
Appendix D

Technical Reports

Fire Station #51

EMW-2009-FC-05882

**Fire Station #51
EMW-2009-FC-05882**

**GEOLOGIC
ASSESSMENT**

Geologic Assessment
 For Regulated Activities
 on The Edwards Aquifer Recharge/transition Zones
 and Relating to 30 TAC §213.5(b)(3), Effective June 1, 1999

REGULATED ENTITY NAME: **21.028-Acre Tract, SWC Beckwith Blvd. & Vance Jackson, San Antonio, Texas**

TYPE OF PROJECT: WPAP AST SCS UST

LOCATION OF PROJECT: Recharge Zone Transition Zone Contributing Zone within the Transition Zone

PROJECT INFORMATION

1. Geologic or manmade features are described and evaluated using the attached **GEOLOGIC ASSESSMENT TABLE**
2. Soil cover on the project site is summarized in the table below and uses the SCS Hydrologic Soil Groups* (*Urban Hydrology for Small Watersheds, Technical Release No. 55, Appendix A, Soil Conservation Service, 1986*). If there is more than one soil type on the project site, show each soil type on the site Geologic Map or a separate soils map.

Soil Units, Infiltration Characteristics & Thickness			* Soil Group Definitions (Abbreviated)
Soil Name	Group*	Thickness (feet)	
Cb-Crawford and Bexar stony soils	D	3.0	A. Soils having a <u>high infiltration</u> rate when thoroughly wetted. B. Soils having a <u>moderate infiltration</u> rate when thoroughly wetted. C. Soils having a <u>slow infiltration</u> rate when thoroughly wetted. D. Soils having a <u>very slow infiltration</u> rate when thoroughly wetted.
HnB-Houston clay, 1 to 3 percent slopes	D	3.0	

3. A **STRATIGRAPHIC COLUMN** is attached at the end of this form that shows formations, members, and thicknesses. The outcropping unit should be at the top of the stratigraphic column.
4. A **NARRATIVE DESCRIPTION OF SITE SPECIFIC GEOLOGY** is attached at the end of this form. The description must include a discussion of the potential for fluid movement to the Edwards Aquifer, stratigraphy, structure, and karst characteristics of the site.
5. Appropriate **SITE GEOLOGIC MAP(S)** are attached:

The Site Geologic Map must be the same scale as the applicant's Site Plan. The minimum scale is 1" : 400'

Applicant's Site Plan Scale	1" = _____'
Site Geologic Map Scale	1" = _____'
Site Soils Map Scale (if more than 1 soil type)	1" = <u>1667'</u>
6. Method of collecting positional data:
 Global Positioning System (GPS) technology.

GEOLOGIC ASSESSMENT TABLE

PROJECT NAME: 21.028-AC. SITE, SWC BECKWITH BLVD. & VANCE JACKSON RD.

LOCATION		FEATURE CHARACTERISTICS										EVALUATION			PHYSICAL SETTING			
1A	1B*	1C*	2A	2B	3	4			5	5A	6	7	8A	8B	9	10	11	12
FEATURE ID	LATITUDE	LONGITUDE	FEATURE TYPE	POINTS	FORMATION	DIMENSIONS (FEET)			TREND (DEGREES)	DENSITY (NOFT)	APERTURE (FEET)	INFILL	RELATIVE INFILTRATION RATE	TOTAL	SENSITIVITY	CATCHMENT AREA (ACRES)	TOPOGRAPHY	
						X	Y	Z							<40	<1.6	>1.6	
S-1	29.57276667	-98.58681666	CD	5	Kdr	20	20	0.5				F	10	15		X	HILLTOP	
S-2	29.57221667	-98.58678333	CD	5	Kdr	30	10	1				F	10	15		X	HILLTOP	
S-3	29.57186667	-98.58661666	CD	5	Kep	25	15	1				F	10	15		X	HILLTOP	
S-4	29.57148334	-98.58684999	CD	5	Kep	5	5	2				F	10	15		X	HILLTOP	
S-5	29.57150001	-98.58691666	CD	5	Kdr	20	20	1				F	10	15		X	HILLTOP	
S-6	29.57100001	-98.58656666	CD	5	Kep	15	5	1				F	10	15		X	HILLTOP	
S-7	29.57106667	-98.58628333	CD	5	Kep	45	50	2				F	10	15		X	HILLTOP	
S-8	29.57108334	-98.586615	CD	5	Kep	60	25	3				F	10	15		X	HILLTOP	
S-9	29.57126667	-98.58599999	CD	5	Kep	30	20	1				F	10	15		X	HILLTOP	
S-10	29.57196667	-98.58641666	CD	5	Kep	20	20	1				F	10	15		X	HILLTOP	
S-11	29.57250001	-98.58611666	CD	5	Kep	25	25	1.5				F	10	15		X	HILLTOP	
S-12	29.57241667	-98.58971666	CD	5	Kdr	50	50	2				F	10	15		X	HILLSIDE	
S-13	(See Geologic Map)		F	20	Kdr/Kep	730	5		015°	10		F	5	35		X	HILLTOP	

* DATUM: NAD 83

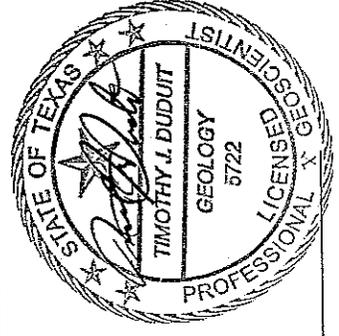
2A TYPE	TYPE	2B POINTS
C	Cave	30
SC	Solution cavity	20
SF	Solution-enlarged fracture(s)	20
F	Fault	20
O	Other natural bedrock features	5
MB	Manmade feature in bedrock	30
SW	Swallow hole	30
SH	Sinkhole	20
CD	Non-karst closed depression	5
Z	Zone, clustered or aligned features	30

8A INFILLING

- N None, exposed bedrock
- C Coarse - cobbles, breakdown, sand, gravel
- O Loose or soft mud or soil, organics, leaves, sticks, dark colors
- F Fines, compacted clay-rich sediment, soil profile, gray or red colors
- V Vegetation. Give details in narrative description
- FS Flowstone, cements, cave deposits
- X Other materials

12 TOPOGRAPHY

Cliff, Hilltop, Hillside, Drainage, Floodplain, Streambed



I have read, I understand, and I have followed the Texas Commission on Environmental Quality's instructions to Geologists. The information presented here complies with that document and is a true representation of the conditions observed in the field. My signature certifies that I am qualified as a geologist as defined by 30 TAC Chapter 213.

