GEOTECHNICAL INVESTIGATION REPORT
NEW HIGH SPEED TAXIWAY ON RUNWAY 3-21
AND TAXIWAY D REPAIRS
SAN ANTONIO INTERNATIONAL AIRPORT (SAT)
SAN ANTONIO, TEXAS

SUBMITTED TO
AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057-1599

BY
HVJ ASSOCIATES, INC.
OCTOBER 12, 2012

HVJ REPORT NO. AG 06 24041

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October 12, 2012

Mr. Guo-Pin Fuan, P.E.
AECOM
5757 Woodway
Houston, TX 77057-1599

Re: New High Speed Taxiway on Runway 3-21 and Taxiway D Repairs
Owner: City of San Antonio, Texas (COSA), San Antonio International Airport (SAT)
HVJ Project No: AG0624041

Dear Guo-Pin:

Submitted herein is the geotechnical data report of our geotechnical investigation for the above referenced project. The study was performed in accordance with HVJ proposal number AG0624041 dated October 24, 2011 (Revised November 29, 2011 and February 6, 2012).

It has been a pleasure to work for you on this project and we appreciate the opportunity to be of service. Please notify us if there are questions or if we may be of further assistance.

Sincerely,

HVJ ASSOCIATES, INC.
Texas Firm Registration No. F-000646

Jason Schwarz, P.E.
Project Manager

STATE OF TEXAS
JASON C. SCHWARZ
99343
LICENSED
PROFESSIONAL ENGINEER

10-12-12

The seal appearing on this document was authorized by Jason Schwarz, PE 99343 on October 12, 2012. Alteration of a sealed document without proper notification to the responsible engineer is an offense under the Texas Engineering Practice Act.

TABLE OF CONTENTS

Page

I. EXECUTIVE SUMMARY I

1 INTRODUCTION 1
1.1 General 1
1.2 Scope of Work 1

2 FIELD EXPLORATION 1
2.1 General 1
2.2 Sampling Methods and Field Testing 1
2.3 Borehole Completion 2

3 LABORATORY TESTING 2

4 SITE CHARACTERIZATION 3
4.1 General Geology 3
4.2 Subsurface Stratigraphy 3
4.3 Groundwater 5

5 LIMITATIONS 5

ILLUSTRATIONS

PLATE

SITE VICINITY MAP 1

GEOLOGY MAP 2

PLAN OF BORINGS 3

BORING LOGS ..... 4 - 7

KEY TO SYMBOLS ..... 8A & 8B

APPENDICES

APPENDIX

LABORATORY TEST RESULTS SUMMARY ..... A

I. EXECUTIVE SUMMARY

HVJ Associates, Inc. (HVJ) was retained by AECOM to perform a geotechnical investigation for the proposed new High Speed Taxiway on Runway 3-21 as well as proposed repairs to existing Taxiway D at the San Antonio International Airport, located just north of Loop 410 and east of US Highway 281, in San Antonio, TX.

A brief summary of the investigational findings and pertinent recommendations is as follows:

1. Four (4) borings, designated as B-5 through B-8, were drilled with truck-mounted equipment using dry auger and sampling techniques, at designated locations, to termination depths between approximately eight (8) ten and (10) feet below grade. The concrete on Taxiway D was cored using a portable coring rig.

2. The existing concrete thickness on Taxiway D ranged between approximately fourteen (14) and nineteen (19) inches and was underlain by twelve (12) to sixteen (16) inches of cement treated base. Table 1 provides data for the pavement and base/fill thicknesses.

Table 1 – Concrete and Base Thickness

Boring No.	Concrete Thickness (inches)	Approximate Base Thickness (inches)
B-7	19	12
B-8	14	16

3. Groundwater was not encountered in any of the project borings during drilling operations. Please note that groundwater levels may fluctuate seasonally, in response to changing climatic conditions. Perched groundwater conditions may also exist at the interface between soil and bedrock.

4. The subsurface soil encountered in B-5 and B-6, the proposed high speed taxiway borings, consisted of fat clay fill material ranging between four and a half (4½) and ten (10) feet in thickness. The fill material in boring B-5 was underlain by residual soil classifying mainly as gravels. Beneath the base material in the Taxiway D borings, B-7 and B-8, was approximately six (6) inches of gravelly lean clay fill material, underlain by approximately three and a half (3½) feet of residual soils classifying as clayey gravel. Moderately to highly weathered Limestone from the Pecan Gap Chalk formation was encountered in both of the borings at approximately six and half (6½) feet below grade.

5. A maximum Potential Vertical Rise (PVR) of 4.5 inches is evaluated based on laboratory test data and according to test method TEX-124-E. This PVR was evaluated on the top 10 feet of the soil layer based on borings B-5 and B-6.

Please note that this executive summary does not fully relate our findings and opinions. These findings and opinions are only presented through the full report.

1 INTRODUCTION

1.1 General

HVJ Associates, Inc. (HVJ) was retained by AECOM to perform a geotechnical investigation for the proposed new High Speed Taxiway on Runway 3-21 as well as proposed repairs to existing Taxiway D at the San Antonio International Airport, located just north of Loop 410 and east of US Highway 281, in San Antonio, TX.

1.2 Scope of Work

HVJ's scope of work is to provide information on subsurface conditions at the locations of the proposed high speed taxiway and the proposed Taxiway D repairs, determine existing concrete and base material thicknesses on Taxiway D, and evaluate potential vertical rise of expansive soils.

The primary objective of this study was accomplished by:

1. Drilling four (4) borings to termination depths between approximately eight (8) ten and (10) feet to determine existing concrete thickness and characteristics of the subsurface stratigraphy and to obtain samples for laboratory testing; and

2. Performing laboratory tests to determine physical and engineering characteristics of the soils and bedrock material encountered;

3. Determination of Potential Vertical Rise (PVR) based on laboratory tests and TEX-124-E Method.

Subsequent sections of this report contain descriptions of the subsurface exploration, laboratory testing program, and subsurface conditions. If should be noted, pavement design was not part of our scope of work.

2 FIELD EXPLORATION

2.1 General

The field exploration program undertaken for the project was conducted on April 16, 2012, with a representative from AECOM present. The four (4) project borings, B-5 through B-8, were advanced with a truck mounted drill rig equipped with soil sampling and dry auger equipment. Borings B-7 and B-8, on Taxiway D, were first cored with a portable coring rig to determine the concrete thickness. Termination depths for the borings ranged between approximately eight (8) and ten (10) feet below grade. Approximate boring locations are provided in the Plan of Borings, Plate 3.

The final boring logs are presented on Plates 4 through 7, with a key to terms and symbols used provided on Plates 8A and 8B.

2.2 Sampling Methods and Field Testing

Fine grained, cohesive soils encountered were sampled using a 3-inch diameter thin-walled tube, which was pushed into the soil in general accordance with ASTM standard D 1587- *Thin Walled Tube Sampling of Soils*. The samples were extruded in the field and a calibrated pocket penetrometer was used to obtain an estimate of the unconfined compressive strength of the sample.

Standard Penetration Tests (SPTs) were conducted in non-cohesive soils within the soil strata. The SPTs were performed in general accordance with ASTM D 1586 – *Penetration Test and Split-Barrel Sampling of Soils*. This procedure consisted of driving a standardized 1-5/8 inch diameter split-spoon sampler into undisturbed soil with a 140-pound hammer falling 30 inches. The split-spoon sampler was first seated 6 inches to penetrate any loose cuttings and was then driven an additional 12 inches with blows from the hammer. The number of hammer blows required to drive the sampler each 6-inch increment was recorded. The penetration resistance, or "N-value", is defined as the number of hammer blows required to drive the sampler the final 12 inches and was used in the field to estimate the density of granular soils or the consistency of cohesive soils. In very dense material the SPT test was typically stopped after 50 blows from the hammer and the measurement was recorded as 50 blows per distance penetrated (e.g. 50 over 3 inches).

Classification and field test results for both the thin-walled tube and split-spoon samples were recorded onto field logs, which included a visual description in accordance with ASTM D 2488 – *Description and Identification of Soils*. A preliminary soil classification was also assigned to each sample based on ASTM D 2487 – *Classification of Soil for Engineering Purposes.* After field documentation and logging was complete, the individual soil samples were either wrapped in plastic or placed in sealed containers to prevent loss of moisture and were transported to our laboratory for further examination and testing.

2.3 Borehole Completion

All project borings were backfilled with soil cuttings and bentonite chips, as required. Borings B-7 and B-8 were topped with a quick setting, non-shrink grout to match the existing concrete thickness and surface elevation, upon completion of drilling.

3 LABORATORY TESTING

Soil samples transported to our laboratory were further examined and described in accordance with ASTM D 2488 – *Description and Identification of Soils*. A preliminary soil classification was assigned to each soil sample based on ASTM D 2487 – *Classification of Soil for Engineering Purposes.*

Classification testing, which included moisture contents, Atterberg limits, and percent passing the No. 200 sieve, was subsequently conducted on select samples. In addition, unconfined compressive strength tests with wet and dry unit weight determinations were performed on select soil samples from the foundation boring. All testing was performed in accordance with the relevant ASTM Standards. The results of these tests were used to confirm or modify the preliminary soil classifications.

<u>Atterberg Limits</u>

Select samples were tested to determine the Atterberg Limits in accordance with ASTM D4318-10. The Atterberg Limit test is used to classify the soil using the Unified Soil Classification System (USCS). The Atterberg Limit test consists of two parts: a liquid limit test and a plastic limit test. The liquid limit equipment setup consists of a brass cup partially filled with soil which is grooved with a specialized grooving tool, and then dropped freely from a specified height to the rubber base below at a constant rate of 2 drops per second. The liquid limit test is performed on soil that has been sieved through the No. 40 sieve and brought to a moisture content that would close the ½-inch groove within 20 to 30 blows for two consecutive tests. The moisture content of the soil is then measured and recorded as the liquid limit. The second part of the tests consists of a rolling a remolded sample between the tips of the fingers and a glass plate until transverse cracks appear at a rolled diameter of 1/8-inch. The moisture content of the rolled sample is taken and recorded as the plastic limit.

Percent Passing the No. 200 Sieve

Select soil samples were tested in accordance with ASTM D1140-00 to determine the amount of material finer than the No. 200 sieve for use in classification. An oven dried sample of material is weighed then washed over a 75-µm (No. 200) sieve, allowing clay and other particles to be dispersed and removed from the soil. The retained material is oven dried then reweighed. The loss in mass resulting from the washing is calculated as mass percent of the original sample and is reported as the percentage of material finer than a No. 200 sieve.

Moisture Content

Moisture content testing was performed on select soil samples to determine the in situ state of moisture of the soil. A fresh sample was weighed before being placed in an oven with a controlled temperature of 230°F and dried back to a constant mass. Upon the drying and reweighing of the sample, the total mass of water lost was recorded. The ratio of the water loss to the dried mass is recorded as the moisture content. This test was performed in accordance with ASTM D2216-10.

The sampling information obtained in the field was used in conjunction with the laboratory examination and testing to generate final boring logs, provided on Plates 4 through 7. A Key of Terms and Symbols for the boring logs is provided on Plates 8A and 8B. The laboratory test results are provided on the final borings logs, as well as tabulated in Appendix A.

4 SITE CHARACTERIZATION

4.1 General Geology

According to the Geologic Atlas of Texas, San Antonio Sheet (University of Texas Bureau of Economic Geology, 1974), the proposed project is located within an area characterized by the Leona Formation (Qle) and the Pecan Gap Chalk (Kpg). A geologic map of the project vicinity is provided on Plate 2.

The Leona Formation is comprised of fluviatile terrace deposits of gravel, sand, silt, and clay.

The Pecan Gap Chalk is a very light yellow to yellow, chalk and chalky marl, which ranges in thickness from 50 to 75 feet

San Antonio, TX is located within the Balcones Fault Zone, which is a group of faults that trends northeast/southwest across central Texas. According to available geologic data, there appears to be at least two faults mapped within the vicinity of the San Antonio International Airport.

4.2 Subsurface Stratigraphy

High Speed Taxiway on Runway 3-21

Soil and groundwater conditions along the project alignment described herein are based on information obtained at the boring locations only. Significant variations at areas not explored by the project borings may require reevaluation of our findings and conclusions. Subsurface soils as encountered at the boring locations are discussed below.

Borings B-5 and B-6 encountered between approximately four and a half (4½) and ten (10) feet of fill material classifying as fat clay and gravelly fat clay. The fill material in boring B-5 was underlain

by approximately five (5) feet of residuals soils that classified mainly as gravels with varying amounts of clay.

Laboratory test results for the soils encountered in borings B-5 and B-6 are summarized in Table 2 and Table 3 as well as presented in Appendix A and on the final boring logs, Plates 4 and 5.

