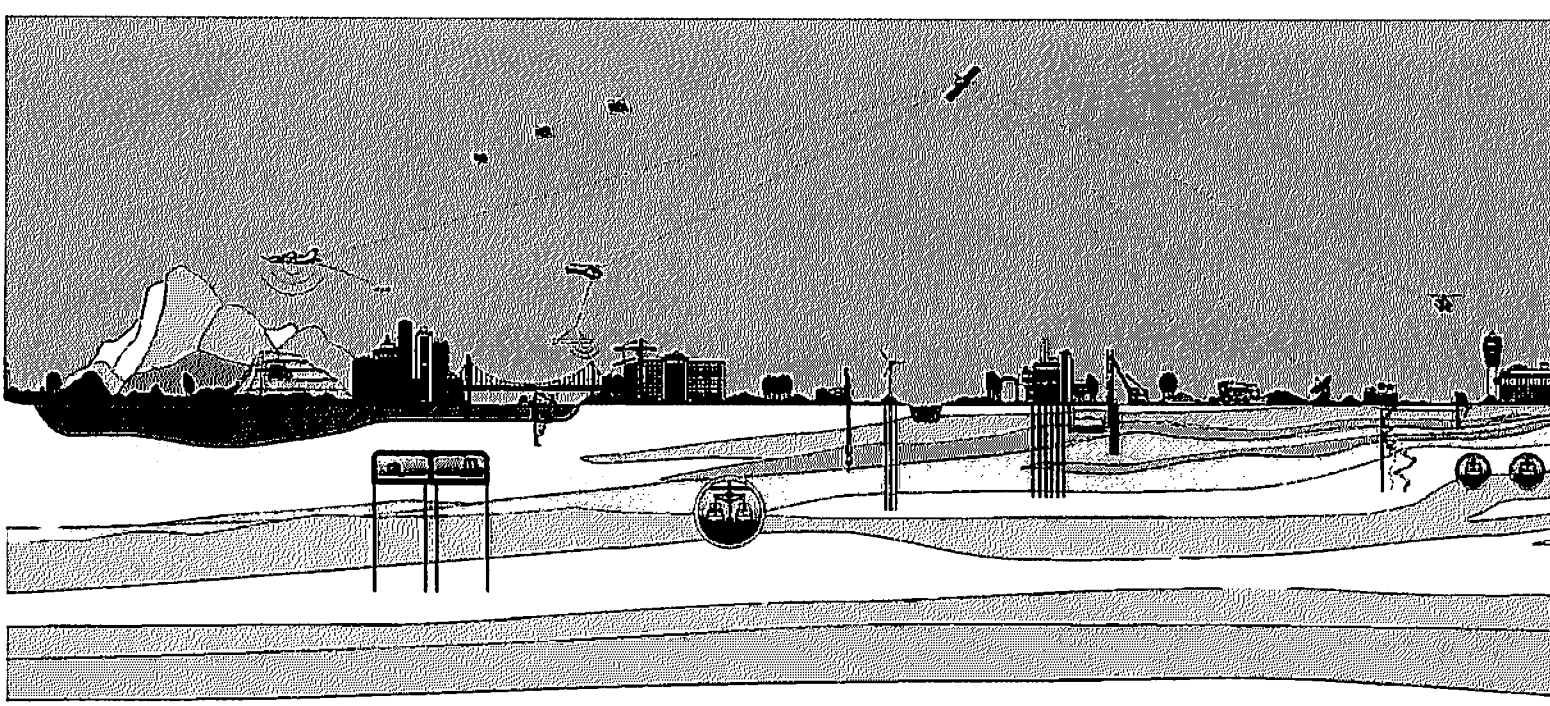
FUGRO CONSULTANTS, INC.

GEOTECHNICAL STUDY
SPRING BRANCH TENNIS CENTER
JUMBO EVANS SPORTS PARK
SPRING BRANCH, TEXAS

SPRING BRANCH TENNIS CENTER
Spring Branch, Texas



Report No. 04.60091113
October 20, 2010

11009 Osgood
San Antonio, Texas 78233
Phone: 210-655-9516
Fax: 210-655-9519

Comal County
Spring Branch Tennis Center
193 Hilltop Circle
Spring Branch, Texas 78070

Attention: Ms. Erinn Murray
President, Director of Tennis Center

Geotechnical Study
Spring Branch Tennis Center
Jumbo Evans Sports Park
Spring Branch, Texas

Introduction

Fugro Consultants, Inc. (Fugro) is pleased to present this report for the above project. This study was done in general accordance with Fugro's Proposal No. 04.60091113, dated January 21, 2010. The work was authorized by Comal County with Purchase Order No. 103151, dated September 3, 2010. This report provides geotechnical information and recommendations for the design of planned facilities.

