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Texas Registered Engineering Firm F-3123

29 September 2011

Thomas E. Klein, Jr., P.E., PMP
Project Engineer
Replacements & Improvements
San Antonio Water System
2800 U.S. Hwy 281 North, Suite 300
San Antonio, Texas 78212

VIA E-MAIL: Thomas.Klein@saws.org

RE: Olmos Basin Central Watershed Sewer Relief Line (C-3) Project: Geotechnical Data Study
Reach 1 Through Reach 3 Geotechnical Report
SAWS Job No. 08-2512
WESTON WO# 10412.015.001

Dear Mr Klein:

Please disregard the previously posted geotechnical report, and replace with the attached report.

The attached geotechnical report prepared by Fugro Consultants, Inc., dated Novemeber 5, 2011 (Revised September 23, 2011), is being provided as supplemental information only. Please note that this document does not supersede the San Antonio Water System construction documents, specifications, special conditions or the Contract Documents.

If you have any questions please call me at 210-248-2425.

Very truly yours,

WESTON SOLUTIONS, INC.

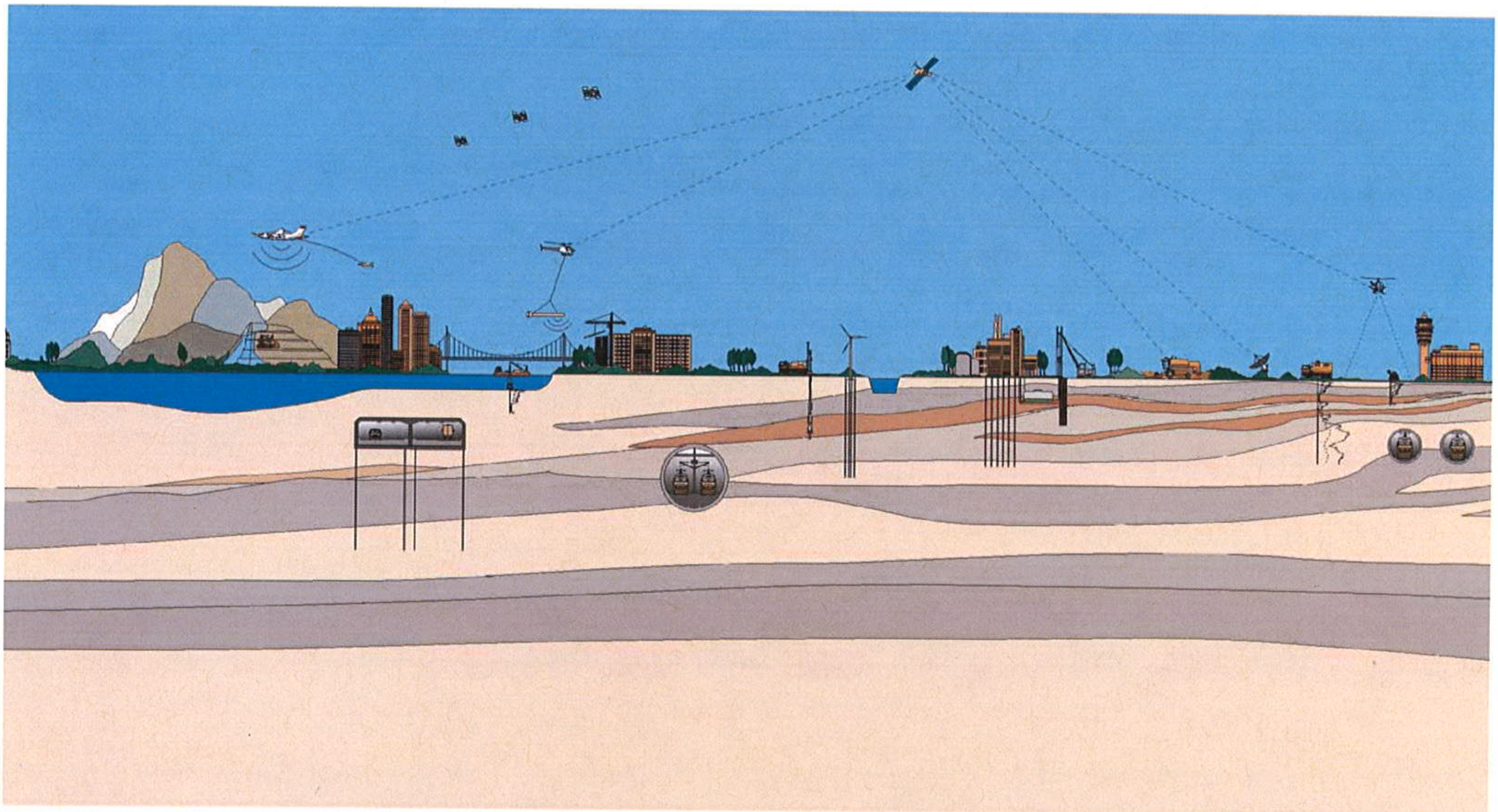
Abdel Hamed, P.E.
Project Manager

cc: Project File
Ms. Tracee Wulff, SAWS
Mr. Gerardo Gomez, SAWS
Ms. Maridel Jimenez, P.E. WESTON

FUGRO CONSULTANTS, INC.

GEOTECHNICAL DATA STUDY
REACH 1 THROUGH REACH 3
OLMOS BASIN CENTRAL WATERSHED SEWER LINE RELIEF
SAN ANTONIO WATER SYSTEM
SAN ANTONIO, TEXAS

WESTON SOLUTIONS, INC.
San Antonio, Texas



FUGRO CONSULTANTS, INC.

11009 Osgood
San Antonio, Texas 78233
Phone: 210-655-9516
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Project No. 04.60081210
November 5, 2010
Revised September 23, 2011

Weston Solutions, Inc.
70 NE Loop 410, Suite 600
San Antonio, Texas 78216

Attention: Mr. Abdel Hamed, P.E. and
Ms. Maridel R. Jimenez, P.E.

Geotechnical Data Study
Reach 1 through Reach 3
Olmos Basin Central Watershed Sewer Relief Line
San Antonio Water System
San Antonio, Texas

Introduction

Fugro Consultants, Inc. (Fugro) is submitting this report on the geotechnical study for the above-referenced project. This study was performed in general accordance with Weston Solutions, Inc. Purchase Order 0072512, which included the Consulting Services Agreement. Fugro's scope of services is set forth in Attachment C to the Purchase Order, Proposal for Geotechnical Study, dated August 12, 2010 (2nd revision).

Project Description

The proposed project will consist of three reaches running north-south, generally along Avenue B between East Josephine Street and Pershing Avenue as shown on the Vicinity Map, Plate 1. The sanitary sewer will vary in size from 54-inch to 66-inch diameter, with the size increasing to the south. We understand open cut techniques will generally be used to install the line, except at the two siphons that will run below existing storm sewer drains. A summary of the stationing of the Reaches and existing drains is presented in the following table.

Reach	Begin Station	End Station	Existing Sewer Approximate Begin Station	Existing Sewer Approximate End Station
1	0+00	25+71	11+30	11+60
2	25+71	44+90	38+60	39+30
2 *	*	*	none	None
3	44+90	73+95	none	None

* A supplemental line runs down Humphrey Avenue between Broadway Avenue and Margaret Street, then down Margaret Street to East Mulberry Street.

Purpose

The purpose of this geotechnical study was to obtain samples of the subsurface soils along the alignment to measure pertinent physical characteristics of the materials. This purpose was accomplished by:

1. advancing eighteen borings, at about 500 ft spacing along the sewer line alignment to explore the subsurface conditions, and to obtain soil samples;
2. performing laboratory tests on selected soil samples recovered from the borings to evaluate pertinent physical properties; and
3. preparing a data report.

Field Investigation

The subsurface exploration program consisted of eighteen 5- to 35-ft deep borings, designated as borings B-1 through B-18. The approximate locations of the borings are illustrated on a Plan of Borings, Plate 2. A summary of the borings drilled including boring number, reach number, approximate station of boring, and depth of boring are listed in the table below.

Boring Number	Reach	Approximate Station of Boring Location	Approximate Depth to Bottom of Pipe (feet)	Boring Depth (feet)
B-1	1	0+50	12	20
B-2	1	5+75	9	15
B-3	1	10+50	19 (1)	35
B-4	1	15+50	13	20
B-5	1	20+00	10	15
B-6	1	25+50	10	15
B-7	2	30+00	12	20.5
B-8	2	35+00	13	20
B-9	2	38+75	23 (1)	28.9
B-10	2	Humphrey Avenue	Unknown	5
B-11	2	Margaret Street	Unknown	20
B-12	3	45+00	16	25
B-13	3	50+00	20	25
B-14	3	55+00	22	30
B-15	3	60+00	22	30
B-16	3	65+00	25	30
B-17	3	70+00	24	19
B-18	3	73+95	23	30

(1) Approximate depth to bottom of drain.

Detailed descriptions of the subsurface strata encountered are presented on the Logs of Borings, Plates 3 through 20. Pocket penetrometer values in tons per square foot (tsf) and SPT N-values in blows per foot (bpf) are also shown on the logs of borings. Keys to Terms and Symbols used on the boring logs are set forth on Plates 21 and 22. Groundwater notes are presented at the bottom of the boring logs. Weston Solutions provided the coordinates and ground surface elevations of the actual boring locations shown on the boring logs.

The borings were drilled with a truck-mounted drill rig equipped with 1) continuous flight augers for advancing the holes dry and recovering disturbed samples (ASTM D 1452), 2) seamless push-tubes for obtaining samples of cohesive strata (ASTM D 1587), 3) split-barrel samplers and drive-weight assembly for obtaining representative samples and measuring penetration resistance (N-values) of non-cohesive soil strata (ASTM D 1586), and 4) double-tube core barrels equipped with carbide or diamond impregnated bits for obtaining nominal 2-inch diameter rock cores (ASTM D 2113). In general, soil samples were obtained at about 2-ft intervals to the 10-ft depth, and then at 5-ft intervals thereafter to the boring completion depth. The boreholes were backfilled with soil cuttings and bentonite pellets, and capped with asphaltic concrete cold patch, where appropriate.

Boring B-3 was completed as a piezometer. A schematic drawing of the piezometer installation is provided on Plate 23. The piezometer/water well was installed by a licensed water well driller and registered with the State of Texas. A summary of the depth where groundwater was encountered during drilling is presented in the following table. Further, a water depth of 14.4 and 15.0 ft was obtained within the piezometer at the boring B-3 location on November 4, 2010 and September 23, 2011, respectively.

Boring Number	Depth to Water (feet)	Date
B-1	dry	9-27-10
B-2	12.5	9-28-10
B-3	14.0	10-1-10
B-4	14.2	9-28-10
B-5	11.7	9-28-10
B-6	dry	9-28-10
B-7	dry	9-28-10
B-8	11.3	9-30-10
B-9	dry	10-8-10

Boring Number	Depth to Water (feet)	Date
B-10	Dry	9-30-10
B-11	8.4	9-30-10
B-12	Dry	9-27-10
B-13	Dry	9-27-10
B-14	Dry	10-8-10
B-15	14.5	10-1-10
B-16	Dry	10-8-10
B-17	Dry	10-1-10
B-18	11.2	9-30-10

Laboratory Testing

The laboratory testing program was directed toward identification and classification of the soils encountered at the boring locations. To aid in soil classification, Atterberg limits (ASTM D4318) and the percentage of material passing selected U.S. Standard sieves (ASTM D 422) were performed on selected soil samples. Water content measurements were performed on samples in which classifications tests were performed. Unconfined compressive strength tests (ASTM D 2850) were also performed on selected samples; moisture content and unit dry weights were measured as routine portions of the compression tests. The results of the laboratory classification tests are presented on the individual boring logs.

The laboratory testing program also included natural pH, soluble chloride, soluable sulfate and electrical resistivity tests. A summary of the analytical laboratory test results is presented in the following table.

Boring Number	Sample Depth (feet)	PH	Electrical Resistivity (ohm-cm)	Soluble * Sulfate Content (ppm)	Soluble * Chloride Content (ppm)
B-1	6 - 7	8.5	390	1,220	< 100
B-7	6 - 7	8.2	450	250	< 100
B-16	24 - 25	8.6	1,540	< 100	< 100
* based on dry weight of soil					

Soil Descriptions and Classifications

Descriptions of strata made in the field at the time the borings were drilled were modified in accordance with results of laboratory tests and visual evaluation in the laboratory. All recovered soil samples were evaluated and classified in general accordance with ASTM D 2487 and described as recommended in ASTM D 2488. Rock strata were classified in general accordance with "Rock Classification and Description", Chapter 1, Section 5, NAVFAC DM-7[1]. Classifications of the soils and finalized descriptions of both rock and soil strata are shown on the logs of borings.