SITE SPECIFIC STRATIGRAPHIC COLUMN

System	Group	Formation	Function	Member or Informal Unit	Function	Thickness Feet	Lithology	Hydrostratigraphy
Cretaceous		Del Rio Clay	CB			40-60	Calcareous shale and clay.	Not water bearing
	Edwards	Person (Edwards Aquifer)	AQ	Marine	AQ	90 - 150	Limestone and dolomite; honeycombed limestone interbedded with chalky porous limestone and massive, recrystallized limestone	Reefal limestone and carbonate deposits under normal open marine conditions. Zones with significant porosity and permeability are laterally extensive. Karstified unit.
				Leached and collapsed members	AQ	60 - 90	Limestone and dolomite. Recrystallized limestone occurs predominantly in the freshwater zone of the Edwards Aquifer. Dolomite occurs in the saline zone.	Tidal land supratidal deposits, conforming porous beds of collapsed breccias and burrowed biomicrites. Zones of honeycombed porosity are laterally extensive.
				Regional dense bed	CB	20 - 30	Dense argillaceous limestone.	Deep water limestone. Negligible permeability and porosity. Laterally extensive bed that is a barrier to vertical flow in the Edwards Aquifer.
	Edwards	Kainer (Edwards Aquifer)	AQ	Grainstone	AQ	50 - 60	Limestone, hard, micritic grainstone with associated beds of marly mudstones and wackestones.	Shallow water, lagoonal sediment deposited in a moderately high energy environment. A cavernous honeycombed layer commonly occurs near the middle of the subdivision. Interparticle porosity is locally significant.
				Dolomitic (includes Kirschberg evaporite)	AQ	150 - 200	Limestone, calcified dolomite, and dolomite. Leached, evaporitic rocks with breccias toward top. Dolomite occurs principally in the saline zone of the aquifer.	Supratidal deposits towards top. Mostly tidal to subtidal deposits below. Very porous and permeable zones formed by boxwork porosity in breccias or by burrowed zones.
				Basal Nodular Bed	CB	40 - 70	Limestone, hard, dense clayey; nodular, mottled, stylolitic.	Subtidal deposits. Negligible porosity and permeability.
	Trinity	Glen Rose	CB	Upper part of Glen Rose	CB	300 - 400	Limestone, dolomite, shale and marl. Alternating beds of carbonates and marls. Evaporites and dolomites toward top; variable bedding.	Supratidal and shoreline deposits towards top. Tidal to subtidal deposits below. Unit has little vertical permeability but has moderate lateral permeability.
				Lower part of Glen Rose	AQ	200 - 250	Massive limestone with few thin beds of marl.	Marine deposits - caprinid reef zones and porous and permeable honeycomb porosity near the base.

AQ - Aquifer

CB - Confining Bed

Site Specific Geology and Soil Characteristics

21.028-Acre Tract

SWC Beckwith Boulevard & Vance Jackson Road

San Antonio, Texas

Area Geologic Setting

The site is located within the outcrop of the Person Formation and Del Rio Clay, which were deposited approximately 90 million years ago. The Person Formation is considered part of the Edwards Aquifer, the primary source of drinking water for San Antonio and other communities in central Texas.

The site is located in the Balcones fault zone, which separates the Edwards Plateau from the Gulf Coastal Plain physiographic province. The Balcones fault zone is a series of steep angle, normal faults that generally strike northeast-southwest. Active movement in the Balcones fault zone ceased during the Miocene Epoch. The intense, close spaced faulting along the Balcones fault zone combined with the various rock types of the upper Cretaceous section exposed in central Texas makes rapid changes in rock and soil type the norm rather than the exception.

The depositional environment and lithology of the Edwards Group limestones changes from Kinney County in southwest Texas to Hays County east of San Antonio. The site is located in the San Marcos Arch structural province, which is a distinct depositional province marked by a relatively consistent lithology and stratigraphy of the Cretaceous age limestones, marls, shales, and clays.

The entire Edwards Formation is approximately 350 feet thick in the area. The rocks that comprise the Edwards formation include hard, dense calcium carbonate limestone and some magnesium carbonate limestone called dolomite. These limestones are made up of the shells of invertebrate animals that inhabited the shallow seas of the lower Cretaceous period. These shells range from large, reef forming clams to microscopic foraminifers that secrete shells of the mineral calcite or aragonite, which is composed of calcium carbonate. Aragonite shells are more soluble in water, especially the slightly acid, normal rainwater that contains a weak carbonic acid. The wide ranges of specific minerals making up the shells that compose the limestone are soluble in water in differing amounts. The preferential dissolution of fossil shells gives rise to many of the geologic features observed in rocks of the Edwards Group limestone.

The intense faulting and fracturing of the limestone rocks in the Balcones fault zone and the varying ability of minerals to be dissolved by groundwater lead to the formation of the geologic features that are mapped within the Edwards Aquifer Recharge Zone. The combination of faulting, fracturing, rock dissolution, mineral deposition, erosion, and geologic time produce the caves, closed depressions, fractured rock outcrops, fault zones, solution cavities, and vugular rock features which are mapped during a Geologic Assessment. The characteristics and physical settings of these geologic features are described to assign a relative infiltration rate and potential recharge ranking to assist in managing the resource of the Edwards Aquifer.

The Edwards Aquifer Recharge Zone Map, Castle Hills Quadrangle, shows that the line separating the Edwards Aquifer Recharge Zone from the Contributing Zone of the Edwards Aquifer Transition Zone cuts across the site, as shown on the Geologic Map. Geologic features within the site were assessed in accordance with 30 TAC Chapter 213, even though some of these features occurred in the outcrop of the Del Rio Clay, which is not part of the Edwards Aquifer, as defined in the above referenced regulations.

Site Geology

The site is located in the outcrop of the Edwards Limestone, according to the Geologic Atlas of Texas, San Antonio Sheet by Virgil E. Barnes, Bureau of Economic Geology, Austin, Texas 1974. The site is located on the outcrop of the Person Formation of the Edwards Group, according to Structure Map of the San Antonio Segment of the Edwards Aquifer and Balcones Fault Zone, South-Central Texas: Structural Framework of a Major Limestone Aquifer: Kinney, Uvalde, Medina, Bexar, Comal, and Hays Counties; Edward W. Collins and Susan D. Hovorka, Bureau of Economic Geology, Miscellaneous Map No. 38, 1997. There was no evidence of faulting noted during the walkthrough of this site and stereo aerial photos of the site show one weak lineation intersecting the site. The site is devoid of outcropping geologic units and is covered with thick clay soil. There are numerous cobbles and boulders of Buda Limestone scattered throughout the eastern half of the site and some scattered boulders of Edwards Limestone which appear to have been dumped on the site. The entire site has scattered shells of *Ilymatogyra arietina*, a small pelecypod, which occur more frequently in the western half of the site. This fossil is diagnostic of the Del Rio Clay. Some outcrops of the Del Rio Clay are visible in the western end of the site.

