PAVEMENT INVESTIGATION
MIDWAY ROAD
BELT LINE ROAD TO LINDBERGH DRIVE
ADDISON, TEXAS

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For

Town of Addison, Texas

Through

Shimek, Jacobs & Finklea, L.L.P.
Dallas, Texas

INTRODUCTION

In general accordance with notice to proceed and the authorization of our 8 March 1999 proposal, we have completed a Pavement Investigation of Midway Road from Belt Line Road to Lindbergh Drive in Addison, Texas. Information relative to the scope of this project was provided through a meeting at the site and through discussions with Mr. John W. Birkhoff, P.E., of Shimek, Jacobs & Finklea, L.L.P. We understand that this section of Midway Road has experienced difficulties with seepage through the joints in the pavement and vertical displacements at the joints in a longitudinal direction. The pavement was milled to create a smooth surface within the last two or three years. The vertical displacements have re-occurred to the point that many panels have vertical offsets of one inch, or more, at the present time.

PURPOSE AND SCOPE

The purpose of this investigation was to develop specific geotechnical data at the site by means of subsurface exploration, laboratory testing and engineering and geologic analyses of the resultant data from six soil borings. Shallow (less than four feet)

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groundwater observation elements were to be set in four boreholes to observe the water levels under the pavement and two monitor wells were to be set to observe water levels and provide access for water sampling in the deeper strata at the site. This report presents the results of the basic field and laboratory data developed and provides findings and recommendations to guide remediation of pavement. Recommendations to facilitate design and construction were made based on geological conditions encountered and geotechnical parameters obtained from this investigation. The interpretation of these data is considered appropriate to the extent that the investigated locations are typical of conditions present at the project site.

FIELD INVESTIGATION

The field or subsurface investigation conducted consisted of advancing six (6) soil borings to depths varying from about 3.5 to 20.5 feet below ground or pavement surfaces. These borings were advanced by means of a truck-mounted rotary drilling rig which employs dry sampling techniques to advance the borings. Five (5) of the borings were drilled through the pavement section of Midway Road; the concrete was cored using a 9-inch diameter diamond concrete coring bit. The drilling was performed by a Henley-Johnston & Associates, Inc., drill crew. The approximate locations of the borings drilled are indicated on Plate 1. The borings were located on the site by an HJA Engineer, using a measuring wheel and measuring from existing landmarks (roadways, railroads, curbs, etc.). The borehole locations indicated on Plate 1 are considered accurate to the degree implied by the method used.

Samples of cohesive soils and the upper strata of the weathered limestone were obtained using conventional Shelby-tube sampling techniques (ASTM D 1587) whereby a thin-walled tube is advanced into the formation by a rapid, continuous thrust from balanced hydraulic rams on the drilling rig. Disturbed, representative samples of the weathered and unweathered primary limestone strata were obtained from the auger cuttings.

All soil and limestone samples obtained from the borings were encased in polyethylene plastic to prevent changes in moisture content and to preserve in situ physical properties. All samples were classified as to basic type and texture in the field by an experienced Engineering Geologist, labeled as to appropriate boring number and depth, and placed in core boxes for transport to the laboratory. The concrete cores were returned to the laboratory where 2-3/4-inch diameter cores were cut for compressive strength testing of the concrete.

Groundwater was not encountered during the course of this investigation. Upon completion of drilling, temporary groundwater observation elements were set in each open borehole. The risers and wellscreens set in Boring Nos. MW-1 and MW-2 were sealed from surface infiltration of water by a 10-foot grout section over a 2-foot bentonite section. Below the grout/bentonite seal, the wellscreen was surrounded by 20/40 silica sand. Valve covers were grouted over the tops of these installations. In the shallow borings (B-1 through B-4) through the pavement, the wellscreens extended up to approximately the bottom of the pavement and were surrounded by 20/40 silica sand. Above that level, grout seals which also hold valve covers in place, were formed to prevent surface water from accessing the observation units. Details depicting each specific installation are appended hereto following the report illustrations.

LABORATORY TESTING

All soil samples were classified in accordance with the Unified Soil Classification System. Rock samples of the primary strata were described using standard geologic terms. Terms and symbols used on the boring logs are described on the enclosed sheet entitled "Legend, Lithology, Soil Consistency & Relative Rock Hardness."

To aid in the classification process, Atterberg Limits, Moisture Content and Dry Unit Weight tests were performed on representative samples. All of the above test data are summarized on Plate 2. Atterberg Limits also are presented on the Plasticity Chart on Plate 3.

Compressive Strength tests were performed on cores from the concrete pavement at each boring located in the pavement section. The results of these tests are presented on Plate 4.

The strength of each cohesive sample was estimated using a hand penetrometer. The results of these estimates are tabulated on Plate 5. The strength properties of selected soil samples were investigated by Unconfined Compression tests. In this test, axial load is applied to a laterally unsupported cylindrical sample until failure occurs within the sample. This test is conducted fairly rapidly (failure within about 10 minutes) and generally conforms to ASTM D 2166. The Elastic Modulus values were interpreted from the stress-strain curves of the Unconfined Compression tests using a tangent modulus at 50 percent of peak strength. The soil strength test data are summarized on Plate 5. Stress-strain data for the Unconfined Compression tests are presented graphically on Plates 6 through 11.

Water samples obtained from each boring location and from a nearby source of tap (municipal) water were tested by Southern Spectrographic Laboratory, Irving, Texas. The results of those tests and a brief statement from Southern Spectrographic about the anticipated sources of the water are presented on Plate 12.

SUBSURFACE CONDITIONS

The site of this investigation is in Addison, Texas, along the northbound lanes of Midway Road between Belt Line Road to the south and Lindbergh Drive to the north, as shown on Plate 1. A section of the "ADDISON" USGS quad sheet topographic map which includes this area is presented on Plate 13. This indicates that the roadway drops about 10 feet in elevation from Belt Line Road to the creek/railroad track, and remains fairly level or slightly uphill from the railroad track to Lindbergh Drive. Primary sediments at the site have been identified as limestone strata of the Austin Chalk Formation of Cretaceous Age. The specific types, depths, and thicknesses of materials penetrated by the borings are reflected on the individual "Log of Boring" illustrations.

Five of the borings were drilled through the concrete pavement of Midway Road. The concrete was found to be between 0.65 and 0.7 feet in thickness. Fill materials were encountered below the pavement in all borings except Boring No. B-1 and below ground surface in Boring No. MW-1. These fill materials extend to depths ranging from about 1.1 feet in Boring No. B-2 to about 3.0 feet in Boring No. B-3. The upper portion of the fill in Boring No. B-3 and the fill in Boring No. B-4 is clay which is believed to have been lime-treated. The remaining fill is silty clay with calcareous nodules, and probably is on site material which was relocated to fill low areas. Below the fill or pavement in Boring Nos. MW-1, B-1 and B-3 are thin zones of silty clay which the Atterberg Limits indicate to be low to moderate plasticity materials. In Boring Nos. MW-2 and B-4, slightly silty clays were found below the fill materials. These materials are indicated to be high plasticity clays; this may explain why these materials were lime-treated. All of the clay strata encountered are dark shades of brown or gray in color. These materials are stiff to very stiff in consistency and contain varying amounts of calcareous nodules.

Below the surficial clays, limestone strata of the primary formation (Austin Chalk Formation of Cretaceous Age) were encountered. The uppermost portions of the limestone were found to be variably weathered, having been leached by percolating waters over time. These weathered materials are generally severely to moderately weathered, jointed and fractured and contain occasional soft clayey seams. The weathered section is typically firm to moderately hard in rock hardness and light brown and tan in color. The weathered sections of limestone materials encountered ranged in thickness from about 8.5 feet in Boring No. MW-2 to about 14.5 feet in Boring No. MW-1.

Unweathered limestone strata were encountered below the zone of differential weathering at depths varying from about 13 feet in Boring No. MW-2 to about 17 feet in Boring No. MW-1. Once encountered, the unweathered limestone strata continued to at least the 20.5-foot maximum depth explored. Data from other investigations nearby indicate that the unweathered limestone is in excess of 30 feet thick in this vicinity. The unweathered limestone is moderately hard to hard in rock hardness and gray in color.

Groundwater was not encountered during the course of this investigation prior to the installation of the water level observation elements and monitor wells. Groundwater in this vicinity is typically perched on top of the unweathered limestone and is contained within joints and fractures present within the weathered limestone materials and within the silty clay overburden soils. Groundwater levels at this site can be expected to fluctuate with seasonal variations in rainfall.

Water levels were measured in each observation element installation. The following table provides the results of these water level readings.

Location	6-25-99	7-28-99
MW-1	8.9	9.5
B-1	2.6	2.6
B-2	0.5	1.6
B-3	0.4	0.8
B-4	0.7	0.7
MW-2	4.6	6.2

All of the elements, except Boring No. B-1, were bailed to within a few inches of the bottom of the installation on 25 June 1999 after water level readings were obtained. The water found in the elements on 28 July 1999 had entered the installations since the 25 June readings.

WATER LEVELS AND SOURCES

Based on approximate elevations from the topographic map on Plate 13, we estimate that the surface elevation at Boring No. MW-1 is about Elevation 625 and the surface elevation at Boring No. MW-2 is about Elevation 622. The flow line of the creek south of the railroad is estimated to be at about Elevation 610 to 620. The water level measurements in Boring Nos. MW-1 and MW-2 ("deep" installations) indicate that these levels are probably near the flow line elevation of Rawhide Creek.

The water level observed in Boring No. B-1 has remained relatively constant, indicating that water has not been coming into the installation during the observation period. The other three "shallow" installations have shown increases in water level during a time when little or no rain has fallen in the area; consequently, these elements indicate water infiltration from sources other than rainfall. During the same period of time, the water levels in Boring Nos. MW-1 and MW-2 have decreased.

The data from Southern Spectrographic indicate that the chemistry of water found in Boring Nos. B-1, B-2, B-3, and B-4 is very close to that of the referenced tap (municipal) water. The elevated potassium levels, we understand, are generally related to water migrating through fertilized areas (landscaped areas, etc.). The chemistry of water sampled from Boring No. MW-1 is similar to that of the tap water, but has higher concentrations of sodium, chloride, and sulfate, and less fluoride than tap water. The chemistry of water from Boring No. MW-2 appears to be predominantly from some source other than tap water.