Table 2 – High Speed Taxiway on Runway 3-21 – Fill

Laboratory Test	Average	Maximum	Minimum	Standard Deviation
Moisture Content (%)	23.6	27.9	18.1	5.0
Liquid Limit (%)	75	86	70	9
Plasticity Index (%)	50	58	45	7
% Passing No. 200 Sieve	81.1	89.6	64.9	14.1

Table 3 - High Speed Taxiway on Runway 3-21 – Residual Soil

Laboratory Test	Results
Moisture Content (%)	7.4
Liquid Limit (%)	43
Plasticity Index (%)	27
% Passing No. 200 Sieve	36.0

Taxiway D

The thickness of the existing concrete on Taxiway D, borings B-7 and B-8, was approximately nineteen (19) and fourteen (14) inches, respectively. The concrete was underlain by cement treated base material that extended to approximately two and a half (2½) feet below grade. Underlying the cement treated base was approximately six (6) inches of gravelly lean clay fill material, which extended to approximately three (3) feet below grade. A table of the concrete and base thicknesses is provided below.

Table 4 – Concrete and Base Thickness

Boring No.	Concrete Thickness (inches)	Approximate Base Thickness (inches)
B-7	19	12
B-8	14	16

Beneath the fill material, both borings encountered residuals soils classifying as clayey gravel, containing limestone flags, which extended from approximately three (3) feet to six and half (6½) feet below grade. These residuals soils are the result of weathering of underlying Pecan Gap Chalk limestone which was encountered at approximately six and half (6½) feet below grade and extended to the boring termination depths.

Laboratory test results for the soils encountered in borings B-7 and B-8 are summarized in Table 5 as well as presented in Appendix A and on the final boring logs, Plates 6 and 7.

Table 5 – Taxiway D

Laboratory Test	Average	Maximum	Minimum	Standard Deviation
Moisture Content (%)	7.4	9.2	6.4	1.6
Liquid Limit (%)	43	53	23	17
Plasticity Index (%)	24	34	9	13
% Passing No. 200 Sieve	22.5	29.4	15.2	7.1

4.3 Groundwater

Groundwater was not observed in any of the project borings during drilling operations. It should be noted, however, that groundwater levels may fluctuate seasonally, in response to changing climatic conditions. Perched groundwater conditions may also exist at the interface between soil and bedrock.

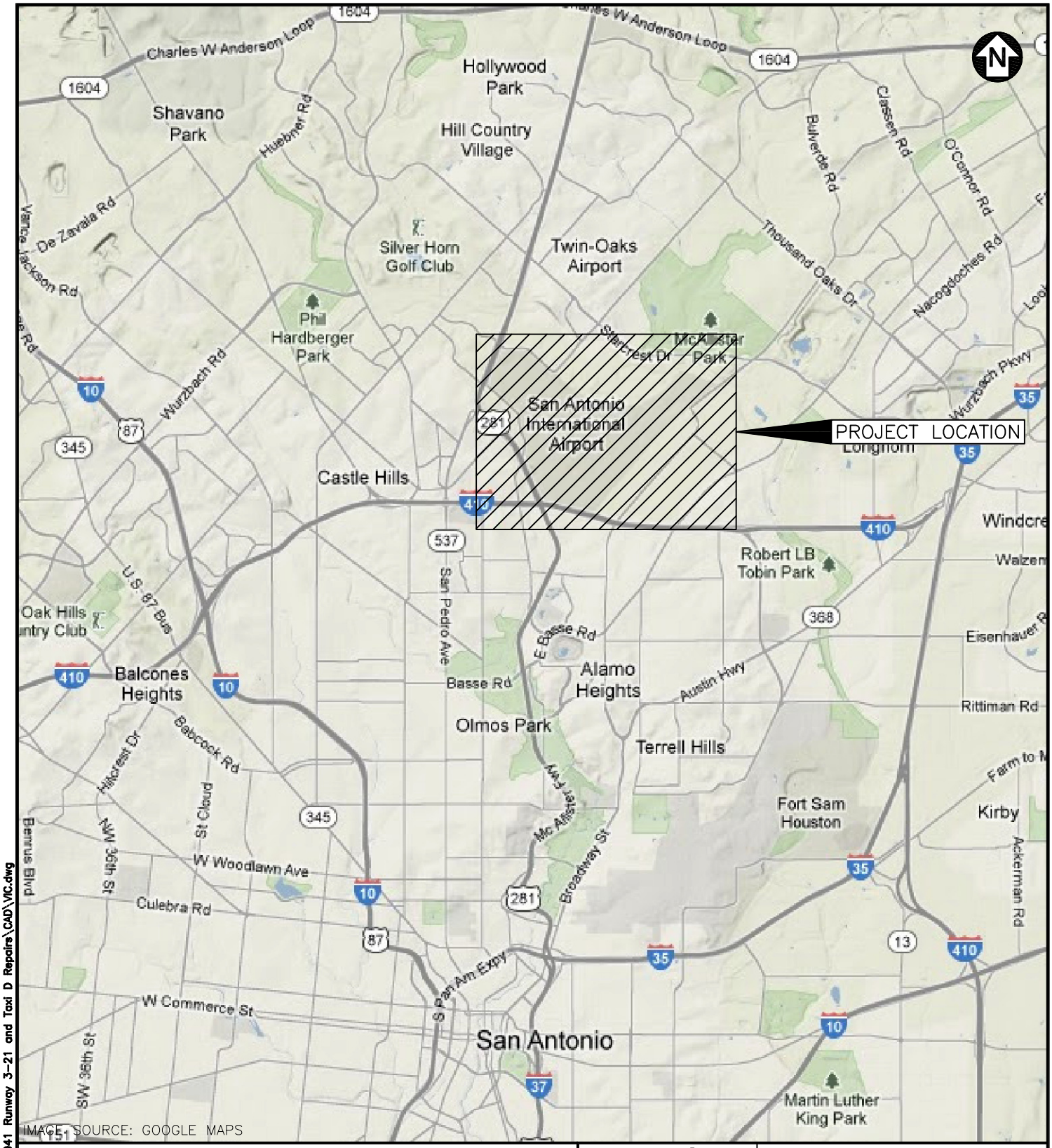
5 LIMITATIONS

This study was performed for the exclusive use of AECOM, Inc. for specific application to the New High Speed Taxiway on Runway 3-21 and Taxiway D Repairs project at San Antonio International Airport in Bexar County, Texas. HVJ Associates, Inc. has endeavored to comply with generally accepted geotechnical engineering practice common in the local area. HVJ Associates, Inc. makes no warranty, express or implied. Any analysis and recommendation contained in this report are based on data obtained from subsurface exploration, laboratory testing, project information provided to HVJ Associates, Inc., and HVJ Associates, Inc.'s experience with similar soils and site conditions.

The methods used indicate subsurface conditions only at the specific location where the single sample was obtained, only at the time it was obtained, and only to the depth penetrated. The sample cannot be relied on to accurately reflect the strata variations that usually exist at locations other than the sampling location. Should any subsurface conditions other than those described in the boring log be encountered, HVJ Associates, Inc. should be immediately notified so that further investigation and supplemental recommendations can be provided.

Subsurface conditions at the site can differ significantly from those encountered in the boring due to the placement of fill materials as well as natural variation of geologic conditions, which may not have been detected by the limited field boring program. In the event that any changes in the nature, design or location of the improvements are made, the conclusions and recommendations in this report should not be considered valid until the changes are reviewed and the conclusions and recommendations modified or verified in writing by HVJ Associates, Inc.

ILLUSTRATIONS



MAP LOCATION

HVJ ASSOCIATES

SCALE: N.T.S		
DATE: 04/04/2012		
DRAWN BY: JD	PROJ. CHK: JS	APPRV. BY: JS

SITE VICINITY MAP
NEW HIGH SPEED TAXI ON RUNWAY 3–21
AND TAXIWAY D REPAIRS
SAN ANTONIO, TX

PROJECT NO.: AG 06 24041	FILENAME: VIC	PLATE 1

DATE: 5/7/2012 10:35:19 AM
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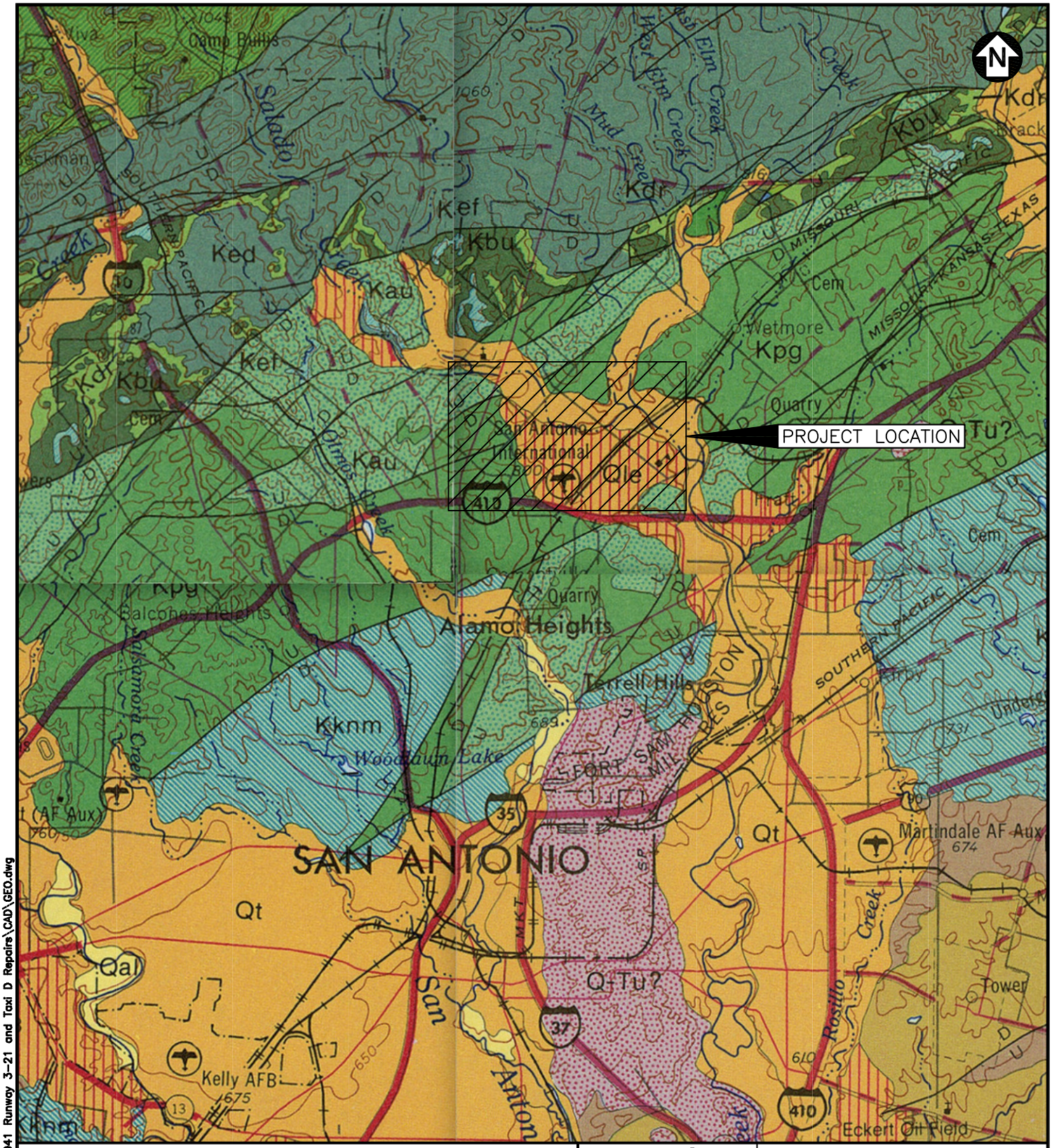

