SINGLE PRESSURE PLANE FACILITIES
NORTH PUMP STATION
(Bid No. 018-19)

This Addendum forms a part of the Contract Documents and Specifications. Acknowledge receipt of the Addendum in the space provided in the Bid Form and on the outer envelope of the Bid Proposal. Failure to acknowledge receipt of this Addendum may subject Bidder to disqualification.

SPECIFICATIONS

1. Add the attached geotechnical report to the Soils Information in the Appendix of the Project Manual.

SUBSURFACE EXPLORATION & PAVMENT THICKNESS RECOMMENDATIONS

ELEVATED STORAGE TANK & PUMP STATION
NORTH PUMP STATION
LUCAS, TEXAS

AGG REPORT: DE18-165

MARCH 13, 2019

PREPARED FOR:

BW2 ENGINEERS, INC.
GARLAND, TEXAS

PRESENTED BY:

ALLIANCE GEOTECHNICAL GROUP

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ALLIANCE GEOTECHNICAL GROUP

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- Environmental Consulting
- Construction Materials Engineering and Testing
- Construction Inspection

March 13, 2019

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Re: Subsurface Exploration & Pavement Thickness Recommendations
Proposed Elevated Storage Tank and Pump Station
North Pump Station
Lucas, Texas
AGG Project: DE18-165

Ms. Burge:

Please find enclosed our report summarizing the results of the geotechnical investigation that was performed at the above referenced project. We that trust the recommendations derived from this investigation will provide you with the information necessary to complete your proposed project successfully.

For your future construction materials testing and related quality control requirements, it is recommended that the work be performed by Alliance Geotechnical Group in order to maintain continuity of inspection and testing services for the project under the direction of the geotechnical project engineer.

We thank you for the opportunity to provide you with our professional services. If we can be of further assistance, please do not hesitate to contact us.

Respectfully,
ALLIANCE GEOTECHNICAL GROUP

Michael D. Roland, P.E.
Vice President

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AASHTO R18

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NORTH PUMP STATION
LUCAS, TEXAS

1.0 INTRODUCTION

1.1 PROJECT DESCRIPTION

The project will consist of a new proposed elevated storage tank and an associated pump station at the North Pump Station in Lucas, Texas. It is understood the elevated storage tank will stand 180 feet in height and generate a total load of approximately 5,922 kips. Based on the site grading plan provided, the cut and fills required to achieve final pad grades are minimal (less than 2 feet). We understand that this subsurface exploration investigation is being performed to provide test borings and laboratory test data to be used by a design-build contractor to design and construct the proposed structures.

In conjunction with the proposed new structures, we understand that new concrete pavement will be constructed. We understand that the new concrete pavement drives will occasionally be used by dump trucks. Concrete pavement thickness recommendations are included in this report.

1.2 PURPOSE AND SCOPE

The purposes of this geotechnical investigation were to: 1) explore the subsurface conditions at the site, 2) provide boring logs that present subsurface conditions encountered including water level observations and laboratory test results, 3) provide fill placement recommendations and subgrade preparation recommendations for new pavements, 4) provide comments on the presence and effect of expansive soils on the proposed new pavements, and 5) provide pavement section recommendations. This investigation was performed in accordance with AGG Proposal P18-1044E-R1 dated November 8, 2018.

2.0 FIELD INVESTIGATION

The field investigation consisted of drilling two (2) test borings (Borings B-1 and B-2) in the vicinity of the proposed elevated storage tank and drilling one (1) test boring (Boring B-3) in the vicinity of the proposed pump station. The test borings were advanced to depths of 35 feet below the existing ground surface. A truck-mounted drilling rig was used to advance the borings and to obtain samples for laboratory evaluation. The approximate locations of the borings are shown on the Plan of Borings (Figure 1).

Subsurface soil samples were obtained at intermittent intervals with standard, thin-walled, seamless tube samplers. These samples were extruded in the field, logged, sealed, and packaged to protect them from disturbance and maintain their in-situ moisture content during transportation to our laboratory. The test borings were backfilled with soil cuttings and the pavements were patched upon completion of drilling.