Based on the information from the water observation and sampling installations, water chemistry tests, and our observations at the site; it is our opinion that water which has emitted from the joints in the pavement on Midway Road probably is related to tap water (irrigation or water from nearby businesses) or surface run-off. It would be advantageous to be able to observe these installations and obtain samples of water during a rainy period. Water has easy access to the subgrade soils through open joints in the pavement. Water can flow from landscaped areas in the median or along the outside of the pavement through open joints in the curbs and pavement to the subgrade soils. We have observed water flowing into the street from one of the businesses near Belt Line Road; this water flows downhill on Midway Road, encounters open joints and travels transversely until it can soak into the subgrade.

PAVEMENT ANALYSES

Traffic counts on Midway Road for Tuesday and Wednesday, 30 and 31 March, 1999, were provided to us. The 24-hour traffic volume in one northbound lane (outside) was divided into thirteen types of vehicles. We have used the program "Concrete Pavement Technology, Version 2.0" from the American Concrete Pavement Association to perform pavement analyses based on available information from this investigation. This program is based on the 1986 "AASHTO Guide for the Design of Pavement Structures."

We have used the following general design parameters:

Serviceability	
Initial	4.5
Terminal	2.25
Design Life	20 Years
Reliability	90 percent
Overall Deviation	0.35
Load Transfer	3.2 - assuming edge support and aggregate interlock for existing pavement 2.7 - assuming edge support and dowelled reinforced pavement for future pavement
Drainage Coefficient	Variable for existing pavement - 0.8, 1.0, 1.1 For potential future pavement - 1.0
Traffic Growth Rate	0.325 percent/year

For analysis of the existing pavement, we estimated the flexural strength of the concrete from the compressive strength values of the concrete cores. These flexural strength values varied from about 640 to 700 psi. For concrete near the south end of the site, we used a value of 660 psi; for the pavement near Lindbergh Drive, we used a value of 640 psi. For potential future pavement sections, we used a value of 650 psi.

For analyses of existing and future pavement, we have assumed that the subgrade materials have a CBR value of about 3, and have used a Resilient Modulus of 4500 psi. For lime-treated soils we have used a Resilient Modulus of 20,000 psi, and for asphalt treated base, we have used a Resilient Modulus of 350,000 psi.

For 8-inch (0.65 to 0.7-foot) thick pavement, the total ESAL's for 20-year life of the pavement is about 14,100,000 assuming the traffic volume indicated by the March traffic count. For existing conditions, with a Drainage Coefficient of 0.8, indicating poor drainage as observed in place, the design life of the pavement is slightly more than one year. Assuming better drainage conditions with a Drainage Coefficient of 1.0, the design life increases to about 2.3 years and with good drainage conditions, a Drainage Coefficient of 1.1, the design life increases to about 3.2 years.

This indicates that the traffic volume currently using Midway Road is significantly in excess of the volume that would be expected for a 20 or 30-year design life for the pavement in place.

The moisture contents of the near-surface soils (subgrade materials) are relatively high at all boring locations. Indications are that these soils have been saturated and remain saturated over long periods of time. We believe that this has resulted in softening of the soils at the south end of each pavement panel and settlement of that end of the panel. In some cases, this has resulted in a reverse rocking of the panel and the creation of a void under the north end of the panel. Because of these physical movements of some of the panels and the deterioration of the subgrade under the panels, we recommend that the existing pavement be removed, the subgrade be reworked and new pavement be placed. Recommendations for the replacement of this pavement are contained in subsequent paragraphs.

Pavement analyses indicate that the following sections could be used as replacements for the pavement along Midway Road.

20-year Life

10-inch Reinforced Concrete Paving
12-inch Compacted Lime-Treated Subgrade
or
10-inch Reinforced Concrete Paving
4-inch Compacted Asphalt-Treated Base

30-year Life

11-inch Reinforced Concrete Paving
12-inch Compacted Lime-Treated Subgrade
or
11-inch Reinforced Concrete Paving
4-inch Compacted Asphalt-Treated Base

An alternative to complete replacement is to provide remediation of the loss of support under the panels and a concrete pavement overlay. Loss of support may be remediated by removal and replacement of the ends of the panels (with appropriate subgrade conditioning and compaction) or by selective grouting under the ends of the panels. The concrete overlay should be jointed, reinforced concrete with a 9-inch overlay for 20-year life and a 10-inch overlay for 30-year life. This will require transition zones where the pavement has to meet existing grades at intersections, railroad tracks and other features.

In the event concrete is to be removed and replaced, after the soil surface in each area has been brought to grade, the performance of pavement can be enhanced by treating the clay soils exposed at grade with lime-slurry for use as sub-base. Subject to modification during construction, a lime content of six (6) percent by dry soil weight (approximately 6 pounds of lime per cubic foot of soil treated) would be expected to effectively treat the subgrade soil.

Soils treated with lime-slurry for use as sub-base should be compacted to a dry density at least 95 percent of the maximum dry density as defined by ASTM D 698 and at a moisture content at least 2 percentage points above Optimum Moisture content.

Good surface drainage and treatment of adjacent landscaping areas to control irrigation water are necessary to minimize moisture changes in the subgrade. We recommend that the irrigation water be collected in a drain along the median and the sidewalk on either side of the pavement, and directed into storm drains or Rawhide Creek, as permitted. Alternatively, a moisture barrier may be formed at the backside of the curb on both sides of the pavement. We recommend that such a barrier extend at least two feet below grade. All joints should be sealed and the sealant maintained throughout the lifetime of the pavement.

For reinforced concrete paving, it is essential that any and all reinforcing be placed so as to insure a minimum of $1^1/_2$-inches of cover. Selection of the proper section should be based on anticipated traffic loads, frequency and long term maintenance, as well as project economics.

EARTHWORK

Earthwork recommendations are as follow:

1. Excavate and waste, or store for future use, surficial organic, deleterious, and concrete materials encountered at the surface.

2. Scarify subgrade soils exposed in fill areas and transitional areas (cut to fill and fill to cut) to a depth of approximately eight (8) inches, add moisture (if required), mix and recompact to a density between 95 and 98 percent of maximum density obtained by a Standard Proctor Compaction Test (ASTM D 698). The moisture content of the compacted soils should be maintained between optimum and plus four percent of the optimum value (determined by ASTM D 698) until covered by fill or pavement.

3. Place fill soils for pavement in loose lifts not exceeding eight (8) inches and compact to the moisture/density values specified in No. 2 above.

4. We recommend that imported select fill material consist of inert sandy clay (material with greater than 50 percent passing the No. 200 mesh sieve) with a Liquid Limit less than 35 and a Plasticity Index between 6 and 15, or flexible base materials meeting the requirements of Texas Department of Transportation Item 247, Type 1, Grade A.

QUALIFICATIONS

In the event that any changes in the nature, design or location of the proposed pavement are planned, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and conclusions of this report modified or verified in writing.

The analyses and recommendations submitted in this report are based in part upon the data obtained from six borings. The nature and extent of subsurface variations at the site may not become evident until construction. If variations then appear evident, it may be necessary to reevaluate the recommendations of this report.

It is recommended that the soil and foundation engineer be provided the opportunity for general review of final design drawings and specifications in order that earthwork and foundation recommendations may be properly interpreted and implemented in the design drawings and specifications.

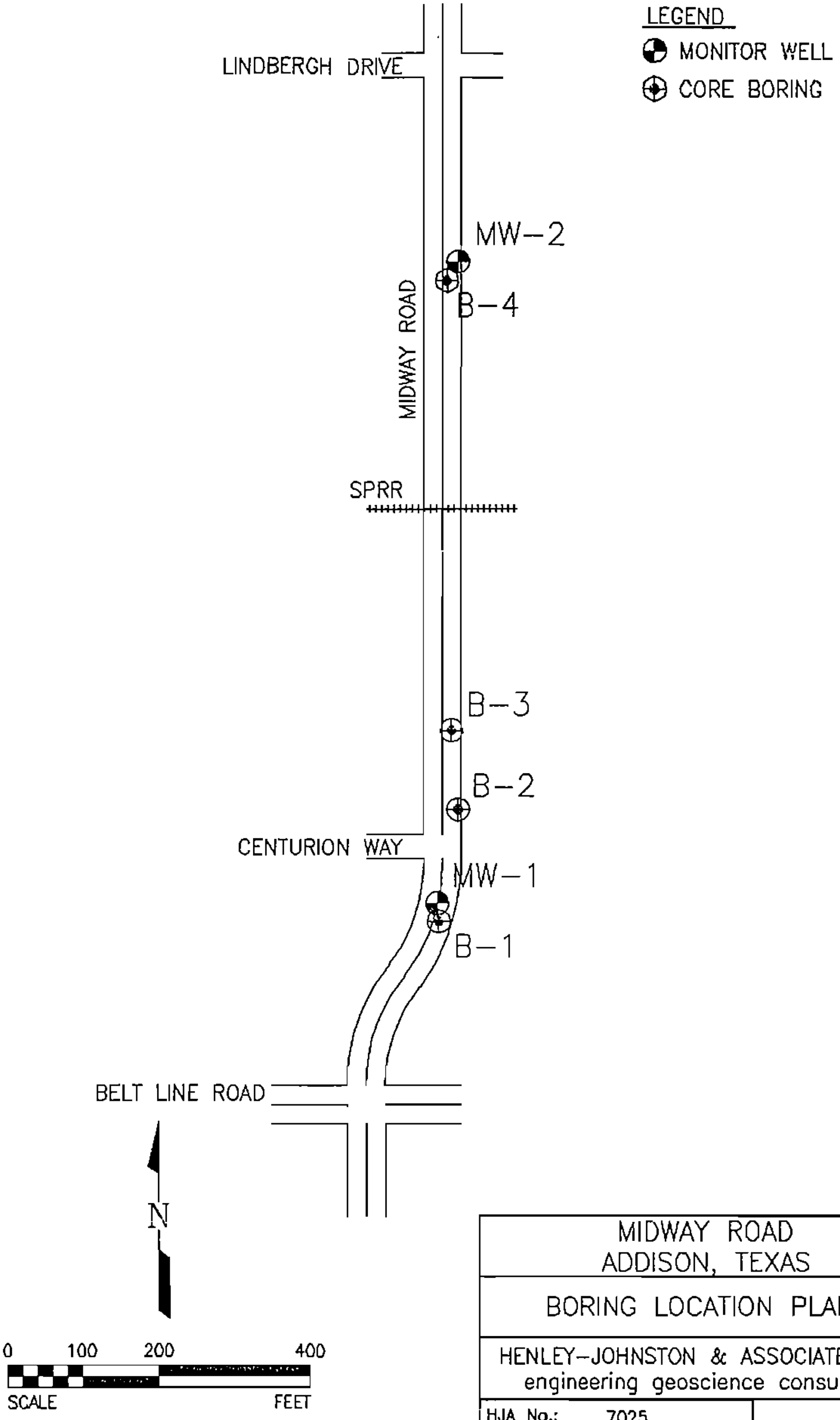
We appreciate the opportunity to work with you on this phase of the project. Please call us when we can be of further service during later stages of design or during construction.