A geotechnical study by Fugro South, Inc. was conducted on the site and a copy of the boring logs and boring location map are attached. The relative elevations of the top of the Edwards Limestone on these boring logs show what appears to be a fault, which is shown on the Geologic Map as feature S-13. There were no traces of the fault on the surface and no openings at the surface in the fault area.

The site appeared to have a long history of soil and rock dumping and clearing activities. All of the closed depressions mapped at this site appeared to be connected with site clearing activities in one way or another. Some closed depressions appeared to be the result of tree removal, some the result of heavy equipment sinking in soft soil, and some the result of brush clearing and mowing activities. Photographs of the features mapped during this assessment are presented at the end of this section.

Site Soil Characteristics

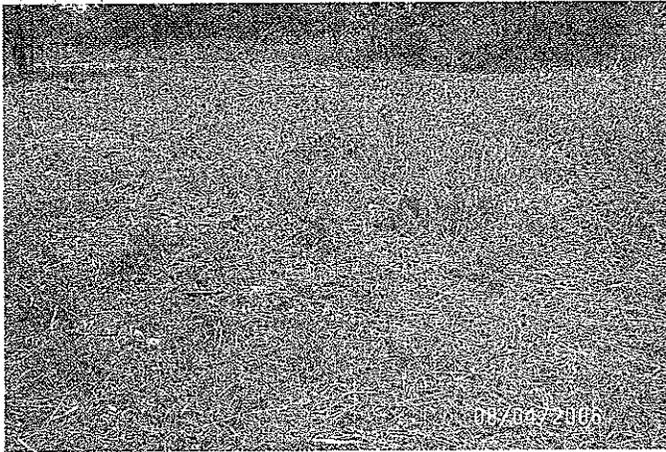
The site is covered with clay soil up to three feet thick throughout, according to observations on the site and information from the geotechnical boring logs. The site has no visible bedrock. According to the Soil Survey of Bexar County, Texas by F. B. Taylor, R. B. Hailey, and D. L. Richmond, US Department of Agriculture, June, 1991, the soil type on the eastern quarter of the site is the *Bexar and Crawford stony soils*, which is composed of 51 percent Crawford soils. The Crawford soils are listed as Hydrologic Soil Group D, in Appendix B of Urban Hydrology for Small Watersheds, by the United States Department of Agriculture, Natural Resources Conservation Service, Conservation Engineering Division, Technical Release 55, June, 1986. The remainder of the site is covered by the *Houston clay, 1 to 3 percent slopes* soil, which is also listed as Hydrologic Soil Group D. The soil throughout the site has large surficial soil cracking, which is expected in soils with a high plasticity indexes (see boring logs) such as those throughout the site. A map showing the distribution of soil types on the site is presented at the end of this section.

Assessment

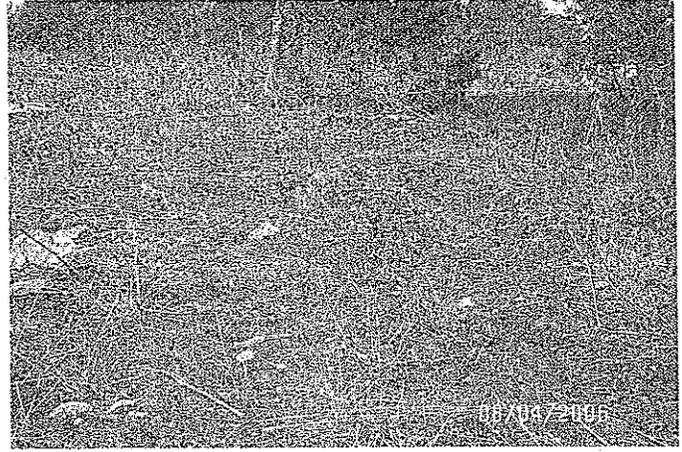
In general, there is a very low potential for fluid movement from the surface of the site to the Edwards Aquifer due to the absence of rock outcrops, the very thick clay soil, the very low infiltration rate Group D clay soils, the man-made features present on the site, the lack of openings to the subsurface, and the presence of the Del Rio Clay over most of the site, with the Del Rio Clay not being part of the Edwards Aquifer, as defined in 30 TAC 213.3 (8).

POINT	LATITUDE	LONGITUDE	EASTING	NORTHING
S01	29.57276667	-98.58681666	2099838	13756033
S02	29.57221667	-98.58678333	2099846	13755840
S03	29.57186667	-98.58661666	2099896	13755712
S04	29.57148334	-98.58684999	2099829	13755572
S05	29.57150001	-98.58691666	2099801	13755573
S06	29.57100001	-98.58656666	2099920	13755383
S07	29.57106667	-98.58628333	2100004	13755414
S08	29.57108334	-98.58615	2100047	13755422
S09	29.57126667	-98.58599999	2100098	13755488
S10	29.57196667	-98.58641666	2099965	13755736
S11	29.57250001	-98.58611666	2100060	13755933
S12	29.57241667	-98.58971666	2098924	13755898