Project Description

Spring Branch Tennis Center is planning a new tennis facility located at 101 Jumbo Evans Boulevard in Jumbo Evans Park in Spring Branch, Texas. The project location is indicated on the Vicinity Map, Plate 1. The planned site is approximately 1.8 acres. The project will include the construction of a ten new tennis courts and a clubhouse. Detailed details are unknown at the time of this report. However, current plans are the tennis courts will be of concrete construction. The clubhouse will be about 7,500 ft^2 in plan area. We understand Westbrook Engineering will be providing structural design on the clubhouse, and the United States Tennis Association (USTA) will be designing the tennis courts. Water retention/detention ponds and parking facilities are also planned. However, geotechnical design recommendations for these facilities are beyond our scope.

Purposes and Scope

The purpose of this geotechnical study was to evaluate the subsurface conditions at the site and provide geotechnical data to aid in the design and construction of the proposed tennis courts and clubhouse. This study was accomplished by:

- advancing three borings to explore the subsurface conditions and to obtain soil samples;

- performing laboratory tests on the soil samples to evaluate pertinent physical properties; and
- preparing a geotechnical report.

Field Investigation

The field portion of this study was performed on September 30, 2010. Three borings were performed at the site, designated as Borings B-1 through B-3, to explore subsurface conditions. Boring B-1 was advanced and sampled to 13.9-ft depth at the planned clubhouse location and Borings B-2 and B-3 were drilled to 9-ft depth in the area of the tennis courts. The approximate locations of the borings are illustrated on the Plan of Borings presented on Plate 2. Detailed descriptions of the subsurface strata encountered in each boring are presented on the Logs of Borings, Plates 3 through 5. A key to terms and symbols used on the boring logs is presented on Plate 6.

Drilling. The sample borings were drilled to the completion depth using a dry auger drilling technique utilizing solid stem augers. The borings were drilled with a truck-mounted drill rig equipped with the following sampling tools: (1) continuous-flight augers for advancing the hole dry and recovering disturbed samples; (2) seamless metal tubes (Shelby) for obtaining undisturbed samples of cohesive strata (ASTM D 1587); and (3) split-barrel samplers and drive weight assembly for obtaining representative samples and measuring the Standard Penetration Test (SPT) N-values of non-cohesive or hard cohesive soil strata (ASTM D 1586).

Sampling. In the borings, samples were generally obtained at about 2-ft intervals to 10-ft depth, then at 5-ft intervals thereafter. After recovery, each sample was removed from the sampler and visually classified by our field technician. Representative portions of each sample were then packaged, sealed, and transported to Fugro's San Antonio laboratory for further evaluation and testing.

To aid in field classification, the compressive strength of cohesive samples was estimated using a pocket penetrometer, and the penetration resistance of the SPT sampler was recorded. The hand penetrometer values, in tons per square foot (ksf), and the SPT N-values, in blows per foot (bpf), are shown on the logs. It should be noted the undrained shear strength in kips per square foot (ksf) is equivalent to unconfined compressive strength in tons per square foot (tsf).

The borings were advanced without the use of drilling fluids. At the completion of the field exploration, the boreholes were sounded for groundwater using a weighted measuring tape and then backfilled with the soil cuttings. Any depth to water measurements are recorded on the boring logs.

Laboratory Testing

The laboratory testing program included identification and classification testing of the soil samples obtained from the borings. Soil classification tests, including Atterberg limit determinations (ASTM D 4318) and partial grain-size analyses (ASTM D 422), were conducted on representative samples of the soil strata. The classification tests included natural water content determinations (ASTM D 2216). The results of the tests are tabulated on the boring logs at sample recovery depths.

Stratigraphy and Engineering Properties

Subsurface conditions at the site can be understood by a review of the three boring logs presented on Plates 3 through 5. A brief summary of the subsurface conditions encountered at the boring locations is presented in the following paragraphs.