STATE OF TEXAS
JOHN W. JOHNSTON
30968
REGISTERED
PROFESSIONAL ENGINEER

Respectfully submitted,

John W. Johnston, P.E.
Henley-Johnston & Associates, Inc.

JWJ
HJA No. 7025
9 September 1999



MIDWAY ROAD
ADDISON, TEXAS

BORING LOCATION PLAN

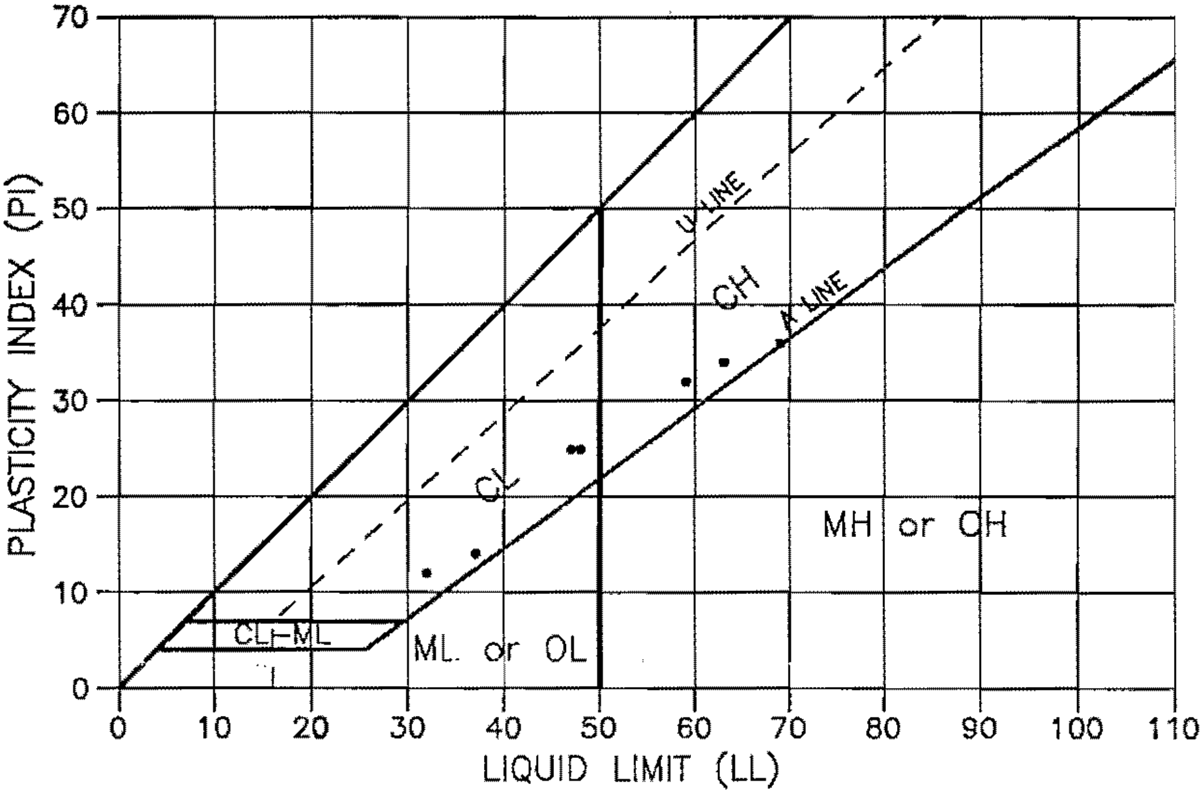
HENLEY-JOHNSTON & ASSOCIATES, INC.
engineering geoscience consultants

HJA No.: 7025	PLATE 1
DATE: SEPTEMBER 1999	

MIDWAY ROAD
BELT LINE ROAD TO LINDBERGH DRIVE
ADDISON, TEXAS

SUMMARY OF INDEX PROPERTIES

BORING NUMBER	DEPTH (ft.)	LL (%)	PI	MC (%)	DUW (pcf)	UNIFIED SOIL CLASSIFICATION
MW-1	0.0-1.8			15.9		
MW-1	1.8-2.5	48	25	19.0		CL
MW-1	2.5-4.0			16.3		
MW-1	9.0-10.0			17.2		
MW-1	14.0-15.0			17.6		
MW-1	19.0-20.0			17.4		
MW-2	0.6-2.2			40.4	79.1	
MW-2	2.2-3.8	69	36	39.3	79.0	CH
MW-2	3.8-5.0			23.1	103.2	
MW-2	9.0-10.0			15.3		
MW-2	14.0-15.0			11.9		
B-1	0.8-2.0	37	14	21.0	105.5	CL
B-1	2.0-3.5			16.6		
B-2	0.6-1.7	32	12	21.3		CL
B-2	1.7-3.5			14.3		
B-3	0.6-1.4			37.0		
B-3	1.4-2.2	59	32	29.6	101.4	CH
B-3	3.0-3.5	47	25	23.3		CL
B-4	0.6-1.3			23.7		
B-4	1.3-2.2	63	34	32.4	90.5	CH



SUMMARY OF ATTERBERG LIMITS

BORING NUMBER	SAMPLE DEPTH,ft.	LIQUID LIMIT	PLASTICITY INDEX	UNIFIED SOIL CLASSIFICATION
MW-1	1.8-2.5	48	25	CL
MW-2	2.2-3.8	69	36	CH
B-1	0.8-2.0	37	14	CL
B-2	0.6-1.7	32	12	CL
B-3	1.4-2.2	59	32	CH
B-3	3.0-3.5	47	25	CL
B-4	1.3-2.2	63	34	CH

MIDWAY ROAD
ADDISON, TEXAS

SUMMARY OF
ATTERBERG LIMITS

HENLEY-JOHNSTON & ASSOCIATES,INC.
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HJA NO.: 7025
DATE TESTED: 06/28/99

PLATE 3

MIDWAY ROAD
BELT LINE ROAD TO LINDBERGH DRIVE
ADDISON, TEXAS

SUMMARY OF LABORATORY TESTS ON CONCRETE CORE

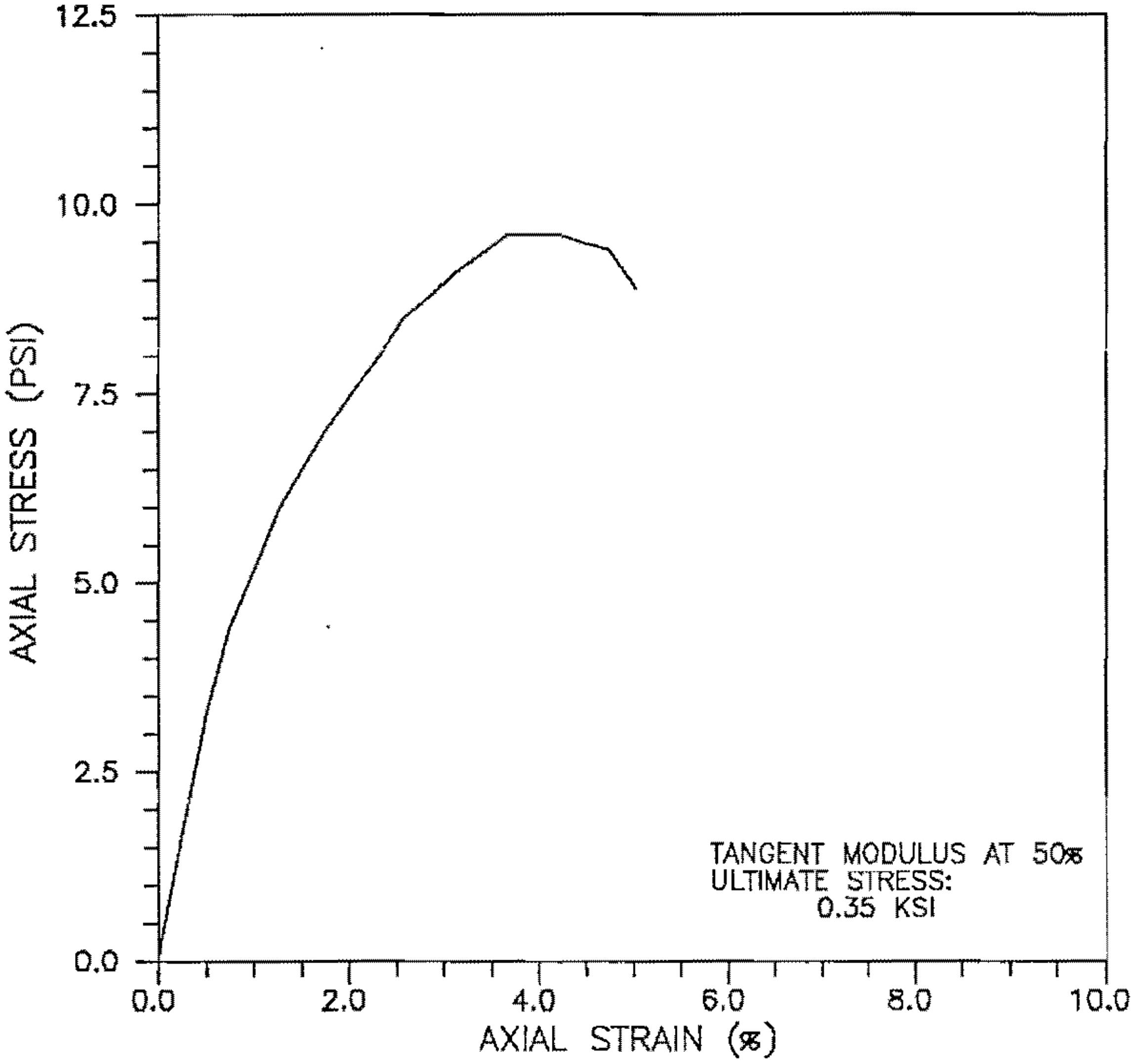
BORING NUMBER	PAVEMENT THICKNESS (in.)	SAMPLE HEIGHT (in.)	SAMPLE DIAMETER (in.)	COMPRESSIVE STRENGTH (psi)
MW-2	7.8	5.594	2.777	5018
B-1	8.4	5.679	2.775	5610
B-2	7.8	6.094	2.778	5378
B-3	7.8	5.502	2.773	5728
B-4	7.8	4.114	2.772	6060