LEGEND

Qt	FLUVIATILE TERRACE DEPOSITS
Qle	LEONA FORMATION
Kpg	PECAN GAP CHALK
Kau	AUSTIN CHALK
Kbu	BUDA FORMATION

MAP LOCATION

HVJ ASSOCIATES

SCALE: N.T.S		
DATE: 05/02/2012		
DRAWN BY: JD	PROJ. CHK: JS	APPRV. BY: JS

GEOLOGY MAP
NEW HIGH SPEED TAXIWAY ON RUNWAY 3–21
AND TAXIWAY D REPAIRS
SAN ANTONIO INTERNATIONAL AIRPORT

PROJECT NO.: AG 06 24041	FILENAME: GEO	PLATE 2

DATE: 5/7/2012 10:32:30 AM
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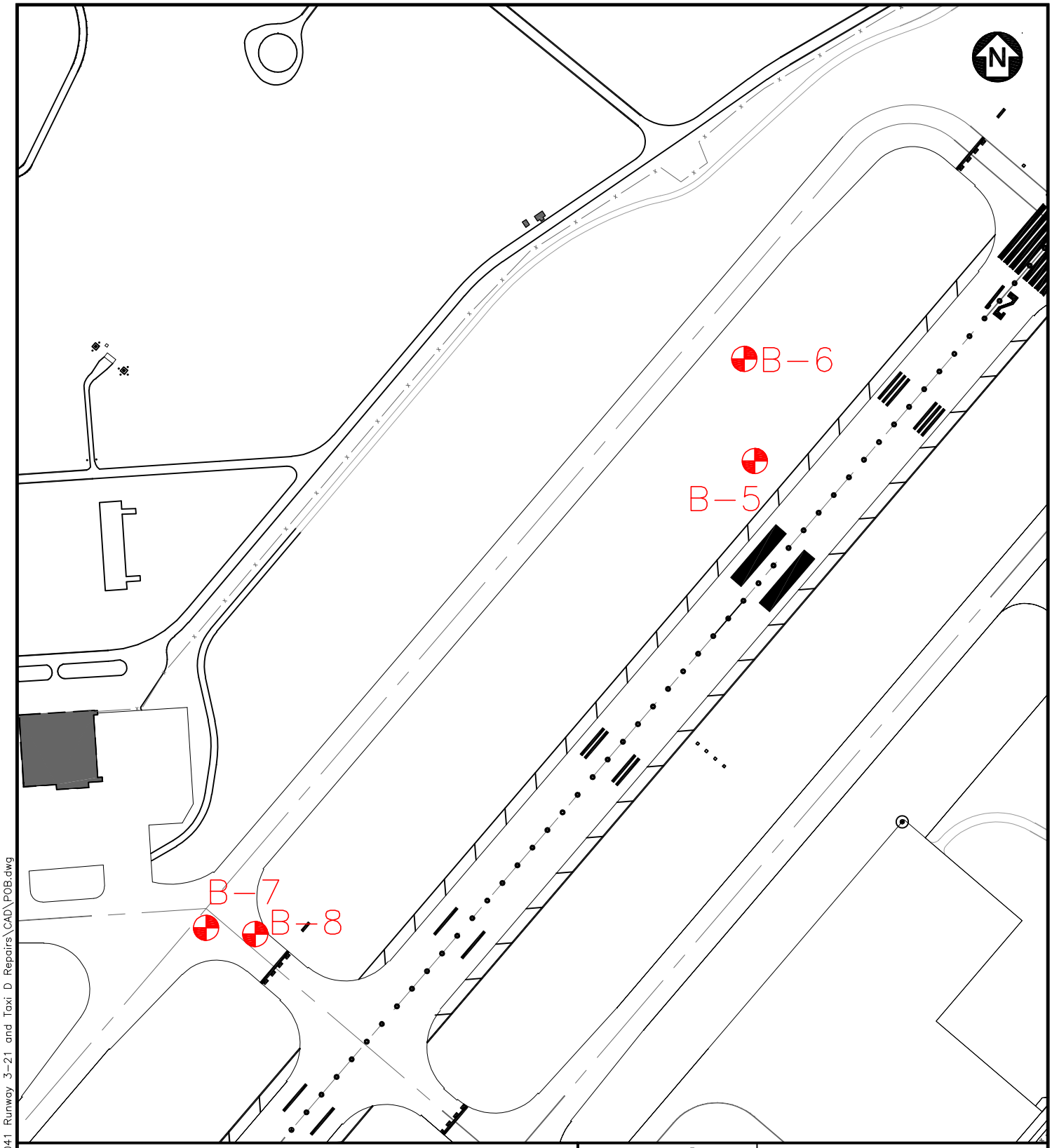

APPROXIMATE BORING LOCATION

MAP LOCATION

HVJ ASSOCIATES

SCALE: N.T.S		
DATE: 04/05/2012		
DRAWN BY: JD	PROJ. CHK: JS	APPRV. BY: JS

BORING LOCATION MAP
NEW HIGH SPEED TAXIWAY ON RUNWAY 3-21
AND TAXIWAY D REPAIRS
SAN ANTONIO, TX

PROJECT NO.: AG 06 24041	FILENAME: POB	PLATE 3

DATE: 5/7/2012 10:39:12 AM
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LOG OF BORING

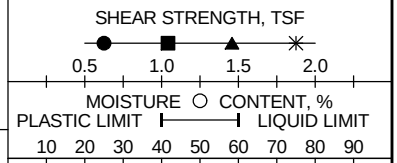
Project: New High Speed Taxiway on Runway 3-21 and Taxiway D Repairs | Project No.: AG 06 24041

Boring No.: B-5 | Date: 4/16/2012 | Elevation:

Groundwater during drilling: --- | Northing: -- | Station: --

Groundwater after drilling: --- | Easting: -- | Offset: --

ELEV. DEPTH, FEET	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	SOIL/ROCK CLASSIFICATION	% PASSING NO. 200 SIEVE	DRY DENSITY PCF
0	PP = 4.5+ tsf	Dark brown, very stiff to hard, **FAT CLAY (CH)**, with organics. (Fill)		
	PP = 2.75 tsf		90	
	PP = 4.5+ tsf	- 4" gravel layer at approximately 4' (Fill)		
	25-45-20	Gray to yellowish brown, very stiff, **LEAN CLAY (CL)**. (Residual soil)		
5		Gray, very dense, **WELL GRADED GRAVEL (GW)**. (Residual soil)		
	15-15-24	Gray to yellowish brown, dense to very dense, **CLAYEY GRAVEL (GC)**. (Residual soil)	36	
	28-50/6"			
10				



Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

PLATE 4

HVJ ASSOCIATES

LOG OF SOIL BORING LOGS.GPJ HVJ.GDT 10/12/12

LOG OF BORING

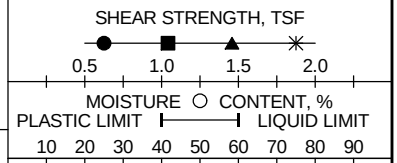
Project: New High Speed Taxiway on Runway 3-21 and Taxiway D Repairs | Project No.: AG 06 24041

Boring No.: B-6 | Date: 4/16/2012 | Elevation:

Groundwater during drilling: --- | Northing: -- | Station: --

Groundwater after drilling: --- | Easting: -- | Offset: --

ELEV. DEPTH, FEET	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	SOIL/ROCK CLASSIFICATION	% PASSING NO. 200 SIEVE	DRY DENSITY PCF
0	PP = 3.5 tsf	Dark brown, very stiff to hard, **FAT CLAY (CH)**. (Fill)		
		- with gravel and organics 0' - 2'		
	PP = 3.5 tsf		89	
	PP = 4.5+ tsf			
5				
	PP = 4.5+ tsf	Dark brown, hard, **GRAVELLY FAT CLAY (CH)**. (Fill)	65	
	PP = 4.5+ tsf			
		- tan at approximately 9.5'		
10				



Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

PLATE 5

HVJ ASSOCIATES

LOG OF SOIL BORING LOGS.GPJ HVJ.GDT 10/12/12

LOG OF BORING

Project: New High Speed Taxiway on Runway 3-21 and Taxiway D Repairs | Project No.: AG 06 24041

Boring No.: B-7 | Date: 4/16/2012 | Elevation:

Groundwater during drilling: --- | Northing: -- | Station: --

Groundwater after drilling: --- | Easting: -- | Offset: --

ELEV. DEPTH, FEET	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	SOIL/ROCK CLASSIFICATION	% PASSING NO. 200 SIEVE	DRY DENSITY PCF	SHEAR STRENGTH, TSF (0.5, 1.0, 1.5, 2.0) / MOISTURE ○ CONTENT, % (PLASTIC LIMIT — LIQUID LIMIT; 10 20 30 40 50 60 70 80 90)
0		19" **CONCRETE**			
		Approximately 12" **CEMENT TREATED BASE**			
		Gray, hard, **GRAVELLY LEAN CLAY (CL)**. (Fill)			
	50/0" 50/6"	Orangish brown, very dense, **CLAYEY GRAVEL (GC)**. (Residual soil)	23		○
5	40-50/6"	- with limestone flags 3' - 6.5'			
		Orangish brown, soft, moderately to highly weathered, **LIMESTONE**. (Pecan Gap Chalk)			
	50/3"				
10					

Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

PLATE 6

HVJ ASSOCIATES

LOG OF SOIL BORING LOGS.GPJ HVJ.GDT 10/12/12

LOG OF BORING

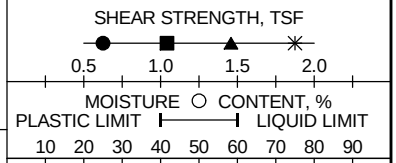
Project: New High Speed Taxiway on Runway 3-21 and Taxiway D Repairs | Project No.: AG 06 24041

Boring No.: B-8 | Date: 4/16/2012 | Elevation:

Groundwater during drilling: --- | Northing: -- | Station: --

Groundwater after drilling: --- | Easting: -- | Offset: --

ELEV. DEPTH, FEET	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	SOIL/ROCK CLASSIFICATION	% PASSING NO. 200 SIEVE	DRY DENSITY PCF
0		14" **CONCRETE**		
		Approximately 16" **CEMENT TREATED BASE**		
		Gray, **GRAVELLY LEAN CLAY (CL)**. (Fill)	29	
	22-28-40	Orangish brown, very dense, **CLAYEY GRAVEL (GC)**. (Residual soil)		
	33-37-30/3.5"		15	
5		- with limestone flags 3' - 6.5'		
	42-50/2"	Orangish brown, soft, moderately to highly weathered, **LIMESTONE**. (Pecan Gap Chalk)		
	50/1			
10				



Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

PLATE 7

HVJ ASSOCIATES

LOG OF SOIL BORING LOGS.GPJ HVJ.GDT 10/12/12

SOIL SYMBOLS

Soil Types

Clay, Silt, Sand, Fill

Modifiers

Clayey, Silty, Sandy Clay, Cemented

Construction Materials

Asphaltic Concrete, Stabilized Base, Fill or Debris, Base

SAMPLER TYPES

- Thin Walled Shelby Tube
- No Recovery
- Split Barrel
- Auger
- Liner Tube
- Jar Sample

WATER LEVEL SYMBOLS

- Groundwater level determined during drilling operations
- Groundwater level after drilling in open borehole or piezometer

SOIL GRAIN SIZE

Classification	Particle Size	Particle Size or Sieve No. (U.S. Standard)
Clay	< 0.002 mm	< 0.002 mm
Silt	0.002 - 0.075 mm	0.002 mm - #200 sieve
Sand	0.075 - 4.75 mm	#200 sieve - #4 sieve
Gravel	4.75 - 75 mm	#4 sieve - 3 in.
Cobble	75 - 200 mm	3 in. - 8 in.
Boulder	> 200 mm	> 8 in.

DENSITY OF COHESIONLESS SOILS

Descriptive Term	Penetration Resistance "N" * Blows/Foot
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	> 50

CONSISTENCY OF COHESIVE SOILS

Consistency	Undrained Shear Strength (tsf)
Very Soft	0 - 0.125
Soft	0.125 - 0.25
Firm	0.25 - 0.5
Stiff	0.5 - 1.0
Very Stiff	1.0 - 2.0
Hard	> 2.0

PENETRATION RESISTANCE

3/6	Blows required to penetrate each of three consecutive 6-inch increments per ASTM D-1586 *
50/4"	If more than 50 blows are required, driving is discontinued and penetration at 50 blows is noted
0/18"	Sampler penetrated full depth under weight of drill rods and hammer

* The N value is taken as the blows required to penetrate the final 12 inches

TERMS DESCRIBING SOIL STRUCTURE

Slickensided	Fracture planes appear polished or glossy, sometimes striated
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Inclusion	Small pockets of different soils, such as small lenses of sand scattered through a mass of clay
Parting	Inclusion less than 1/4 inch thick extending through the sample
Seam	Inclusion 1/4 inch to 3 inches thick extending through the sample
Layer	Inclusion greater than 3 inches thick extending through the sample
Laminated	Soil sample composed of alternating partings of different soil type
Stratified	Soil sample composed of alternating seams or layers of different soil type
Intermixed	Soil sample composed of pockets of different soil type and laminated or stratified structure is not evident
Calcareous	Having appreciable quantities of calcium carbonate
Ferrous	Having appreciable quantities of iron
Nodule	A small mass of irregular shape

HVJ ASSOCIATES

PROJECT NO.: AG 06 24041

DRAWING NO.: PLATE 8A

KEY TO TERMS AND SYMBOLS USED ON BORING LOGS FOR SOIL

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ROCK TYPES

- Limestone
- Shale
- Sandstone
- Highly Weathered Limestone
- Weathered Shale
- Weathered Sandstone
- Weathered Limestone
- Dolomite
- Granite

SAMPLER TYPES

- Thin-Walled Tube
- Rock Core
- Standard Penetration Test
- Auger
- THD Cone Penetration Test
- Bag Sample

SOLUTION AND VOID CONDITIONS

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

HARDNESS

Very Soft	Can be carved with a knife, broken with finger pressure, or UCS less than 30 tsf
Soft	Can be gouged or grooved readily with a knife, or UCS between 30 and 100 tsf
Moderately Hard	Can be scratched easily with a knife, or UCS between 100 and 250 tsf
Hard	Can be scratched rarely with a knife, or UCS greater than 250 tsf
Very Hard	Cannot be scratched with a knife

WEATHERING GRADES OF ROCKMASS (1)

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 into 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.