GEOLOGIC ASSESSMENT PHOTOGRAPHS
21.028-ACRE TRACT, SWC BECKWITH BLVD. & VANCE JACKSON RD. SAN ANTONIO, TEXAS



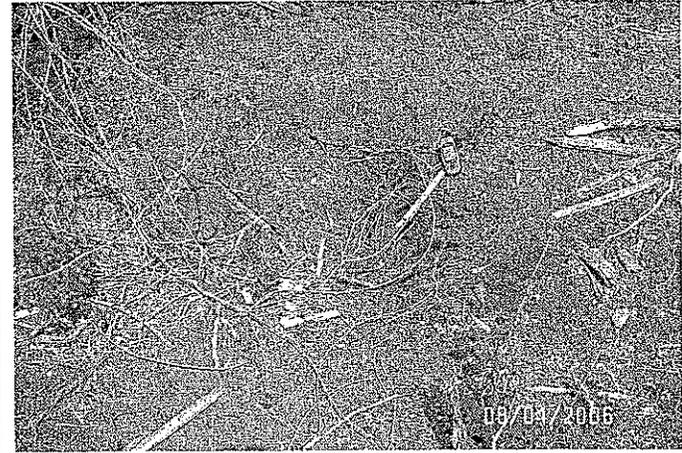
S-1



S-2



S-3



S-4



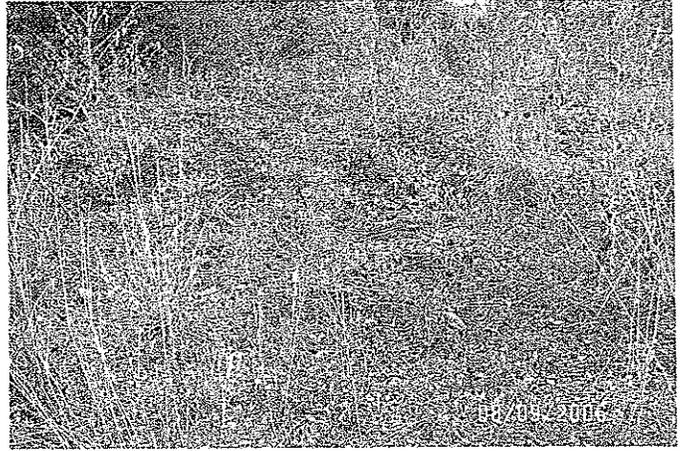
S-5



S-6



S-7



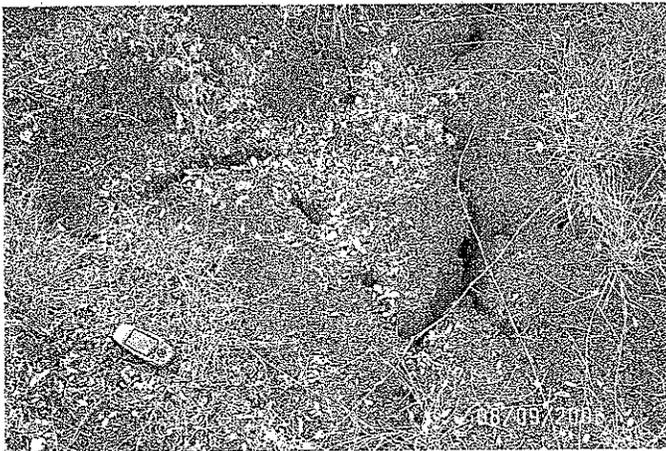
S-8



S-9



S-10



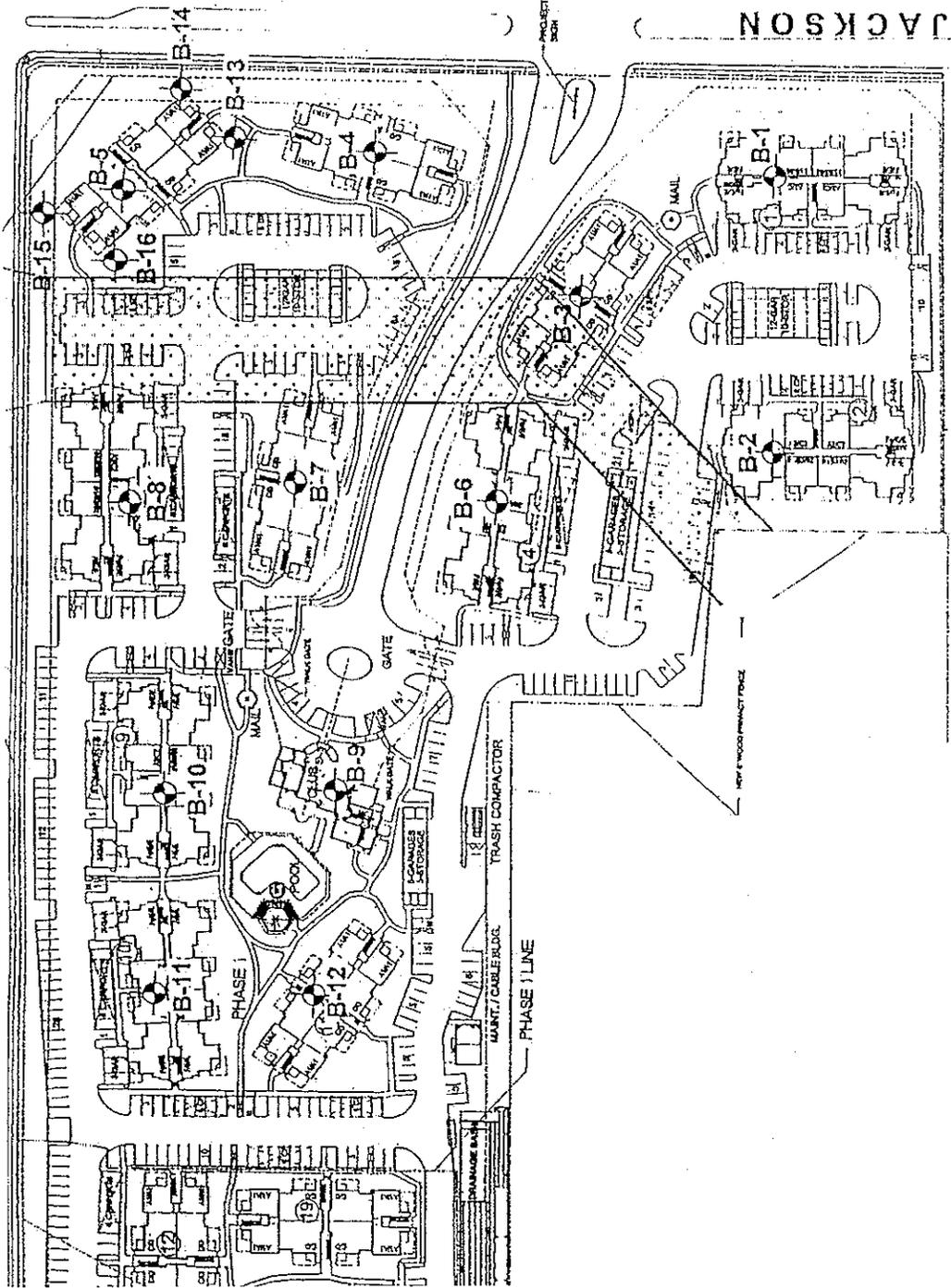
Soil cracking in clay soil at the site.



Del Rio Clay with *Ilymatogyra arietina* fossils.