MIDWAY ROAD
BELT LINE ROAD TO LINDBERGH DRIVE
ADDISON, TEXAS

SUMMARY OF LABORATORY STRENGTH TESTS

BORING NUMBER	DEPTH (ft.)	POCKET PENETROMETER (tsf)	PEAK STRESS (psi)	FAILURE STRAIN (%)	TANGENT MODULUS (ksi)	MATERIAL TYPE
MW-2	0.6-2.2	3.0	9.6	3.7	0.35	CLAY, slightly silty, dark gray
MW-2	2.2-3.8	3.0	16.0	12.0	0.15	CLAY, slightly silty, dark gray
MW-2	3.8-5.0	4.5+	15.2	4.7	0.46	CLAY, slightly silty, dark gray
B-1	0.8-2.0	3.5 (top) 4.5+ (bottom)	22.1	3.0	0.94	CLAY, silty, brown
B-2	0.6-1.7	4.5+				LIMESTONE, weathered, light brown, brown, and tan
B-3	1.4-2.2		35.1	2.6	2.78	CLAY, silty, dark brown (FILL)
B-3	2.2-2.6	4.5+				CLAY, silty, dark brown (FILL)
B-4	1.3-2.2	3.0	25.8	14.3	0.94	CLAY, slightly silty, dark gray
B-4	2.2-3.8	3.75				CLAY, slightly silty, dark gray

BORING NO.: MW-2
DEPTH (FT): 0.6-2.2
CLAY, slightly silty,
dark gray



TANGENT MODULUS AT 50%
ULTIMATE STRESS:
0.35 KSI

TEST TYPE: UNCONFINED COMPRESSION TEST
(ASTM D 2166)

MOISTURE CONTENT (%): 40.4
DRY UNIT WEIGHT (PCF): 79.1

MIDWAY ROAD
ADDISON, TEXAS

UNCONFINED COMPRESSION TEST
STRESS-STRAIN PLOT

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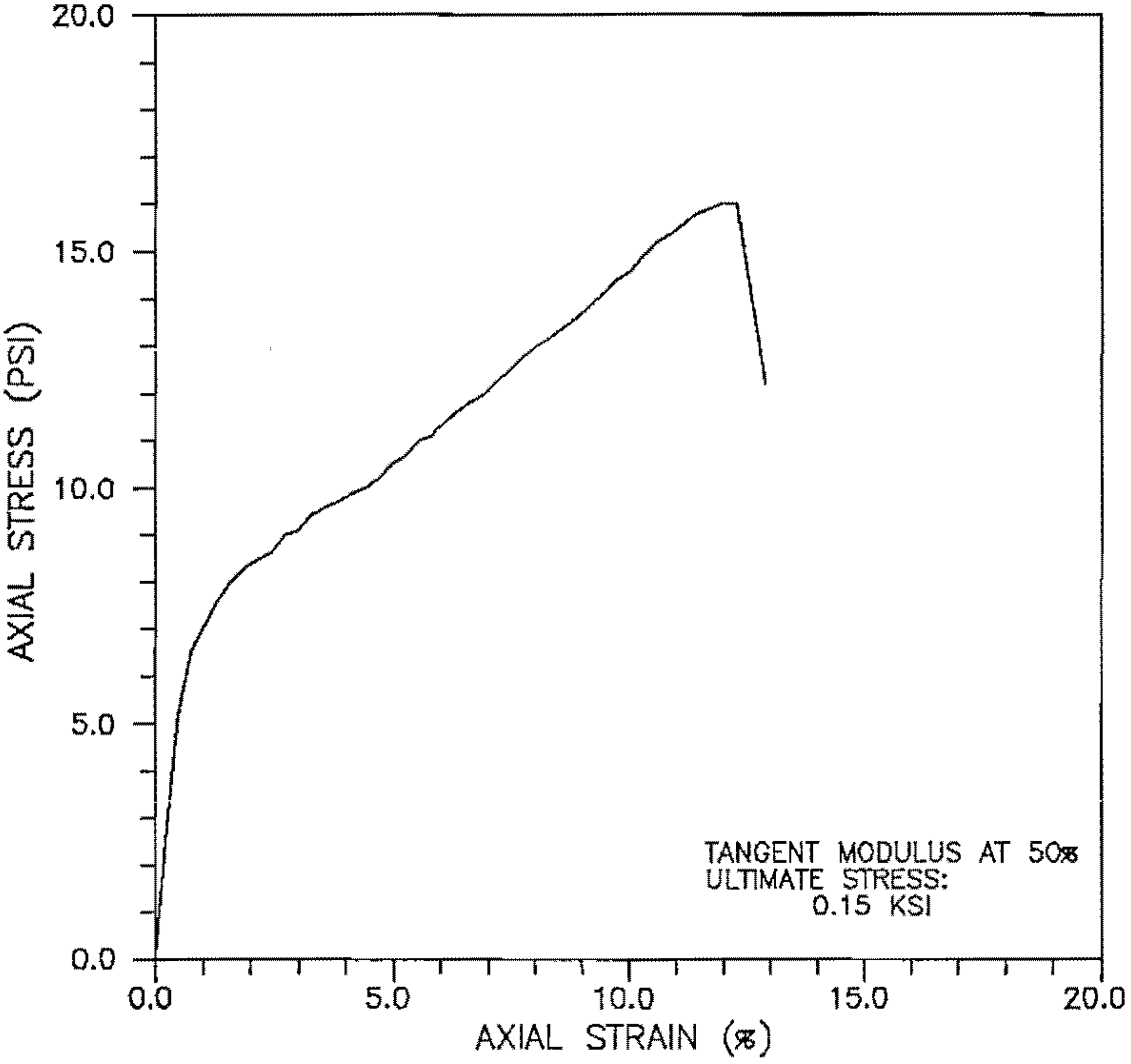
HJA NO.: 7025
DATE TESTED: 06/26/99

PLATE 6

BORING NO.: MW-2
DEPTH (FT): 2.2-3.8
CLAY, slightly silty,
dark gray



TANGENT MODULUS AT 50%
ULTIMATE STRESS:
0.15 KSI

TEST TYPE: UNCONFINED COMPRESSION TEST
(ASTM D 2166)

MOISTURE CONTENT (%): 39.3
DRY UNIT WEIGHT (PCF): 79.0

MIDWAY ROAD
ADDISON, TEXAS

UNCONFINED COMPRESSION TEST
STRESS-STRAIN PLOT

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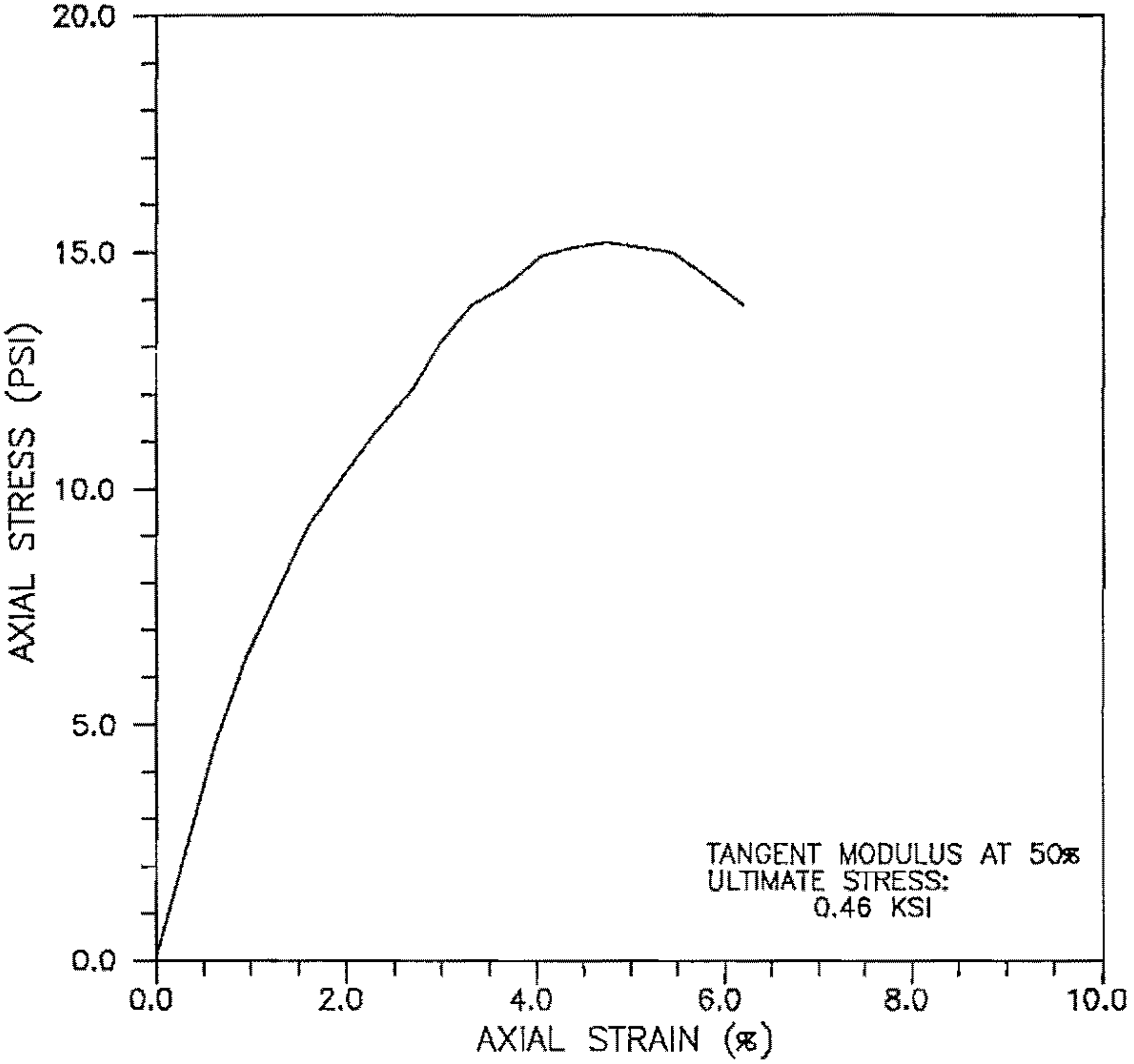
HJA NO.: 7025
DATE TESTED: 06/26/99

PLATE 7

BORING NO.: MW-2
DEPTH (FT): 3.8-5.0
CLAY, slightly silty,
dark gray



TEST TYPE: UNCONFINED COMPRESSION TEST
(ASTM D 2166)

