A&R

GEOTECHNICAL INVESTIGATION
Proposed Foundations
17000 Aldine Westfield Road Bldg. 'E' - Indoor Shooting Range
Houston, Texas

Reported to
CSF Consulting, L.P.
Houston, Texas

Prepared by
A&R Engineering and Testing, Inc.
Houston, Texas

PROJECT NO. : 11S4508

October, 2011

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October 28, 2011

CSF Consulting, L.P.
11210 Steeplecrest Drive, Suite 202
Houston, Texas 77065

Attention: Mr. Cory Walker, P.E.

Reference: Geotechnical Investigation
Proposed Foundations
17000 Aldine Westfield Road Bldg. 'E' - Indoor Shooting Range
Houston, Texas
A&R NO.: 11S4508

Dear Mr. Walker:

A&R Engineering and Testing, Inc. is pleased to submit this report for the above referenced project. This study was authorized by you on October 24, 2011. This report briefly describes the procedures employed in our investigation and presents the conclusions and recommendations of our studies.

We appreciate the opportunity to work with you on this phase of the project. If you have any question concerning this report or require additional information, please contact us.

Very Truly Yours,

STATE OF TEXAS
RASMY M. HASSOUNA
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REGISTERED
PROFESSIONAL ENGINEER

Russ M. Hassouna, MSCE., P.E.
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Principal Engineer

INTRODUCTION

A&R Engineering and Testing, Inc. (A&R) hereby submits this report of Geotechnical Investigation of subsurface conditions at the site of the Proposed Foundations located at 17000 Aldine Westfield Road in Houston, Texas. **A&R's** investigation was authorized by Mr. Cory Walker, P.E. on behalf of CSF Consulting, L.P. on October 24, 2011.

PURPOSE

The purpose of the Geotechnical Investigation was to determine the subsurface soil conditions on the site of the Proposed Foundations with particular reference to the design of the foundation for the structure.

FIELD INVESTIGATION

The field portion of this study was completed on the site located at 17000 Aldine Westfield Road in Houston, Texas on October 26, 2011. The subsurface soil conditions were explored by advancing and sampling one (1) soil boring drilled to a depth of twenty (20) feet below existing ground surface. The approximate boring location is shown on the attached Boring Plan, Plate No. 1.

Sample depth, description of soil and soil classification (Based on the Unified Soil Classification System) are presented on the Boring Log, Plate No.2. Keys to terms and symbols used on the boring log are shown on Plate No. 3.

The soil boring was of three-inch nominal diameter. Undisturbed samples of the soils were obtained at two (2) foot intervals continuously to a depth of ten (10) feet, and at five (5) foot intervals thereafter. Samples of the soils were obtained by means of three-inch O.D. shelby tube sampler. All undisturbed samples were extruded mechanically from the shelby tubes in the field, wrapped in aluminum foil, and sealed in plastic bags to prevent moisture loss and disturbance. All of the samples were transported to our geotechnical laboratory for examination, testing and analysis.

LABORATORY TESTING

All field soil samples from the boring were examined and classified by a soils engineer. Laboratory tests were then performed on selected soil samples in order to evaluate and determine the physical and engineering properties of the foundation soils in accordance with the prescribed ASTM standards. Strength properties of the foundation soils were determined by means of Pocket Penetrometer and Unconfined Compression Tests performed on undisturbed samples.

The type and number of laboratory tests performed for this study are:

DESCRIPTION	**NO. OF TESTS**
Hand Penetrometer Test	7
Moisture Content Tests	7
Atterberg Limits	4
Unconfined Compression Tests	2
Dry Density Tests	2

The tests noted above were performed to establish the index properties and to aid in the proper classification of the subsurface soils. The test results are shown on the boring logs and are presented on Plate No. 2.

GENERAL SUBSURFACE CONDITIONS

The site is adjacent to Building "E" relatively level and covered with low vegetation and a row of trees. The surface soils were dry and hard at the time of our investigation. The specific subsurface stratigraphy as determined by the field exploration, is shown in detail on the boring logs herein. However, the stratigraphy can be generalized as follows:

Depth (FT.)	**DESCRIPTION**
0' - 4'	Very Stiff Gray and Tan Silty Clay (CL)*.
4' - 12'	Very Stiff Light Gray and Tan Clay to Silty Clay (CH-CL).
12' - 20'	Very Stiff Reddish-Brown and Light Gray Clay (CH).