Subsurface Conditions

Geologic Setting. A review of available geologic information,[2] indicates the southern most portion (B-1 and B-2) of the alignment is underlain by Fluviatile terrace deposits and the remainder of the alignment is underlain by alluvial soils. Fluviatile terrace deposits and alluvium

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[1] U.S. Navy (1971) Design Manual - Soil Mechanics, Foundations, and Earth Structures, NAVFAC DM-7.

[2] Fisher, W.L. (1974), "Geologic Atlas of Texas, Austin Sheet," Bureau of Economic Geology. The University of Texas at Austin, map and accompanying explanatory bulletin.

(floodplain deposits) consist of various amounts of clay, silt, sand, and gravel. The Fluviatile terrace deposits and alluvial soils are underlain by clay and clayshale of the Navarro Group. Navarro Group clays generally consist of the lower part of the formation and are composed of dominantly montmorillonitic, greenish-gray to brownish-gray clay, which weathers to a black clay. The clays can exhibit a high shrink/swell potential. The deeper unweathered portions of the Navarro consist of gray clay shale.

Stratigraphy. Subsurface conditions at the site can be understood by a thorough review of the eighteen boring logs presented on Plates 3 through 20. A brief summary of the subsurface conditions is provided in the following paragraphs.

Fill material was encountered at the surface at 13 of the 18 boring locations. The fill generally consisted of hot mix asphaltic concrete over crushed limestone base material with a thickness less than 1.5 feet. At the boring B-10, B-11, B-12 and B-17 locations, the fill material encountered was likely trench backfill. Below the base material, the fill consisted of fat clay, lean clay, clayey gravel, clayey sand, and poorly graded gravel. These soils have moisture contents between 6 and 26 (average 18), liquid limits between 31 and 57 (average 50), plasticity indices between 16 and 42 (average 34), percentage of material passing the No. 4 sieve between 77 and 96 (average 89), and percentage of material passing the No. 200 sieve between 28 and 83 (average 64).

Alluvial soils and/or terrace deposits were encountered at 15 of the 18 boring locations at the surface or below the fill material. These soils generally consisted of fine-grained material (lean and fat clay) over coarser grained soils (sand and gravel). The clay soils have moisture contents between 13 and 26 (average 19), liquid limits between 30 and 73 (average 57), plasticity indices between 17 and 56 (average 41), percentage of material passing the No. 4 sieve between 89 and 100 (average 99), and percentage of material passing the No. 200 sieve between 56 and 94 (average 88). Measured unconfined compressive strengths in the fine-grained deposits were between 1.6 and 21.6 tsf (average 8.0 tsf).

The coarser grained deposits (clayey gravel, clayey sand, and poorly graded gravel) have moisture contents between 4 and 11 (average 8), liquid limits between 34 and 68 (average 52), plasticity indices between 20 and 51 (average 37), percentage of material passing the No. 4 sieve between 38 and 89 (average 64), and percentage of material passing the No. 200 sieve between 8 and 40 (average 24). The sand and gravels have SPT N-values between 4 bpf and refusal (average 35+ bpf).

The fill, alluvium and/or terrace deposits are underlain by tan and gray clay of the Navarro Group at 14 of the 18 boring locations. The clay soils of the Navarro Group have moisture contents between 13 and 29 (average 22), liquid limits between 36 and 65 (average 51), plasticity indices between 18 and 49 (average 34), percentage of material passing the No. 4

sieve between 99 and 100 (average 100), and percentage of material passing the No. 200 sieve between 91 and 99 (average 96). Measured unconfined compressive strengths in the Navarro clay were between 3.0 and 8.1 tsf (average 5.7 tsf).

The gray clayshale of the Navarro Group was encountered at the boring B-3, B-9 and B-11 locations beneath the tan and gray clay of the Navarro Group. The clayshale has measured moisture contents of 14 and 15, liquid limits between 40 and 42, plasticity indices 23 and 29, percentage of material passing the No. 4 sieve of 100, and percentage of material passing the No. 200 sieve of 92 and 98. Measured unconfined compressive strengths within the clayshale were 7.7 and 11.2 tsf.

Groundwater

The borings were advanced using a dry technique; no water or other drilling fluid was introduced to promote the drilling operation. Free water was observed in 8 of the 18 open boreholes between depths of 8.4 and 14.5 feet. A summary of groundwater observations is presented in the Field Investigation section of this report. Groundwater levels will fluctuate with seasonal variations in precipitation. The presence of groundwater should be planned for during installation of the new sewer lines. Amounts of water will depend on antecedent rainfall and location of site drainage features.

Dewatering

The design of dewatering systems and groundwater control is the responsibility of the contractor. This is very appropriate since water control affects construction operations, including excavation and scheduling. However, specifications are necessary to ensure the support properties of subsoil strata are not reduced and adjacent structures are not endangered.

The following technical specification[3] regulating dewatering could be used: "Control of groundwater shall be accomplished in a manner that will preserve the strength of the foundation soils, will not cause instability of the excavated slopes, and will not result in damage to existing structures. Where necessary to this purpose, the water will be lowered in advance of excavation, by wells, wellpoints, or similar methods. Open pumping will not be permitted if it results in boils, loss of fines, softening of the subgrade, or slope instability. Wells and wellpoints will be installed with suitable screen and filters so that pumping of fines does not occur. Discharge will be arranged to facilitate sampling by the engineer."

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[3] Fang (1991), Chapter 7, "Dewatering Groundwater Control" by Powers, J.P., p. 244.

OSHA Soil/Rock Classifications for Temporary Trench Design

The design of construction and/or temporary slopes and temporary retainage systems are the soil responsibility of the contractor. Suggestions are set forth below in accordance with OSHA[4] for classifying soil and rock encountered in our investigation. It is stressed that these are suggestions only for preliminary planning based on apparent conditions, and the actual trench safety system design, installation, and performance are the contractor's sole responsibility.

Material	OHSA Classification	OSHA Slope
Soil (CH, CL, SC, GC), except loose fill	Type B	1H to 1V
Saturated Soil (CH, CL, SC, GC) including loose fill	Type C	1.5H to 1V or flatter
** Sloping and benching for excavation greater than 20 ft deep shall be designed by a registered professional engineer.		

Soil Corrosion Potential

Steel and concrete elements in contact with soil are subject to degradation due to corrosion or chemical attack. Therefore, buried steel and concrete elements should be designed to resist corrosion and degradation based on accepted practices. General discussions regarding the corrosion of steel and the degradation of concrete with respect to the results of the analytical tests are provided in the following sections of this report.

Corrosion of Steel. Corrosion is a major factor in the life of steel elements in contact with soil. Corrosion is caused by migration of electrons from the steel into the surrounding soil. Three measurable soil properties that indicate the corrosion potential for steel in contact with soil are: 1) soluble chloride, 2) pH, and 3) resistivity. Analytical test results are presented earlier in this report in the "Laboratory Testing" section. It is generally accepted that corrosion of steel is most likely to occur in environments that have chloride ions (even in low concentrations) and low pH.

The following table presents some general guidelines concerning the corrosion potential of soil on steel pipe as a function of soluble chloride. If the pH is less than 7, the soil is acidic and corrosive conditions are indicated[5].

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[4] Code of Federal Regulations Title 29 Part 1926 (1989), "Labor", Occupational Safety and Health Administration, Department of Labor, Subpart P - Excavations, pgs 45963-45971.

[5] Johnson Division, UOP Inc., (1975), Ground Water and Wells, Saint Paul, Minnesota, pg. 194.

Soluble Chloride Concentration[6] (ppm)	Electrical Resistivity[7] (ohm-cm)	Corrosion Potential
> 500	0 –1,000	Very Severe
100 – 500	1,000 – 2,000	Severe
25 – 100	2,000 – 5,000	Moderate
10 – 25	5,000 – 10,000	Mild
-----	10,000 +	Very Mild

Each variable should be used independently of the others when evaluating soil corrosion potential. For example, it is not necessary to have both a resistivity between 0 and 1,000 ohm-cm and a pH less than 7 to indicate a very high corrosion potential.

Measured pH values between 8.2 and 8.6 indicate the soils have a low corrosion potential; measured soluble chloride contents less than 100 ppm indicate the soils have a mild corrosion potential; and measured electrical resistivity values between 390 and 1,540 ohm-cm indicate the soils have a severe to very severe corrosion potential. Based on the results of our analyses, the soils at the site appear to exhibit a very severe tendency to corrode buried steel, such as underground steel piping. A Corrosion Engineer should review the test results discussed herein when designing appropriate methods of protecting buried steel.

Degradation of Concrete

The degradation of concrete is caused by chemical agents in the soil or groundwater that react with concrete to either dissolve the cement paste or precipitate larger compounds which cause cracking and flaking. The concentration of water-soluble sulfates in the soils is a good indicator of the potential for chemical attack of concrete. The soluble sulfate content in soil can be used to evaluate the need for protection of concrete based on the following table.

Water Soluble Sulfate Content In Soil[8], (percent)	Water Soluble Sulfate Content In Soil, (ppm)	Degradation Potential
> 2.0	> 20,000	Very Severe
0.2 – 2.0	2,000 – 20,000	Severe
0.1 – 0.2	1,000 – 2,000	Moderate
0.0 – 0.1	0 – 1,000	Mild

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[6] Department of the Navy, Bureau of Yards and Docks, Design Manual, Civil Engineering, NAVDOCKS DM-5, pg. 5-9-53.

[7] Palmer, J. F., "Soil Resistivity Measurements and Analysis," *Materials Performance*, Vol. 13, January 1974.

[8] American Concrete Institute, *ACI Manual of Concrete Practice*, 1998, Part 1, Materials and General Properties of Concrete, Section 201.2R-10.

Measured soluble sulfate content values < 100, 250 and 1,220 ppm indicate the soils have a mild to moderate potential for the degradation of concrete.

Conditions

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 professional services that form the basis for this report have 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.

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 Consultants, 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 following plates are attached and complete this report:

	Plate
Vicinity Map	1
Plan of Borings	2
Boring Logs	3 - 20
Key to Terms and Symbols Used on Boring Logs for Soil and Rock	21 & 22
Piezometer Schematic	23

We appreciate the opportunity to be of service to Weston Solutions and SAWS on this project. Please call if we can be of additional assistance.