Site Description. The planned facility will include ten adjacent tennis courts located north of Jumbo Evans Boulevard on the west end of the roadway. A clubhouse will be constructed in the center of the southern half of the court area. The area is currently an open field vegetated with weeds and grasses. However, several oak and cedar trees run along the lot adjacent to the road. Overhead power lines border the area to the south and west. Soccer fields are currently located to the north and an irrigation line runs east-west between the area of the proposed tennis courts and the soccer fields. Based on available site grading information provided by the Client, the existing grade slopes downward from about Elevation (El) 1078 ft in the northwest corner of the tennis court facility to about El 1070 ft at the southeast corner.

Stratigraphy. The subsurface conditions encountered at this site generally consisted of three strata. Highly plastic 'fat' clays (CH) were encountered in Borings B-1 and B-3 at the ground surface and extending to a depth of about 4 ft. Low plasticity 'lean' clays (CL) were encountered in Boring B-2 at the ground surface. Beneath the fat clays, weathered limestone was encountered. The fat clays were not encountered in Boring B-2.

The dark brown clays (in Borings B-1 and B-3) are classified as 'fat' clays (CH) based on liquid limits ranging of 65 and 77, plasticity indices (PI's) of 46 and 55, and fines percentages (percent passing the No. 200 sieve) of 81 and 88. The near-surface fat clays would be expected to have a very high potential for volumetric change (shrink/swell) resulting from moisture fluctuations[1]. The dark brown clay in Boring B-2 is classified as low plasticity 'lean' clay (CL) based upon a liquid limit of 34, PI of 15 and 52 percent fines. The lean clay would be expected to have a low to medium shrink/swell potential. However, the material may be fill consisting of reworked on-site soils. Fill materials can be prone to differential settlements if not properly compacted at the

[2] Peck, R.B., Hanson, W.E., and Thornburn, T.H., (1974) Foundation Engineering, Second Edition, John Wiley & Sons, Inc., New York, Pg. 337.

time of placement. The clays were very stiff to hard in consistency based on hand penetrometer readings ranging from 2.0 to greater than 4.5 tsf.

The underlying stratum consisted of weathered limestone. The highly weathered upper portions of this material are classified as gravelly lean clay (CL) based on a liquid limit of 26, a PI of 6 and 50 percent fines. Based on correlations with the plasticity characteristics, this stratum would generally be expected to have little or no potential for volumetric change resulting from moisture fluctuations. The clays of this stratum were hard in consistency based on SPT N-values generally over 50 bpf.

Groundwater Conditions. The borings were drilled to their completion depths without the use of drilling fluids. Water seepage was observed at 7-ft depth in Boring B-1. We believe the water source for the seepage may have been a nearby sprinkler line. Free water was not encountered in the other open boreholes. It should be noted that groundwater levels may fluctuate with seasonal variations in precipitation. Also, it is common for water seeps to be found within the limestone stratum or perched between the soil and limestone strata.

Variations in Subsurface Conditions. Subsurface conditions have been obtained at the boring locations only. Since some variation was found in subsurface conditions at the boring locations, all parties should recognize that even more variation may be possible across the site. In addition, the soil stratigraphy described above, and on the boring logs, is based on interpretation of the technician's observations during sampling, and classification of the soil samples. The boundaries between soil layers are approximate, and transitions between soil types may be gradual.

Foundation Evaluation

As noted earlier, the plasticity indices for the near-surface clay soils encountered at the site indicate a very high shrink/swell potential.[2] Estimates of soil swell at the site were evaluated using the Potential Vertical Rise[3] (PVR) method. The PVR estimate was computed to be about 3¼ inches. Average liquid limit and plasticity index (PI) values were used in the PVR calculation. Note that the PVR procedure derives potential swell from a historic PI versus swell curve. Therefore, the estimated swell values calculated using the PVR method might be different from actual measured movements that occur at the study site. In addition, these estimates of heave potential should be regarded as approximate.

In this report, we are recommending that a portion of the surficial clays be removed and replaced with a low swelling select fill material to reduce potential heave. The table on the following page provides guidelines on the amount of clay removal and replacement based upon

---

[2] Ibid.

[3] McDowell, C., (1956), "Interrelationship of Load, Volume change, and Layer Thickness of Soil to the Behavior of Engineering Structures," Proceedings, Highways Research Board.

heave potential. Normal design practice in central Texas region is to remove and replace a sufficient amount of material to reduce the PVR to 1 inch. Final movement tolerances for the clubhouse and for the tennis courts should be selected by the designer.