JOINT DESCRIPTION

SPACING	
Very Close	<2"
Close	2"-12"
Medium Close	12"-3'
Wide	>3'

INCLINATION	
Horizontal	0-5
Shallow	5-35
Moderate	35-65
Steep	65-85
Vertical	85-90

SURFACES	
Slickensided	Polished, grooved
Smooth	Planar
Irregular	Undulating or granular
Rough	Jagged or pitted

REFERENCES:

(1) British Standard (1981) Code of Practice for Site Investigation, BS 5930.

(2) The Bridge Div., Tx. Highway Dept. Foundation Exploration & Design Manual, 2nd Division, revised June, 1974.

BEDDING THICKNESS (2)

Very Thick	>4'
Thick	2'-4'
Thin	2"-2'
Very Thin	1/2"-2"
Laminated	0.08"-1/2"
Thinly Laminated	<0.08"

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.

HVJ ASSOCIATES

PROJECT NO.: AG 06 24041

DRAWING NO.: PLATE 8B

KEY TO TERMS AND SYMBOLS USED ON BORING LOGS FOR ROCK

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APPENDICES

LABORATORY TEST RESULTS SUMMARY
Project Name: New High Speed Taxiway on Runway 3-21 and Taxiway D Repairs
Project Number: AG 06 24041

Boring Number	Depth (ft)	% Passing No. 200 Sieve	Liquid Limit (%)	Plasticity Index (%)	Moisture Content (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	Compressive Strength (tsf)	Hand Penetrometer Reading (tsf)
B-5	0-2								4.5+
	2-4	89.6	70	45	24.9				2.75
	4-4.5								4.5+
	6.5-8	36.0	43	27	7.4				
B-6	0-2								3.5
	2-4	88.8	70	46	27.9				3.5
	4-6								4.5+
	6-8	64.9	86	58	18.1				4.5+
	8-10								4.5+
B-7	3-3.5	22.8	53	34	6.4				
B-8	2.5-3	29.4	52	28	9.2				
	4.5-6	15.2	23	9	6.6				

GEOTECHNICAL INVESTIGATION REPORT
PERIMETER ROAD EST PHASE 2
SAN ANTONIO INTERNATIONAL AIRPORT (SAT)
SAN ANTONIO, TEXAS

SUBMITTED TO

AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057-1599

BY
HVJ ASSOCIATES, INC.

JUNE 10, 2012

HVJ REPORT NO. AG 06 24042

HVJ ASSOCIATES

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June 10, 2012

Mr. John Bush, P.E.
AECOM
5757 Woodway
Houston, TX 77057-1599

Re: Perimeter Road Est Phase 2
Owner: City of San Antonio, Texas (COSA), San Antonio International Airport (SAT)
HVJ Project No: AG0624042

Dear Mr. Bush:

Submitted herein is the geotechnical data report of our geotechnical investigation for the above referenced project. The study was performed in accordance with HVJ proposal number AG0624042 dated December 20, 2011 (Revised February 6, 2012).

It has been a pleasure to work for you on this project and we appreciate the opportunity to be of service. Please notify us if there are questions or if we may be of further assistance.

Sincerely,

HVJ ASSOCIATES, INC.
Texas Firm Registration No. F-000646

Jason Schwarz, P.E.
Project Manager

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LICENSED
PROFESSIONAL ENGINEER

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The seals appearing on this document were authorized by Jason Schwarz, PE 99343 and Linda Barlow, PE 63878 on June 10, 2012. The geotechnical recommendations presented in this report were developed by Mr. Schwarz and certified by the seal above; the pavement recommendations presented in this report were developed by Ms. Barlow and are certified by the seal above. This document has been released for purpose of interim review under authorization Alteration of a sealed document without proper notification to the responsible engineer is an offense under the Texas Engineering Practice Act.

TABLE OF CONTENTS

Page

I. EXECUTIVE SUMMARY I

1 INTRODUCTION 1
1.1 General 1
1.2 Scope of Work 1

2 FIELD EXPLORATION 1
2.1 General 1
2.2 Sampling Methods and Field Testing 2
2.3 Borehole Completion 2

3 LABORATORY TESTING 2

4 SITE CHARACTERIZATION 3
4.1 General Geology 3
4.2 Subsurface Stratigraphy 4
4.3 Groundwater 5

5 PAVEMENT DESIGN RECOMMONDATIONS 5
5.1 General 6
5.2 Design Criteria and Performance Constraints 6
5.3 Traffic Data 6
5.4 Subgrade and Pavement Layer Strengths 7
5.5 Recommended Pavement Section and Materials 8

6 LIMITATIONS 9

ILLUSTRATIONS

PLATE

SITE VICINITY MAP 1

GEOLOGY MAP 2

PLAN OF BORINGS ..... 3A – 3C

BORING LOGS ..... 4 - 7

KEY TO SYMBOLS ..... 8A & 8B

APPENDICES

APPENDIX

LABORATORY TEST RESULTS SUMMARY ..... A

DARWIN OUTPUTS ..... B

I. EXECUTIVE SUMMARY

HVJ Associates, Inc. (HVJ) was retained by AECOM to perform a geotechnical investigation for the reconstruction of a portion of the perimeter road surrounding San Antonio International Airport, located just north of Loop 410 and east of US 281, in San Antonio, TX.

It is our understanding that the project involves the rehabilitation of approximately 2,280 feet of the southernmost portion of the perimeter road, located just north of Loop 410.

A brief summary of the investigational findings and pertinent recommendations is as follows:

1. Four (4) borings, designated as B-1 through B-4, were drilled with truck-mounted equipment using dry auger and sampling techniques, at designated locations along the proposed rehabilitation alignment, to termination depths of approximately ten (10) feet below grade. The existing concrete at the boring locations was cored using a portable coring rig.

2. The existing concrete thickness along the project alignment ranged between approximately six and a half (6½) and eight (8) inches and was underlain by various base materials which ranged in thickness between approximately four (4) and eight (8) inches. Table I-1 provides data for the pavement and base thicknesses.

Table I-1 – Concrete and Base Thickness

Boring No.	Concrete Thickness (inches)	Approximate Base Thickness (inches)
B-1	8	6
B-2	6½	8
B-3	7¾	4
B-4	7¾	8

3. Groundwater was not encountered in any of the project borings during drilling operations. Please note that groundwater levels may fluctuate seasonally, in response to changing climatic conditions. Perched groundwater conditions may also exist at the interface between soil and bedrock.

4. The subsurface soil encountered below the road base material consisted of fill material, ranging in thickness between approximately four (4) feet and eight (8) feet in thickness, which was characteristically medium stiff to very stiff, fat clay. The fill material was underlain by clays and gravels from the Leona Formation, which extended to the boring termination depths.

5. The Potential Vertical Rise (PVR) was evaluated for the dry case and the worst case was 3.81 inches.

6. The DARWin computer program, based on the 1993 AASHTO Pavement Design Procedure, was used for the pavement designs. The resulting pavement thickness designs for the fuel truck loading are:

10" JRCP	or	10" JRCP
4" HMAC TY B Base		8" Flexible Crushed Aggregate Base*
8" Lime Stabilized Subgrade		8" Lime Stabilized Subgrade

The HMAC base option is recommended, however should the Flexible Crushed Aggregate Base option be selected, the following must be considered:

*Due to the erodible nature of Flexible Crushed Aggregate Base, it is recommended that some type of separating layer be included between the JRCP and the Flexible base. It appears that some of the current pavement distress includes cracking, spalling and settlement, therefore if flexible crushed aggregate base is utilized, additional protection should be provided to reduce potential for similar distress to occur in the new pavement. Possible considerations for protection of the erodible base may include: geotextile fabric, waterproofing membrane, paving fabric, etc. It is anticipated that an asphalt emulsion may not provide adequate coverage and may wear off or deteriorate with time therefore is not recommended.

Please note that this executive summary does not fully relate our findings and opinions. These findings and opinions are only presented through the full report.

1 INTRODUCTION

1.1 General

HVJ Associates, Inc. (HVJ) was retained by AECOM to perform a geotechnical investigation for the reconstruction of a portion of the perimeter road surrounding San Antonio International Airport, located just north of Loop 410 and east of US 281, in San Antonio, TX. A map of the site vicinity is provided on Plate 1.

It is our understanding that the project involves the rehabilitation of approximately 2,280 feet of the southernmost portion of the perimeter road, located just north of Loop 410.

1.2 1.2 Scope of Work

HVJ's scope of work is to provide information on subsurface conditions along the alignment of the proposed road improvements, determine existing pavement and base material thicknesses, evaluate potential vertical rise of expansive soils, and provide design and construction recommendations for one PCC section for fuel truck loading.

The primary objective of this study was accomplished by:

1. Drilling four (4) borings to termination depths of approximately ten (10) feet to determine existing concrete thickness and characteristics of the subsurface stratigraphy and to obtain samples for laboratory testing; and

2. Performing laboratory tests to determine physical and engineering characteristics of the soils and bedrock material encountered;

3. Obtaining design traffic data and defining pavement design inputs for pavement thickness designs.

Subsequent sections of this report contain descriptions of the subsurface exploration, laboratory testing program, general site and subsurface conditions, evaluation of potential vertical rise of expansive soils, and PCC design and construction recommendations.

2 FIELD EXPLORATION

2.1 General

The field exploration program undertaken for the project was conducted on April 16, 2012. The four (4) project borings, B-1 through B-4, were cored through the concrete with a portable coring rig and advanced with a truck mounted drill rig equipped with soil sampling and dry auger equipment. Termination depths for the borings were approximately ten (10) feet below grade, with the exception of boring B-3 which was sampled to nine and half (9.5) feet below grade. Approximate boring locations are provided in the Plan of Borings, Plate 3.

The final boring logs are presented on Plates 4 through 7, with a key to terms and symbols used provided on Plates 8A and 8B.

2.2 Sampling Methods and Field Testing

Fine grained, cohesive soils encountered were sampled using a 3-inch diameter thin-walled tube, which was pushed into the soil in general accordance with ASTM standard D 1587- *Thin Walled Tube Sampling of Soils*. The samples were extruded in the field and a calibrated pocket penetrometer was used to obtain an estimate of the unconfined compressive strength of the sample.

Standard Penetration Tests (SPTs) were conducted in non-cohesive soils within the soil strata. The SPTs were performed in general accordance with ASTM D 1586 – *Penetration Test and Split-Barrel Sampling of Soils*. This procedure consisted of driving a standardized 1-5/8 inch diameter split-spoon sampler into undisturbed soil with a 140-pound hammer falling 30 inches. The split-spoon sampler was first seated 6 inches to penetrate any loose cuttings and was then driven an additional 12 inches with blows from the hammer. The number of hammer blows required to drive the sampler each 6-inch increment was recorded. The penetration resistance, or "N-value", is defined as the number of hammer blows required to drive the sampler the final 12 inches and was used in the field to estimate the density of granular soils or the consistency of cohesive soils. In very dense material the SPT test was typically stopped after 50 blows from the hammer and the measurement was recorded as 50 blows per distance penetrated (e.g. 50 over 3 inches).

Classification and field test results for both the thin-walled tube and split-spoon samples were recorded onto field logs, which included a visual description in accordance with ASTM D 2488 – *Description and Identification of Soils*. A preliminary soil classification was also assigned to each sample based on ASTM D 2487 – *Classification of Soil for Engineering Purposes*. After field documentation and logging was complete, the individual soil samples were either wrapped in plastic or placed in sealed containers to prevent loss of moisture and were transported to our laboratory for further examination and testing.

2.3 Borehole Completion

All project borings were backfilled with soil cuttings and bentonite chips, as required. The borings were topped with a quick setting, non-shrink grout to match the existing concrete thickness and surface, upon completion of drilling.