Sincerely,

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

JUNE M. POTTER
106243
9-23-1

June M. Potter, P.E.
Project Engineer

Thomas C. Wesling, P.E.
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THOMAS C. WESLING
81589
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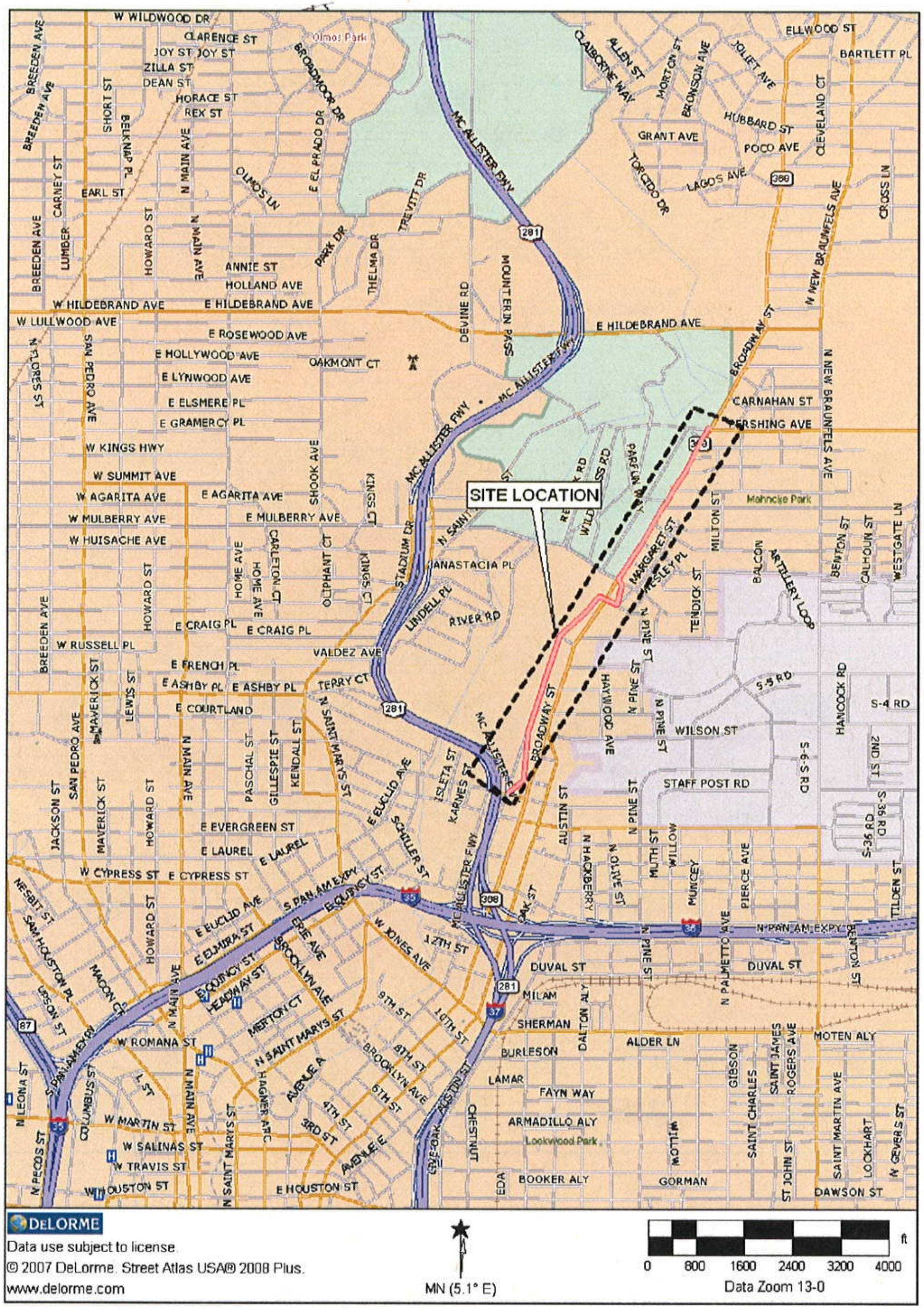
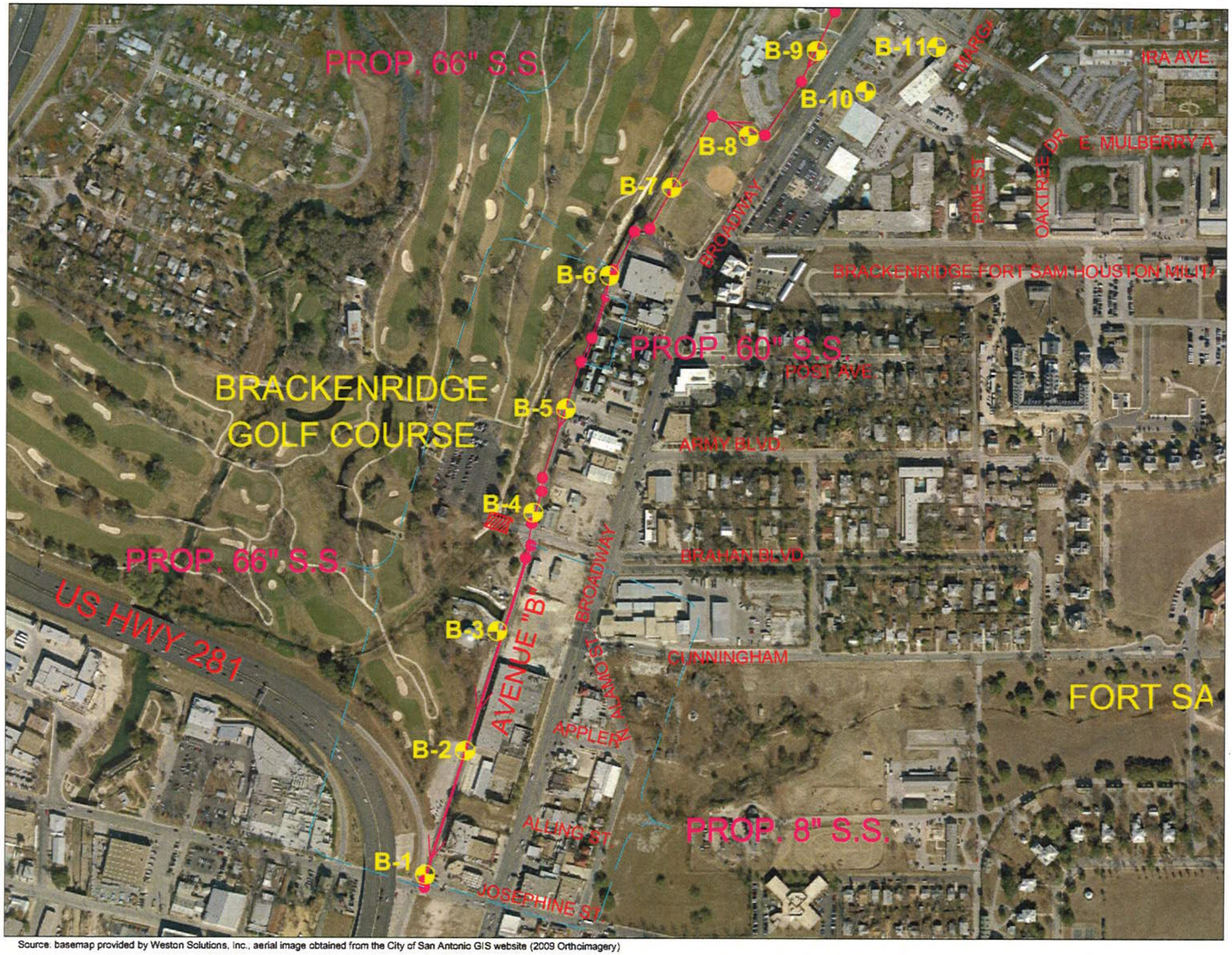
Copies Submitted: (4)
(Geotech:\Geotech 2008\04.60081210\report\60081210 Rpt Olmos Sewer Relief Line Reach 1 – 3)



VICINITY MAP
Reach 1 through Reach 3
Olmos Basin Central Watershed Sewer Relief Line
San Antonio Water System
San Antonio, Texas

PLATE 1

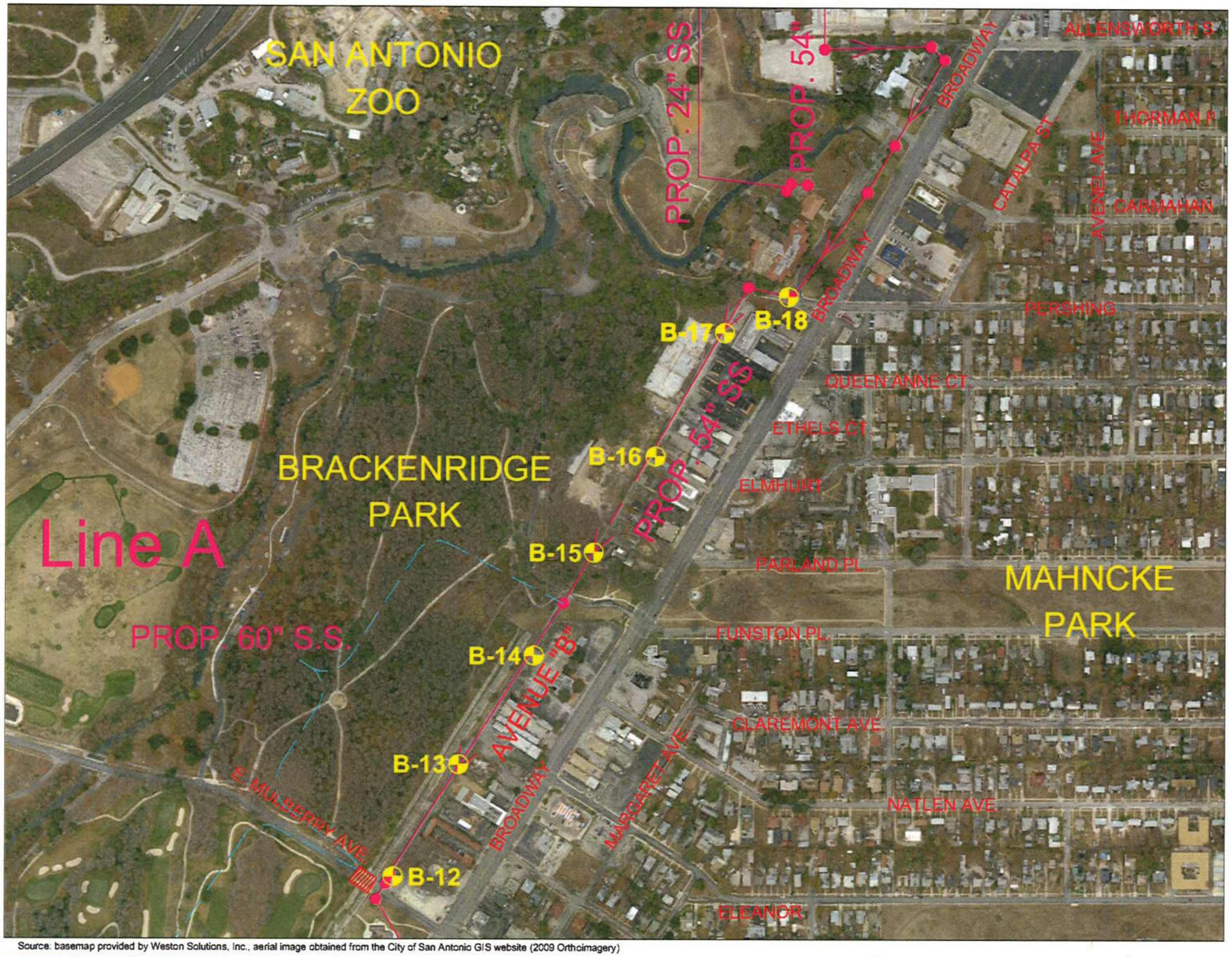


Source: basemap provided by Weston Solutions, Inc., aerial image obtained from the City of San Antonio GIS website (2009 Orthoimagery)

PLAN OF BORINGS

Reach 1 Through Reach 3
Olmos Basin Central Watershed Sewer Relief Line
San Antonio Water System
San Antonio, Texas

PLATE 2a



Source: basemap provided by Weston Solutions, Inc., aerial image obtained from the City of San Antonio GIS website (2009 Orthoimagery)

PLAN OF BORINGS
Reach 1 Through Reach 3
Olmos Basin Central Watershed Sewer Relief Line
San Antonio Water System
San Antonio, Texas

PLATE 2b

LOG OF BORING NO. B-1

Reach 1 through Reach 3
Olmos Basin Central Watershed Sewer Relief Line
San Antonio Water System,
PROJECT NO. 04.60081210

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC/RQD, %	STRATUM DESCRIPTION SURF. ELEVATION: 660.9 ft	LAYER ELEV./ DEPTH, FT	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNCONFINED STRENGTH TSF
			N = 6	3.5" Asphaltic Concrete / 5.5" Crushed Limestone (Fill)	660.2							
				FAT CLAY (CH), light brown and light gray, firm to very stiff (Fluviatile terrace deposits)	0.8							
			P = 3.0			23	57	41	100	94		
						23					103	3.5
5			P = 4.0									
			P = 4.5+		653.9							
			N = 34	CLAYEY GRAVEL WITH SAND (GC), light gray, dense to very dense, with chert (Fluviatile terrace deposits)	7.0	8	57	40	50	24		
10			N = 80									
			N = 54		646.9							
15				LEAN CLAY (CL), tan and gray, hard (Navarro)	14.0	15	30	17	98	75		
			P = 4.5+									
20					640.9							
				Note: Boring drilled near Station 0+50, see Plan of Borings.	20.0							
25												
30												
35												

Fugro Consultants, Inc.