Removal/Replacement, ft	Estimated Heave, inches
0	3¼
1	2½
2	1½
3	1
4	¾

Surface Drainage. It is very important that future ponding or standing water around the foundation slab not be permitted. Surface drainage measures should be designed to positively direct water well away from the planned sports court. Drainage facilities should be properly maintained at all times.

Slab Design Parameters

The following section presents slab design parameters, as outlined in the 2009 International Building Code (IBC)[4]. As discussed above, the PVR is about 2½ inches. Based on the computed PVR and the nature of the planned structure, we are recommending the foundation consist of a flat slab on grade. We are providing design parameters used in the Wire Reinforcement Institute (WRI) and Post-Tensioning Institute (PTI) methods for the Structural Engineer's information and possible use.

PTI Parameters. The following PTI parameters have been developed as part of this study for the proposed structures. The parameters are valid for the conditions as indicated in the table below. The conditions were evaluated using the two-dimensional moisture flow analysis computer program, VOLFLO v1.5. The VOLFLO program generates the PTI support parameters (e_m and y_m) in accordance with the updated methods outlined in PTI's "Design of Post-Tensioned Slabs-on-Ground, 3rd Edition (2004)."[5] The table on the following page presents parameters for various building pad thicknesses for the tennis courts and clubhouse.

4 Chapter 18, The International Building Code, International Code Council, 2006.

5 Design of Post-Tensioned Slabs-on-Ground, 3rd Edition, Post-Tensioning Institute, Phoenix, 2004, Chapter 3.

Minimum Building Pad Thickness (feet)	PTI Differential Movement (y_m) (inches)		Edge Moisture Variation Distance (e_m) (feet)	
	Center Lift	Edge Lift	Center Lift	Edge Lift
0	2.6	4.7	8.0	4.1
2	1.7	2.6	9.0	4.5
3	1.2	1.8	9.0	4.7
4	0.9	1.3	9.0	4.9

The PTI differential soil movement (y_m) estimates are based on the computer software VOLFLO v1.5. Our analysis assumes the soil moisture conditions are controlled by climate alone, which results in the maximum soil swelling and shrinking. The center lift condition represents an initial wet suction profile and a final dry profile. The edge lift condition was computed using an initial dry profile and final wet suction profile. The soil volume changes can be mitigated by providing and maintaining favorable site conditions related to drainage, vegetation, and irrigation. Furthermore, the soil movement estimates are considered invalid when soil moisture conditions are influenced by non-climatic factors such as vegetation, slope, drainage, irrigation, downspouts, leaking water lines, etc.

WRI Parameters. The building slabs may also be designed using parameters for slab on grade construction developed by the Wire Reinforcement Institute (W.R.I.). Suggested design methods and procedures are presented in a design guide manual developed for the WRI entitled "Design of Slab-On-Ground Foundations" (March 1996).

According to the manual, the slab type depends on two fundamental factors, the soil type and the climate. Using U.S. Weather Bureau data and the W.R.I. report, the following factors were estimated to describe the soil and climate at this site. The factors are given for the assumed existing conditions as well as for various select fill pad thicknesses.

Minimum Building Pad Thickness (feet)	Climatic Rating (C_w)	Effective PI	Soil-Climate Support Index (1-C)
0	17	55	0.38
2	17	26	0.12
3	17	22	0.07
4	17	18	0.03

The Structural Engineer may use the above parameters to complete the slab and design.

Preparation of the Foundation Pad

1. Within and 3 ft outside the footprint of the facilities (tennis courts and clubhouse), remove and dispose of the selected amount of the surficial clay soils (as per the Owner's desired performance level based on the "Foundation Evaluation" section of this report) and any loose soils, organics or other deleterious materials which may be present. In addition, we recommend removal of the existing fill material at the site.

2. Scarify at least 6 inches of the cut soil subgrade, and recompact to at least 98 percent of the maximum dry density determined using Texas Department of Transportation (TxDOT) Test Method TEX-114-E. Maintain water contents from 0 to +4 percent of the optimum moisture content.

3. Bring the foundation pad to grade with crushed limestone meeting the following material requirements:

Retained on 2-1/2" sieve	0%
Retained on No. 4 sieve	40% - 75%
Retained on No. 40 sieve	50% - 85%
Plasticity Index	8 to 15

   Material meeting Flexible Base Types A or C; Grades 1 or 2; as specified by TxDOT, Standard Specifications for Construction of Highways, Streets and Bridges, Item 247 (current edition) would also be acceptable.