* Classification is in accordance with the Unified Soil Classification system.

The information in this report summarizes conditions as found on the date the borings were drilled. Free groundwater was not encountered during the field drilling operation. Long term monitoring of the groundwater level was beyond the scope of this study. It should be noted that the groundwater table may be expected to fluctuate with environmental variations such as frequency and magnitude of rainfall and at the time of year when construction begins.

EXPANSIVE CLAY

The Atterberg Limit tests indicate that the Liquid Limit of the soils is in the order of 31 to 70 and the Plasticity Index (P.I.) is in the order of 14 to 46. The subsoil would then be described as clays having a moderate to high shrink/swell potential.

A. UNDERREAMED FOOTINGS

Based on the soil conditions revealed by the field soil test boring, the structure at this site can be supported on a foundation system comprised of drilled and underreamed footings bearing at a depth of thirteen (13) feet below existing grade in the layer of Reddis-Brown and Light Gray Clay. The footings may be sized for a net allowable bearing pressure of 3,500 psf for dead load plus sustained live load. The bearing pressure contains a factor of safety of 2.5 and can be increased 25 percent for total load conditions, whichever is critical.

The plinths of underreamed footings should be reinforced with sufficient reinforcing steel to resist the potential tension force induced by swelling soils between the depth of seasonal moisture changes and the final ground surface elevation.

Caving of piers may occur during construction of the drilled piers due to the presence of Calcareous Nodules. In order to minimize the possibility of piers caving during drilled pier construction, the construction contractor should be prepared to use Cased Piers or Straight Sided Shaft Foundations if caving occur. We recommend that the drilling be performed under the supervision of a Geotechnical Engineer.

Experience indicates that underreams can be successfully installed, and based on local practice for performing underream drill piers is to utilize 3.0 to 1.0 for underream to shaft ratio. Should caving occur during belling operations, the shaft diameter may have to be increased, thereby, changing the bell to shaft ratio. If the soil conditions warrant the changing of the shaft diameter, the Structural Engineer of record should be informed about any changes because they may require a change in reinforcing steel or bell diameter. Another alternative, would be to change the typical 45 degree angle of the underream to 60 degree.

The concrete should be placed in a timely manner after drilling to minimize the potential for caving of the foundation soils. No footings should be poured without the prior approval of the Project Engineer, Architect or Owners Representative. Since the exact size and locations of the footings are not known at this time. A detailed settlement analysis was not authorized, nor performed. It is anticipated that the footings designed using the recommended allowable bearing capacity will experience small settlements that will be well within the tolerable limits for the proposed structure. A detailed settlement analysis can be performed, if desired.

Consideration should be given to providing a void space of four (4) inches beneath the grade beams. This void space allows for movement of the expansive soils below the grade beams without distressing the structural system. Structural cardboard void forms are often used to provide this void space.

Void Boxes are typically placed under the grade beams to provide this void space, and act as a barrier separating the grade beams from the expansive soils. The purpose for using the void boxes is when the underlying expansive soils swell, the void boxes will then collapse, thus minimizing the uplift loads caused from the expansive soils on the grade beams. These voids may act as a channel for water to travel under a foundation system with poor area drainage, however, if this condition occurs, it may result in the subsequent swelling of the soils and an increase in subsoil moisture loads on the floor slabs.

It is our opinion that the determination whether or not to provide voids under the grade beams be made by the owner, builder, architect, or engineer after both the positive and negative aspects are evaluated. A&R Engineering and Testing from our experience with these voids, as well as the experiences of other experts, brings us to the conclusion that even though they may be effective in reducing swell pressures on the grade beams, they may provide void area where water could accumulate and be available for absorption by slab support soils.

We recommend that the concrete slab of the structure be placed on a minimum of thirty (30) inches of non-active type select fill material having a P.I. between 10 and 20. The fill pad should be extended to a minimum of the fill thickness outside the perimeter of grade beams. The concrete slab and the grade beams of the structure should be poured monolithically in order to minimize the possibility of vertical displacement.