COMPLETION DEPTH, FT: 20.0
DATE DRILLED: 9-27-10
WATER LEVEL / SEEPAGE, FT: Dry
UPON COMPLETION: NA

LONGITUDE: 98°28'37.7" W
LATITUDE: 29°26'41.4" N

PLATE 3

LOG OF BORING NO. B-2

Reach 1 through Reach 3
Olmos Basin Central Watershed Sewer Relief Line
San Antonio Water System,
PROJECT NO. 04.60081210

SURF. ELEVATION: 658.4 ft

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC/RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH, FT	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNCONFINED STRENGTH TSF
			N = 17	2.5" Asphaltic Concrete / 15.5" Crushed Limestone (Fill)	656.9 1.5							
			P = 2.5	FAT CLAY (CH), dark brown to brown, very stiff to hard (Fluviatile terrace deposits)								
			P = 3.0			22	66	47	100	94		
5						23					102	3.6
			P = 4.0									
			P = 4.5+		649.9 8.5							
			N = 9	SANDY LEAN CLAY (CL), light gray and reddish brown, stiff, with gravel (Fluviatile terrace deposits)		15	34	19	89	56		
10												
					▽ 645.9 12.5							
			N = 6	CLAYEY GRAVEL WITH SAND (GC), tan, loose (Fluviatile terrace deposits)								
15					643.4 15.0							
				Note: Boring drilled near Station 5+75, see Plan of Borings.								
20												
25												
30												
35												

Fugro Consultants, Inc.

COMPLETION DEPTH, FT: 15.0
DATE DRILLED: 9-28-10
WATER LEVEL / SEEPAGE, FT: 12.5
UPON COMPLETION: NA

LONGITUDE: 98°28'35.88" W
LATITUDE: 29°26'46.32" N

PLATE 4

FUGRO STD (NO PL) 04.60081210.GPJ FUGRO DATA TEMPLATE 042610.GDT 11/5/10

LOG OF BORING NO. B-3

Reach 1 through Reach 3

Olmos Basin Central Watershed Sewer Relief Line

San Antonio Water System,

PROJECT NO. 04.60081210

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC/RQD, %	STRATUM DESCRIPTION SURF. ELEVATION: 660.8 ft	LAYER ELEV./ DEPTH, FT	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNCONFINED STRENGTH TSF
	▨		P = 4.5+	FAT CLAY (CH), dark brown to brown, hard, with sand (Alluvium)								
	▨		P = 4.5+									
	▨					19	73	56	100	93	108	18.7
	▨		P = 4.5+									
5	▨											
	▨		P = 4.5+									
	▨		P = 4.5+									
10	▨											
					648.3 12.5							
	⁘		N = 18	CLAYEY GRAVEL (GC), light brown, medium dense, with chert (Alluvium)	▽							
15	⁘											
					642.8 18.0							
	▨		N = 12	FAT CLAY (CH), tan and gray, stiff to hard (Navarro) - lean clay layer, 19' to 20'		23	47	29	99	97		
20	▨											
	▨		N = 17									
25	▨											
	▨		P = 4.5+									
30	▨											
					628.8 32.0							
	☰		P = 4.5+	CLAYSHALE, gray, moderately weathered, soft (Navarro)		15	42	29	100	98	115	11.2
35					625.8 35.0							
				Note: Boring drilled near Station 10+50, see Plan of Borings.								

Fugro Consultants, Inc.

COMPLETION DEPTH, FT: 35.0

DATE DRILLED: 10-1-10

WATER LEVEL / SEEPAGE, FT: 14.0

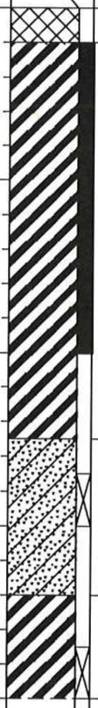
UPON COMPLETION: NA

LONGITUDE: 98°28'34.38" W

LATITUDE: 29°26'50.82" N

LOG OF BORING NO. B-4

Reach 1 through Reach 3
Olmos Basin Central Watershed Sewer Relief Line
San Antonio Water System,
PROJECT NO. 04.60081210



DEPTH, FT	POCKET PEN, tsf Blows/ft. REC/RQD, %	STRATUM DESCRIPTION SURF. ELEVATION: 662.7 ft	LAYER ELEV./ DEPTH, FT	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNCONFINED STRENGTH TSF
		6" Asphaltic Concrete / 6" Crushed Limestone with asphaltic concrete (Fill)	661.7 1.0							
	P = 4.5+	FAT CLAY (CH), dark brown to brown, very stiff to hard (Alluvium)		21	71	52	100	91		
	P = 2.5			26					94	4.8
	P = 4.0									
5										
	P = 4.0									
				22					104	4.8
	P = 4.5+									
10										
		CLAYEY SAND (SC), brown, medium dense, with gravel (Alluvium)	650.2 12.5							
	N = 28	∇		10	34	20	87	33		
15										
		FAT CLAY (CH), tan and gray, very stiff (Navarro)	645.7 17.0							
	N = 29									
20			642.7 20.0							
		Notes: Boring drilled near Station 15+50, see Plan of Borings.								
25										
30										
35										

Fugro Consultants, Inc.

COMPLETION DEPTH, FT: 20.0
DATE DRILLED: 9-28-10
WATER LEVEL / SEEPAGE, FT: 14.2
UPON COMPLETION: NA

LONGITUDE: 98°28'32.94" W
LATITUDE: 29°26'55.5" N

LOG OF BORING NO. B-5

Reach 1 through Reach 3
Olmos Basin Central Watershed Sewer Relief Line
San Antonio Water System,
PROJECT NO. 04.60081210

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC/RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH, FT	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNCONFINED STRENGTH TSF
				SURF. ELEVATION: 660.8 ft								
				2" Asphaltic Concrete / 5" Crushed Limestone with asphaltic concrete (Fill)	660.3 0.5							
			P = 2.0									
			P = 4.0	FAT CLAY (CH), dark brown to brown, stiff to hard (Alluvium)								
						18	63	45	100	92		
			P = 3.75									
5						21					106	3.9
			P = 4.5+		654.3 6.5							
			N = 48	CLAYEY SAND (SC), brown, medium dense to dense, with gravel (Alluvium)								
			N = 21			8	36	21	88	32		
10												
					▽							
			N = 17									
15					645.8 15.0							
				Note: Boring drilled near Station 20+00, see Plan of Borings.								
20												
25												
30												
35												

Fugro Consultants, Inc.

COMPLETION DEPTH, FT: 15.0
DATE DRILLED: 9-28-10
WATER LEVEL / SEEPAGE, FT: 11.7
UPON COMPLETION: NA

LONGITUDE: 98°28'31.5" W
LATITUDE: 29°26'59.46" N

PLATE 7

LOG OF BORING NO. B-6

Reach 1 through Reach 3
Olmos Basin Central Watershed Sewer Relief Line
San Antonio Water System,
PROJECT NO. 04.60081210

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC/RQD, %	STRATUM DESCRIPTION SURF. ELEVATION: 659.9 ft	LAYER ELEV./ DEPTH, FT	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNCONFINED STRENGTH TSF
	▨	■	P = 1.0	FAT CLAY (CH), dark brown, stiff to hard, with sand (Alluvium)								
	▨	■	P = 4.0	- highly organic to 1'								
	▨	■	P = 4.5+									
5	▨	■				20	73	54	99	89	105	10.1
	▨	■			651.9 8.0							
	▨	■	P = 3.25	CLAYEY SAND WITH GRAVEL (SC), light reddish brown and gray, dense (Alluvium)								
10	▨	☒	N = 49									
	▨				646.4 13.5							
	▨	☒	N = 32	LEAN CLAY (CL), tan and gray, hard (Navarro)		17	48	30	100	98		
15					644.9 15.0							
				Notes: Boring drilled near Station 25+50, see Plan of Borings.								
20												
25												
30												
35												

Fugro Consultants, Inc.

COMPLETION DEPTH, FT: 15.0
DATE DRILLED: 9-28-10
WATER LEVEL / SEEPAGE, FT: Dry
UPON COMPLETION: NA

LONGITUDE: 98°28'29.46" W
LATITUDE: 29°27'4.8" N

PLATE 8

LOG OF BORING NO. B-7

Reach 1 through Reach 3
Olmos Basin Central Watershed Sewer Relief Line
San Antonio Water System,
PROJECT NO. 04.60081210

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC/RQD, %	STRATUM DESCRIPTION SURF. ELEVATION: 663.7 ft	LAYER ELEV./ DEPTH, FT	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNCONFINED STRENGTH TSF
			P = 2.5	FAT CLAY (CH), dark brown, stiff to hard, with gravel and roots (Alluvium)								
			N = 8			20	64	46	100	89		
			P = 4.5+									
5						18					102	9.0
			P = 4.5+									
			N = 13									
			N = 12									
10												
				CLAYEY SAND (SC), brown, dense, with gravel (Alluvium)	651.7 12.0							
			N = 39			10	56	41	89	40		
15												
				LEAN CLAY (CL), light gray and reddish brown, hard (Navarro)	646.7 17.0							
			P = 4.5+			16	42	29	100	99	110	6.7
20												
				Notes: Boring drilled near Station 30+00, see Plan of Borings.	643.2 20.5							
25												
30												
35												

Fugro Consultants, Inc.

COMPLETION DEPTH, FT: 20.5
DATE DRILLED: 9-28-10
WATER LEVEL / SEEPAGE, FT: Dry
UPON COMPLETION: NA

LONGITUDE: 98°28'26.82" W
LATITUDE: 29°27'8.34" N

LOG OF BORING NO. B-8

Reach 1 through Reach 3
Olmos Basin Central Watershed Sewer Relief Line
San Antonio Water System,
PROJECT NO. 04.60081210

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC/RQD, %	STRATUM DESCRIPTION SURF. ELEVATION: 663.8 ft	LAYER ELEV./ DEPTH, FT	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNCONFINED STRENGTH TSF
			P = 2.0	FAT CLAY (CH), dark brown, stiff to very stiff, with sand (Alluvium)								
			P = 1.75	- highly organic to 1'		22					101	1.6
			P = 2.5			18	55	39	98	85		
5												
			P = 3.75		655.8							
			N = 22	CLAYEY GRAVEL WITH SAND (GC), brown, medium dense, highly calcareous (Alluvium)	8.0							
10												
				∇	650.8							
			P = 1.5	LEAN CLAY (CL), tan and gray, stiff to very stiff (Navarro)	13.0	19	37	22	100	96	112	3.0
15												
			N = 23		643.8							
20					20.0							
				Note: Boring drilled near Station 35+00, see Plan of Borings.								
25												
30												
35												

Fugro Consultants, Inc.

COMPLETION DEPTH, FT: 20.0
DATE DRILLED: 9-30-10
WATER LEVEL / SEEPAGE, FT: 11.3
UPON COMPLETION: NA

LONGITUDE: 98°28'23.22" W
LATITUDE: 29°27'10.44" N

LOG OF BORING NO. B-9

Reach 1 through Reach 3
Olmos Basin Central Watershed Sewer Relief Line
San Antonio Water System,
PROJECT NO. 04.60081210

DEPTH, FT	POCKET PEN, tsf Blows/ft. REC/RQD, %	STRATUM DESCRIPTION SURF. ELEVATION: 665.4 ft	LAYER ELEV./ DEPTH, FT	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNCONFINED STRENGTH TSF
	N = 21	FAT CLAY (CH), dark brown, very stiff (Alluvium) - with gravel 1' to 2.5'								
	N = 19									
	P = 4.5+		660.4							
5		LEAN CLAY (CL), brown to light brown, hard (Alluvium)	5.0							
	P = 4.5+			10	39	25	99	79		
		- highly calcareous, 7' to 8'								
	P = 4.5+									
			655.4	17					110	6.2
10		CLAYEY GRAVEL (GC), gray, medium dense (Alluvium)	10.0							
	N = 23									
			650.4							
15		FAT CLAY (CH), tan and gray, very stiff to hard (Navarro)	15.0							
	P = 4.5+									
				20					108	3.2
20										
	P = 4.5+	- lean clay layer, 23' to 24'	641.4	16	36	18	100	92		
25		CLAYSHALE, gray, moderately weathered, soft (Navarro)	24.0							
	N = 50/5"		636.5 28.9							
30		Note: Boring drilled near Station 38+50, see Plan of Borings.								
35										

Fugro Consultants, Inc.