MOISTURE CONTENT (%): 23.1
DRY UNIT WEIGHT (PCF): 103.2

MIDWAY ROAD
ADDISON, TEXAS

UNCONFINED COMPRESSION TEST
STRESS-STRAIN PLOT

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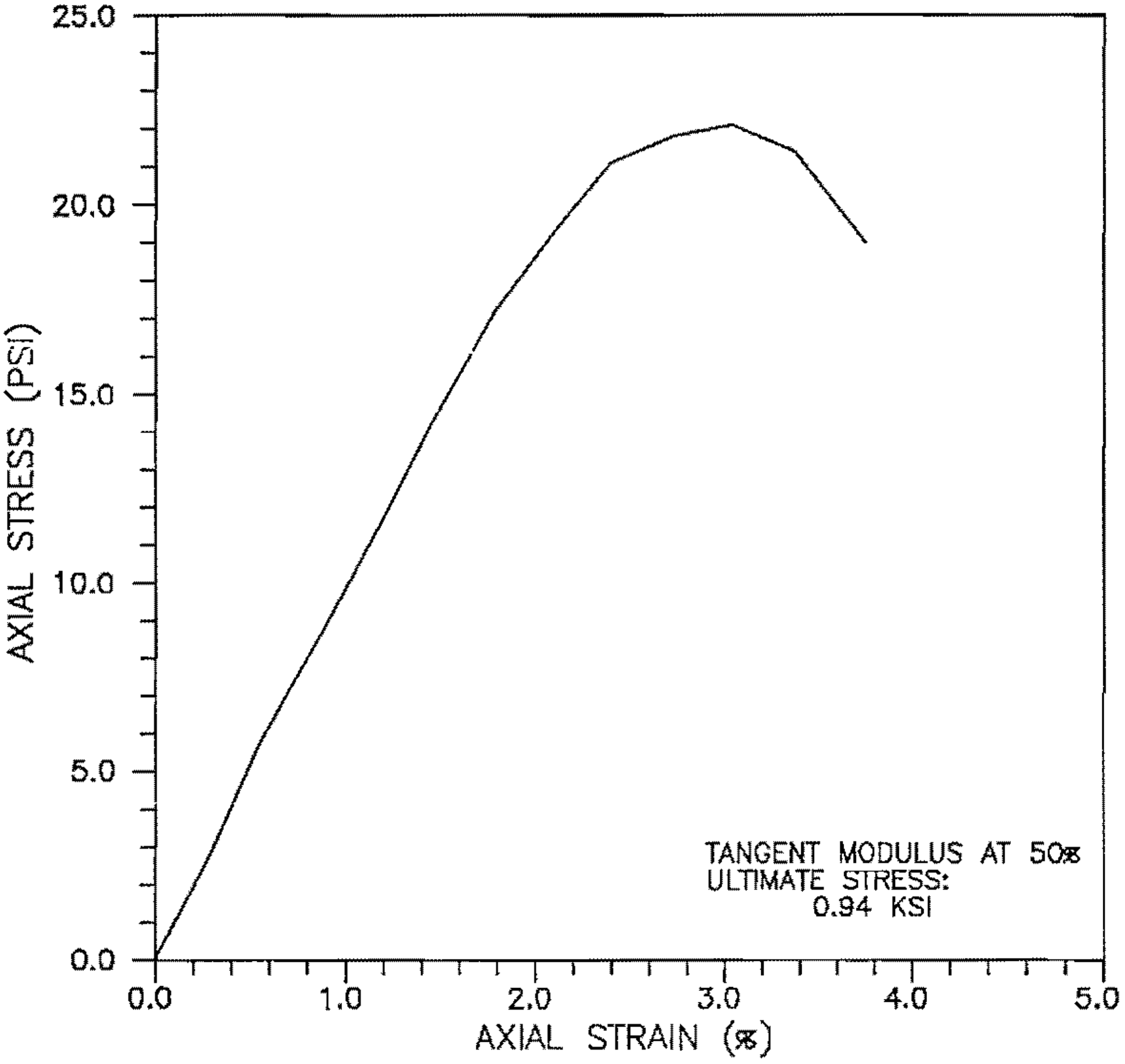
HJA NO.: 7025
DATE TESTED: 06/26/99

PLATE 8

BORING NO.: B-1
DEPTH (FT): 0.8-2.0
CLAY, silty, brown



TANGENT MODULUS AT 50% ULTIMATE STRESS:
0.94 KSI

TEST TYPE: UNCONFINED COMPRESSION TEST
(ASTM D 2166)

MOISTURE CONTENT (%): 21.0
DRY UNIT WEIGHT (PCF): 105.5

MIDWAY ROAD
ADDISON, TEXAS

UNCONFINED COMPRESSION TEST
STRESS-STRAIN PLOT

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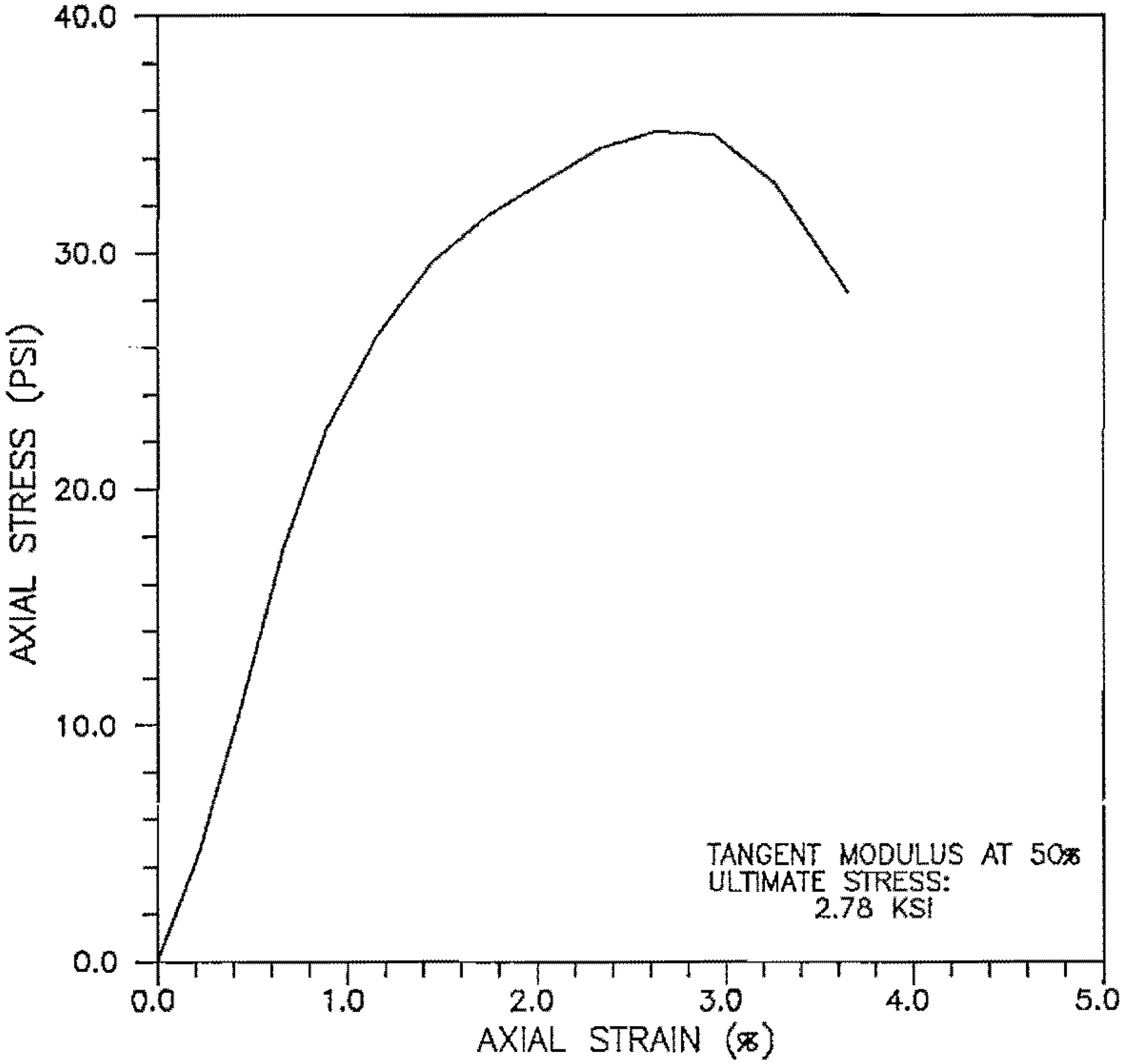
engineering geoscience consultants

HJA NO.: 7025
DATE TESTED: 06/26/99

PLATE 9

BORING NO.: B-3
DEPTH (FT): 1.4-2.2
CLAY, silty, dark brown
(FILL)



TANGENT MODULUS AT 50%
ULTIMATE STRESS:
2.78 KSI

TEST TYPE: UNCONFINED COMPRESSION TEST
(ASTM D 2166)