4. Compact the select fill material to at least 98 percent of the maximum dry density as determined using TxDOT Test Method TEX-113-E. Hold water contents to ± 2 percent of the optimum moisture content, and maintain compacted lift thicknesses to 6 inches or less.

5. Keep trees and any other vegetation capable of withdrawing moisture from the soil at a distance from the slabs equal to at least three-quarters of their ultimate height.

Slab-On-Ground.

1. If needed, a modulus of subgrade reaction of 100 pci can be used for the design of the slabs using a flat slab-on-grade and elastic half space analogy. This value is for a 1-ft square plate and must be corrected for size or shape, assuming a cohesionless subgrade.

2. The foundation slab, including slab thickness and placement of reinforcing bars, if used, should be designed to resist cracking as the foundation slab bends due to differential shrink/swell movements of the foundation system.

3. An expansion joint, to control differential movements and shrinkage cracking, should be provided between every two courts.

4. The designer should design the slabs to provide sufficient stiffness to tolerate the anticipated movements. The designer may wish to consider interior stiffening beams for this purpose.
5. Future ponding or standing water around the facilities should not be permitted. All surface drainage measures should be designed to positively direct water well away from the courts and clubhouse. A surface or subsurface drainage system that carries the water well away and down grade from the facility should be made part of the design. Drainage facilities should be properly maintained at all times.

Construction Considerations

Trench Excavations. All OSHA trench safety guidelines should be strictly followed during excavation operations. The design of construction slopes and temporary support systems is the sole responsibility of the contractor. Excavations below the dark brown clays may encounter limestone that may be difficult to excavate using conventional equipment.

Groundwater Control. Groundwater seepage is not anticipated for shallow excavations at the site. However, localized groundwater levels may rise during times of wet seasonal conditions. If groundwater seepage does occur in construction excavations, this seepage can, more likely than not, be pumped from the excavation.

Surface Drainage. Future ponding or standing water around the tennis courts should not be permitted. All surface drainage measures should be designed to positively direct water well away from the courts. A surface or subsurface drainage system that carries the water well away and downhill from the tennis courts should definitely be part of the design. Drainage facilities should be properly maintained at all times.

Concrete. Concrete will experience additional cracking due to concrete shrinkage during curing and thermal variations. The addition of water during placement will aggravate shrinkage cracking. We highly recommend the slump be maintained to less than 5 inches to reduce the potential for shrinkage cracking.

Conditions

The professional services that form the basis for this report has been performed using that degree of care and skill ordinarily exercised, under similar circumstances, by reputable geotechnical engineers practicing in the same locality. No warranty, express or implied, is made as to the professional advice set forth. Fugro's scope of work does not include the investigation, detection, or design related to the presence of any biological pollutants. The term 'biological pollutants' includes, but is not limited to, mold, fungi, spores, bacteria, and viruses, and the byproducts of any such biological organisms.

Our interpretations of subsurface conditions are based on data obtained at the soil boring locations only. Subsurface variations may exist between the boring locations and at areas not explored by soil borings. Statements in this report as to subsurface variation over given areas are intended only as estimations from the data obtained at specific boring locations. In addition, the condition of the soils may change subsequent to our field exploration. Significant variations in subsurface conditions or changed soil conditions may require changes to our conclusions and recommendations. Observations during construction are recommended to check for variations in subsurface conditions and possible changed conditions.

The results, conclusions, and recommendations contained in this report are directed at, and intended to be utilized within the scope of work contained in this report. This report is not intended to be used for any other purposes. Fugro Consultants, Inc. makes no claim or representation concerning any activity or condition falling outside the specified purposes to which this report is directed, said purposes being specifically limited to the scope of work as defined in said agreement. Inquiries as to said scope of work or concerning any activity or condition not specifically contained therein should be directed to Fugro Consultants, Inc. for a determination and, if necessary, further investigation.

This report was prepared for the sole and exclusive use by the client, as an instrument of service. This report shall remain the property of Fugro Consultant, Inc. No third party may use or rely upon the information provided in this report without our express written consent. We assume no responsibility for the unauthorized use of this report by other parties and for purposes beyond the stated project objectives and scope limitations.

The recommendations presented in this report were developed based on our understanding of the construction as currently planned. Revisions of the construction could affect our recommendations. If the construction differs from the descriptions in this report, Fugro Consultants, Inc. should be contracted to review the construction changes and provide new recommendations and/or design criteria, if necessary.