COMPLETION DEPTH, FT: 28.9
DATE DRILLED: 10-8-10
WATER LEVEL / SEEPAGE, FT: Dry
UPON COMPLETION: NA

LONGITUDE: 98°28'20.1" W
LATITUDE: 29°27'13.68" N

LOG OF BORING NO. B-10

Reach 1 through Reach 3
Olmos Basin Central Watershed Sewer Relief Line
San Antonio Water System,
PROJECT NO. 04.60081210

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC/RQD, %	STRATUM DESCRIPTION SURF. ELEVATION: 663.4 ft	LAYER ELEV./ DEPTH, FT	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNCONFINED STRENGTH TSF
			N = 8	3.5" Asphaltic Concrete / 6.5" Crushed Limestone (Fill)	662.4 1.0							
			P = 1.0 P = 2.5	FAT CLAY (CH), brown, gray and tan, stiff to very stiff, with calcareous deposits, with sand and gravel (Fill)	658.9 4.5	15	54	38	88	75		
5			N = 50/0"	CLAYEY GRAVEL WITH SAND (GC), gray, very dense (Fill)	658.4 5.0							
10												
15												
20												
25												
30												
35												

Notes:

1) Boring terminated at a depth of 5.0 ft due to concrete being encountered after SAWS cleared boring of subsurface utilities. Area too congested with utilities to drill another boring in the area.
2) Boring drilled in Humphrey Avenue, see Plan of Borings.

Fugro Consultants, Inc.

COMPLETION DEPTH, FT: 5.0
DATE DRILLED: 9-30-10
WATER LEVEL / SEEPAGE, FT: Dry
UPON COMPLETION: NA

LONGITUDE: 98°28'18.06" W
LATITUDE: 29°27'16.8" N

PLATE 12

LOG OF BORING NO. B-11

Reach 1 through Reach 3
Olmos Basin Central Watershed Sewer Relief Line
San Antonio Water System,
PROJECT NO. 04.60081210

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC/RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH, FT	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNCONFINED STRENGTH TSF
				SURF. ELEVATION: 661.8 ft								
			N = 11	1.5" Asphaltic Concrete / 8.5" Crushed Limestone (Fill)	660.8 1.0							
			P = 3.25	FAT CLAY WITH SAND (CH), dark brown, stiff, with calcareous nodules and brown clay (Fill)	657.8 4.0	18	56	38	95	71		
5 10			P = 3.0 N = 1 N = 1	POORLY GRADED GRAVEL (GP), brown, very loose (Fill) - nail found in 4' to 6' sample	650.3 11.5							
15			P = 3.0	FAT CLAY (CH), tan and gray, very stiff (Navarro)	643.8 18.0							
20			P = 4.5+	CLAYSHALE, gray, moderately weathered, soft (Navarro)	641.8 20.0	14	40	23	100	92	112	7.7
25 30 35				Note: Boring drilled in Margaret Street, see Plan of Borings.								

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COMPLETION DEPTH, FT: 20.0
DATE DRILLED: 9-30-10
WATER LEVEL / SEEPAGE, FT: 8.4
UPON COMPLETION: NA

LONGITUDE: 98°28'14.82" W
LATITUDE: 29°27'13.92" N

PLATE 13

LOG OF BORING NO. B-12

Reach 1 through Reach 3
Olmos Basin Central Watershed Sewer Relief Line
San Antonio Water System,
PROJECT NO. 04.60081210

DEPTH, FT	POCKET PEN, tsf Blows/ft. REC/RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH, FT	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNCONFINED STRENGTH TSF
		SURF. ELEVATION: 667.9 ft								
	N = 22	0.3" Asphaltic Concrete / 2" Crushed Limestone (Fill)	667.4 0.5							
		CLAYEY SAND WITH GRAVEL (SC), brown, medium dense, with brown clay (Fill)		6	31	16	77	28		
	N = 12		663.9							
	P = 4.5+	FAT CLAY (CH), dark brown, hard (Alluvium)	4.0	21					99	8.0
5	P = 4.5+									
	P = 4.5+			18	72	52	100	97		
			657.9							
10		CLAYEY GRAVEL WITH SAND (GC), light gray, medium dense, with chert (Alluvium)	10.0							
	N = 22									
15			650.9							
		FAT CLAY (CH). tan and gray, hard (Navarro)	17.0							
	P = 4.5+									
20										
	P = 4.5+			16	65	48	100	99	111	8.1
			642.9							
25			25.0							
		Note: Boring drilled near Station 45+00, see Plan of Borings.								
30										
35										

FUGRO
Fugro Consultants, Inc.

COMPLETION DEPTH, FT: 25.0
DATE DRILLED: 9-27-10
WATER LEVEL / SEEPAGE, FT: Dry
UPON COMPLETION: NA

LONGITUDE: 98°28'19.77" W
LATITUDE: 29°27'18.06" N

PLATE 14

FUGRO STD (NO PL) 04.60081210.GPJ FUGRO DATA TEMPLATE 042610.GDT 11/5/10

LOG OF BORING NO. B-13

Reach 1 through Reach 3
Olmos Basin Central Watershed Sewer Relief Line
San Antonio Water System,
PROJECT NO. 04.60081210

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC/RQD, %	STRATUM DESCRIPTION SURF. ELEVATION: 672.7 ft	LAYER ELEV./ DEPTH, FT	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNCONFINED STRENGTH TSF
			N = 11	2" Asphaltic Concrete / 9" Crushed Limestone (Fill)	671.7							
				FAT CLAY (CH), dark brown to brown, hard (Alluvium)	1.0							
			P = 4.5+									
						15	50	34	100	94	117	14.2
			P = 4.5+									
5												
					666.7							
			P = 4.5+	LEAN CLAY (CL), reddish brown and gray, hard, highly calcareous (Alluvium)	6.0							
			P = 4.5+			22					104	2.7
10												
					659.7							
			N = 68	CLAYEY GRAVEL WITH SAND (GC), brown, very dense, with chert (Alluvium)	13.0							
					657.7							
15				FAT CLAY (CH), tan and gray, very stiff to hard (Navarro)	15.0							
			P = 3.0			22	57	37	100	98		
20												
			P = 4.5+			17					113	5.6
					647.7							
25					25.0							
				Notes: Boring drilled near Station 50+00, see Plan of Borings.								
30												
35												

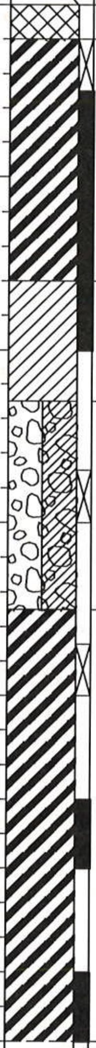
Fugro Consultants, Inc.

COMPLETION DEPTH, FT: 25.0
DATE DRILLED: 9-27-10
WATER LEVEL / SEEPAGE, FT: Dry
UPON COMPLETION: NA

LONGITUDE: 98°28'16.98" W
LATITUDE: 29°27'22.26" N

LOG OF BORING NO. B-14

Reach 1 through Reach 3
Olmos Basin Central Watershed Sewer Relief Line
San Antonio Water System,
PROJECT NO. 04.60081210



DEPTH, FT	POCKET PEN, tsf Blows/ft. REC/RQD, %	STRATUM DESCRIPTION SURF. ELEVATION: 673.6 ft	LAYER ELEV./ DEPTH, FT	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNCONFINED STRENGTH TSF
		1.5" Asphaltic Concrete / 5.5" Crushed Limestone (Fill)	672.6 1.0							
	N = 21	FAT CLAY (CH), dark brown, very stiff to hard (Alluvium)								
	P = 4.5+									
				23					97	6.9
	P = 4.5+									
5										
	P = 4.5+	- brown to light brown below 6'								
			665.6 8.0	21	65	48	99	89		
	P = 4.5+	LEAN CLAY (CL), light brown, hard, highly calcareous (Alluvium)								
10										
			662.1 11.5							
		POORLY GRADED GRAVEL WITH SAND (GP-GC), brown, very dense (Alluvium)								
	N = 69			6	68	50	41	11		
15										
			656.1 17.5							
		FAT CLAY (CL), tan and gray, very stiff to hard (Navarro)								
	N = 37									
20										
	P = 3.5									
25				17					113	5.4
	P = 4.5+									
		- lean clay, 29' to 30'	643.6 30.0	19	44	29	100	94	107	5.6
30										
		Note: Boring drilled near Station 55+00, see Plan of Borings.								
35										

Fugro Consultants, Inc.

COMPLETION DEPTH, FT: 30.0
DATE DRILLED: 10-8-10
WATER LEVEL / SEEPAGE, FT: Dry
UPON COMPLETION: NA

LONGITUDE: 98°28'13.5" W
LATITUDE: 29°27'26.82" N

PLATE 16

LOG OF BORING NO. B-15

Reach 1 through Reach 3
Olmos Basin Central Watershed Sewer Relief Line
San Antonio Water System,
PROJECT NO. 04.60081210

SURF. ELEVATION: 674.7 ft

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC/RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH, FT	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNCONFINED STRENGTH TSF
			N = 13	3" Asphaltic Concrete / 6" Crushed Limestone with asphaltic concrete (Fill)	673.7 1.0							
			P = 4.5+	FAT CLAY (CH), dark brown, hard (Alluvium)								
			P = 4.5+									
5												
			P = 4.5+	LEAN CLAY (CL), light brown to tan, hard, highly calcareous (Alluvium)	668.7 6.0	14	49	34	100	96	115	21.6
			P = 4.5+									
10				CLAYEY GRAVEL (GC), gray, loose (Alluvium)	664.7 10.0							
			N = 4		▽							
15												
			N = 9	FAT CLAY (CH), tan and gray, stiff to very stiff (Navarro)	656.2 18.5	22	64	47	100	91		
20												
			P = 3.5									
				- sand seam at 24'								
25												
			N = 15									
30					644.7 30.0							
				Note: Boring drilled near Station 60+00, see Plan of Borings.								
35												

Fugro Consultants, Inc.

COMPLETION DEPTH, FT: 30.0
DATE DRILLED: 10-1-10
WATER LEVEL / SEEPAGE, FT: 14.5
UPON COMPLETION: NA

LONGITUDE: 98°28'10.8" W
LATITUDE: 29°27'30.54" N

PLATE 17

LOG OF BORING NO. B-16

Reach 1 through Reach 3
Olmos Basin Central Watershed Sewer Relief Line
San Antonio Water System,
PROJECT NO. 04.60081210

DEPTH, FT	POCKET PEN, tsf Blows/ft. REC/RQD, %	STRATUM DESCRIPTION SURF. ELEVATION: 678.7 ft	LAYER ELEV./ DEPTH, FT	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNCONFINED STRENGTH TSF
	N = 26	6" Crushed Limestone (Fill)	678.2 0.5							
		FAT CLAY (CH), dark brown, very stiff to hard (Alluvium)								
	N = 37									
	P = 4.5+			13	54	38	100	97		
5		- with calcareous deposits below 5'		14					119	12.9
	P = 4.5+									
	P = 4.5+									
10										
		CLAYEY GRAVEL WITH SAND (GC), brown, very dense (Alluvium)	666.7 12.0							
	N = 50/6"									
				4	47	33	58	21		
15										
	N = 50/4"									
20		FAT CLAY (CH), tan and gray, hard (Navarro)	658.7 20.0							
	P = 4.5+			18	61	40	100	95	110	7.6
25										
	P = 4.5+			20					110	7.6
30			648.7 30.0							
		Note: Boring drilled near Station 65+00, see Plan of Borings.								
35										

Fugro Consultants, Inc.

COMPLETION DEPTH, FT: 30.0
DATE DRILLED: 10-8-10
WATER LEVEL / SEEPAGE, FT: Dry
UPON COMPLETION: NA

LONGITUDE: 98°28'8.04" W
LATITUDE: 29°27'34.44" N

PLATE 18

LOG OF BORING NO. B-17

Reach 1 through Reach 3
Olmos Basin Central Watershed Sewer Relief Line
San Antonio Water System,
PROJECT NO. 04.60081210

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC/RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH, FT	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNCONFINED STRENGTH TSF
				SURF. ELEVATION: 677.1 ft								
			N = 7	4.5" Asphaltic Concrete / 7.5" Crushed Limestone (Fill)	676.1 1.0							
				FAT CLAY WITH SAND (CH), dark brown to brown, firm to very stiff (Fill)								
			P = 3.0			26					100	2.2
			P = 3.0			19	57	42	96	83		
5												
			N = 4									
			P = 1.0			24					92	1.1
10				CLAYEY GRAVEL WITH SAND (GC), dark brown, medium dense (Fill)	667.1 10.0							
			N = 18	- piece of rubberized asphalt in 13.5' to 15' sample								
15												
				- drill pipe went sideways after initial 6-inch seating	658.1 19.0							
20												
25												
30												
35												

Notes:
1) Boring drilled near Station 70+00, see Plan of Borings.
2) Terminated boring at 19 ft, likely encountered sewer line, after SAWS cleared boring of underground utilities. Due to congestion of underground utilities in the area, other boring locations were not attempted in this area.