Foundation bearing properties of the fill soils were occasionally evaluated by the Standard Penetration Test in conjunction with split spoon sampling. The Standard Penetration Tests involves driving a standard 2 inch diameter sampler a total of eighteen inches and recording the blow counts and driving distances for each 6 inch or 50 blow increment. The first 6 inch drive is for seating purposes. The results of the Standard Penetration Tests are recorded at the respective testing depths on the Logs of Borings.

The rock encountered in the test borings was evaluated by the Texas Department of Transportation Penetrometer (TxDOT Cone) tests. The TxDOT Cone is driven with the resulting penetration in inches recorded for 100 blows. The results of the TxDOT Cone test are recorded at the respective testing depths on the Logs of Borings.

The results of the boring program are presented on the Boring Logs (Figures 2 thru 4). The key to the descriptive terms and symbols used on the logs are presented in Figure 5.

3.0 LABORATORY TESTING

Laboratory tests were performed on representative samples of the soil to aid in classification of the soil materials. These tests included Atterberg limits tests, moisture content tests, and dry unit weight determinations. Hand penetrometer tests were performed on the soil samples to provide indications of the swell potential and the foundation bearing properties of the subsurface strata. Unconfined compression strength testing was performed on selected soil samples to provide foundation bearing values. The results of these tests are presented on the Logs of Borings (Figures 2 through 4).

To provide additional information about the swell characteristics of these soils at their in-situ moisture conditions, absorption swell tests were performed on selected samples of the clay soils (Figure 6).

4.0 SITE AND SUBSURFACE CONDITIONS

4.1 GENERAL SITE CONDITIONS

The project will consist of a new proposed elevated storage tank and an associated pump station at the North Pump Station in Lucas, Texas. See the Plan of Borings (Figure 1) for site configuration, location and aerial view.

4.2 SUBSURFACE CONDITIONS

Subsurface conditions encountered in the borings, including descriptions of the various strata and their depths and thickness, are presented on the Boring Logs. Note that depth on all borings refers to the depth from the existing grade or ground surface present at the time of the investigation. Boundaries between the various soil types are approximate.

4.3 SITE GEOLOGY

As shown on the Dallas sheet of the Geologic Atlas of Texas, the site is located in an area underlain by the Austin Chalk Limestone Formation. The formation typically consists of limestone with interbedded layers of clay. Soils derived from this formation are typically plastic clays exhibiting a moderate to high shrink/swell potential with variations in moisture content.

4.4 GROUNDWATER CONDITIONS

The borings were advanced using continuous flight auger methods. Advancement of the borings using these methods allows observation of the initial zones of seepage. Groundwater seepage was encountered within Borings B-2 and B-3 at depths ranging from 6 to 9 feet below the existing ground surface during the drilling operations. No groundwater was encountered within Boring B-1. It should be noted that an extended period of rainy weathered occurred prior to drilling these test borings.

It is not possible to accurately predict the magnitude of subsurface water fluctuations that might occur based upon short-term observations. The subsurface water conditions are subject to change with variations in climatic conditions and are functions of subsurface soil conditions and rainfall.

4.5 SOIL MOVEMENTS

The subsurface exploration revealed the presence of active clay soils. The clay soils will have a moderate to high shrink/swell potential depending upon the soil moisture condition at the time of construction. Potential soil swell movement calculations were performed using swell test results, pocket penetrometer readings, and moisture content tests to estimate the swell potential of the soil. The potential soil swell movement values are based upon current soil moisture conditions and current grades at the test boring locations.

The soil swell movement values based upon the current soil moisture conditions at the boring locations have been estimated to be on the order of 2 to 3 inches. It should be noted that the clay soils were generally in a moist to average moisture condition at the time of this investigation. If the clay soils were allowed to significantly dry prior to pavement construction, the potential soil swell heave could exceed 8+ inches. It is anticipated that dry conditions with potential soil swell movements on the order of 8 inches currently exists within tree influenced areas. Therefore, relatively large differential movements in excess of 6 inches exists between tree influenced areas and non-tree areas if existing trees are removed during construction or if existing trees should die after the pavement is reconstructed.