MOISTURE CONTENT (%): 29.6
DRY UNIT WEIGHT (PCF): 101.4

MIDWAY ROAD
ADDISON, TEXAS

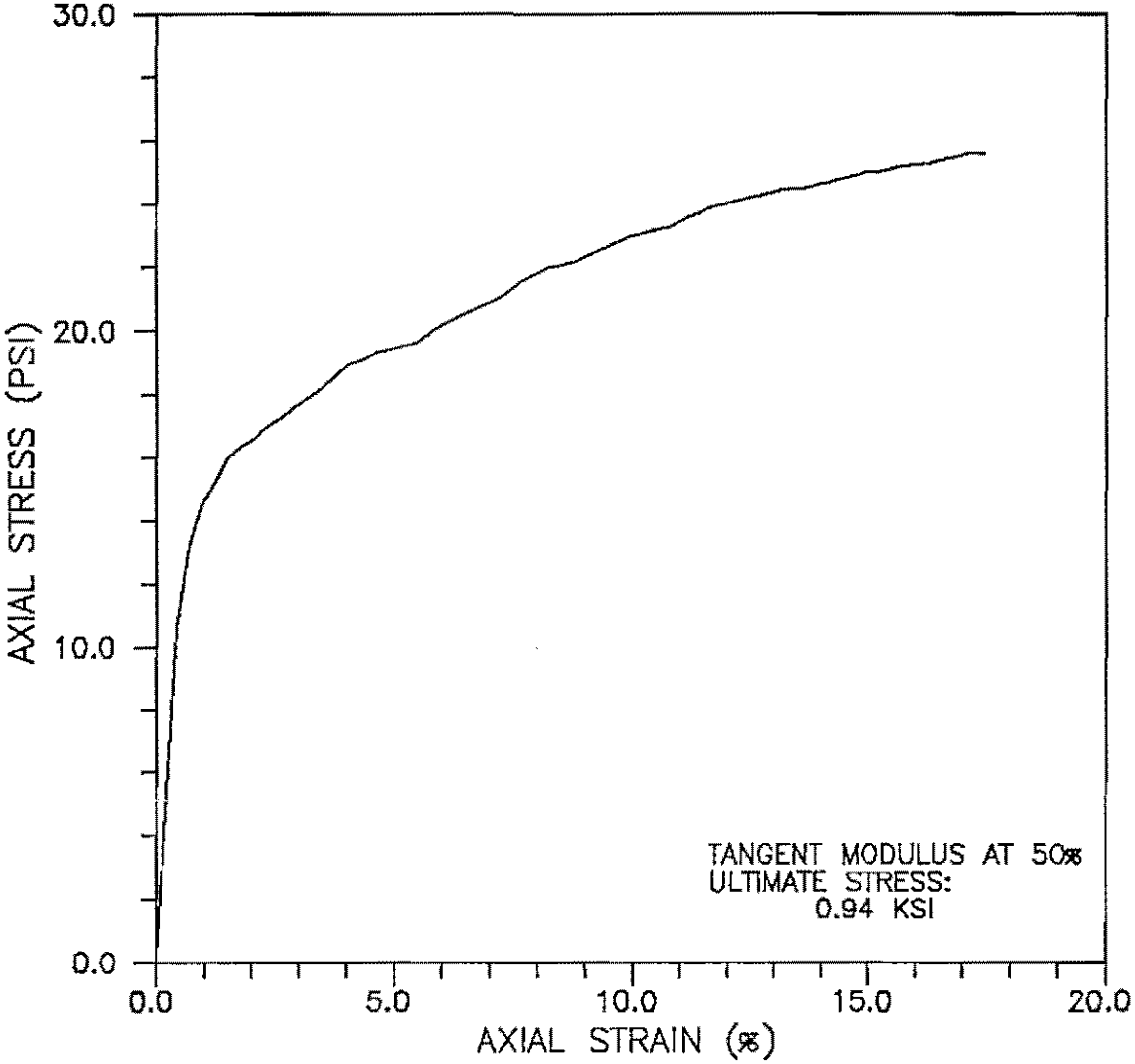
UNCONFINED COMPRESSION TEST
STRESS-STRAIN PLOT

HENLEY-JOHNSTON & ASSOCIATES,INC.
engineering geoscience consultants

HJA NO.: 7025
DATE TESTED: 06/26/99

PLATE 10

BORING NO.: B-4
DEPTH (FT): 1.3-2.2
CLAY, slightly silty,
dark gray



TANGENT MODULUS AT 50%
ULTIMATE STRESS:
0.94 KSI

TEST TYPE: UNCONFINED COMPRESSION TEST
(ASTM D 2166)

MOISTURE CONTENT (%): 32.4
DRY UNIT WEIGHT (PCF): 90.5

MIDWAY ROAD
ADDISON, TEXAS

UNCONFINED COMPRESSION TEST
STRESS-STRAIN PLOT

HENLEY-JOHNSTON & ASSOCIATES,INC.
engineering geoscience consultants

HJA NO.: 7025
DATE TESTED: 06/26/99

PLATE 11

SOUTHERN SPECTROGRAPHIC LABORATORY

P.O. BOX 153469
IRVING, TEXAS 75015-3469
TEL. (972) 986-1745
METRO (972) 399-1828
FAX (972) 399-1829

September 7, 1999

Henley Johnston & Associates, Inc.
Attn: John W. Johnston
235 Morgan Ave.
Dallas, Texas 75203-1088

Report#: 0737-28-160

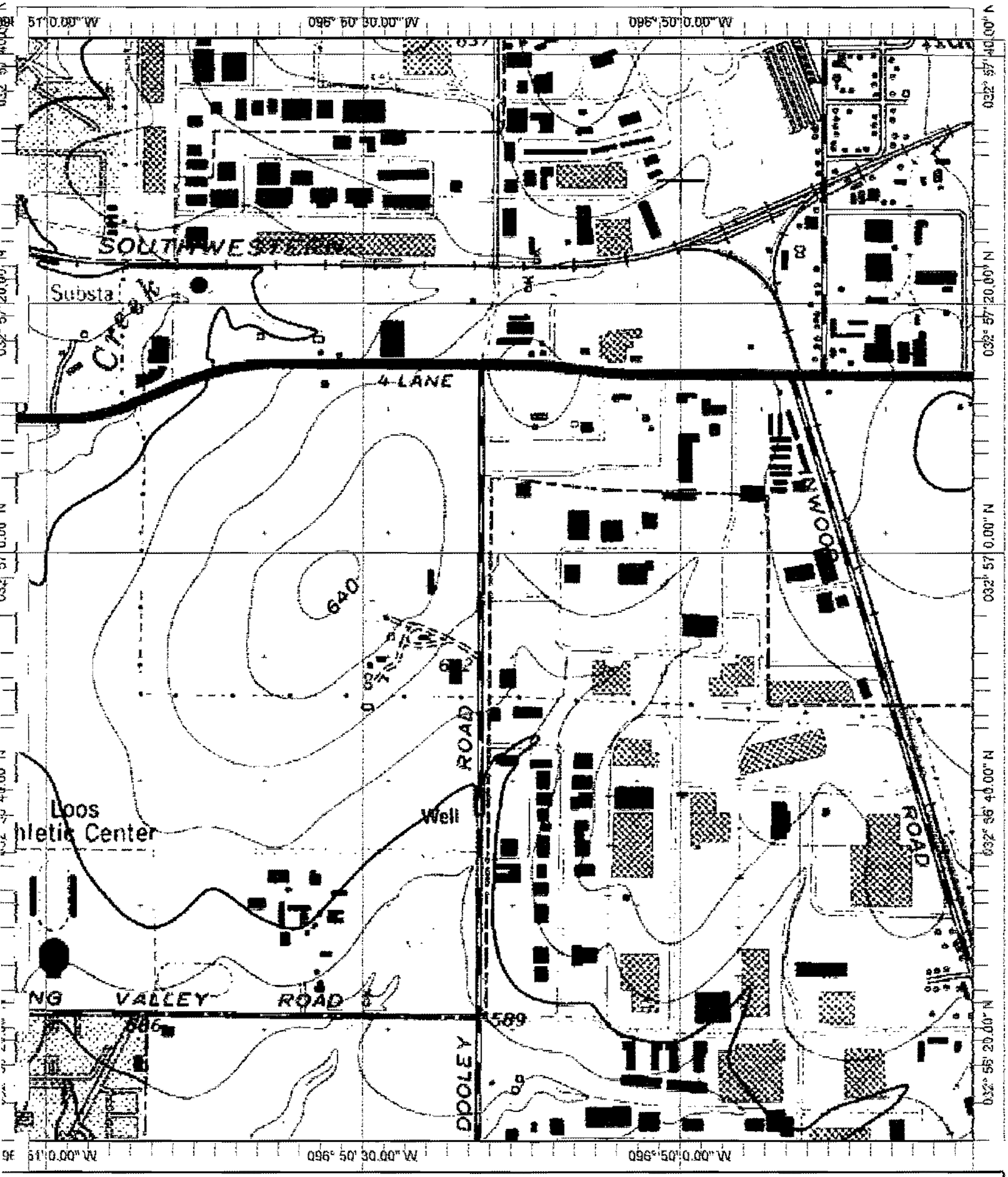
Re: Evaluation of water samples
Date Taken (7/28/99)

Sample ID	Mg/l					
	Sodium	Potassium	Chloride	Sulfate	Fluoride	Total Chlorine
7025 B-1 (0612)	19.1	15.3	17	48	0.6	< 0.1
7025 B-2 (0624)	17.8	9.0	21	56	0.4	< 0.1
7025 B-3 (0637)	17.7	4.0	17	53	1.0	< 0.1
7025 B-4 (0703)	15.5	6.7	19	37	0.4	< 0.1
7025 MW-1 (0600)	22.5	3.2	24	68	0.3	< 0.1
7025 MW-2 (0654)	168	5.0	17	351	0.8	< 0.1
Reference Tap Water	12.1	3.9	17	35	0.7	< 0.1

Comments

The above listed ion ratios indicate that the water in samples B-1, B-2, B-3, & B-4 are very similar to those of the tap water. MW-1 appears to be reasonably similar to the tap water with the possibility of some evaporative concentration and/or influence from residual soluble salts in the soil. Another sample from MW-1 may show a close match to the tap water. MW-2 appears to be majorly from a source other than tap water.

Gary Cude, CPC



Name: ADDISON
ate: 9/7/99
cale: 1 inch equals 1000 feet

Location: 032° 56' 57.2" N 096° 50' 17.5" W

PLATE 13

CLASSIFICATION SYMBOLS

SOIL	
	Asphalt or Lignite
	Concrete
	Fill
GW	Gravel or Sandy Gravel well graded
GP	Gravel or Sandy Gravel poorly graded
GM	Silty Gravel or Silty Sandy Gravel
GC	Clayey Gravel or Clayey Sandy Gravel
SW	Sand or Gravelly Sand well graded
SP	Sand or Gravelly Sand poorly graded
SM	Silty Sand or Silty Gravelly Sand
SC	Clayey Sand or Clayey Gravelly Sand
ML	Silts, Sandy Silts, Gravelly Silts, or Diatomaceous Soils
CL	Lean Clays, Sandy Clays, or Gravelly Clays
OL	Organic Silts or Lean Organic Clays
MH	Micaceous Clays or Diatomaceous Soil
CH	Fat Clays
OH	Fat Organic Clays
ROCK	
Ls	Limestone
Sh	Shale
	Marl
Ss	Sandstone
	Fracture Zone
	Weathered Zone

ABBREVIATIONS

abnt.	abundant
ang.	angular
aren.	arenaceous
arg.	argillaceous
bdd.	bedded
bdg.	bedding
bent.	bentonite
bldr.	boulder
BT	Brazil Tensile
calc.	calcareous
carb.	carbonaceous
cbl.	cobble
cgl.	conglomerate
clst.	claystone
cmt.	cemented
dia.	diameter
dk.	dark
DUW	Dry Unit Weight
El.	elevation
fossil.	fossiliferous
frac.	fracture
gyp.	gypsiferous
incl.	inclusion
intbdd.	interbedded
jnt.	joint
lam.	laminated
LL	Liquid Limit
lt.	light
MC	Moisture Content
ME	Modulus of Elasticity
med.	medium
min.	minutes
mod.	moderately
nod.	nodule
occ.	occasional
part.	particle
Pen.	Penetrometer
phos.	phosphatic
PI	Plasticity Index
py.	pyritized
Qu	Unconfined Compression
Rec.	recovery
rnd.	rounded
RQD	Rock Quality Designation
sat.	saturated
sept.	septarian
sev.	severely
sil.	siliceous
sli.	slightly
slk.	slickensided
T.D.	Total Depth
v.	very
wea.	weathered