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COMPLETION DEPTH, FT: 19.0
DATE DRILLED: 10-1-10
WATER LEVEL / SEEPAGE, FT: Dry
UPON COMPLETION: NA

LONGITUDE: 98°28'4.86" W
LATITUDE: 29°27'39.48" N

PLATE 19

LOG OF BORING NO. B-18

Reach 1 through Reach 3
Olmos Basin Central Watershed Sewer Relief Line
San Antonio Water System,
PROJECT NO. 04.60081210

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC/RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH, FT	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNCONFINED STRENGTH TSF
				SURF. ELEVATION: 675.1 ft								
			N = 10	2.5" Asphaltic Concrete / 8.5" Crushed Limestone (Fill)	674.1							
				FAT CLAY (CH), dark brown to brown, stiff to very stiff (Alluvium)	1.0							
			P = 2.5									
5			P = 4.0			21					104	3.0
			P = 2.5									
			P = 4.0			20	60	44	93	86		
10												
					▽ 663.1							
				POORLY GRADED GRAVEL WITH CLAY AND SAND (GP-GC), brown, medium dense (Alluvium)	12.0							
15			N = 27			11	68	51	38	8		
20			N = 20	- more clay below 19 ft								
25			N = 21		649.1							
				FAT CLAY (CH), tan and gray, hard (Navarro)	26.0							
30			N = 31		645.1 30.0	26	64	49	100	97		
				Note: Boring drilled near Station 73+95, see Plan of Borings.								
35												

FUGRO STD (NO PL) 04.60081210.GPJ FUGRO DATA TEMPLATE 042610.GDT 11/5/10

FUGRO
Fugro Consultants, Inc.

COMPLETION DEPTH, FT: 30.0
DATE DRILLED: 9-30-10
WATER LEVEL / SEEPAGE, FT: 11.2
UPON COMPLETION: NA

LONGITUDE: 98°28'2.1" W
LATITUDE: 29°27'40.86" N

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

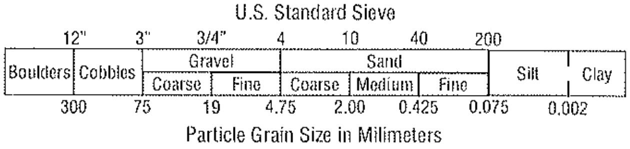
Strength of Fine Grained Soils			
Consistency	**SPT (# blows/ft)(1)**	**UCS (TSF)(1)**	**PP (Fugro DFW)**
Very Soft	< 2	< 0.25	0.4
Soft	2 - 4	0.25 - 0.5	0.5 - 0.8
Medium Stiff	4 - 8	0.5 - 1.0	0.9 - 1.6
Stiff	8 - 15	1.0 - 2.0	1.7 - 3.3
Very Stiff	15 - 30	2.0 - 4.0	> 3.4
Hard	> 30	> 4.0	

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)



Structure(3)

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

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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 21

TERMS AND SYMBOLS USED ON BORING LOGS FOR ROCK

Sampler Types

- ▯ Rock Core
- ▽ Texas Cone Penetration Test (TCP)
- ■ Bag Sample

Notation for Rock Core Samples	
RC_	Rock Core sample + depth interval
Rec	Rock Core Sample Recovery (ASTM D2113)
RQD	Rock Quality Designation (ASTM D6032)

Material Types

- ▦ LIMESTONE (L)
- ▤ SHALE (SH)
- ▒ SANDSTONE (SS)
- ☰ MARL (M)
- ▦ WEATHERED LIMESTONE (W)
- ▤ WEATHERED SHALE (WSH)
- ▒ WEATHERED SANDSTONE (WSS)
- ☰ WEATHERED MARL (WM)

Weathering(4)

Weathering Grades of Rock Mass	
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 a 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

Hardness

Criteria for Field Hardness	
Very Soft	Can be carved with a knife. Can be excavated readily with point of pick. Pieces 1" or more in thickness can be broken by finger pressure. Readily scratched with fingernail
Soft	Can be gouged or grooved readily with knife or pick point. Can be excavated in chips to pieces several inches in size by moderate blows with the pick point. Small, thin pieces can be broken by finger pressure
Medium	Can be grooved or gouged ¼" deep by firm pressure on knife or pick point. Can be excavated in small chips to pieces about 1' maximum size by hard blows with the point of a pick
Hard	Can be scratched with knife or pick only with difficulty. Hard blow of hammer required to detach a hand specimen
Very Hard	Cannot be scratched with knife or sharp pick. Breaking of hand specimens requires several hard blows from a hammer or pick

Grain Size(3)

U.S. Standard Sieve

3"	3/4"	4	10	40	200
Gravel		Sand			
Coarse	Fine	Coarse	Medium	Fine	
75	19	4.75	2.00	0.425	0.075

Particle Grain Size in Milimeters

Secondary Components(3)

Criteria for Describing Structure	
Trace	< 5% of sample
Few	5% to 10% of sample
Little	10% to 25% of sample
Some	25% to 50% of sample

Structure

Bedding Thickness and Spacing of Planar Features			
Type	Spacing	Thickness	Fracture Spacing
Parting	< 1/8 in.	Laminar	NA
Seam	1/8 to 3/4 in.	Extremely thin	Extremely close (< 3/4 in.)
	3/4 to 2 1/2 in.	Very thin	Very close
Layer	2 1/2 to 6 in.	Thin	Close
	6 to 24 in.	Medium	Moderate
Bed	2 to 7 ft.	Thick	Wide
	7 ft. to 20 ft.	Very thick	Very wide
	> 20 ft.	Extremely thick	Extremely wide
	Massive	No stratification observed	NA
	Occasional	Occurring once or less per foot	
	Frequently	Occurring more than once per foot	

Discontinuities	
Joint	A natural fracture along which no displacement has occurred. May occur in parallel groups called sets.
Fracture/ Shear	A natural fracture along which differential movement has occurred. May be slickensided or striated.
Fault	A natural fracture along which displacement has occurred. Usually lined with gouge and slickensides.

Surface Planarity	
Curved	A moderately undulating surface, with no sharp breaks or steps.
Planar	A flat surface
Stepped	A surface with asperities or steps. The height of the asperity should be estimated or measured.

Roughness	
Very Rough	Near vertical steps and ridges occur on the discontinuity
Rough	Some ridges and side-angle steps are evident; asperities are clearly visible, surface feels very abrasive.
Slightly Rough	Asperities on the discontinuity surfaces can be seen and felt.
Smooth	Surface appears smooth and feels smooth.
Slickensided	Evidence of polishing and movement are visible.

Aperture	
Tight	Core pieces on either side of fracture can be fitted together so that no visible void spaces remain.
Open	Core pieces on either side of fracture cannot be fitted tightly together and voids are visible.
Healed	A completely healed fracture or vein is not considered a discontinuity and should not be included when describing rock core fracturing or calculating RQD. This feature should be described including a record of dip, spacing, thickness, type of filling and any observed alteration.

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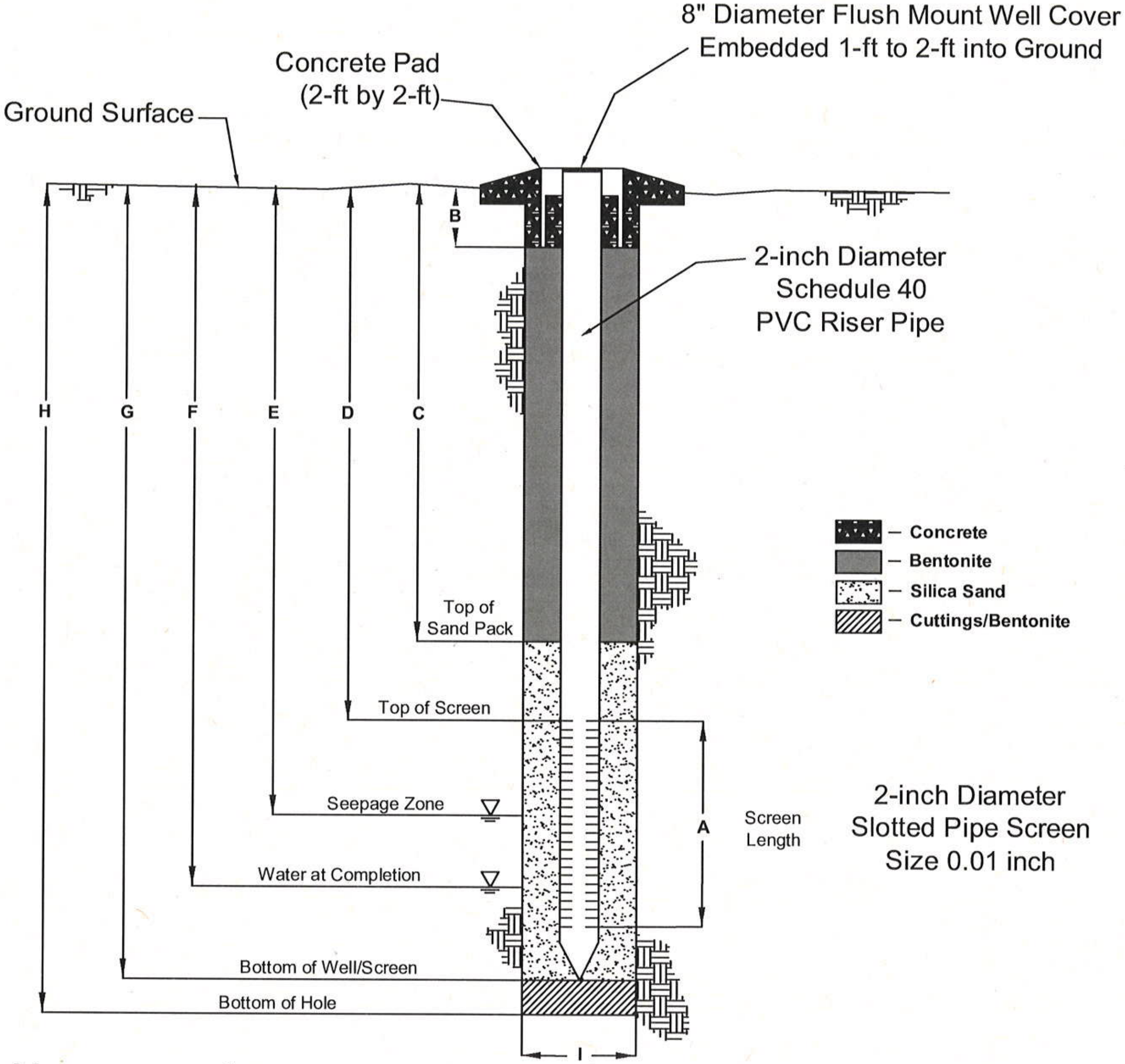
Note: Information on each boring log is a compilation of subsurface conditions and soil and rock classificaitons obtained from the field as well as from laboratory testing of samples. Strata have been interpreted by commonly accepted procedures. The stratum lines on the logs may be transitional and approximate 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.
(3) ASTM International, ASTM D 2488 Standard Practice for Description and Identification of Soils.
(4) British Standard (1981), Code of Practice for Site Investigation BS 5930.

Piezometer Number: P @ B-3

Installation Date: October 4, 2010



Field Measurements:

A: 10'

C: 8.5'

E: N/A

G: 20.5'

I: 7.5"

B: 1.5'

D: 10.5'

F: N/A

H: 20.5'

PIEZOMETER SCHEMATIC

Reach 1 Through Reach 3
Olmos Basin Central Watershed Sewer Relief Line
San Antonio Water System
San Antonio, Texas

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

Weston Solutions, Inc.
70 N.E. Loop 410, Suite 600
San Antonio, Texas 78216
Office (210) 308-4300 • Fax (210) 308-4329

Texas Registered Engineering Firm F-3123

29 September 2011

Thomas E. Klein, Jr., P.E., PMP
Project Engineer
Replacements & Improvements
San Antonio Water System
2800 U.S. Hwy 281 North, Suite 300
San Antonio, Texas 78212

VIA E-MAIL: Thomas.Klein@saws.org

RE: Olmos Basin Central Watershed Sewer Relief Line (C-3) Project: Geotechnical Data Study
Reach 4 Geotechnical Report
SAWS Job No. 08-2512
WESTON WO# 10412.015.001

Dear Mr Klein:

Please disregard the previously posted geotechnical report, and replace with the attached report.