4.6 OPTIONAL SITE MODIFICATION TO REDUCE SOIL MOVEMENTS

As mentioned above, large differential upward pavement movements are likely to occur at this site due to future shrink/swell movements especially between existing tree areas and non-tree areas. If this magnitude of differential pavement movements are not acceptable, site preparation work will have to be performed in order to lower the potential differential movements to acceptable levels. If it is required for the differential soil swell movements for the proposed new pavements to be reduced, excavation and moisture conditioning of the existing clay soils will be required. Moisture conditioning can be accomplished by excavation and moisture conditioning of the in-situ soils in compacted lifts. An AGG Engineer should be contacted for site preparation work recommendations in order to reduce the potential soil swell movements to acceptable levels if it is desired to reduce differential upward pavement movements.

Note : See Section 6.0 regarding tree effects adjacent to the existing alignments.

5.0 PAVEMENT DESIGN ANALYSIS AND RECOMMENDATIONS

5.1 PAVEMENT RECOMMENDATIONS

We understand that new concrete pavement will be constructed. We understand that the new concrete pavement drives will occasionally be used by dump trucks. The pavement recommendations provided below are based upon this understanding.

5.2 SUBGRADE PREPARATION

It is recommended that provisions be made in the contract documents to provide for proofrolling after the existing pavements have been removed and prior to any filling. After the existing pavement has been removed and excavated to the required subgrade elevation, the entire subgrade should be proofrolled. Proofrolling can generally be accomplished using a heavy (25 ton or greater total weight) pneumatic tired roller making several passes over the areas. Where soft, loose or compressible zones are encountered, these areas should be removed to a firm subgrade. Wet or very moist surficial materials may need to be undercut and either dried or replaced with proper compaction or replaced with a material which can be properly compacted. Any resulting void areas should be backfilled to finished subgrade in 8 inch compacted lifts compacted to 95% ASTM D 698 at optimum to +3% above optimum moisture content. The upper eight (8) inches of subgrade soil should be compacted at -1% to +2% of optimum moisture to a minimum of 98% Standard Proctor density (ASTM D 698).

After proofrolling is performed and any soft, loose or compressible zones are removed and replaced, compact upper 8 inches of subgrade to 95% ASTM D698 as specified above. Then fill to pavement subgrade using on-site clay soils. Compact the fill in 8 inch compacted lifts compacted at optimum to +3% above optimum to 95% ASTM D 698. The upper eight (8) inches of subgrade soil should be compacted at -1% to +2% of optimum moisture to a minimum of 98% Standard Proctor density (ASTM D 698).

5.3 LIME STABILIZATION

The surficial clay soils are active and have a high shrink/swell potential. Clay soils react with hydrated lime, which serves to improve their support value and provide a firm, uniform subgrade beneath the paving. It is anticipated that six (6) to eight (8) percent hydrated lime by dry weight (36 to 48 pounds per square yard per 8-inch depth) would be required to stabilize the existing clay subgrade. The actual lime requirement will depend upon the actual subgrade soils exposed at final grade and should be determined at the time of construction.

The lime should be thoroughly mixed and blended with the top 8 inches of the subgrade per TxDOT Item 260. The mixture should be compacted to a minimum of 95 percent of maximum dry density as determined in accordance with ASTM D 698, within -2% and +2% of the soil's optimum moisture content. We recommend that this lime stabilization extend 2 feet beyond exposed pavement edges in order to reduce the effects of shrinkage during extended dry periods.

Note: After final grading has been performed, depth checks and PI verification checks should be performed to verify that proper stabilization has been achieved as evidenced by a PI of 15 or less.

Sand should be specifically prohibited beneath pavement areas during final grading (after stabilization), since these more porous soils can allow water inflow, resulting in heave and strength loss of subgrade soils. It should be specified that only lime stabilized soil will be allowed for fine grading. After fine grading each area in preparation for paving, the subgrade surface should be lightly moistened, as needed, and recompacted to obtain a tight non-yielding subgrade.

Project specifications should allow a curing period between initial and final mixing of the lime/soil mixture. After initial mixing, the lime treated subgrade should be lightly rolled and maintained at or to 5% above the soil's optimum moisture content until final mixing and compaction. We recommend a 3-day curing period for these soils. The following gradation requirements are recommended for the stabilized materials before final compaction:

	Percent
Minimum Passing 1 3/4" Sieve	100
Minimum Passing 3/4" Sieve	85
Minimum Passing No. 4 Sieve	60

All non-slaking aggregates retained on the No. 4 sieve should be removed before testing.