3 LABORATORY TESTING

Soil samples transported to our laboratory were further examined and described in accordance with ASTM D 2488 – *Description and Identification of Soils*. A preliminary soil classification was assigned to each soil sample based on ASTM D 2487 – *Classification of Soil for Engineering Purposes*.

Classification testing, which included moisture contents, Atterberg limits, and percent passing the No. 200 sieve, was subsequently conducted on select samples. In addition, unconfined compressive strength tests with wet and dry unit weight determinations were performed on select soil samples from the foundation boring. All testing was performed in accordance with the relevant ASTM Standards. The results of these tests were used to confirm or modify the preliminary soil classifications.

3.1 Atterberg Limits

Select samples were tested to determine the Atterberg Limits in accordance with ASTM D4318-10. The Atterberg Limit test is used to classify the soil using the Unified Soil Classification System (USCS). The Atterberg Limit test consists of two parts: a liquid limit test and a plastic limit test.

The liquid limit equipment setup consists of a brass cup partially filled with soil which is grooved with a specialized grooving tool, and then dropped freely from a specified height to the rubber base below at a constant rate of 2 drops per second. The liquid limit test is performed on soil that has been sieved through the No. 40 sieve and brought to a moisture content that would close the ½-inch groove within 20 to 30 blows for two consecutive tests. The moisture content of the soil is then measured and recorded as the liquid limit. The second part of the tests consists of a rolling a remolded sample between the tips of the fingers and a glass plate until transverse cracks appear at a rolled diameter of 1/8-inch. The moisture content of the rolled sample is taken and recorded as the plastic limit.

3.2 Percent Passing the No. 200 Sieve

Select soil samples were tested in accordance with ASTM D1140-00 to determine the amount of material finer than the No. 200 sieve for use in classification. An oven dried sample of material is weighed then washed over a 75-µm (No. 200) sieve, allowing clay and other particles to be dispersed and removed from the soil. The retained material is oven dried then reweighed. The loss in mass resulting from the washing is calculated as mass percent of the original sample and is reported as the percentage of material finer than a No. 200 sieve.

3.3 Moisture Content

Moisture content testing was performed on select soil samples to determine the in situ state of moisture of the soil. A fresh sample was weighed before being placed in an oven with a controlled temperature of 230°F and dried back to a constant mass. Upon the drying and reweighing of the sample, the total mass of water lost was recorded. The ratio of the water loss to the dried mass is recorded as the moisture content. This test was performed in accordance with ASTM D2216-10.

3.4 Sulfate Determination

Testing was performed on select samples to determine sulfate content in accordance with Tex-145-E, Determining Sulfate Content in Soils - Colorimetric Method.

The sampling information obtained in the field was used in conjunction with the laboratory examination and testing to generate final boring logs, provided on Plates 4 through 7. A Key of Terms and Symbols for the boring logs is provided on Plates 8A and 8B. The laboratory test results are provided on the final borings logs, as well as tabulated in Appendix A.

4 SITE CHARACTERIZATION

4.1 General Geology

According to the Geologic Atlas of Texas, San Antonio Sheet (University of Texas Bureau of Economic Geology, 1974), the proposed project is located within an area characterized by the Leona Formation (Qle) and the Pecan Gap Chalk (Kpg). A geologic map of the project vicinity is provided on Plate 2.

The Leona Formation is comprised of fluviatile terrace deposits of gravel, sand, silt, and clay.

The Pecan Gap Chalk is a very light yellow to yellow, chalk and chalky marl, which ranges in thickness from 50 to 75 feet.

San Antonio, TX is located within the Balcones Fault Zone, which is a group of faults that trends northeast/southwest across central Texas. According to available geologic data, there appears to be at least two faults mapped within the vicinity of the San Antonio International Airport.

4.2 Subsurface Stratigraphy

Concrete/Base

The concrete encountered in the project borings ranged in thickness between six and a half (6½) and eight (8) inches. There were various base materials encountered beneath the concrete in the project borings, ranging in thickness between four (4) and eight (8) inches. The concrete and base thicknesses, along with descriptions of the base materials, are provided in Table 4-1.

Table 4-1 – Concrete/Base Material

Boring No.	Concrete Thickness (inches)	Approximate Base Thickness (inches)	Base Material Description
B-1	8	6	clean gravel
B-2	6½	8	clean gravel
B-3	7¾	4	sandy clay
B-4	7¾	8	cement treated clayey sand

Fill

Soil and groundwater conditions along the project alignment described herein are based on information obtained at the boring locations only. Significant variations at areas not explored by the project borings may require reevaluation of our findings and conclusions. Subsurface soils as encountered along the project alignment are discussed below.

Subsurface conditions along the project alignment were evaluated by drilling and sampling a total of four (4) borings, designated as B-1 through B-4, to termination depths of approximately ten (10) feet. The base materials were underlain by fill materials that ranged in thickness between approximately four (4) feet and eight (8) feet. The fill material was characteristically dark gray or brown to yellowish brown, medium stiff to very stiff, fat clay.

Below the fill materials beginning at depths between approximately six (6) and eight (8) feet below grade were soils from the Leona Formation which extended to the boring termination depths. These soils were characteristically yellowish brown, and varied between fat and lean clays and clayey gravels. Detailed descriptions of the materials encountered in the borings are shown on the final boring logs presented on Plates 4 through 7.

Laboratory testing was performed on the fill material encountered in boring B-4 between two (2) and four (4) feet below grade, the results are presented in Table 4-2.

Table 4-2 – Laboratory Test Results for Low Plasticity Fill

Laboratory Test	Results
Moisture Content (%)	11.7
Liquid Limit (%)	35
Plasticity Index (%)	12
% Passing No. 200 Sieve	22.3

Laboratory test results for the soils encountered are summarized in Table 4-3 as well as presented in Appendix A and on the final boring logs, Plates 4 through 7.

Table 4-3 – Laboratory Test Results

Laboratory Test	Average	Maximum	Minimum	Standard Deviation
Moisture Content (%)	29.4	34.4	20.9	4.4
Liquid Limit (%)	75	88	59	11
Plasticity Index (%)	53	67	38	11
% Passing No. 200 Sieve	93.1	96.9	85.9	3.6
Sulfates (ppm)	N/A	58.5	ND*	N/A

***Note: ND is Not Detected**

4.3 Groundwater

Groundwater was not observed in any of the project borings during drilling operations. It should be noted, however, that groundwater levels may fluctuate seasonally, in response to changing climatic conditions. Perched groundwater conditions may also exist at the interface between soil and bedrock.

5 EVALUATION OF POTENTIAL VERTICAL RISE OF EXPANSIVE SOILS

5.1 General

The site exploration program indicates the subsurface generally consists of stiff to hard Fat and Lean Clay with variable amounts of sand and gravel. The Fat Clay in particular will undergo shrinking/swelling with variation in moisture content. Shrinkage or expansion of the native soils will result in a certain amount of vertical rise (or fall) of the surface and pavement.

The vertical rise potential for the site was evaluated using the Texas Department of Transportation Method Tex-124-E. The method computes the potential vertical rise (PVR) based on site specific geotechnical data. Assuming a dry soil to wet soil scenario (i.e. worst case), the computed PVR for the site ranges from approximately 0.7 to 3.8 inches. The magnitude of the computed vertical rise may also cause uneven pavement areas, including cracking and long term performance issues.

Based on the type of facility and anticipated structures/improvements, the most critical geotechnical aspect of the project is to address the potential vertical rise of the expansive soils.

Table 5-1 – Summary of PVR Calculations

Borehole Number	Existing Condition	Dry Condition
	PVR at 7 ft	PVR at 7 ft
BH1	2.94	3.26
BH2	2.15	2.29
BH3	3.68	3.81
BH4	1.12	0.68
Average	**2.47**	**2.51**
Maximum	3.68	3.81

6 PAVEMENT DESIGN RECOMMONDATIONS

6.1 General

The DARWin computer program, based on the 1993 AASHTO Pavement Design Procedure, was used for the pavement designs. The design inputs required include: design and performance constraints, traffic, subgrade and pavement layer strengths. Results of the field and laboratory data were used to develop pavement design inputs.

6.2 Design Criteria and Performance Constraints

Parameters relative to design criteria and performance constraints are discussed below.

Reliability Level and Overall Standard Deviation. A reliability level (R) of 90 percent was selected for the pavement design performance. A mean value of the overall standard deviation (S_o) was selected to be 0.35.

Serviceability. The serviceability of a pavement is defined as its ability to serve the type of traffic that uses the facility. The condition of the pavement after the performance period is characterized by a Terminal Serviceability Index (P_t) a Terminal Serviceability Index of 2.5 was used for the designs and the original or initial serviceability (P_o) of 4.5 was selected.

Drainage. The treatment for the expected level of drainage for a rigid pavement is through the use of a drainage coefficient, C_d. A C_d value of 1.00 was selected for good quality of drainage.

Load Transfer. The load transfer coefficient, J, is a factor used in rigid pavement design to account for the ability of a concrete pavement structure to transfer load across discontinuities, such as joints. A mean value of the load transfer coefficient (J) of 3.6 was selected based on the construction plan details of jointed reinforced concrete pavement with tied curbs but no load transfer devices (except in construction joints).

6.3 Traffic Data

The traffic data estimated for the road is based on four different fuel trucks. The truck factor was calculated based on analyzing four truck weights and AASHTO truck equivalency tables. The truck factor and percent distribution for each truck are:

Table 6-1 – Summary of Truck Data

Fuel Truck Weight	Truck Factor	% Distribution
130,000 lbs	17.41	25%
102,240 lb	6.63	25%
86,790 lb	3.96	25%
98,950 lb	5.93	25%

Based on average of 80 fuel trucks per day and an estimated 4% annual growth, the resulting Equivalent 18kip Single Axle Loads (ESALs) for this 20 year design is 3,420,449 ESALs.

6.4 Subgrade and Pavement Layer Strengths

Subgrade Strength. Subgrade design strength has been developed based on the results of the field and laboratory tests. These soils were characteristically yellowish brown, and varied between fat and lean clays and clayey gravels. Correlations were made to strength properties required for design as seen in tables below. An elastic modulus of 2,300 psi for fat clay soil was selected for design.

Table 6-2 – Summary of PI and Correlated Modulus

Borehole Number	Depth (ft)	Plasticity Index (%)	Correlated Elastic Modulus, psi
B-1	2-4	56	2,200
	6-8	54	2,200
B-2	2-4	42	2,400
	6-8	45	2,300
B-3	2-4	67	2,200
	4-6	66	2,200
	8-9.5	38	2,500
B-4	2-4	12	9,800
	6-8	54	2,200
avg all		48	3,111
avg fat clay		53	2,275

The predominant subgrade soils on this project exhibit a potential for swell. Subgrade stabilization is recommended for the entire length of the project for firm construction platform purposes. The percentage of lime should be determined during construction based on testing of the actual subgrade materials. Since high levels negatively affect the use of lime treatment for subgrade soils, HVJ testing included sulfates. The resulting sulfate content is significantly less than 8,000 ppm per testing procedure Tex-145-E and Tex-146-E; therefore it is recommended that the top 6 to 8 inches of the subgrade be stabilized with lime.

Effective Modulus of Subgrade Reaction. The composite K-value for design used is based on they type and depth of proposed base material. Although a non-erodible Hot Mix Asphalt Concrete (HMAC) base is recommended, flexible crushed aggregate base, an erodible base, was also considered. The resulting effective modulus of subgrade reactions are:

The composite K-value for 4 in. of HMAC base at 500,000 psi modulus is 68 pci.
The composite K-value for 8 inches of flexible base at 50,000 psi modulus is 27 pci.

The base materials may settle, contain voids, or may be susceptible to erosion, resulting in loss of support. Overloading the concrete slab will create excessive bending stresses where the slab has no support. The result is severe cracking, possible spalling, and settlement. Current TxDOT policy requires a non-erodible base beneath all rigid pavements.

Loss of Support. This factor, LS, was included in the design of rigid pavement to account for the potential loss of support arising for subbase erosion and/or differential vertical soil movement. A LS value of 1.0 was selected based on the condition of HMAC base and a value of 2.0 was considered for flexible crushed aggregate base.

Concrete Elastic Modulus and Modulus of Rupture. A mean flexural strength of 600 psi for design purposes is considered and a value of 4,000,000 psi is used for the modulus of elasticity of the concrete (E_c) based on the City of San Antonio Design Guidance Manual.