JACKSON

STREET B C W





LOG OF BORING NO. 1
PROPOSED APARTMENT COMPLEX
SAN ANTONIO, TEXAS

TYPE: *Flight Auger*

LOCATION: *See Plate 2*

DEPTH, FT	SYMBOL	SAMPLES	BLOWS PER FOOT OR REC/(ROD), %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNDRAINED SHEAR STRENGTH KSF
				SURFACE ELEVATION: 1000.0 ±								
			38	CLAY (CH), dark brown, fat, hard, with calcareous deposits (Residual Soils)		47	78	20	58			
			ref/6"	-with roots to 1.5'								
			ref/0"	-with gravel below 2.5'	996.0	16						
5			ref/0"	LIMESTONE, tan, slightly weathered (Edwards Formation)	4.0							
			ref/0"			1						
			ref/0"		991.4							
10					8.6							
				Note: No free groundwater was observed.								
15												
20												
25												
30												

COMPLETION DEPTH: 8.6 ft

DATE: 3-22-99

PROJECT NO. 1002-0121

U = Unconfined P = Pocket Penetrometer
 Q = Unconsolidated- T = Torvane
 Undrained Triaxial





LOG OF BORING NO. 2
PROPOSED APARTMENT COMPLEX
SAN ANTONIO, TEXAS

TYPE: *Flight Auger*

LOCATION: *See Plate 2*

DEPTH, FT	SYMBOL	SAMPLES	BLOWS PER FOOT OR REC(ROD), %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX(PI), %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNDRAINED SHEAR STRENGTH KSF
			19	SURFACE ELEVATION: 999.2 ± CLAY (CH), dark brown, fat, very stiff, with roots and gravel (Residual Soils)		32					90	
			ref/1"		995.2	21	86	20	66			
5			ref/0"	LIMESTONE, tan, slightly weathered (Edwards Limestone)	4.0							
			ref/0"									
			ref/0"		990.6							
10			ref/0"		8.6	1						
				Note: No free groundwater was observed.								
15												
20												
25												
30												
COMPLETION DEPTH: 8.6 ft						U = Unconfined P = Pocket Penetrometer Q = Unconsolidated- Undrained Triaxial T = Torvane						
DATE: 3-23-99			PROJECT NO. 1002-0121									





LOG OF BORING NO. 3
PROPOSED APARTMENT COMPLEX
SAN ANTONIO, TEXAS

TYPE: *Flight Auger*

LOCATION: *See Plate 2*

DEPTH, FT	SYMBOL	SAMPLES	BLOWS PER FOOT OR REC/(ROD), %	STRATUM DESCRIPTION	LAYER ELEV. / DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNDRAINED SHEAR STRENGTH KSF
				CLAY (CH), dark brown, fat, hard, with gravel (Residual Soils)		22	89	20	69			
					996.6							
				LIMESTONE, tan, slightly weathered (Edwards Formation)	3.0							
5			50/7"									
			ref/0"									
			ref/0"			9						
			ref/0"									
10												
			ref/0"									
15												
			ref/0"			986.0						
					13.6	7						
				Note: No free groundwater was observed.								
20												
25												
30												
COMPLETION DEPTH: 13.6 ft						U = Unconfined P = Pocket Penetrometer						
DATE: 3-22-99						Q = Unconsolidated-T = Torvane Undrained Triaxial						
PROJECT NO. 1002-0121												





LOG OF BORING NO. 4
PROPOSED APARTMENT COMPLEX
SAN ANTONIO, TEXAS

TYPE: *Flight Auger*

LOCATION: *See Plate 2*

DEPTH, FT	SYMBOL	SAMPLES	BLOWS PER FOOT OR REC/(RQD), %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNDRAINED SHEAR STRENGTH KSF
				SURFACE ELEVATION: 1000.5 ±								
				CLAY (CH), dark brown, fat, very stiff, with ferrous deposits (Residual Soils) -with roots and gravel to 6'		32	73	20	53		89	0.7 (U) 3.3 (P)
5			14									
			19	-dark brown and tan below 4.5'		29				73		
			ref/6"		993.5							
			ref/0"	LIMESTONE, tan, weathered, with clay seams (Edwards Formation) -less weathered below 8'	7.0							
10												
			ref/0"		986.9							
					13.6	5						
15												
				Note: No free groundwater was observed.								
20												
25												
30												
COMPLETION DEPTH: 13.6 ft						U = Unconfined P = Pocket Penetrometer Q = Unconsolidated- T = Torvane Undrained Triaxial						
DATE: 3-22-99						PROJECT NO. 1002-0121						





LOG OF BORING NO. 5
PROPOSED APARTMENT COMPLEX
SAN ANTONIO, TEXAS

TYPE: *Flight Auger*

LOCATION: *See Plate 2*

DEPTH, FT	SYMBOL	SAMPLES	BLOWS PER FOOT OR REC/(RQD), %	STRATUM DESCRIPTION	LAYER ELEV / DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNDRAINED SHEAR STRENGTH KSF
				SURFACE ELEVATION: 1001.1 ±								
				CLAY (CH), dark brown to tan, fat, hard, with gravel, roots and calcareous deposits (Residual Soils)		27	72	24	48		99	2.2 (U)
				-brown clayey gravel below 4'								4.5+ (P)
5			50/4"			11				38		
			13									
			ref/0"	LIMESTONE, tan, weathered (Edwards Formation)	994.6							
			ref/0"		6.5							
10						15						
			ref/0"									
15					987.5							
					13.6							
				Note: No free groundwater was observed.								
20												
25												
30												

COMPLETION DEPTH: 13.6 ft

DATE: 3-22-99

PROJECT NO. 1002-0121

U = Unconfined P = Pocket Penetrometer
 Q = Unconsolidated T = Torvane
 Undrained Triaxial





LOG OF BORING NO. 6
PROPOSED APARTMENT COMPLEX
SAN ANTONIO, TEXAS

TYPE: *Flight Auger*

LOCATION: *See Plate 2*

DEPTH, FT	SYMBOL	SAMPLES	BLOWS PER FOOT OR REC/(RQD), %	STRATUM DESCRIPTION	LAYER ELEV / DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNDRAINED SHEAR STRENGTH KSF	
				SURFACE ELEVATION: 998.8 ±									
			10	CLAY (CH), dark brown, fat, very stiff, with roots and ferrous deposits (Del Rio)									
			16				29	93	27	66			
5			30										
					-light gray and tan below 6'		19	54	17	37		107	4.5+ (P)
10						16					126	5.7 (U)	
												4.5+ (P)	
					985.7								
				LIMESTONE, tan, slightly weathered (Edwards Formation)	13.1	3							
15					985.2								
					13.6								

Note: No free groundwater was observed.