The stabilized subgrade should be protected and moist cured or sealed with a bituminous material for a minimum of 7 days or until the pavement materials are placed. Pavement areas should be graded to prevent ponding and infiltration of excessive moisture on or adjacent to the pavement areas.

5.4 RECOMPACTED PAVEMENT SUBGRADE

If subgrade stabilization is not performed, a thickened concrete pavement section should be used over a compacted subgrade. The upper eight (8) inches of subgrade soil should be compacted at -1% to +2% of optimum moisture to a minimum of 98% Standard Proctor density (ASTM D 698). The subgrade should be proof-rolled prior to subgrade compaction.

Only on-site soil (comparable to the underlying subgrade soil) should be used for fine grading the pavement areas. After fine grading, the subgrade should again be watered if needed and re-compacted in order to re-achieve the moisture and density levels discussed above and provide a tight non-yielding subgrade. Sand should not be allowed for use in fine grading the pavement areas as discussed previously. The subgrade moisture content and density must be maintained until paving is completed. The subgrade should be watered just prior to paving to assure concrete placement over a moist subgrade.

Note: If a rain event occurs prior to paving, the subgrade should be aerated and re-tested prior to paving.

5.5 DRIVE APPROACHES

Water should not be allowed to pond in drive approaches prior to paving. Density tests should be performed on the subgrade soils in each drive approach prior to fine grading in preparation for paving to verify compliance with project specifications.

5.6 PAVEMENT SECTIONS

Tables 1 and 2 presents the recommended pavement sections for this project:

TABLE 1. LIGHT DUTY PAVEMENT SECTION

AUTOMOBILE TRAFFIC ONLY
PCC SECTION
5 inches Portland Cement Concrete
8 inches Scarified and Compacted Subgrade *

* A lime stabilized subgrade could be used to improve performance and reduce maintenance but is not required by design.

TABLE 2. MODERATELY DUTY PAVEMENT SECTIONS

MODERATE TRUCK USE *
PCC SECTION 6 inches Portland Cement Concrete 8 inches Lime Stabilized Subgrade Or 7 inches Portland Cement Concrete 8 inches Scarified and Compacted Subgrade

** For 12 heavy fully loaded dump trucks repetitions per week (20-year design life).

The concrete in automobile traffic only areas should have a minimum 28 day compressive strength of 3,600 psi. In truck drive areas, the concrete strength should be increased to 4,000 psi for improved performance and increased serviceable life. Concrete quality will be important in order to produce the desired flexural strength and long term durability. We recommend that the concrete have 5% entrained air plus or minus 1%. The concrete should be placed at a slump of 4 inches plus or minus 1 inch for hand pours and a slump of 2 inches plus or minus 1 inch for machine finish pours.

Proper joint placement and design is critical to pavement performance. Load transfer at all longitudinal joints and maintenance of watertight joints should be accomplished by use of tie bars and dowels. Control joints should be sawed as soon as possible after placing concrete and before shrinkage cracks occur. All joints including sawed joints should be properly cleaned and sealed as soon as possible to avoid infiltration of water.

Our previous experience indicates that joint spacing on 12 to 15 foot centers have generally performed satisfactorily. It is our recommendation that the concrete pavement be reinforced with No. 3 bars placed on chairs on approximately 18-inch centers in each direction. We recommend that the perimeter of the pavements have a stiffening curb section to prevent possible distress due to heavy wheel loads near the edge of the pavements and to provide channelized drainage.

5.7 PAVEMENT CONSIDERATIONS

All joints and pavements should be inspected at regular intervals to ensure proper performance and to prevent crack propagation. The soils at the site are active and differential heave within the parking area will likely occur (see Sections 4.5 and 4.6 of report). The service life of paving may be reduced due to water infiltration into subgrade soils through heave induced cracks in the paving section. This will result in softening and loss of strength of the subgrade soils. A regular maintenance program to seal paving cracks will help prolong the service life of the paving.