The attached geotechnical report prepared by Fugro Consultants, Inc., dated September 1, 2011 (Revised September 23, 2011), is being provided as supplemental information only. Please note that this document does not supersede the San Antonio Water System construction documents, specifications, special conditions or the Contract Documents.

If you have any questions please call me at 210-248-2425.

Very truly yours,

WESTON SOLUTIONS, INC.

Abdel Hamed

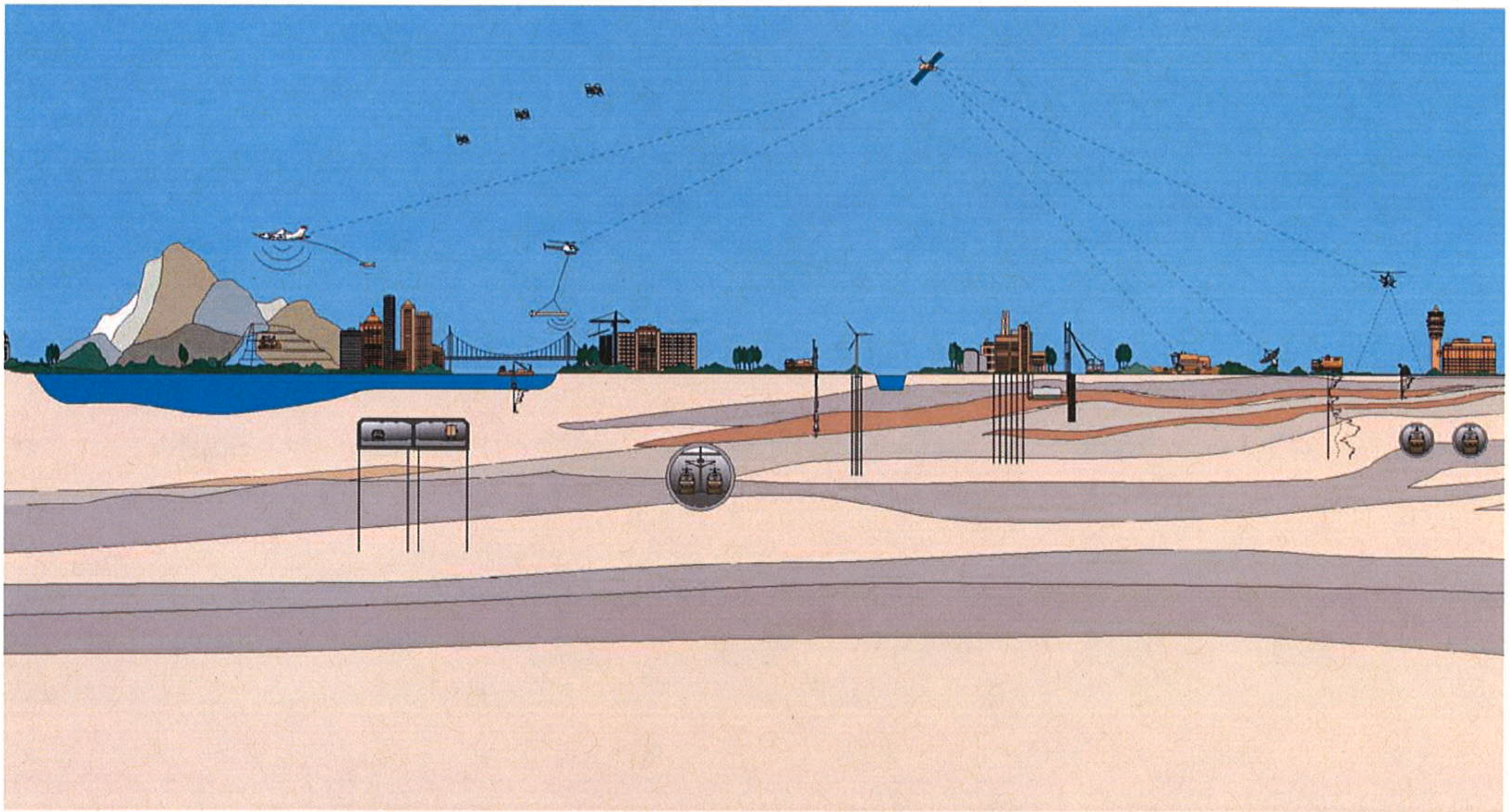
Abdel Hamed, P.E.
Project Manager

cc: Project File
Ms. Tracee Wulff, SAWS
Mr. Gerardo Gomez, SAWS
Ms. Maridel Jimenez, P.E. WESTON

FUGRO CONSULTANTS, INC.

GEOTECHNICAL DATA STUDY
REACH 4
OLMOS BASIN CENTRAL WATERSHED SEWER LINE RELIEF
SAN ANTONIO WATER SYSTEM
SAN ANTONIO, TEXAS

WESTON SOLUTIONS, INC.
San Antonio, Texas



FUGRO CONSULTANTS, INC.

Project No. 04.60081210-1
September 1, 2011
Revised September 23, 2011

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

Weston Solutions, Inc.
70 NE Loop 410, Suite 600
San Antonio, Texas 78216

Attention: Mr. Abdel Hamed, P.E. and
Ms. Maridel R. Jimenez, P.E.

Geotechnical Data Study
Reach 4
Olmos Basin Central Watershed Sewer Relief Line
San Antonio Water System
San Antonio, Texas

Introduction

Fugro Consultants, Inc. (Fugro) performed a geotechnical study for the San Antonio Water System (SAWS), Olmos Basin Central Watershed Sewer Relief Line, Reach 1 through 3. Our findings were presented in Fugro's Report No. 04.60081210, dated November 5, 2010. This study provides information for Reach 4. This study was performed in general accordance with Weston Solutions, Inc. Purchase Order 0072512, Change Order 1, which included the Consulting Services Agreement. Fugro's scope of services is set forth in Modification #1 to the Purchase Order, Proposal for Geotechnical Study, dated June 22, 2011

Project Description

The proposed project for Reach 4 generally runs north-south along the west side of Broadway Avenue within the Witte Museum property, as shown on the Vicinity Map, Plate 1. The sanitary sewer will consist of a 54-inch diameter line that will extend from Station 72+40 to 80+87 (847 ft).

Purpose

The purpose of this geotechnical study was to obtain samples of the subsurface soils along the alignment to measure pertinent physical characteristics of the materials. This purpose was accomplished by:

1. advancing one boring to explore the subsurface conditions, and to obtain soil samples;

2. performing laboratory tests on selected soil samples recovered from the boring to evaluate pertinent physical properties; and
3. preparing a data report.

Field Investigation

The subsurface exploration program consisted of one 20-ft deep boring, as requested. The boring is designated as boring B-19. The boring has been numbered to be in sequence with the previous study. Borings B-1 through B-18 were drilled for Reaches 1 through 3 and presented in the previous study. The approximate locations of borings B-18 and B-19 are illustrated on a Plan of Borings, Plate 2.

Detailed descriptions of the subsurface strata encountered is presented on the Log of Boring, Plate 3. Pocket penetrometer values in tons per square foot (tsf) and SPT N-values in blows per foot (bpf) are also shown on the boring log. A Keys to Terms and Symbols used on the boring log is set forth on Plate 4. Groundwater notes are presented at the bottom of the boring log. Coordinates of the boring location was taken with a hand held GPS.

The borings were drilled with a truck-mounted drill rig equipped with 1) continuous flight augers for advancing the holes dry and recovering disturbed samples (ASTM D 1452), 2) seamless push-tubes for obtaining samples of cohesive strata (ASTM D 1587), and 3) split-barrel samplers and drive-weight assembly for obtaining representative samples and measuring penetration resistance (N-values) of non-cohesive soil strata (ASTM D 1586). In general, soil samples were obtained at about 2-ft intervals to the boring completion depth. The borehole was backfilled with soil cuttings and/or bentonite pellets.

Laboratory Testing

The laboratory testing program was directed toward identification and classification of the soils encountered at the boring location. To aid in soil classification, Atterberg limits (ASTM D 4318) and the percentage of material passing selected U.S. Standard sieves (ASTM D 422) were performed on selected soil samples. Water content measurements were performed on samples in which classifications tests were performed. Unconfined compressive strength tests (ASTM D 2850) were also performed on selected samples; moisture content and unit dry weights were measured as routine portions of the compression tests. The results of the laboratory classification tests are presented on the individual boring log.

Soil Descriptions and Classifications

Descriptions of strata made in the field at the time the boring was drilled was modified in accordance with results of laboratory tests and visual evaluation in the laboratory. All recovered soil samples were evaluated and classified in general accordance with ASTM D 2487 and described as recommended in ASTM D 2488. Classifications of the soils and finalized descriptions of soil strata are shown on the log of boring.

Subsurface Conditions

Geologic Setting. A review of available geologic information,[1] indicates the alignment is underlain by alluvial soils. Alluvium (floodplain deposits) consist of various amounts of clay, silt, sand, and gravel. The alluvial soils are underlain by clay of the Navarro Group. Navarro Group clays generally consist of the lower part of the formation and are composed of dominantly montmorillonitic, greenish-gray to brownish-gray clay, which weathers to a black clay. The clays can exhibit a high shrink/swell potential. The deeper unweathered portions of the Navarro consist of gray clay shale.

Stratigraphy. Subsurface conditions at the boring location can be understood by a thorough review of the boring log, B-19, presented on Plate 3. A brief summary of the subsurface conditions for encountered at boring B-19 is provided in the following paragraphs.

Fill material was encountered at the surface at the boring B-19 location. The fill consisted of brown fat clay with limestone fragments and a thickness of about 1 ft thick. Alluvial soils were encountered below the fill material to a 10-ft depth. These soils generally consisted of fat clay overlying clayey gravel. The alluvial soils tested have moisture contents between 11 and 18, a liquid limit of 62, plasticity index of 46, percentage of material passing the No. 4 sieve of 48 and 100, and percentage of material passing the No. 200 sieve of 30 and 94. Measured unconfined compressive strength in the alluvial deposits was 11.1 tsf.

The alluvium is underlain by tan and gray clay of the Navarro Group. The clay soils of the Navarro Group have moisture contents of 20 and 22, liquid limit of 77, plasticity index of 54, percentage of material passing the No. 4 sieve of 100, and 98 percent material passing the No. 200 sieve. The measured unconfined compressive strength in the Navarro clay was 3.5 tsf.

Groundwater

The boring was advanced using a dry technique; no water or other drilling fluid was introduced to promote the drilling operation. Free water was not observed at boring B-19. San Antonio is in drought conditions at the time of this report. It should be noted, the clayey gravel layer may be water bearing during periods of higher precipitation. Groundwater levels will fluctuate with seasonal variations in precipitation. The presence of groundwater should be planned for during installation of the new sewer lines. Amounts of water will depend on antecedent rainfall and location of site drainage features.

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[1] Fisher, W.L. (1974), "Geologic Atlas of Texas, Austin Sheet," Bureau of Economic Geology. The University of Texas at Austin, map and accompanying explanatory bulletin.

Dewatering

The design of dewatering systems and groundwater control is the responsibility of the contractor. This is very appropriate since water control affects construction operations, including excavation and scheduling. However, specifications are necessary to ensure the support properties of subsoil strata are not reduced and adjacent structures are not endangered.

The following technical specification[2] regulating dewatering could be used: "Control of groundwater shall be accomplished in a manner that will preserve the strength of the foundation soils, will not cause instability of the excavated slopes, and will not result in damage to existing structures. Where necessary to this purpose, the water will be lowered in advance of excavation, by wells, wellpoints, or similar methods. Open pumping will not be permitted if it results in boils, loss of fines, softening of the subgrade, or slope instability. Wells and wellpoints will be installed with suitable screen and filters so that pumping of fines does not occur. Discharge will be arranged to facilitate sampling by the engineer."

OSHA Soil Classifications for Shallow Excavations

The design of construction and/or temporary slopes and temporary retainage systems are the soil responsibility of the contractor. Suggestions are set forth below in accordance with OSHA[3] for classifying soil encountered in our investigation. It is stressed that these are suggestions only for preliminary planning based on apparent conditions, and the actual trench safety system design, installation, and performance are the contractor's sole responsibility.

Material	OHSA Classification	OSHA Slope
CH Soil, except loose fill	Type B	1H to 1V
Saturated CH Soil	Type C	1.5H to 1V or flatter
** Sloping and benching for excavation greater than 20 ft deep shall be designed by a registered professional engineer.		