Closing

We appreciate the opportunity to work with you on this project. Please call us if we can be of any additional assistance.

Sincerely,

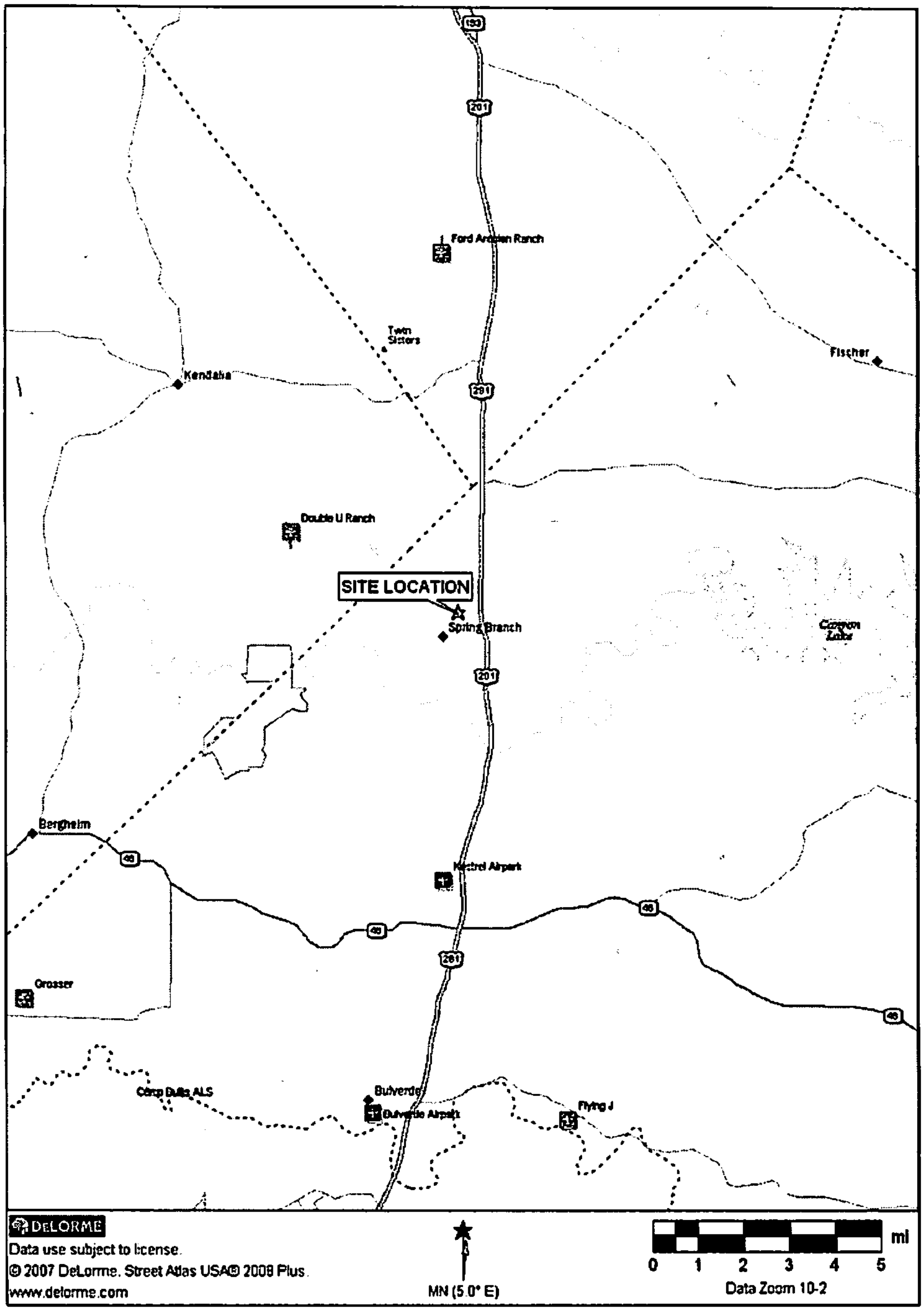
FUGRO CONSULTANTS, INC.
TBPE Firm Registration No. F-299