The life of the pavement can be increased with proper drainage. Areas should be graded to prevent ponding adjacent to curbs or pavement edges. Backfill materials, which could hold water behind the curb, should not be permitted. Flat pavement grades should be avoided.

5.7 SITE GRADING AND DRAINAGE

All grading should provide positive drainage away from the proposed pavements and should prevent water from collecting or discharging near the pavements. Water must not be permitted to pond adjacent to the pavements during or after construction. Otherwise, soil swell movements could exceed the estimates contained in this report.

The pavements will be subject to some post construction movement and should be considered during design of the grading plan. See Sections 4.5 and 4.6. Joints in the pavements should be sealed to prevent the infiltration of water. Since some post construction movement of pavement may occur, joints should be periodically inspected and resealed where necessary.

6.0 TREES EFFECTS

The tree drip lines of several mature trees extend over or near the edge of the existing pavement and are present along the alignments of the proposed new pavement. The roots of mature trees absorb large amounts of moisture from the supporting soils to depths of over 15 feet. The lateral limits of tree root influence extend at least 5 feet beyond the unpruned drip line and to much greater distances when the ground beneath the drip lines is paved and/or if multiple trees are present (which exists at many locations at this site). Tree root systems cause soil shrinkage and localized pavement settlement. One option to minimize settlements would be to remove the trees and perform over-excavation and moisture conditioning within the tree influenced areas to lower the potential differential upward movements to acceptable levels. If this option is desired, Alliance Geotechnical Group should be contacted to provide recommendations.

Another option to reduce future settlement after reconstruction would possibly consist of using root barriers and/or irrigated tree wells. An arborist should be contacted regarding the required depth of the root barrier and/or tree wells and whether or not these are viable solutions based on the site and type of the trees. It is anticipated that root barriers along both pavement edges would sever large roots. This would likely kill the trees. If this occurred, large pavement heave would then occur as described above (same as removing trees). If the barriers are effective in reducing soil suction from the root systems, large differential heave could still occur as the soils regain lost moisture causing differential heave due to soil swelling. Due to these concerns, root barriers are probably not a viable solution at this time.

In our opinion, the most practical solution is to reconstruct the roadway with a thicker reinforced concrete. An additional 1 to 2 inches of concrete (over the required design thickness) could be used within tree influenced areas to provide additional rigidity to the pavement to assist in accommodating differential deflections caused by post construction shrink/swell movements. Additional steel reinforcement could be used to further stiffen the pavement. Either larger bars on a closer spacing or two mats of steel could be used. A Civil Engineer should be consulted regarding the most cost effective reinforcement design for roadway areas near mature trees.

It should be anticipated that differential shrink/swell movements will occur beneath the new roads. If differential settlements due to continued shrinkage caused by the trees become objectionable, these areas could be mudjacked in the future as needed to level the pavement and maintain drainage.

7.0 FIELD SUPERVISION AND DENSITY TESTING

Field density and moisture content determinations should be made on each lift of fill with a minimum of 1 test per 150 linear feet of pavement. Supervision by the field technician and the project engineer is required. Some adjustments in the test frequencies may be required based upon the general fill types and soil conditions at the time of fill placement.

Many problems can be avoided or solved in the field if proper inspection and testing services are provided. It is recommended that all site and subgrade preparation and pavement placement be monitored by a qualified engineering technician. Density tests should be performed to verify compaction and moisture content of any earthwork. Inspection should be performed prior to and during concrete and asphalt placement operations.

8.0 LIMITATIONS

The professional services, which have been performed, the findings obtained, and the recommendations prepared were accomplished in accordance with currently accepted geotechnical engineering principles and practices. The possibility always exists that the subsurface conditions at the site may vary somewhat from those encountered in the test borings. The number and spacing of test borings were chosen in such a manner as to decrease the possibility of undiscovered abnormalities, while considering the nature of loading, size, and cost of the project. If there are any unusual conditions differing significantly from those described herein, Alliance Geotechnical Group should be notified to review the effects on the performance of the recommended foundation system.

The recommendations given in this report were prepared exclusively for the use of the client, and their consultants. The information supplied herein is applicable only for the design of the previously described development to be constructed at locations indicated at this site and should not be used for any other structures, locations, or for any other purpose.