COMPLETION DEPTH: 13.6 ft

DATE: 3-23-99

PROJECT NO. 1002-0121

U = Unconfined P = Pocket Penetrometer
 Q = Unconsolidated Undrained Triaxial T = Torvane





LOG OF BORING NO. 7
PROPOSED APARTMENT COMPLEX
SAN ANTONIO, TEXAS

TYPE: *Flight Auger*

LOCATION: *See Plate 2*

DEPTH, FT	SYMBOL	SAMPLES	BLOWS PER FOOT OR REC/(ROD), %	STRATUM DESCRIPTION	LAYER ELEV. / DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNDRAINED SHEAR STRENGTH KSF			
													SURFACE ELEVATION: 999.3 ±		
5	[Diagonal Hatching]			CLAY (CH), dark brown, fat, hard (Del Rio) -with roots to 2' -with gravel below 2' -dark brown to tan below 4'	993.3	31						92	1.1 (U)		
													4.5+ (P)		
						28	73	23	50		90	3.5 (P)			
													4.5+ (P)		
10	[Diagonal Hatching]			CLAY (CL), tan, lean, hard, with calcareous deposits (Del Rio)	8.0	21						4.5+ (P)			
						11	48	16	32		134	7.4 (U)			
													4.5+ (P)		
15	[Brick Pattern]			LIMESTONE, tan, highly weathered (Edwards Formation)	12.0										
						13.6	8								
				Note: No free groundwater was observed.											
COMPLETION DEPTH: 13.6 ft															
DATE: 3-23-99				PROJECT NO. 1002-0121				U=Unconfined P=Pocket Penetrometer Q=Unconsolidated-T=Torvane Undrained Triaxial							





LOG OF BORING NO. 8
PROPOSED APARTMENT COMPLEX
SAN ANTONIO, TEXAS

TYPE: *Flight Auger*

LOCATION: *See Plate 2*

DEPTH, FT	SYMBOL	SAMPLES	BLOWS PER FOOT OR REC/(RQD), %	STRATUM DESCRIPTION	LAYER ELEV. / DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNDRAINED SHEAR STRENGTH KSF
				SURFACE ELEVATION: 1000.9 ±								
				CLAY (CH), dark brown, fat, hard, with gravel, roots and ferrous deposits (Del Rio)		24						4.5+ (P)
												4.5+ (P)
5						22	58	21	37		111	3.0 (P)
				CLAY (CL), tan to light gray, lean, hard with calcareous and ferrous deposits (Del Rio) -with fossils to 10'	994.9 8.0							4.3 (P)
10						12	40	18	22		132	3.9 (U)
												4.5+ (P)
15					987.3 13.6	12						
				Note: No free groundwater was observed.								
20												
25												
30												
COMPLETION DEPTH: 13.6 ft						U = Unconfined P = Pocket Penetrometer Q = Unconsolidated-Undrained Triaxial T = Torvane						
DATE: 3-23-99						PROJECT NO. 1002-0121						





LOG OF BORING NO. 9
PROPOSED APARTMENT COMPLEX
SAN ANTONIO, TEXAS

TYPE: *Flight Auger*

LOCATION: *See Plate 2*

DEPTH, FT	SYMBOL	SAMPLES	BLOWS PER FOOT OR REC/(ROD), %	STRATUM DESCRIPTION	LAYER ELEV / DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNDRAINED SHEAR STRENGTH KSF
5	[Diagonal Hatching]			CLAY (CH), dark brown, fat, very stiff to hard, with gravel, roots and ferrous deposits (Del Rio)	983.6 4.0	24						4.0 (P)
											2.5 (P)	
											4.0 (P)	
											4.4 (U)	
											4.5+ (P)	
10	[Diagonal Hatching]			CLAY (CL), tan to light gray, lean, hard, with ferrous deposits (Del Rio)	974.6 13.0							4.5+ (P)
											4.5+ (P)	
15	[Diagonal Hatching]			-with fossils below 8'	974.0 13.6							
15	[Staircase Hatching]			LIMESTONE, tan, highly weathered (Edwards Formation)	13.0 13.6	5						
20												
25												
30												
COMPLETION DEPTH: 13.6 ft						U = Unconfined P = Pocket Penetrometer						
DATE: 3-23-99						Q = Unconsolidated- Undrained Triaxial						
PROJECT NO. 1002-0121						T = Torvane						
Note: No free groundwater was observed.												





LOG OF BORING NO. 10
PROPOSED APARTMENT COMPLEX
SAN ANTONIO, TEXAS

TYPE: *Flight Auger*

LOCATION: *See Plate 2*

DEPTH, FT	SYMBOL	SAMPLES	BLOWS PER FOOT OR REC/(ROD), %	STRATUM DESCRIPTION	LAYER ELEV / DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX(PI), %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNDRAINED SHEAR STRENGTH KSF
				SURFACE ELEVATION: 997.9 ±								
				CLAY (CH), light brown, fat, hard, with roots and gravel (Del Rio)								4.5+ (P)
						18	71	18	53			4.5+ (P)
5					991.9							4.5+ (P)
				CLAY (CH), tan to light gray, fat, hard, with gravel, ferrous and gypsum deposits (Del Rio)	8.0							4.5+ (P)
						14	51	14	37		124	4.5+ (P)
10												
						11					129	5.3 (U)
15					982.9							4.5+ (P)
				Note: No free groundwater was observed	15.0							
20												
25												
30												
COMPLETION DEPTH: 15.0 ft						U = Unconfined P = Pocket Penetrometer Q = Unconsolidated- T = Torvane Undrained Triaxial						
DATE: 3-23-99						PROJECT NO. 1002-0121						





LOG OF BORING NO. 13
PROPOSED APARTMENT COMPLEX
SAN ANTONIO, TEXAS

TYPE: Flight Auger

LOCATION: See Plate 2

DEPTH, FT	SYMBOL	SAMPLES	BLOWS PER FOOT OR REC/(PCD), %	STRATUM DESCRIPTION	LAYER ELEV / DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX(PI), %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNDRAINED SHEAR STRENGTH KSF
				SURFACE ELEVATION: 1001.1 ±								
				CLAY (CH), dark brown, fat, hard, with gravel, roots and calcareous deposits (Residual Soils)	999.3 1.8		64	24	40			
				LIMESTONE, tan, highly weathered (Edwards Formation)	997.3 3.8							
5				-highly fractured with multiple cavities, to 3.8'								
				-void from, 3.8' to 7.2'	993.9 7.2							
				-less weathered below 7.1'								
10												
15					986.1 15.0							
				Notes: 1) No free groundwater was observed. 2) Surface elevation assumed to be similar to the nearby Boring 5 surface elevation.								
20												
25												
30												
COMPLETION DEPTH: 15.0 ft						U = Unconfined P = Pocket Penetrometer Q = Unconsolidated- T = Torvane Undrained Triaxial						
DATE: 4-22-99						PROJECT NO. 1002-0121						