6.5 Pavement Designs

The DARWin output is included in Appendix B. The resulting pavement thickness designs for the fuel truck loading are:

10" JRCP	or	10" JRCP
4" HMAC TY B Base		8" Flexible Crushed Aggregate Base*
8" Lime Stabilized Subgrade		8" Lime Stabilized Subgrade

The HMAC base option is recommended; however, should the Flexible Crushed Aggregate Base option be selected for construction, the following must be considered:

* Due to the erodible nature of Flexible Crushed Aggregate Base, it is recommended that some type of separating layer be included between the JRCP and the Flexible base. It appears that some of the current pavement distress includes cracking, spalling and settlement, therefore if flexible crushed aggregate base is utilized, additional protection should be provided to reduce potential for similar distress to occur in the new pavement. Possible considerations for protection of the erodible base may include: geotextile fabric, waterproofing membrane, paving fabric, etc. It is anticipated that an asphalt emulsion may not provide adequate coverage and may wear off or deteriorate with time therefore is not recommended.

7 LIMITATIONS

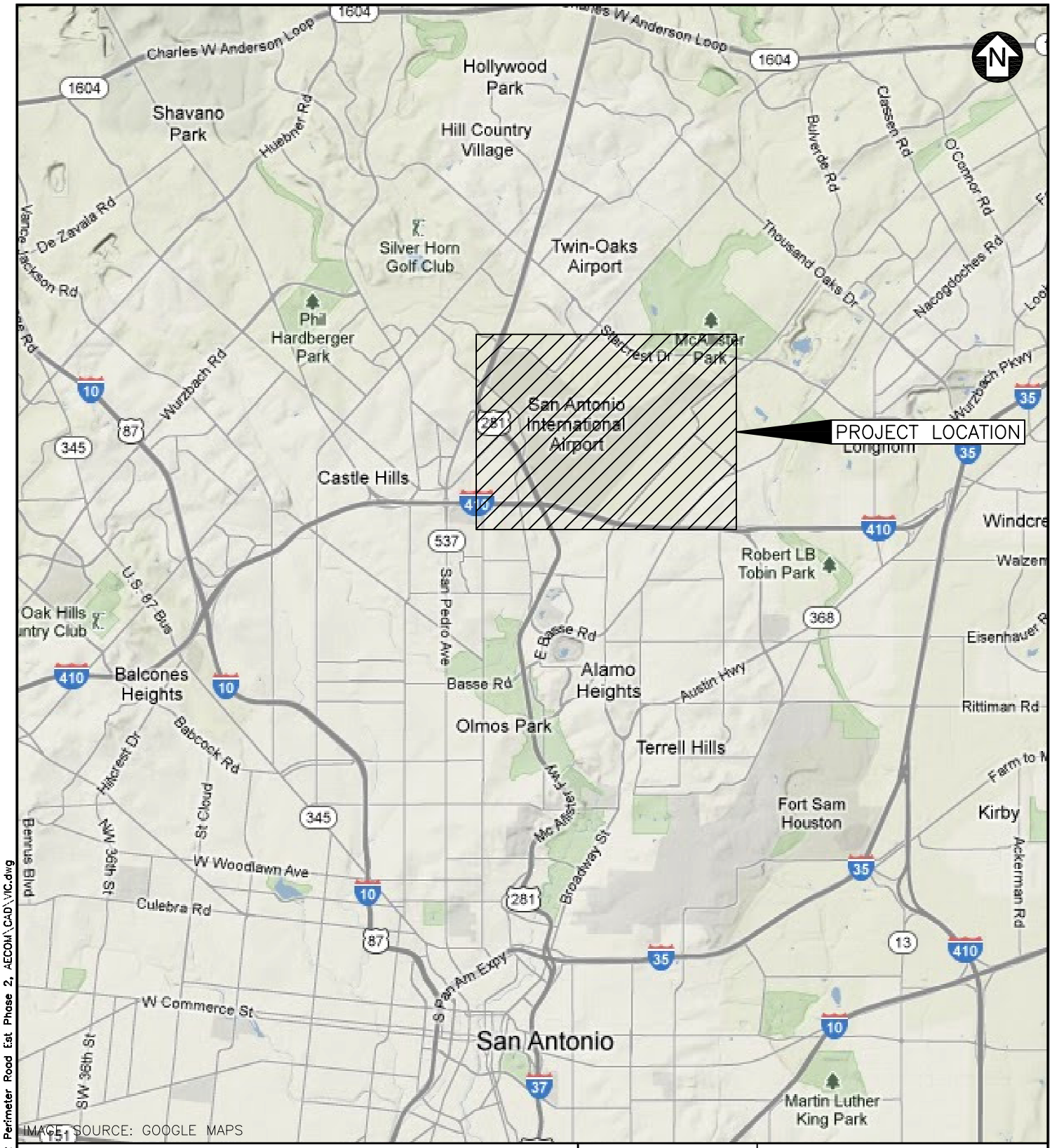
HVJ Associates, Inc. should review the design and construction plans and specifications prior to release to make certain that the pavement design criteria presented herein have been properly interpreted.

This study was performed for the exclusive use of AECOM, Inc. for specific application to the Perimeter Road East Phase 2 project at San Antonio International Airport in Bexar County, Texas. HVJ Associates, Inc. has endeavored to comply with generally accepted geotechnical engineering practice common in the local area. HVJ Associates, Inc. makes no warranty, express or implied. Any analysis and recommendation contained in this report are based on data obtained from subsurface exploration, laboratory testing, project information provided to HVJ Associates, Inc., and HVJ Associates, Inc.'s experience with similar soils and site conditions.

The methods used indicate subsurface conditions only at the specific location where the single sample was obtained, only at the time it was obtained, and only to the depth penetrated. The sample cannot be relied on to accurately reflect the strata variations that usually exist at locations other than the sampling location. Should any subsurface conditions other than those described in the boring log be encountered, HVJ Associates, Inc. should be immediately notified so that further investigation and supplemental recommendations can be provided.

Subsurface conditions at the site can differ significantly from those encountered in the boring due to the placement of fill materials and natural variation of geologic conditions, which may not have been detected by the limited field boring program. In the event that any changes in the nature, design or location of the improvements are made, the conclusions and recommendations in this report should not be considered valid until the changes are reviewed and the conclusions and recommendations modified or verified in writing by HVJ Associates, Inc.

ILLUSTRATIONS



MAP LOCATION

HVJ ASSOCIATES

SCALE: N.T.S		
DATE: 04/04/2012		
DRAWN BY: JD	PROJ. CHK: JS	APPRV. BY: JS

SITE VICINITY MAP
PERIMETER ROAD EST PHASE 2
SAN ANTONIO INTERNATIONAL AIRPORT
SAN ANTONIO, TX

PROJECT NO.: AG 06 24042	FILENAME: VIC	PLATE 1

DATE: 4/4/2012 3:23:22 PM
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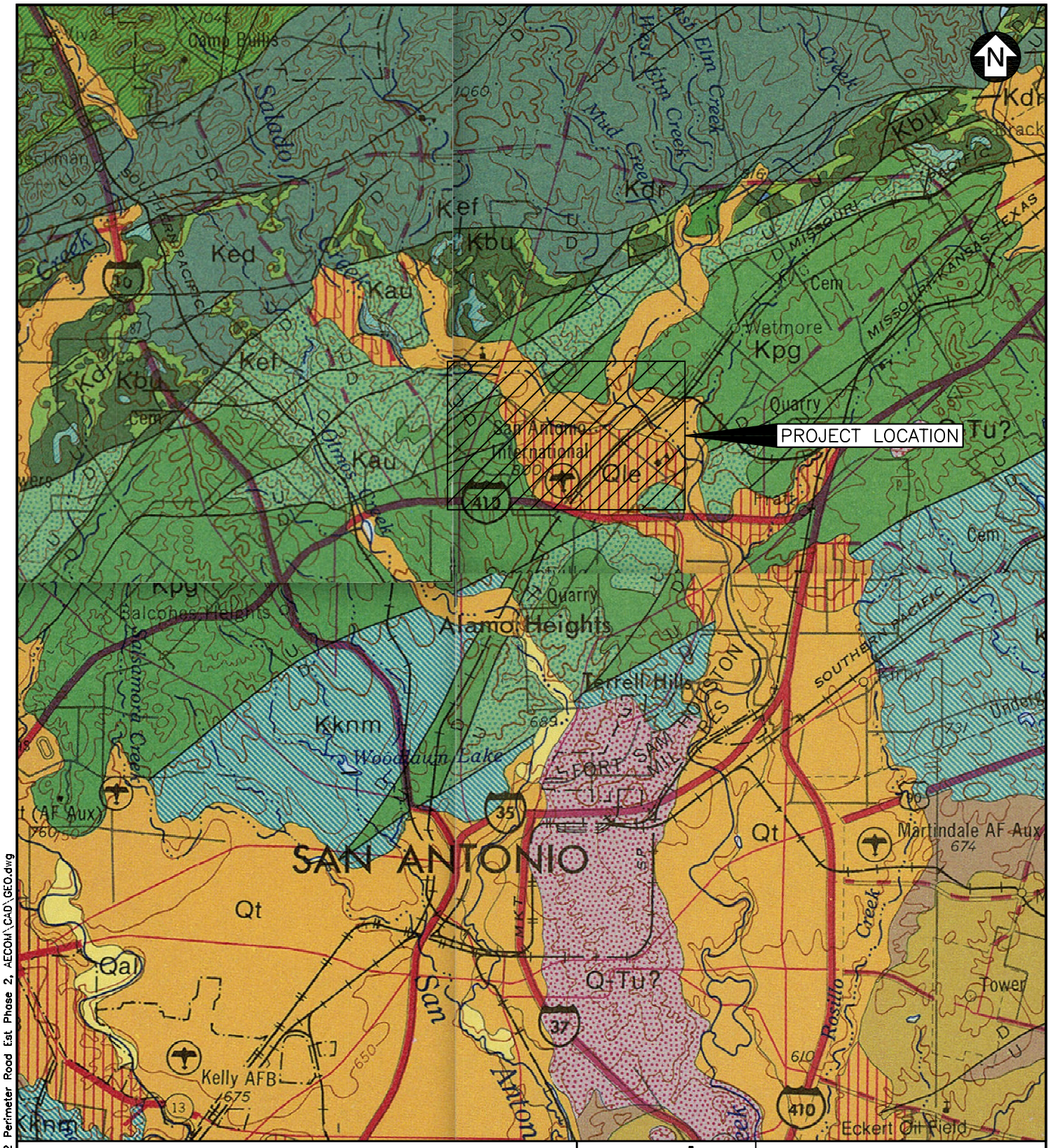