We will retain the samples acquired for this project for a period of 30 days subsequent to the submittal date printed on the report. After this period, the samples will be discarded unless otherwise notified by the owner in writing.

FIGURES

ALLIANCE GEOTECHNICAL GROUP	Project No: DE18-165	PLAN OF BORINGS	
		ELEVATED STORAGE TANK AND PUMP STATION LUCAS, TEXAS	Figure No: 1

LOG OF BORING B-1

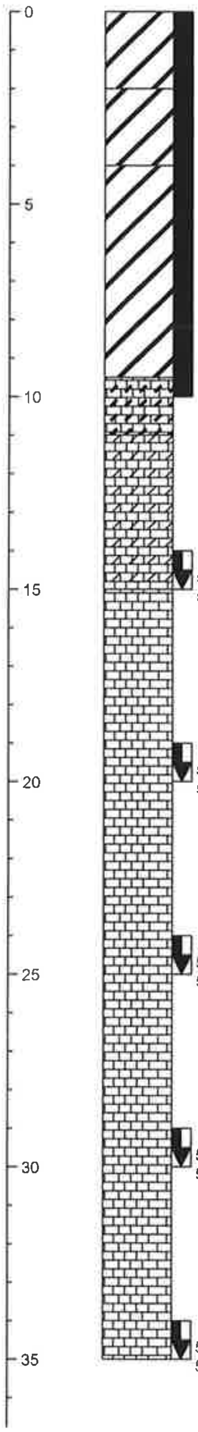
Project: **Lucas Pump Station - Lucas, Texas** Project No.: **DE18-165**

Date: **01/28/2019** Elev.: Location: **See Figure 1**

Depth to water at completion of boring: **Dry**

Depth to water when checked: was:

Depth to caving when checked: was:



ELEVATION/ DEPTH (feet)	SOIL SYMBOLS SAMPLER SYMBOLS & FIELD TEST DATA	DESCRIPTION	MC %	LL %	PL %	PI %	-200 %	DD pcf	P.PEN tsf	UNCON ksf	Strain %
0		Brown CLAY w/ limestone fragments (FILL)	22						2.0 2.5		
		Brown and light gray CLAY, jointed, w/ calcareous nodules and iron nodules	26					90	2.0 2.25	1.6	13.8
5		Light gray and tan CLAY, jointed, w/ calcareous nodules and iron nodules	23	52	18	34		101	2.5 2.75 3.0 3.0 3.5	3.2	14.5
		-water seepage at 9' during drilling	24						3.0		
10		Tan severely weathered LIMESTONE. highly fractured, w/ calcareous clay layers									
	50/0.5" 50/0.5"	Moderately hard to hard tan weathered LIMESTONE. fractured, w/ clay seams									
15		Very hard gray LIMESTONE									
20	50/0.25" 50/0.25"										
25	50/0.5" 50/0.25"										
30	50/0.25" 50/0.25"										
35	50/0.25" 50/0.25"	Boring terminated at 35'									

Notes:

FIGURE:2

LOG OF BORING B-2

Project: **Lucas Pump Station - Lucas, Texas** Project No.: **DE18-165**

Date: **01/28/2019** Elev.: Location: **See Figure 1**

Depth to water at completion of boring: **33.6'**

Depth to water when checked: was:

Depth to caving when checked: was:

ELEVATION/ DEPTH (feet)	SOIL SYMBOLS SAMPLER SYMBOLS & FIELD TEST DATA	DESCRIPTION	MC %	LL %	PL %	PI %	-200 %	DD pcf	P.PEN tsf	UNCON ksf	Strain %
0		Brown CLAY w/ calcareous nodules and iron nodules (FILL)	21						2.25		
									3.0		
			28	59	21	38		93	2.5	2.7	15.0
									2.5		
5		Light gray and tan CLAY, jointed, w/ calcareous nodules and iron nodules	26					98	2.5	3.2	15.0
									3.0		
									2.75		
		Tan and gray CLAY, jointed, w/ calcareous nodules	24						2.75		
		-water seepage at 9' during drilling							3.0		
10	50/2.5" 50/2"	Moderately hard to hard tan weathered LIMESTONE. fractured, w/ clay seams									
15	50/1.5" 50/1"										
		Hard to very hard gray LIMESTONE									
20	50/0.75" 50/0.5"										
25	50/0.25" 50/0.25"										
30	50/0.25" 50/0.25"										
35	50/0.5" 50/0.25"	Boring terminated at 35'									