LOG OF BORING NO. 14
PROPOSED APARTMENT COMPLEX
SAN ANTONIO, TEXAS

TYPE: *Flight Auger*

LOCATION: *See Plate 2*

DEPTH, FT	SYMBOL	SAMPLES	BLOWS PER FOOT OR REC/(RQD), %	STRATUM DESCRIPTION	LAYER ELEV. / DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNDRAINED SHEAR STRENGTH KSF
				SURFACE ELEVATION: 1001.1 ±								
5				CLAY (CH), dark brown, fat, hard, with gravel, roots and calcareous deposits (Residual Soils)			64	23	41			
				-tan, with gravel below 6'	994.6							
10				LIMESTONE, tan, weathered (Edwards Formation)	6.5	9						
15					986.1	4						
					15.0							
20				Notes: 1) No free groundwater was observed. 2) Surface elevation assumed to be similar to the nearby Boring 5 surface elevation.								
25												
30												
COMPLETION DEPTH: 15.0 ft						U = Unconfined P = Pocket Penetrometer Q = Unconsolidated-Undrained Triaxial T = Torvane						
DATE: 4-22-99		PROJECT NO. 1002-0121										





LOG OF BORING NO. 15
PROPOSED APARTMENT COMPLEX
SAN ANTONIO, TEXAS

TYPE: *Flight Auger*

LOCATION: *See Plate 2*

DEPTH, FT	SYMBOL	SAMPLES	BLOWS PER FOOT OR REC/(ROD), %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX(IP), %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNDRAINED SHEAR STRENGTH, KSF
				SURFACE ELEVATION: 1001.1 ±								
				CLAY (CH), dark brown, fat, hard, with gravel, roots and calcareous deposits (Residual Soils)	998.1		66	21	45			
5				LIMESTONE, tan, weathered (Edwards Formation)	3.0							
10												
15					986.1							
					15.0							
20				Notes: 1) No free groundwater was observed. 2) Surface elevation assumed to be similar to the nearby Boring 5 surface elevation.								
25												
30												
COMPLETION DEPTH: 15.0 ft						U = Unconfined P = Pocket Penetrometer Q = Unconsolidated- T = Torvane Undrained Triaxial						
DATE: 4-22-99						PROJECT NO. 1002-0121						





LOG OF BORING NO. 16
PROPOSED APARTMENT COMPLEX
SAN ANTONIO, TEXAS

TYPE: *Flight Auger*

LOCATION: *See Plate 2*

DEPTH, FT	SYMBOL	SAMPLES	BLOWS PER FOOT OR REC/(ROD), %	STRATUM DESCRIPTION	LAYER ELEV / DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNDRAINED SHEAR STRENGTH KSF
				SURFACE ELEVATION: 1001.1 ±								
				CLAY (CH), dark brown, fat, hard, with gravel, roots and calcareous deposits (Residual Soils)	999.1		60	18	42			
				LIMESTONE, tan, weathered (Edwards Formation)	2.0							
5				-void from 5' to 7'	996.1							
					5.0							
					994.1							
					7.0							
10												
15					986.1							
					15.0							
20												
25												
30												

Notes:
 1) No free groundwater was observed.
 2) Surface elevation assumed to be similar to the nearby Boring 5 surface elevation.

COMPLETION DEPTH: 15.0 ft

U = Unconfined P = Pocket Penetrometer
 Q = Unconsolidated-T = Torvane
 Undrained Triaxial

DATE: 4-22-99

PROJECT NO. 1002-0121





TERMS AND SYMBOLS USED ON BORING LOGS FOR ROCK

ROCK TYPES				SAMPLER TYPES					
	LIMESTONE		DOLOMITE		SANDSTONE		Thin-walled Tube		Rock Core
	HIGHLY WEATHERED LIMESTONE		SHALE		CONGLOMERATE		Standard Penetration Test		Auger Sample
	DOLOMITIC LIMESTONE		CLAYSTONE		GRANITE		THD Cone		Dry Core

HARDNESS	
Friable	-Crumbles under hard pressure
Low Hardness	-Can be carved with a knife
Moderately Hard	-Can be scratched easily with a knife
Very Hard	-Cannot be scratched with a knife

WEATHERING GRADES OF ROCKMASS ⁽¹⁾	
TERM	DESCRIPTION
Slightly	Discoloration indicates weathering of rock material and discontinuity surfaces
Moderately	Less than half of the rock material is decomposed or disintegrated to a soil
Highly	More than half of the rock material is decomposed or disintegrated to a soil
Completely	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact
Residual Soil	All rock material is converted to soil. The mass structure and material fabric are destroyed.

SOLUTION & VOID CONDITIONS	
Void	Interstice; a general term for pore space or other openings in rock
Cavities	Small solutional concavities.
Vuggy	Containing small cavities, usually lined with a mineral of different composition from that of the surrounding rock.
Vesicular	Containing numerous small, unlined cavities, formed by expansion of gas bubbles or steam during solidification of the rock.
Porous	Containing pores, interstices, or other openings which may or may not interconnect
Cavernous	Containing cavities or caverns, sometimes quite large. Most frequent in limestones and dolomites.

JOINT DESCRIPTION		
SPACING	INCLINATION	SURFACES
Very Close <2"	Horizontal 0-5	Slickensided-Polished, grooved
Close 2"-12"	Shallow 5-35	Smooth-Planar
Medium Close 12"-3'	Moderate 35-65	Irregular-Undulating or granular
Wide >3'	Steeply 65-85	Rough-Jagged or pitted
	Vertical 85-90	
BEDDING THICKNESS ⁽²⁾		
Very Thick	>4'	
Thick	2'-4'	
Thin	2"-2'	
Very Thin	1/2"-2'	
Laminated	0.08"-1/2"	
Thinly-Laminated	<0.08"	

REFERENCES:
 1) British Standard (1981) Code of Practice for Site Investigation, BS 5930
 2) The Bridge Div., Tx. Highway Dept. Foundation Exploration & Design Manual 2nd Edition, revised June, 1974.

Information on each boring log is a compilation of subsurface conditions and soil and rock classifications 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 observed at the time and places indicated, and may vary with time, geologic condition or construction activity.