CONSISTENCIES AND HARDNESS DESCRIPTIONS

FOR SANDS, GRAVELS, & SANDY SILTS

Peck, Hanson & Thornburn (1974)

Consistency	Standard Penetration Resistance N
Very Loose	Less than 4
Loose	4 to 10
Medium	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

FOR CLAYS & SANDY CLAYS

(COHESIVE SOILS)

Peck, Hanson, & Thornburn (1974)

Consistency	Unconfined Compression tsf	Standard Penetration Resistance N
Very Soft	Less than 0.25	Less than 2
Soft	0.25 to 0.5	2 to 4
Medium	0.5 to 1.0	4 to 8
Stiff	1.0 to 2.0	8 to 15
Very Stiff	2.0 to 4.0	15 to 30
Hard	Greater than 4.0	Greater than 30

RELATIVE HARDNESS MODIFERS (ROCK)

(RELATED TO FRESH SAMPLE)

Modified from SCS EWP. Tech Guide No. 4

Hardness	Rule of Thumb Test
Soft	Permits denting by moderate finger pressure
Firm	Resists denting by fingers but can be penetrated by pencil point to medium to shallow depth (No. 2 pencil)
Mod. Hard	Very shallow penetration of pencil point, can be scratched by knife and in some instances cut with knife
Hard	No pencil penetration, can be scratched with knife, can be broken by light to moderate hammer blows
Very Hard	Cannot be scratched by knife, can be broken by repeated heavy hammer blows

MIDWAY ROAD
ADDISON, TEXAS

LEGEND, LITHOLOGY, SOIL CONSISTENCY, & RELATIVE ROCK HARDNESS

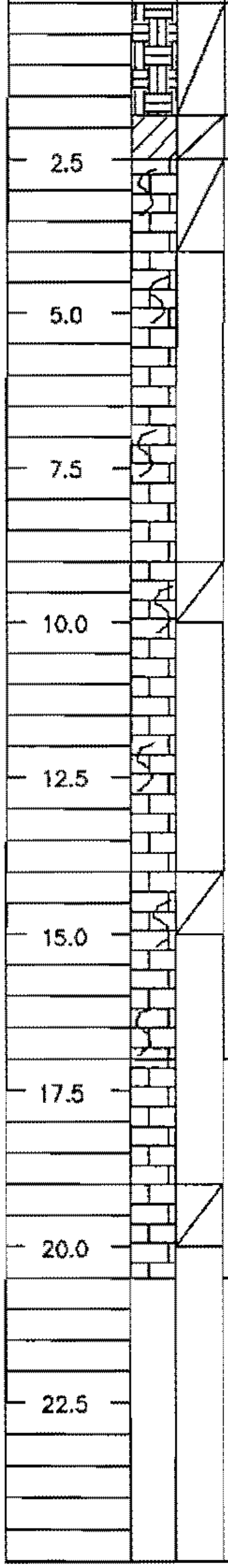
HENLEY–JOHNSTON & ASSOCIATES, INC.
engineering geoscience consultants

HJA No.: 7025

DATE: SEPTEMBER 1999

HENLEY-JOHNSTON & ASSOCIATES, INC. engineering geoscience consultants DRILL DATE: 06/19/99 METHOD: SHELBY TUBE /SPLIT SPOON TO 20.5'	LOG OF BORING / MONITOR WELL MIDWAY ROAD BELT LINE RD. TO LINDBERGH DR. ADDISON, TEXAS	PROJECT No.: 7025 BORING No.: MW-1 SHEET 1 of 1 LOCATION: SEE PLATE 1 GROUND ELEVATION:

DEPTH (feet)	SYMBOL	SAMPLES	MATERIAL DESCRIPTION	ELEVATION, (feet)	WELL INSTALLATION	COMMENTS



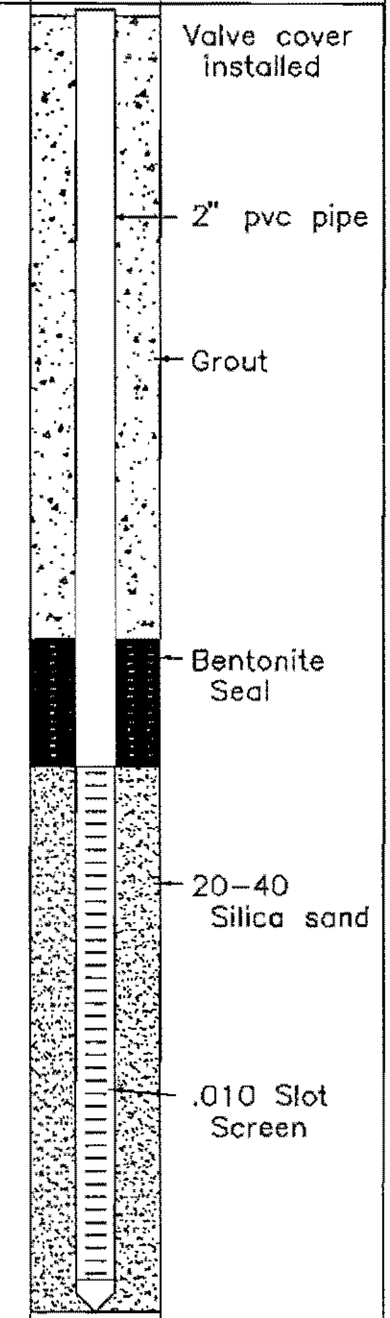
CLAY, silty, with calcareous nodules, weathered limestone fragments, and organics, very stiff, dark brown and brown (FILL)

CLAY, silty, with occasional calcareous nodules, very stiff, brown

LIMESTONE, moderately to severely weathered, with occasional soft clayey seams, firm to moderately hard, light brown, brown, and tan

LIMESTONE, moderately hard to hard, gray

TOTAL DEPTH: 20.5'

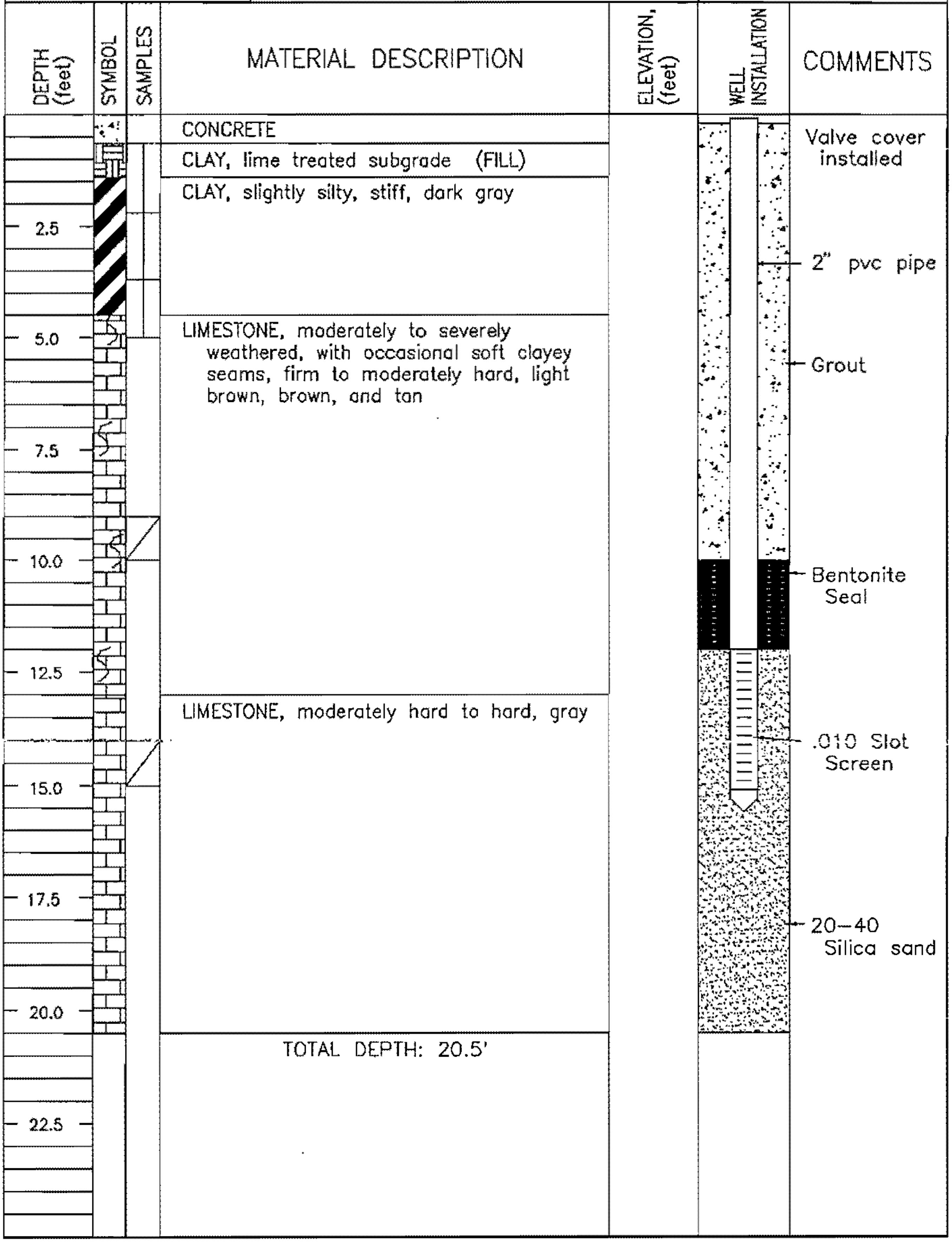


HENLEY-JOHNSTON & ASSOCIATES, INC.
engineering geoscience consultants

DRILL DATE: 06/19/99
METHOD: SHELBY TUBE /SPLIT SPOON TO 20.5'

LOG OF BORING / MONITOR WELL
MIDWAY ROAD
BELT LINE RD. TO LINDBERGH DR.
ADDISON, TEXAS

PROJECT No.: 7025
BORING No.: MW-2
SHEET 1 of 1
LOCATION: SEE PLATE 1
GROUND ELEVATION:



CONCRETE

CLAY, lime treated subgrade (FILL)

CLAY, slightly silty, stiff, dark gray

LIMESTONE, moderately to severely weathered, with occasional soft clayey seams, firm to moderately hard, light brown, brown, and tan

LIMESTONE, moderately hard to hard, gray

TOTAL DEPTH: 20.5'