Notes:

FIGURE:3

LOG OF BORING B-3

Project: **Lucas Pump Station - Lucas, Texas** Project No.: **DE18-165**

Date: **01/28/2019** Elev.: Location: **See Figure 1**

Depth to water at completion of boring: **34'**

Depth to water when checked: was:

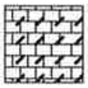
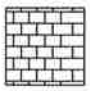
Depth to caving when checked: was:

ELEVATION/ DEPTH (feet)	SOIL SYMBOLS SAMPLER SYMBOLS & FIELD TEST DATA	DESCRIPTION	MC %	LL %	PL %	PI %	-200 %	DD pcf	P.PEN tsf	UNCON ksf	Strain %
0		Soft tan and brown <u>CLAY</u> w/ limestone fragments and trace gravel (FILL)	19						3.0		
									1.1		
	2/6" 2/6" 3/6"								1.0		
		Brown and tan <u>CLAY</u>, jointed, w/ calcareous nodules -water seepage at 6' during drilling	28					95	2.25	2.6	7.5
5									2.5		
		Tan and light gray <u>CLAY</u>, jointed, w/ calcareous nodules and iron stains	20	53	18	35		105	4.0		
									3.0		
									4.0		
	50/3" 50/3"		26	51	18	33		97	4.5+		
10		Soft to moderately hard tan <u>severely weathered</u> <u>LIMESTONE</u>. highly fractured, w/ calcareous clay layers									
		Moderately hard to hard tan <u>weathered</u> <u>LIMESTONE</u>. fractured, w/ clay seams									
15	50/1.5" 50/1.5"										
	50/0.5" 50/0.25"	Hard to very hard gray <u>LIMESTONE</u>									
20											
25	50/0.25" 50/0.25"										
30	50/0.25" 50/0.12"										
35	50/0.5" 50/0.5"	Boring terminated at 35'									

Notes:

FIGURE:4

KEY TO LOG TERMS & SYMBOLS

Symbol	Description
Strata symbols	
	CLAY
	LIMESTONE, severely weathered
	LIMESTONE, weathered
	LIMESTONE
Misc. Symbols	
	Water table at boring completion
Soil Samplers	
	Thin Wall Shelby Tube
	Auger
	THD Cone Penetration Test
	Standard Penetration Test

Notes:

1. Exploratory borings were drilled on dates indicated using truck mounted drilling equipment.

2. Water level observations are noted on boring logs.

3. Results of tests conducted on samples recovered are reported on the boring logs. Abbreviations used are:

DD =	natural dry density (pcf)	LL =	liquid limit (%)
MC =	natural moisture content (%)	PL =	plastic limit (%)
Uncon.=	unconfined compression (tsf)	PI =	plasticity index
P.Pen.=	hand penetrometer (tsf)	-200 =	percent passing #200

4. Rock Cores

   REC = (Recovery) sum of core sample recovered divided by length of run, expressed as percentage.

   RQD = (Rock Quality Designation) sum of core sample recovery 4" or greater in length divided by the run, expressed as percentage.

FIGURE:5

SWELL TEST RESULTS

BORING NO.	DEPTH (FEET	UNIT WEIGHT (pcf)	ATTERBURG LIMITS			IN-SITU MOISTURE CONTENT	FINAL MOISTURE CONTENT	LOAD (psf)	% VERTICAL SWELL
			LL	PL	PI				
B-3	6-7	104.9	53	18	35	19.8	22.7	813	3.2
B-3	9-10	97.4	51	18	33	25.6	26.9	1,188	1.2

PROCEDURE:

1. Sample placed in confining ring, design load (including overburden) applied, free water with surfactant made available, and sample allowed to swell completely.
2. Load removed and final moisture content determined.

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SWELL TEST RESULTS		
LUCAS PUMP STATION		
LUCAS, TEXAS		
ALLIANCE GEOTECHNICAL GROUP		
DE18-165	Date: 03/01/2019	FIGURE 6