Henry Galindo, P.E.
Senior Geotechnical Engineer

JOHN P. STYRON
89488
LICENSED PROFESSIONAL ENGINEER
STATE OF TEXAS

John P. Styron, P.E., LEED AP
Geotechnical Manager

HG/JPS (H:\Geotech 2009\60091113 Spring Branch Tennis Center\Report\04.60091113 Rpt Spring Branch Tennis Center.doc
Copies Submitted: Ms. Erinn Murray (3)
File (2)



VICINITY MAP
Spring Branch Tennis Center
Jumbo Evans Sports Park
Spring Branch, Texas

PLATE 1

PLAN OF BORINGS
Spring Branch Tennis Center
Jumbo Evans Sports Park
Spring Branch, Texas

PLATE 2

LOG OF BORING NO. B-1

Spring Branch Tennis Center
Jumbo Evans Sports Park
Spring Branch, Texas
PROJECT NO. 04.60091113

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN Blows/ft. REC./RQD, %	STRATUM DESCRIPTION SURF. ELEVATION: 1071.0 ft	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	CONFINING PRESSURE, PSI	COMPRESSIVE STRENGTH, TSF
			P = 2.0	FAT CLAY WITH SAND (CH), dark brown, very stiff, with roots - with organics and small gravel to 2'		32	65	46	100	81			
			P = 2.0		1067.0 4.0								
5			N = 50/4"	LIMESTONE, light brown, highly weathered, with clay seams and layers									
			N = 50/1"	- tan, moderately weathered below 6'									
			N = 50/0"										
10													
			N = 50/0"		1057.5 13.5								
15				Notes: 1) Free water seepage at 7- ft depth. 2) Elevation and coordinates shown were estimated using a hand held GPS unit.									

Fugro Consultants, Inc.

COMPLETION DEPTH: 13.5
DATE DRILLED: 9-30-10
WATER LEVEL / SEEPAGE: 7.0
UPON COMPLETION: Dry

LONGITUDE: 98°24'57.69" W
LATITUDE: 29°53'55.15" N

PLATE 3

FUGRO STD UCS & UU (NO PL) 04.60091113GPJ.GPJ FUGRO DATA TEMPLATE 042610.GDT 10/20/10

LOG OF BORING NO. B-2

Spring Branch Tennis Center
Jumbo Evans Sports Park
Spring Branch, Texas
PROJECT NO. 04.60091113

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	CONFINING PRESSURE, PSI	COMPRESSIVE STRENGTH, TSF
				SURF. ELEVATION: 1078.0 ft									
			P = 4.5+	SANDY LEAN CLAY (CL), dark brown, hard, with gravel and large roots (possible fill)		15	34	15	93	52			
				LIMESTONE, light brown, highly weathered, with clay seams and layers	1076.0 2.0								
5			N = 59			12	26	6	71	50			
			N = 50/0"										
			N = 50/0"		1069.5 8.5								
10				Note: Elevation and coordinates shown were estimated using a hand held GPS unit.									
15													

Fugro Consultants, Inc.

COMPLETION DEPTH: 8.5
DATE DRILLED: 9-30-10
WATER LEVEL / SEEPAGE: Dry
UPON COMPLETION: Dry

LONGITUDE: 98°25'0.72" W
LATITUDE: 29°53'56.58" N

PLATE 4

FUGRO STD UCS & UU (NO PL) 04.60091113GPJ.GPJ FUGRO DATA TEMPLATE 042610.GDT 10/20/10

LOG OF BORING NO. B-3

Spring Branch Tennis Center
Jumbo Evans Sports Park
Spring Branch, Texas
PROJECT NO. 04.60091113

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN Blows/ft. REC./RQD, %	STRATUM DESCRIPTION SURF. ELEVATION: 1070.0 ft	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	CONFINING PRESSURE, PSI	COMPRESSIVE STRENGTH, TSF
			P = 3.0	FAT CLAY (CH), dark brown, hard, with limestone fragments and large roots									
			P = 2.3			33	77	55	100	88			
					1066.0 4.0								
5			N = 37										
			N = 50/0"	- tan, moderately weathered below 6'									
			N = 50/0"		1061.5 8.5								
10				Note: Elevation and coordinates shown were estimated using a hand held GPS unit.									
15													

Fugro Consultants, Inc.