B. STRUCTURAL SLAB SUPPORTED ON DRILLED PIERS

Utilization of this type foundation system may be considered for sites that contain highly expansive soils which would normally be separated from bottom of slab by a compacted structural select fill of a given thickness.

This type of foundation systems utilizes drill piers for support of any downward loads and a very stiff slab and beam foundation to resist differential upward movement due to expansion of highly expansive soils caused by moisture changes. There should not be any structural connection between drill piers and grade beams other than those provided for horizontal alignment (sleeved dowels, etc.)

The recommended compacted select fill would not be required and select fill to elevate site should be placed in accordance with our recommendations given in the "Structural Fill and Subgrade Preparation" section. Lack of proper consideration of these factors will result in additional stresses and inferior slab performance.

A void space of six (6) inches beneath the slab and grade beams will be required. This void space allows for movement of the expansive soils below the slab without distressing the structural system.

Void Boxes are typically placed under the floor slab and grade beams to provide this void space, and act as a barrier separating the floor slab from the expansive soils. The purpose for using the void boxes is when the underlying expansive soils swell, the void boxes will then collapse, thus minimizing the uplift loads caused from the expansive soils on the floor slab.

The stiffened slab with drilled piers should be designed in accordance with the Welded Wire Mesh Institute manual "Design of Slab-on-Ground Foundations" and the American Concrete Institute's 318 and 302.1 R codes.

STRUCTURAL FILL AND SUBGRADE PREPARATION

It is recommended that the subgrade and fill material be prepared as follows:

(1) The site should be stripped to suitable depths to remove any existing concrete slab, organics, topsoil and miscellaneous fill material. The exposed subgrade surface should then be proof-rolled. All soft or loose soils should be removed and replaced with select fill.

(2) The natural subgrade should be scarified to a minimum depth of six (6) inches. The scarified soils should then be recompacted to a minimum of 95 percent of the maximum dry density as determined by the Standard Proctor Density Test (ASTM D-698). The moisture content should range -1 to +3% of optimum moisture. The surface soils across the site consist of silty clay materials, therefore, depending on moisture contents at time of construction, these soils may present a problem during compaction activities. Should the surface soils experience problems with stability during compaction activities associated with increased moisture contents, rain, "perched water table", etc., chemical stabilization may be desired.

(3) Select fill used to elevate the grade should consist of a clean sandy clay with a Liquid Limit less than 35 and a Plasticity Index (P.I.) between 10 and 20.

(4) The select fill material should be placed in maximum of eight (8) inch loose lifts and compacted to a minimum of 95 percent of the maximum dry density as per ASTM D-698. The moisture content should be within -1 to +3 % of optimum moisture.

(5) A bedding layer of leveling sand, a maximum of two (2) inches thick can be placed immediately beneath the floor slab. A vapor barrier consisting of 6 mil plastic sheeting should be placed over the sand cushion to prevent water migration through the concrete slab. The excavations for the grade beams should be clean and free of any loose materials prior to concrete placement.

SITE DRAINAGE

It is recommended that site drainage be well developed. Surface water should be directed away from the foundation soils (use a minimum slope of 5% within 10 feet of foundation). No ponding of surface water should be allowed near the structure.

VEGETATION CONTROL

We recommend trees not to be closer than half the canopy diameter of mature trees from the grade beams, typically a minimum of 20 feet. This will minimize possible foundation settlement caused by the tree root systems.

INSPECTION DURING CONSTRUCTION

The recommendations are based on the subsoils data in the field exploration and laboratory testing. Due to the geological deposition of the area, variances may occur between boring locations. Therefore, the footing excavations should be inspected under the supervision of a geotechnical engineer to confirm that the bearing soils are similar to those encountered in our field exploration and that the footing areas have been properly prepared. The geotechnical engineer should be immediately notified should any subsoil conditions be uncovered that will alter the conclusions and recommendations contained in this report. Further investigation and supplemental recommendations may be required if such a condition is encountered.

Prior to placement of concrete, the footings should be inspected to monitor that:

(1) The footing bears in the proper bearing strata at the depth recommended in this report.