Conditions

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

---

[2] Fang (1991), Chapter 7, "Dewatering Groundwater Control" by Powers, J.P., p. 244.

[3] Code of Federal Regulations Title 29 Part 1926 (1989), "Labor", Occupational Safety and Health Administration, Department of Labor, Subpart P - Excavations, pgs 45963-45971.

recommendations. Observations during construction are recommended to check for variations in subsurface conditions and possible changed conditions.

The professional services that form the basis for this report have 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.

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 Consultants, 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 following plates are attached and complete this report:

	Plate
Vicinity Map	1
Plan of Borings	2
Log of Boring	3
Key to Terms and Symbols Used on Boring Log for Soil	4

We appreciate the opportunity to be of service to Weston Solutions and SAWS on this project. Please call if we can be of additional assistance.

Sincerely,

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

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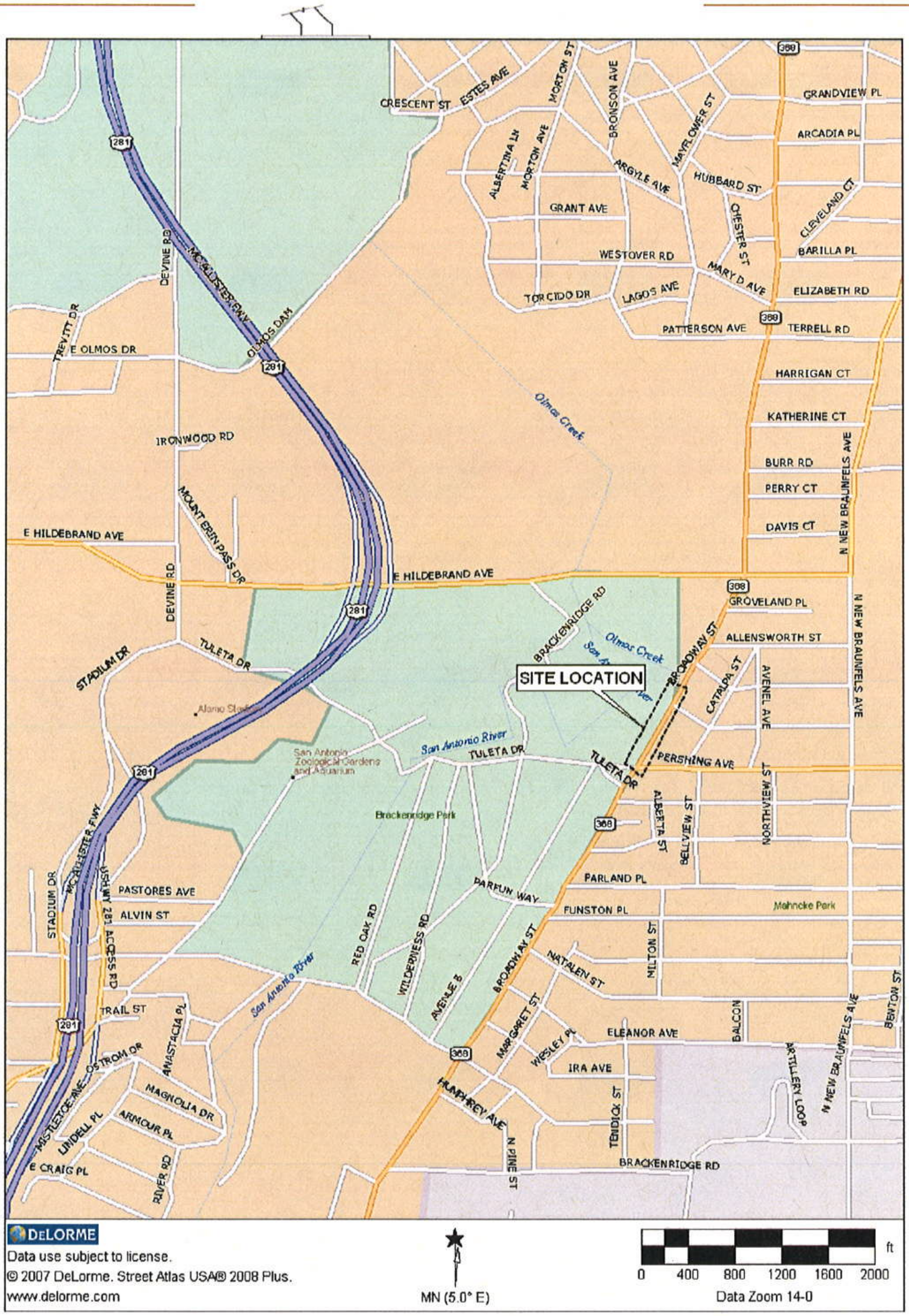
Copies Submitted: (4)
(Geotech:\Geotech 2008\04.60081210-1\report\60081210-1 Rpt Olmos Sewer Relief Line Reach 4)



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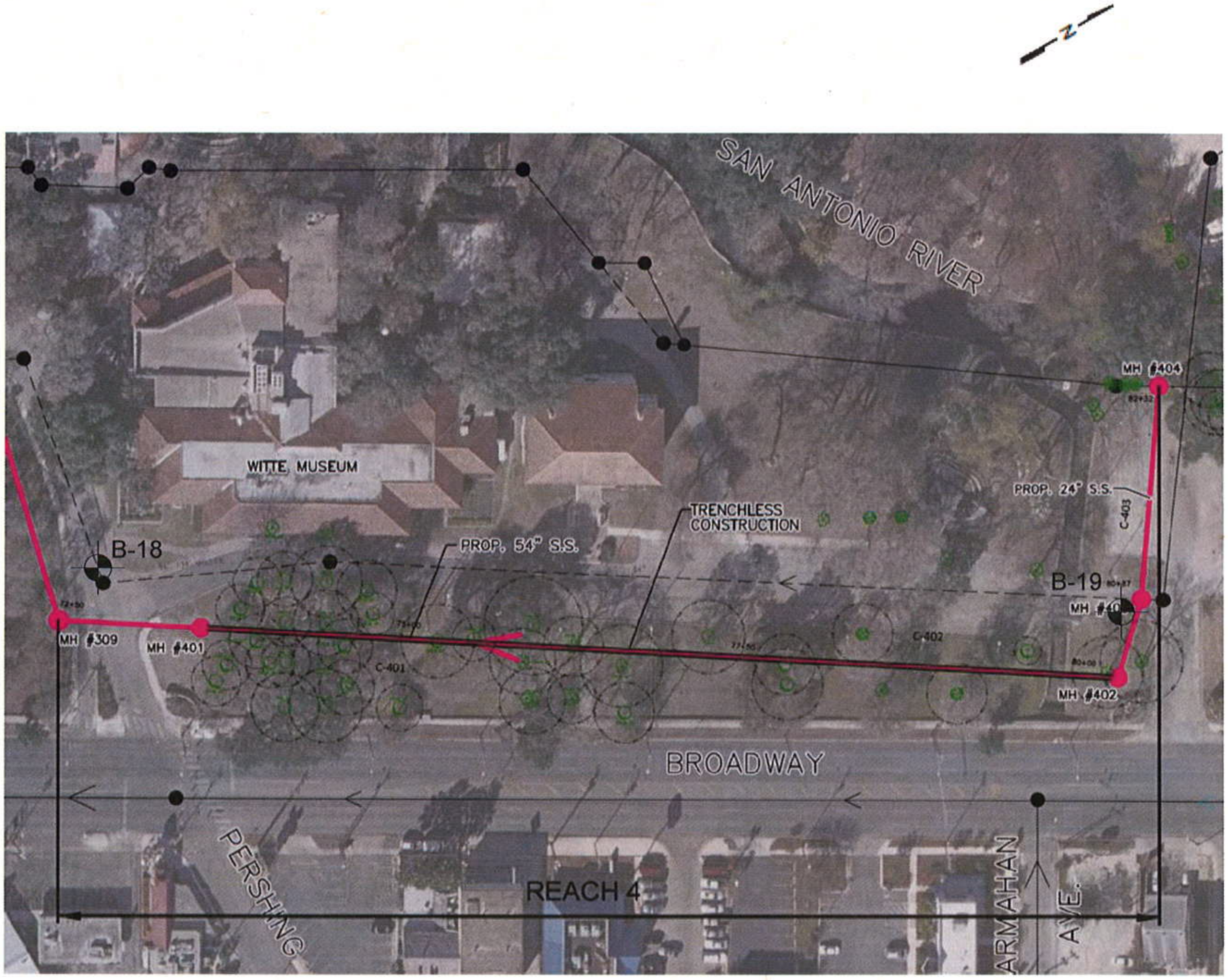
VICINITY MAP
Reach 4
Olmos Basin Central Watershed Sewer Relief Line
San Antonio Water System
San Antonio, Texas

PLATE 1



Note: Boring B-18 drilled for geotechnical study for Reach 1 through 3.

BORING PLAN
Reach 4
Olmos Basin Central Watershed Sewer Relief Line
San Antonio Water System
San Antonio, Texas

PLATE 2

LOG OF BORING NO. B-19

Reach 4

Olmos Basin Central Watershed Relief Line

San Antonio, Texas

PROJECT NO. 04.60081210-1

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC/RQD, %	STRATUM DESCRIPTION SURF. ELEVATION: Unknown ft	LAYER ELEV./ DEPTH, FT	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNDRAINED SHEAR STRENGTH KSF
			P = 4.5+	FAT CLAY (CH), brown, hard, with limestone fragments (fill)	1.0							
			P = 4.5+	FAT CLAY (CH), dark brown, hard, with calcareous nodules (Alluvium)								
			P = 4.5+									
						18	62	46	100	94		
			P = 4.5+									
5						18					106	11.1
			P = 4.5+									
			P = 4.5+		8.5							
			N = 27	CLAYEY GRAVEL WITH SAND (GC), brown, medium dense, with chert (Alluvium)		11			48	30		
10					10.0							
			P = 3.0	FAT CLAY (CH), tan and gray, very stiff to hard (Navarro)								
						22					112	3.5
			P = 3.0									
						20	77	54	100	98		
			P = 4.3									
15												
			P = 4.5+									
			P = 4.5+									
20					20.0							

Note:
1) Boring drilled near Station 84+50.
2) Coordinates taken with a hand held GPS unit.

Fugro Consultants, Inc.

COMPLETION DEPTH, FT: 20.0
DATE DRILLED: 8-18-11
WATER LEVEL / SEEPAGE, FT: Dry
WATER LEVEL UPON COMPLETION, FT: Dry

LONGITUDE: 98°27'57.4" W
LATITUDE: 29°27'46.9" N

PLATE 3

TERMS AND SYMBOLS USED ON BORING LOGS FOR SOIL

SOIL TYPES

▨	CH, fat clays	▨	SC, clayey sands	▨	GC, clayey gravels	▨	CL, lean clays	■	Thin-Walled Tube
▥	SM, silty sands	▨	GM, silty gravels	▥	ML, silts	▦	SW, well graded	◧	Auger Sample
☐	GW, well graded gravels	▩	Fill, unclassified	☐	SP, poorly-graded sands	■	GP, poorly graded gravels	⊠	Standard Penetration Test

SAMPLER TYPES

SOIL GRAIN SIZE

U.S. STANDARD SIEVE

6" 3" 3/4" 4 10 40 200

BOULDERS	COBBLES	GRAVEL		SAND			SILT	CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE		

152 76.2 19.1 4.76 2.00 0.420 0.074 0.002

SOIL GRAIN SIZE IN MILLIMETERS

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	UNDRAINED [2] SHEAR STRENGTH Kips Per Sq. Ft.	NUMBER OF BLOWS [3] PER FT., N
Very Soft	Less Than 0.25	Less Than 2
Soft	0.25 to 0.50	2 to 4
Firm	0.5 to 1.00	4 to 8
Stiff	1.00 to 2.00	8 to 16
Very Stiff	2.00 to 4.00	16 to 32
Hard	greater than 4.00	greater than 32

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 Fissured	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 [1]

Dry	-No water evident in sample; fines less than plastic limit.
Moist	-Sample feels damp; fines near the plastic limit
Wet	-Sample bears free water; fines greater than liquid limit
∇	-Free water first observed during drilling.
▼	-Final water measurement at completion of boring.

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.
3) Das, Braja M., (2002), Principles of Geotechnical Engineering, 5th Edition

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 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.

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.

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