COMPLETION DEPTH: 8.5
DATE DRILLED: 9-30-10
WATER LEVEL / SEEPAGE: Dry
UPON COMPLETION: Dry

LONGITUDE: 98°24'56.19" W
LATITUDE: 29°53'57.11" N

PLATE 5

FUGRO STD UCS & UU (NO PL) 04.60091113GPJ.GPJ FUGRO DATA TEMPLATE 042610.GDT 10/20/10

TERMS AND SYMBOLS USED ON BORING LOGS FOR SOIL

Sampler Types

Thin-walled Tube | Standard Penetration Test (SPT) | Texas Cone Penetration Test (TCP) | Auger Sample | Bag Sample

Material Types

LEAN CLAY (CL)	SANDY LEAN CLAY (CL)	FAT CLAY (CH)	SANDY FAT CLAY (CH)
WELL-GRADED GRAVEL (GW)	POORLY-GRADED GRAVEL (GP)	SILTY GRAVEL (GM)	CLAYEY GRAVEL (GC)
WELL-GRADED SAND (SW)	POORLY-GRADED SAND (SP)	SILTY SAND (SM)	CLAYEY SAND (SC)
FILL (F)	ASPHALT (A)	CONCRETE (C)	AGGREGATE BASE (AB)

Consistency

Strength of Fine Grained Soils			
Consistency	SPT (# blows/ft)[1]	UCS (TSF)[1]	PP (Fugro DFW)
Very Soft	< 2	< 0.25	0.4
Soft	2 - 4	0.25 - 0.5	0.5 - 0.8
Medium Stiff	4 - 8	0.5 - 1.0	0.9 - 1.6
Stiff	8 - 15	1.0 - 2.0	1.7 - 3.3
Very Stiff	15 - 30	2.0 - 4.0	> 3.4
Hard	> 30	> 4.0	

Density of Coarse Grained Soils		
Apparent Density	SPT (# blows/ft)	TCP (# blows/ft)[2]
Very Loose	0 - 4	< 8
Loose	4 - 10	8 - 20
Medium Dense	10 - 30	20 - 60
Dense	30 - 50	60 - 100
Very Dense	> 50	> 100

Moisture

Moisture Content adapted from (3)	
Dry	No water evident in sample
Moist	Sample feels damp
Very Moist	Water visible on sample
Wet	Sample bears free water

Grain Size[3]

U.S. Standard Sieve

	12"		3"		3/4"		4		10		40		200		
Boulders		Cobbles		Gravel: Coarse		Gravel: Fine		Sand: Coarse		Sand: Medium		Sand: Fine		Silt	Clay
	300		75		19		4.75		2.00		0.425		0.075		0.002

Particle Grain Size in Milimeters

Structure[1]

Criteria for Describing Structure	
Description	Criteria
Stratified	Alternating layers of varying material or color with layers at least 6 mm thick; note thickness
Laminated	Alternating layers of varying material or color with the layers less than 6 mm thick; note thickness
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness
Homogeneous	Same color and appearance throughout

Secondary Components

Criteria for Describing Structure adapted from (3)	
Trace	< 5% of sample
Few	5% to 10% of sample
Little	10% to 25% of sample
Some	25% to 50% of sample

Size Modifiers for Inclusions	
Pocket	Inclusion of different material that is smaller than the diameter of the sample
Fragment	Pieces of a whole item - often used with shell and wood
Nodule	A concretion, a small, more or less rounded body that is usually harder than the surrounding soil (as in carbonate nodule) and was formed in the soil by a weathering process
Streak	A line or mark of contrasting color or texture. The mark or line should be paper thin, and it should be natural - not a smear caused by extruding or trimming the sample

FUGRO
Fugro Consultants, Inc.

Note: Information on each boring log is a compilation of subsurface conditions and soil and rock classificaitons obtained from the field as well as from laboratory testing of samples. Strata have been interpreted by commonly accepted procedures. The stratum lines on the logs may be transitional and approximate in nature. Water level measurements refer only to those observed at the times and places indicated, and may vary with time, geologic condition or construction activity.

References: (1) Peck, Hanson and Thornburn, (1974), Foundation Engineering.
(2) TxDOT, (1999), Tex-142-E, Laboratory Classification of Soils for Engineering Purposes.
(3) ASTM International, ASTM D 2488 Standard Practice for Description and Identification of Soils.

PLATE 6

Important Information about Your
Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely, on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with your ASFE-member geotechnical engineer for more information.

ASFE
THE BEST PEOPLE ON EARTH

8811 Colesville Road/Suite G106, Silver Spring, MD 20910
Telephone: 301/565-2733 Facsimile: 301/589-2017
e-mail: info@asfe.org www.asfe.org

IIGER06085.0MRP