(2) The footing shaft is to the proper dimensions and reinforcing steel is placed as shown on the structural drawings.

(3) The footings are concentric with the shaft and the shaft has been drilled plumb within specified tolerances.

(4) Excessive cutting, build up of cutting, and any other soft compressible materials have been removed from the bottom of the excavations.

Samples of the subgrade soil and structural fill material should be obtained prior to compaction operations for laboratory moisture/density testing (Proctor Tests). The tests will then provide a basis for evaluating the in-place density requirements during compaction operations. A qualified soil technician should perform sufficient in-place density tests during the filling operations to verify that proper levels of compaction are being attained.

GENERAL

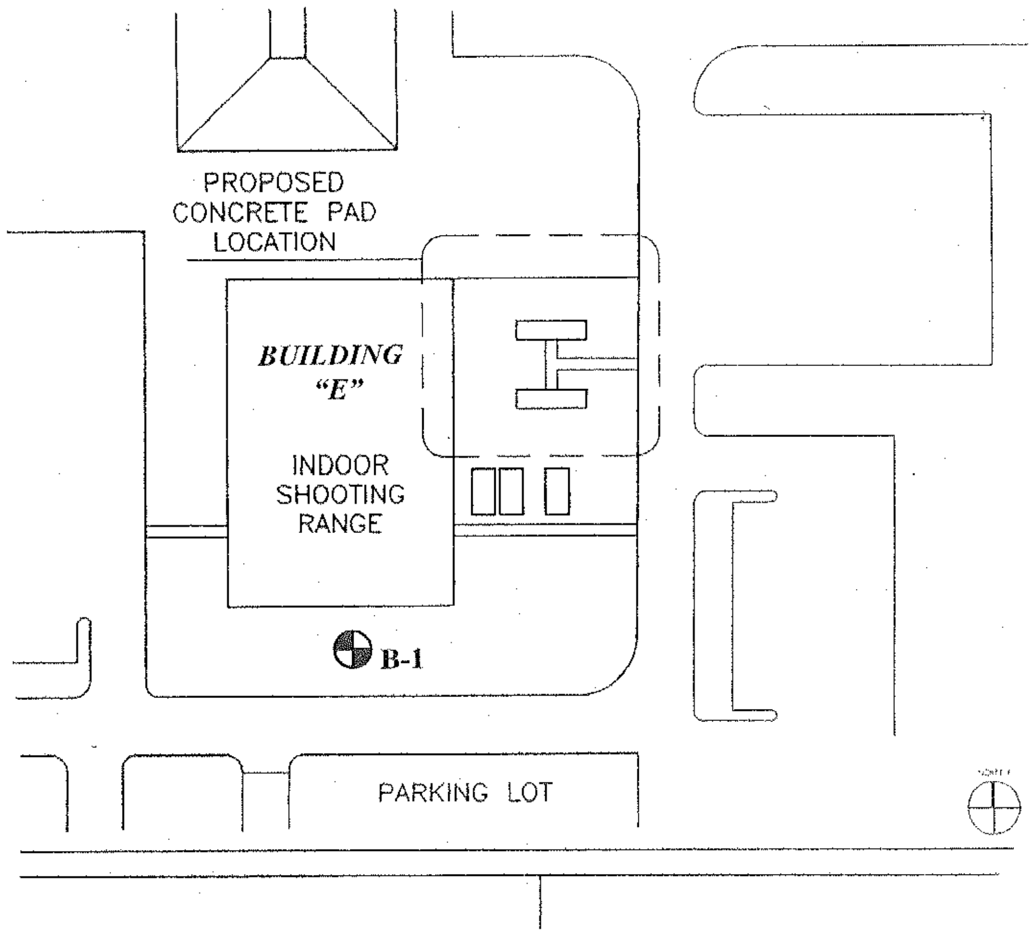
The information and recommendations contained in this report summarized conditions found at the site specified, on the date that the field exploration and soil borings were drilled. The attached boring logs are a true representation of the soils encountered at the specific boring locations on the date of field drilling and represent the stratigraphy as found during the field exploration and drilling of the subject site.