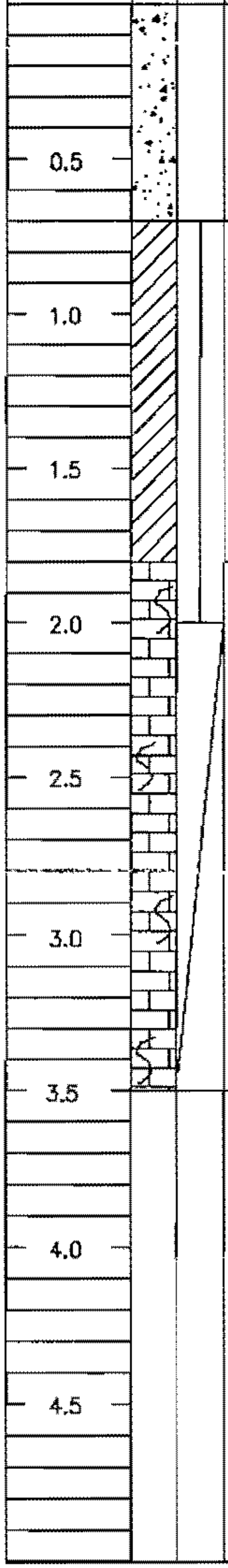
HENLEY-JOHNSTON & ASSOCIATES, INC.
engineering geoscience consultants

DRILL DATE: 06/19/99
METHOD: SHELBY TUBE /SPLIT SPOON TO 3.5'

LOG OF BORING / MONITOR WELL
MIDWAY ROAD
BELT LINE RD. TO LINDBERGH DR.
ADDISON, TEXAS

PROJECT No.: 7025
BORING No.: B-1
SHEET 1 of 1
LOCATION: SEE PLATE 1
GROUND ELEVATION:

DEPTH (feet) | SYMBOL | SAMPLES | MATERIAL DESCRIPTION | ELEVATION, (feet) | WELL INSTALLATION | COMMENTS

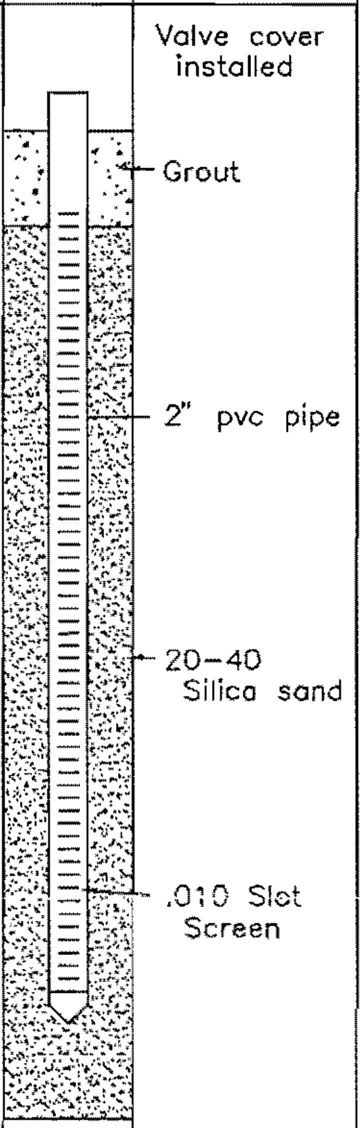


CONCRETE

CLAY, silty, with occasional calcareous nodules, very stiff, brown

LIMESTONE, moderately to severely weathered, with occasional soft clayey seams, firm to moderately hard, light brown, brown, and tan

TOTAL DEPTH: 3.5'



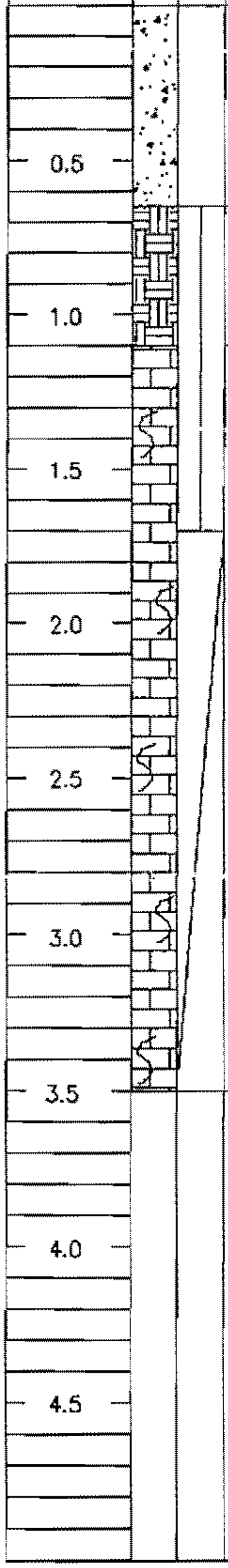
HENLEY-JOHNSTON & ASSOCIATES, INC.
engineering geoscience consultants

DRILL DATE: 06/19/99
METHOD: SHELBY TUBE /SPLIT SPOON TO 3.5'

LOG OF BORING / MONITOR WELL
MIDWAY ROAD
BELT LINE RD. TO LINDBERGH DR.
ADDISON, TEXAS

PROJECT No.: 7025
BORING No.: B-2
SHEET 1 of 1
LOCATION: SEE PLATE 1
GROUND ELEVATION:

DEPTH (feet)	SYMBOL	SAMPLES	MATERIAL DESCRIPTION	ELEVATION, (feet)	WELL INSTALLATION	COMMENTS

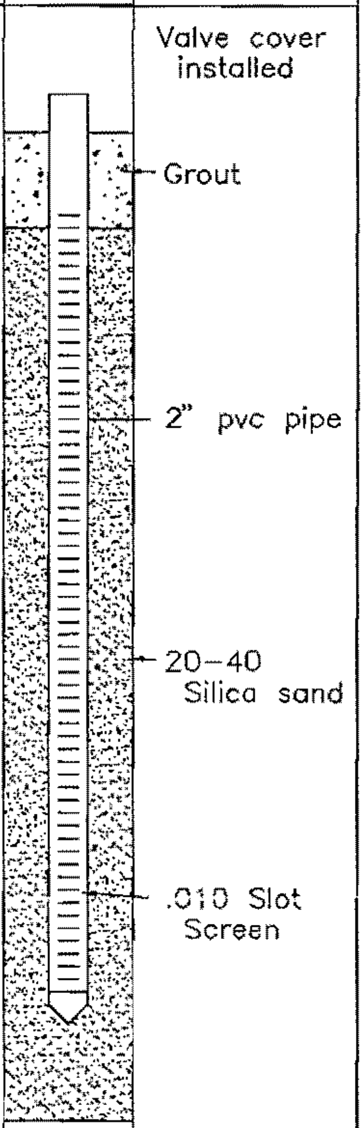


CONCRETE

CLAY, silty, with calcareous nodules and weathered limestone fragments, stiff, dark brown and brown (FILL)

LIMESTONE, moderately to severely weathered, with occasional soft clayey seams, firm to moderately hard, light brown, brown, and tan

TOTAL DEPTH: 3.5'



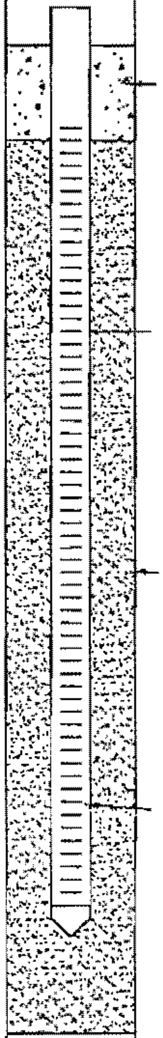
HENLEY-JOHNSTON & ASSOCIATES, INC.
engineering geoscience consultants

DRILL DATE: 06/19/99
METHOD: SHELBY TUBE /SPLIT SPOON TO 3.5'

LOG OF BORING / MONITOR WELL

MIDWAY ROAD
BELT LINE RD. TO LINDBERGH DR.
ADDISON, TEXAS

PROJECT No.: 7025
BORING No.: B-3
SHEET 1 of 1
LOCATION: SEE PLATE 1
GROUND ELEVATION:

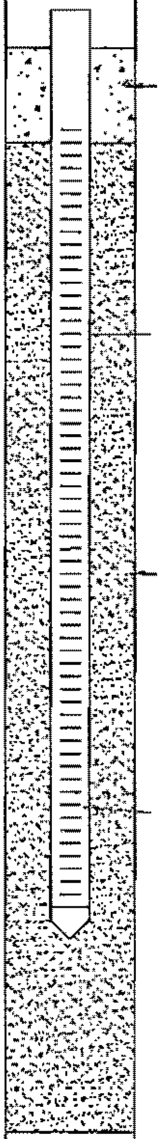
DEPTH (feet)	SYMBOL	SAMPLES	MATERIAL DESCRIPTION	ELEVATION, (feet)	WELL INSTALLATION	COMMENTS
0.5			CONCRETE NOTE: 1/2" VOID UNDER PAVEMENT			Valve cover installed Grout
1.0			CLAY, lime treated subgrade (FILL)			2" pvc pipe
1.5 2.0 2.5			CLAY, silty, with calcareous nodules, limestone fragments, and gravel, very stiff, dark brown (FILL)			20-40 Silica sand .010 Slot Screen
3.0			CLAY, silty, with occasional calcareous nodules, very stiff, brown			
3.5			TOTAL DEPTH: 3.5'			
4.0						
4.5						

HENLEY-JOHNSTON & ASSOCIATES, INC.
engineering geoscience consultants

DRILL DATE: 06/19/99
METHOD: SHELBY TUBE /SPLIT SPOON TO 3.8'

LOG OF BORING / MONITOR WELL
MIDWAY ROAD
BELT LINE RD. TO LINDBERGH DR.
ADDISON, TEXAS

PROJECT No.: 7025
BORING No.: B-4
SHEET 1 of 1
LOCATION: SEE PLATE 1
GROUND ELEVATION:

DEPTH (feet)	SYMBOL	SAMPLES	MATERIAL DESCRIPTION	ELEVATION, (feet)	WELL INSTALLATION	COMMENTS
			CONCRETE			Valve cover installed
0.5			NOTE: 1/2" VOID UNDER PAVEMENT			Grout
			CLAY, lime treated subgrade (FILL)			
1.0						
			CLAY, slightly silty, stiff to very stiff, dark gray			2" pvc pipe
1.5						
2.0						20-40 Silica sand
2.5						
						.010 Slot Screen
3.0						
3.5						
			TOTAL DEPTH: 3.8'			
4.0						
4.5						