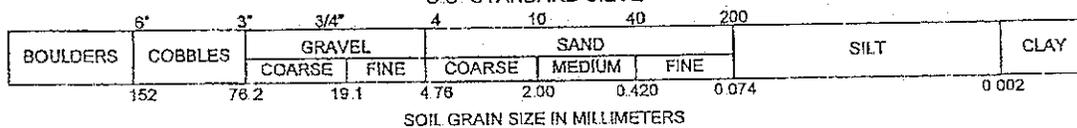


TERMS AND SYMBOLS USED ON BORING LOGS FOR SOIL

SOIL TYPES

	CH, fat clays		SC, clayey sands		GC, clayey gravels		CL, lean clays
	SM, silty sands		GM, silty gravels		ML, silts		SW, well-graded sands
	GW, well-graded gravels		Fill, unclassified		SP, poorly-graded sands		GP, poorly-graded gravels

SOIL GRAIN SIZE U.S. STANDARD SIEVE



CONSISTENCY OF COHESIVE SOILS ⁽²⁾

CONSISTENCY	UNDRAINED SHEAR STRENGTH Klps Per Sq. Ft.
Very Soft	Less Than 0.25
Soft	0.25 to 0.5
Firm	0.5 to 1.0
Stiff	1.00 to 2.0
Very Stiff	2.00 to 4.0
Hard	greater than 4.0

CONDITION OF GRANULAR SOILS ⁽²⁾

NUMBER OF BLOWS PER FT., N	RELATIVE DENSITY
0-4	Very Loose
4-10	Loose
10-30	Medium
30-50	Dense
Over 50	Very Dense

STRUCTURE ⁽¹⁾

DESCRIPTION	CRITERIA
Stratified	Alternating layers of varying material or color with layers at least 6 mm thick.
Laminated	Alternating layers of varying material or color with the layers less than 6 mm thick
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	Inclusions of small pockets of different soils.

MOISTURE

Dry	-No water evident in sample; fines less than plastic limit.
Moist	-Sample feels damp; fines near the plastic limit
Very Moist	-Water visible on sample; fines greater than plastic limit and less than liquid limit
Wet	-Sample bears free water; fines greater than liquid limit

INCLUSIONS ⁽¹⁾

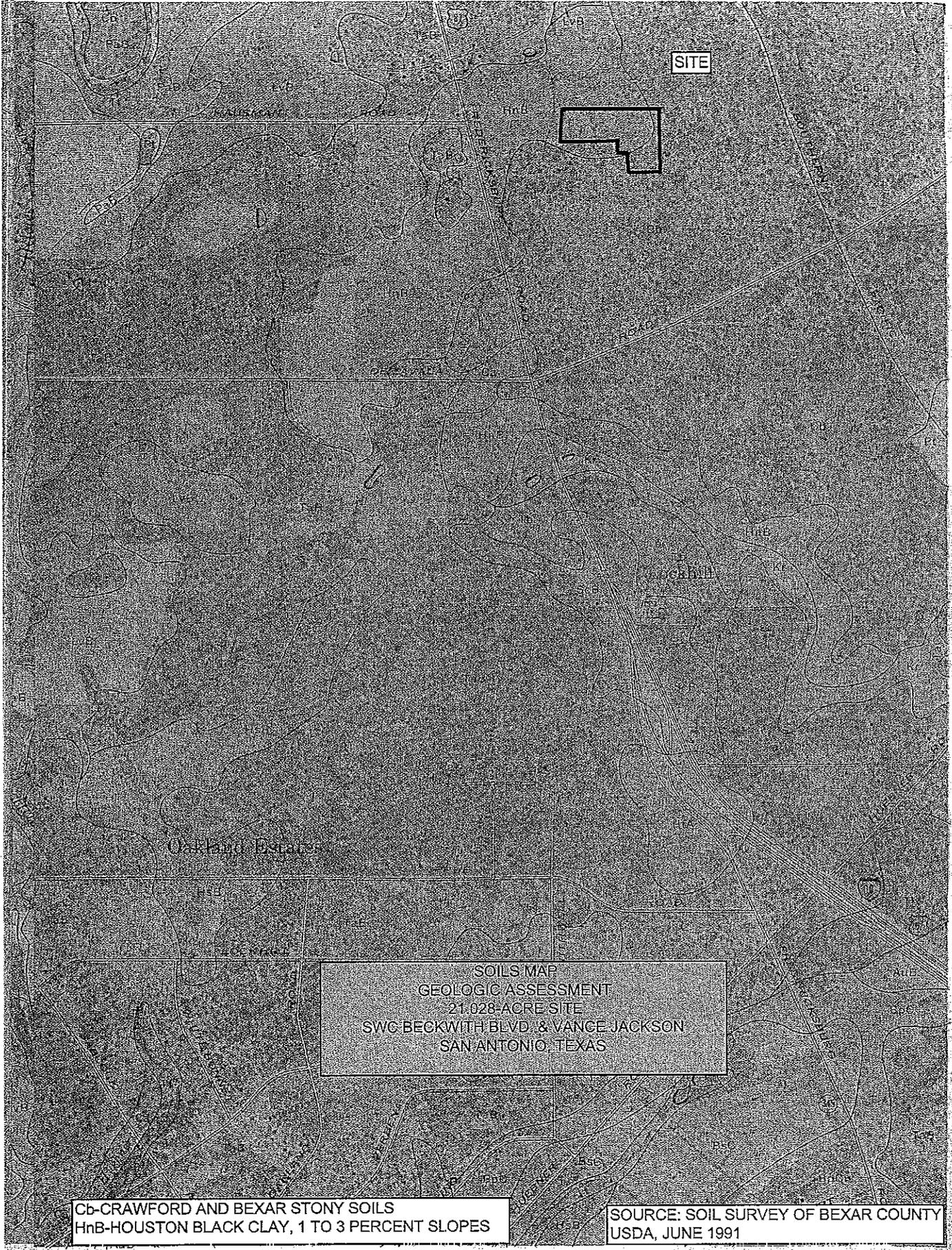
Parting	-Inclusion <1/8" thick extending through sample.
Seam	-Inclusion 1/8" to 3" thick extending through sample.
Layer	-Inclusion >3" thick extending through sample.
Trace	-<5% of sample
Few	-5% to 10% of sample.
Little	-10 to 25 % of sample
Some	-30% to 45% of sample.

REFERENCES:

- 1) ASTM D 2488
- 2) Peck, Hanson, and Thornburn, (1974), Foundation Engineering.

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SOILS MAP
 GEOLOGIC ASSESSMENT
 21,028-ACRE SITE
 SWC BECKWITH BLVD. & VANCE JACKSON
 SAN ANTONIO, TEXAS

Cb-CRAWFORD AND BEXAR STONY SOILS
 HnB-HOUSTON BLACK CLAY, 1 TO 3 PERCENT SLOPES

SOURCE: SOIL SURVEY OF BEXAR COUNTY
 USDA, JUNE 1991