Reasonable variations from the subsurface information presented in this report are assumed. If conditions encountered during construction are significantly different than those presented in this report, **A&R** should be notified immediately.

In addition, the construction process may itself alter site soil conditions. Therefore, experienced personnel should observe and document the construction procedures and all conditions encountered. We would welcome the opportunity to discuss our recommendations with you and hope we may have the opportunity to provide any additional studies or services to complete this project.

The following illustrations are attached and complete this report.

	Plate
Location Plan	1
Boring Log	2
Symbols and Terms Used on Boring Log	3



Approximate Boring Locations

LOCATION
Proposed Foundations
17000 Aldine Westfield Road
Houston, Texas

A&R NO. 11S4508

NOT TO SCALE

PLATE NO. 1

A & R Engineering and Testing, Inc.

GEOTECHNICAL & MATERIALS ENGINEERS

LOG OF BORING

PROJECT NO.: 11S4508

DRY AUGER: 0 - 20'

DATE OF BORING: 10-26-2011

DEPTH (FT)	SOIL SYMBOL	BLOW PER FT.	SAMPLE	DESCRIPTION OF STRATUM B-1	MOISTURE %	DRY DENSITY PCF	% PASS # 200 SIEVE	SHEAR STRENGTH (TSF) O PENETROMETER ● UNCONFINED 0.5 1.0 1.5	LIQUID LIMIT	PLASTICITY INDEX
1				Very Stiff Gray and Tan Silty Clay						
2					11			O	31	14
3										
4					9	101		● O		
5				Very Stiff Light Gray and Tan Clay to Silty Clay						
6				with Calcareous Nodules	9			O	47	29
7										
8					6			O		
9										
10					7			O	61	42
11										
12										
13				Very Stiff Reddish-Brown and Light Gray Clay						
14				with Calcareous Nodules						
15					25	84		● O		
16										
17										
18										
19										
20					22			O	70	46

KEY TO SOIL CLASSIFICATION AND SYMBOLS

SOIL TYPES

- Gravel (GW, GP, GM, GC)
- Sand (SW, SP)
- Silty Sand (SM)
- Clayey Sand (SC)
- Clayey Silt (ML)
- Silt (ML)
- Sandy Silt (ML)
- Silty or Sandy Clay (CL)
- Clay (CH)

CONSISTENCY OF COHESIVE SOILS

Description	Shear Strength-KSF	Penetration Resistance Blows / Ft
Very Soft	Less than 0.25	0 - 2
Soft	0.25 - 0.50	2 - 4
Firm	0.50 - 1.00	4 - 8
Stiff	1.00 - 2.00	8 - 15
VeryStiff	2.00 - 4.00	15 - 30
Hard	Greater than 4.00	> 30

RELATIVE DENSITY OF COHESIONLESS SOIL

Description	Penetration Resistance Blows / Ft	Relative Density . %
Very Loose	0 - 4	0 - 15
Loose	4 - 10	15 - 35
Medium Dense	10 - 30	35 - 65
Dense	30 - 50	65 - 85
Very Dense	> 50	85 -100

SOIL STRUCTURE

CALCAREOUS NODULES	- Nodules of Calcium Carbonate
FERROUS NODULES	- Nodules of Ferrous Material
SLICKENSIDED	- Having inclined planes of weakness that are slick and glossy
BLOCKY	- Having inclined planes of weakness that are frequent and rectangular in pattern
LAMINATED	- Composed of thin layers of varying soil type and texture
FISSURED	- Containing shrinkage cracks frequently filled with fine sand
INTERBEDDED	- Composed of alternate layers of different soil types

SAMPLE SYMBOLS

- Shelby Tube Sample
- Standard Penetration Test
- Auger or Wash Sample
- No Recovery

GROUNDWATER

- (24 hr) - Water level after drilling (time increment after drilling)
- Free water observed during drilling

FAILURE DESCRIPTION (COMPRESSION TEST)

B - Bulge
S - Shear
M/S - Multiple Shear

SLS - Failure surface occuring along slickensided plane
SAS - Failure surface occuring along or in sand seam
SS - Failure surface occuring in or along other secondary structure such as calcareous pockets

PLATE NO.: 3

A&R

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