LEGEND

Qt	FLUVIATILE TERRACE DEPOSITS
Qle	LEONA FORMATION
Kpg	PECAN GAP CHALK
Kau	AUSTIN CHALK
Kbu	BUDA FORMATION

MAP LOCATION

HVJ ASSOCIATES

SCALE: N.T.S		
DATE: 04/04/2012		
DRAWN BY: JD	PROJ. CHK: JS	APPRV. BY: JS

GEOLOGY MAP
PERIMETER ROAD EST PHASE 2
SAN ANTONIO INTERNATIONAL AIRPORT
SAN ANTONIO, TX

PROJECT NO.: AG 06 24042	FILENAME: GEO	PLATE 2

DATE: 4/4/2012 3:06:00 PM
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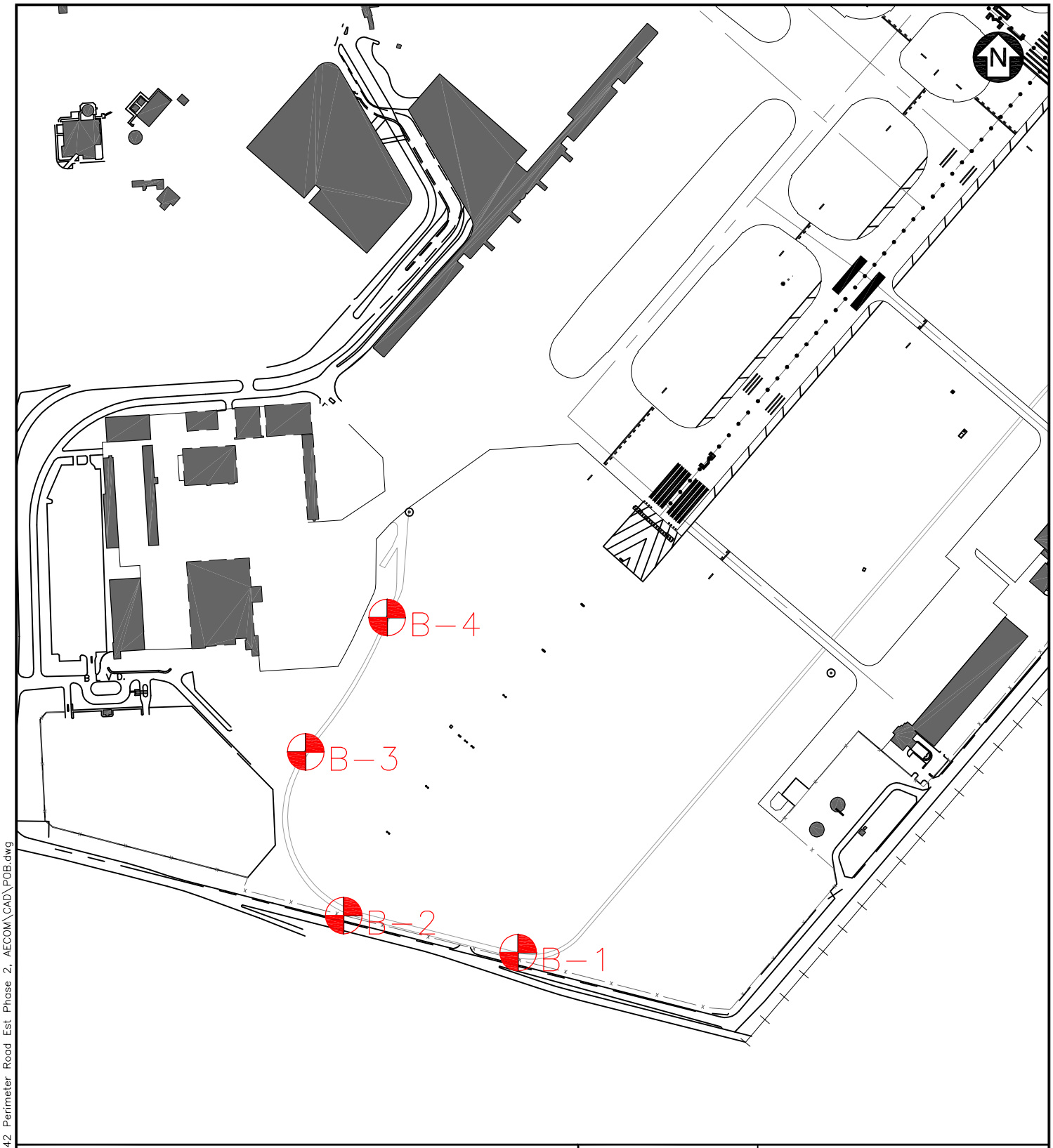


APPROXIMATE BORING LOCATION

MAP LOCATION

HVJ ASSOCIATES

SCALE: N.T.S		
DATE: 04/27/2012		
DRAWN BY: JD	PROJ. CHK: JS	APPRV. BY: JS

BORING LOCATION MAP
PERIMETER ROAD EST PHASE 2
SAN ANTONIO INTERNATIONAL AIRPORT
SAN ANTONIO, TX

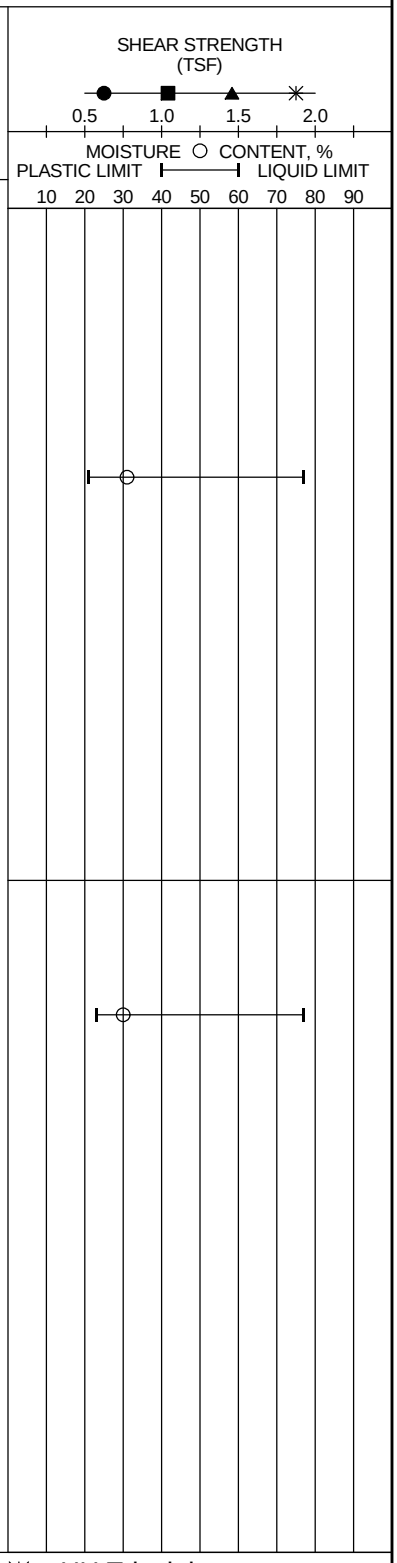
PROJECT NO.: AG 06 24042	FILENAME: POB	PLATE 3

DATE: 4/27/2012 3:04:24 PM
FILE: P:\geo\Projects\2006\AG 06 24042 Perimeter Road Est Phase 2, AECOM\CAD\POB.dwg

LOG OF BORING

Project: Perimeter Road Est Phase 2
Project No.: AG 06 24042
Boring No.: B-1
Date: 4/16/2012
Elevation:
Groundwater during drilling: ---
Northing: --
Station: --
Groundwater after drilling: ---
Easting: --
Offset: --

ELEV. DEPTH, FEET	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	SOIL/ROCK CLASSIFICATION	% PASSING NO. 200 SIEVE	DRY DENSITY PCF
0		8" **CONCRETE**		
		BASE: 6" **CLEAN GRAVEL**		
		Dark brown, **FAT CLAY (CH)**. (Fill)		
		Gray, **POORLY GRADED SAND WITH GRAVEL (SP)**. (Fill)		
	PP = 2.25 tsf	Dark gray, stiff to very stiff, **FAT CLAY (CH)**. (Fill)	94	
	PP = 2.0 tsf			
5				
	PP = 1.25 tsf		94	
	PP = 2.0 tsf	Yellowish brown, stiff to very stiff, **SANDY LEAN CLAY (CL)**. (Leona Formation)		
10				



Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

PLATE 4

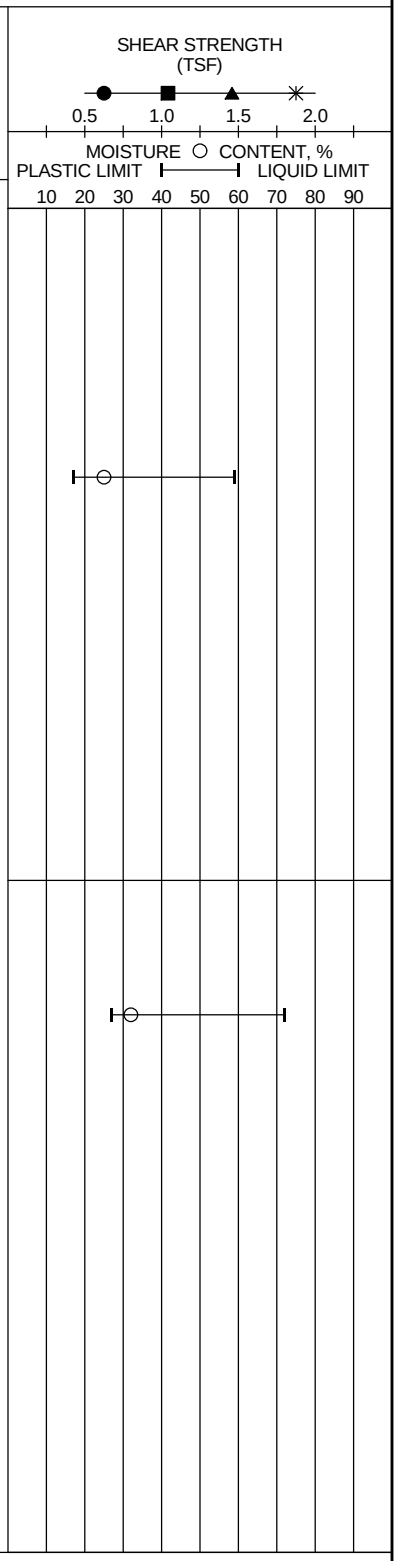
HVJ ASSOCIATES

LOG OF SOIL BORING BORING LOGS.GPJ HVJ.GDT 4/30/12

LOG OF BORING

Project: Perimeter Road Est Phase 2
Project No.: AG 06 24042
Boring No.: B-2
Date: 4/16/2012
Elevation:
Groundwater during drilling: ---
Northing: --
Station: --
Groundwater after drilling: ---
Easting: --
Offset: --

ELEV. DEPTH, FEET	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	SOIL/ROCK CLASSIFICATION	% PASSING NO. 200 SIEVE	DRY DENSITY PCF
0		6.5" **CONCRETE**		
		BASE: 8" **CLEAN GRAVEL**		
		Gray to yellowish brown, **GRAVELLY FAT CLAY (CH)**. (Fill)		
	PP = 1.75 tsf	Gray to brown to yellowish brown, stiff, **FAT CLAY (CH)**. (Fill)	86	
	PP = 1.75 tsf	Dark gray, medium stiff to stiff, **FAT CLAY (CH)**. (Fill)		
5				
	PP = 1.0 tsf		89	
	PP = 2.0 tsf			
		Orangish brown, stiff, **GRAVELLY LEAN CLAY (CL)**. (Leona Formation)		
10				



Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

PLATE 5

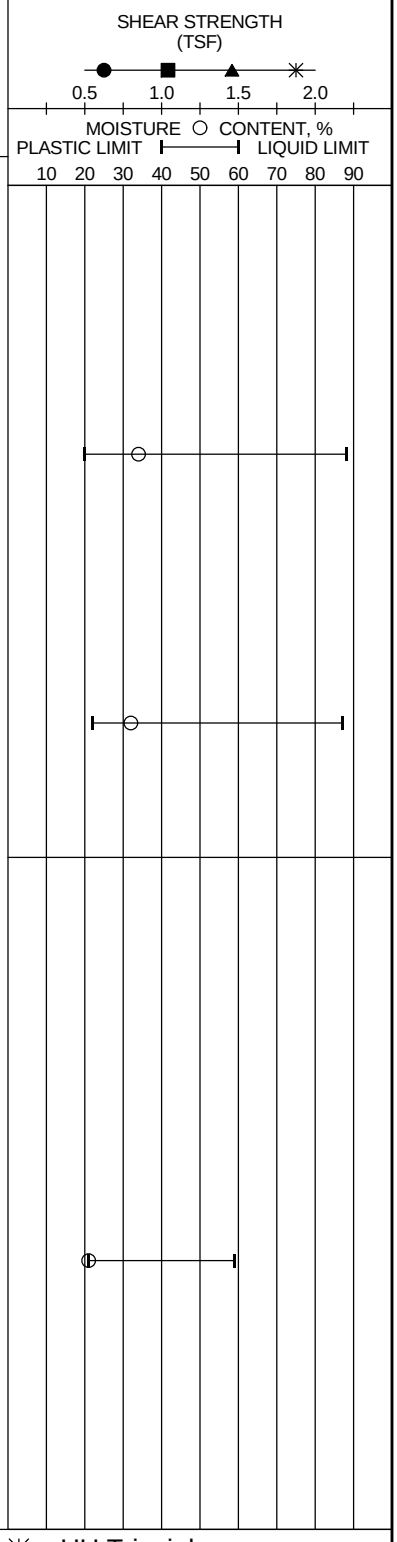
HVJ ASSOCIATES

LOG OF SOIL BORING BORING LOGS.GPJ HVJ.GDT 4/30/12

LOG OF BORING

Project: Perimeter Road Est Phase 2 | Project No.: AG 06 24042
Boring No.: B-3 | Date: 4/16/2012 | Elevation:
Groundwater during drilling: --- | Northing: -- | Station: --
Groundwater after drilling: --- | Easting: -- | Offset: --

ELEV. DEPTH, FEET	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	SOIL/ROCK CLASSIFICATION	% PASSING NO. 200 SIEVE	DRY DENSITY PCF
0		7.75" **CONCRETE**		
		BASE: 4" **SANDY CLAY**		
		Gray, **SANDY LEAN CLAY WITH GRAVEL (CL)**. (Fill)		
	PP = 1.5 tsf	Dark gray, stiff to very stiff, **FAT CLAY (CH)**. (Fill)	96	
	PP = 2.25 tsf		94	
5				
	PP = 1.75 tsf	Dark brown to yellowish brown, stiff, **FAT CLAY (CH)**. (Leona Formation)		
	50/5.5"	Yellowish brown, very dense, **CLAYEY GRAVEL (GC)**. (Leona Formation)		
	10-15-19	Gray to yellowish brown, hard, **FAT CLAY (CH)**. (Residual soil)	97	
10				



Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

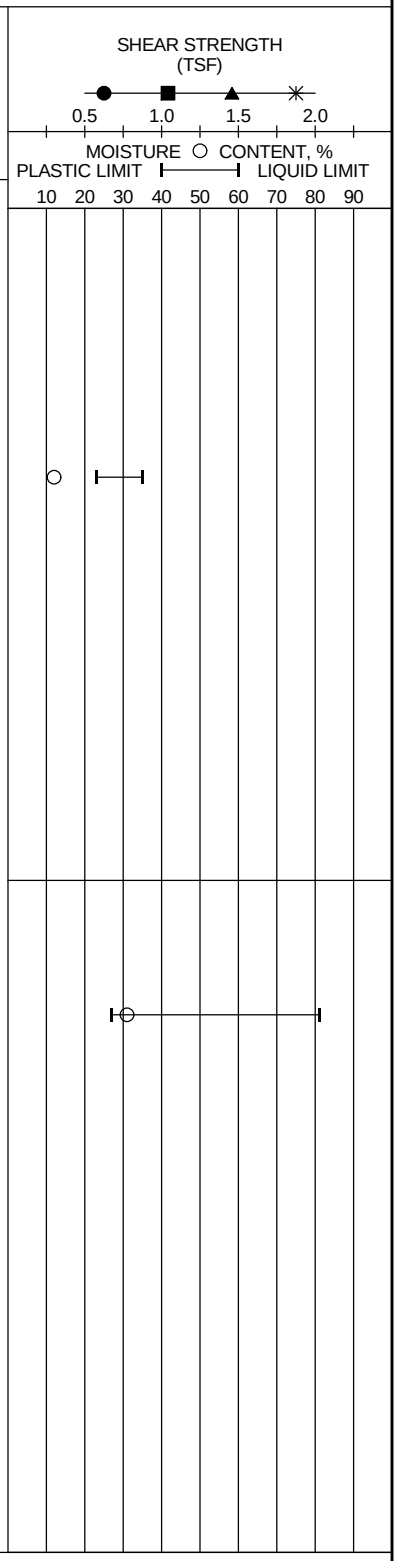
PLATE 6

HVJ ASSOCIATES

LOG OF BORING

Project: Perimeter Road Est Phase 2
Project No.: AG 06 24042
Boring No.: B-4
Date: 4/16/2012
Elevation:
Groundwater during drilling: ---
Northing: --
Station: --
Groundwater after drilling: ---
Easting: --
Offset: --

ELEV. DEPTH, FEET	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	SOIL/ROCK CLASSIFICATION	% PASSING NO. 200 SIEVE	DRY DENSITY PCF
0		7.75" **CONCRETE**		
		BASE: 8" Cement treated, tan, **CLAYEY SAND (SC)**.		
		Orangish brown, **CLAYEY GRAVEL WITH SAND (GC)**. (Fill)	22	
	PP = 1.5 tsf	Dark gray, stiff, **FAT CLAY (CH)**. (Fill)		
5				
	PP = 1.75 tsf		94	
	PP = 4.5+ tsf	Yellowish brown, hard, **FAT CLAY (CH)**. (Residual soil)		
10				



Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

PLATE 7

HVJ ASSOCIATES

LOG OF SOIL BORING BORING LOGS.GPJ HVJ.GDT 4/30/12

SOIL SYMBOLS

Soil Types

Clay | Silt | Sand | Fill

Modifiers

Clayey | Silty | Sandy Clay | Cemented

Construction Materials

Asphaltic Concrete | Stabilized Base | Fill or Debris | Base

SAMPLER TYPES

- Thin Walled Shelby Tube
- No Recovery
- Split Barrel
- Auger
- Liner Tube
- Jar Sample

WATER LEVEL SYMBOLS

- Groundwater level determined during drilling operations
- Groundwater level after drilling in open borehole or piezometer

SOIL GRAIN SIZE

Classification	Particle Size	Particle Size or Sieve No. (U.S. Standard)
Clay	< 0.002 mm	< 0.002 mm
Silt	0.002 - 0.075 mm	0.002 mm - #200 sieve
Sand	0.075 - 4.75 mm	#200 sieve - #4 sieve
Gravel	4.75 - 75 mm	#4 sieve - 3 in.
Cobble	75 - 200 mm	3 in. - 8 in.
Boulder	> 200 mm	> 8 in.

DENSITY OF COHESIONLESS SOILS

Descriptive Term	Penetration Resistance "N" * Blows/Foot
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	> 50

CONSISTENCY OF COHESIVE SOILS

Consistency	Undrained Shear Strength (tsf)
Very Soft	0 - 0.125
Soft	0.125 - 0.25
Firm	0.25 - 0.5
Stiff	0.5 - 1.0
Very Stiff	1.0 - 2.0
Hard	> 2.0

PENETRATION RESISTANCE

3/6	Blows required to penetrate each of three consecutive 6-inch increments per ASTM D-1586 *
50/4"	If more than 50 blows are required, driving is discontinued and penetration at 50 blows is noted
0/18"	Sampler penetrated full depth under weight of drill rods and hammer

* The N value is taken as the blows required to penetrate the final 12 inches

TERMS DESCRIBING SOIL STRUCTURE

Slickensided	Fracture planes appear polished or glossy, sometimes striated
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Inclusion	Small pockets of different soils, such as small lenses of sand scattered through a mass of clay
Parting	Inclusion less than 1/4 inch thick extending through the sample
Seam	Inclusion 1/4 inch to 3 inches thick extending through the sample
Layer	Inclusion greater than 3 inches thick extending through the sample
Laminated	Soil sample composed of alternating partings of different soil type
Stratified	Soil sample composed of alternating seams or layers of different soil type
Intermixed	Soil sample composed of pockets of different soil type and laminated or stratified structure is not evident
Calcareous	Having appreciable quantities of calcium carbonate
Ferrous	Having appreciable quantities of iron
Nodule	A small mass of irregular shape

HVJ ASSOCIATES

PROJECT NO.: AG 06 24042

DRAWING NO.: PLATE 8A

KEY TO TERMS AND SYMBOLS USED ON BORING LOGS FOR SOIL

DATE: 4/27/2012 2:32:05 PM
FILE: P:\geo\Projects\2006\AG 06 24042 Perimeter Road Est Phase 2, AECOM\CAD\SOIL.dwg

ROCK TYPES

- Limestone
- Shale
- Sandstone
- Highly Weathered Limestone
- Weathered Shale
- Weathered Sandstone
- Weathered Limestone
- Dolomite
- Granite

SAMPLER TYPES

- Thin-Walled Tube
- Rock Core
- Standard Penetration Test
- Auger
- THD Cone Penetration Test
- Bag Sample

SOLUTION AND VOID CONDITIONS

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

HARDNESS

Very Soft	Can be carved with a knife, broken with finger pressure, or UCS less than 30 tsf
Soft	Can be gouged or grooved readily with a knife, or UCS between 30 and 100 tsf
Moderately Hard	Can be scratched easily with a knife, or UCS between 100 and 250 tsf
Hard	Can be scratched rarely with a knife, or UCS greater than 250 tsf
Very Hard	Cannot be scratched with a knife

WEATHERING GRADES OF ROCKMASS (1)

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 into 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.

JOINT DESCRIPTION

SPACING		INCLINATION		SURFACES	
Very Close	<2"	Horizontal	0-5	Slickensided	Polished, grooved
Close	2"-12"	Shallow	5-35	Smooth	Planar
Medium Close	12"-3'	Moderate	35-65	Irregular	Undulating or granular
Wide	>3'	Steep	65-85	Rough	Jagged or pitted
		Vertical	85-90		

REFERENCES:

(1) British Standard (1981) Code of Practice for Site Investigation, BS 5930.

(2) The Bridge Div., Tx. Highway Dept. Foundation Exploration & Design Manual, 2nd Division, revised June, 1974.

BEDDING THICKNESS (2)

Very Thick	>4'
Thick	2'-4'
Thin	2"-2'
Very Thin	1/2"-2"
Laminated	0.08"-1/2"
Thinly Laminated	<0.08"

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.

HVJ ASSOCIATES

PROJECT NO.: AG 06 24042

DRAWING NO.: PLATE 8B

KEY TO TERMS AND SYMBOLS USED ON BORING LOGS FOR ROCK

DATE: 4/27/2012 2:40:04 PM
FILE: P:\geo\Projects\2006\AG 06 24042 Perimeter Road Est Phase 2, AECOM\CAD\ROCK.dwg

APPENDIX A

LABORATORY TEST RESULTS SUMMARY

LABORATORY TEST RESULTS SUMMARY
Project Name: Perimeter Road Est Phase 2
Project Number: AG 06 24042

Boring No.	Depth (ft)	% Passing No. 200 Sieve	Liquid Limit (%)	Plasticity Index (%)	Moisture Content (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	Compressive Strength (tsf)	Hand Penetrometer Reading (tsf)
B-1	2-4	94.2	77	56	30.9				2.25
	4-6								2.0
	6-8	94.4	77	54	29.5				1.25
	8-10								2.0
B-2	2-4	85.9	59	42	24.7				1.75
	4-6								1.75
	6-8	89.4	72	45	31.6				1.0
	8-10								2.0
B-3	2-4	95.6	88	67	34.4				1.5
	4-6	94.4	87	66	32.3				2.25
	6-6.5								1.75
	8-9.5	96.9	59	38	20.9				
B-4	2-4	22.3	35	12	11.7				
	4-6								1.5
	6-8	94.1	81	54	31.1				1.75
	8-10								4.5+

May 10, 2012

Jason Schwarz
HVJ Associates, Inc.
4201 Freidrich Lane, Suite 110
Austin, Texas 78744-1045
TEL: (512) 447-9081
FAX (512) 443-3442

Order No.: 1205038

RE: Perimeter Road SAT

Dear Jason Schwarz:

DHL Analytical received 2 sample(s) on 5/3/2012 for the analyses presented in the following report.

There were no problems with the analyses and all data for associated QC met EPA or laboratory specifications except where noted in the Case Narrative and all estimated uncertainties of results are within method specifications.

If you have any questions regarding these tests results, please feel free to call.

Sincerely,

John DuPont
General Manager

This report was performed under the accreditation of the State of Texas Laboratory Certification Number: T104704211-12-8

Table of Contents

Miscellaneous Documents 3

CaseNarrative 1205038 5

Analytical Report 1205038 6

AnalyticalQCSummaryReport 1205038 8

DHL ANALYTICAL
2300 Double Creek Dr. ■ Round Rock, TX 78664
Phone (512) 388-8222 ■ FAX (512) 388-8229
Web: www.dhlanalytical.com
E-Mail: login@dhlanalytical.com

№ 55202

CHAIN-OF-CUSTODY

CLIENT: HVJ Associates Inc
ADDRESS: 4201 Freidrich Ste 110 78744
PHONE: 512-447-9081 FAX/E-MAIL: jschwarz@hvj.com
DATA REPORTED TO: Jason Schwarz
ADDITIONAL REPORT COPIES TO:

DATE: 5/3/12 PAGE 1 OF 1
PO #: 12-150A DHL WORK ORDER #: 1205038
PROJECT LOCATION OR NAME: Perimeter Road SAT
CLENT PROJECT #: A6062404Z COLLECTOR: J Demny

Authorize 5% surcharge for TRRP Report? ❑ Yes ❑ No

S=SOIL P=PAINT W=WATER SL=SLUDGE A=AIR O=OTHER L=LIQUID SO=SOLID

PRESERVATION: HCl, HNO_3, H_2SO_4 ❑ NaOH ❑, ICE, UNPRESERVED

ANALYSES: BTEX ❑ MTBE ❑ (METHOD 8021) TPH 1005 ❑ TPH 1006 ❑ HOLD 1006 ❑ GRO (METHOD 8015) ❑ DRO (METHOD 8105) ❑ VOC 8260 ❑ VOC 624 ❑ VOC 8260/5035 ❑ SVOC 8270 ❑ PAH 8270 ❑ HOLD PAH ❑ SVOC 625 ❑ 8081 PEST ❑ 608 PEST/PCB ❑ 8270 PEST ❑ 8270 O-P PEST ❑ 8082 PCB ❑ 8270 PCB ❑ 8321 HERB ❑ 8330 EXPL ❑ PERCHLORATE ❑ METALS 6020 ❑ METALS 200.8 ❑ DISS. METALS ❑ RCRA ❑ TX11 ❑ ____ ❑ PH ❑ HEX CHROM ❑ ALKALINITY ❑ CHLORIDE ❑ ANIONS ____ ❑ TCLP-SVOC ❑ VOC ❑ PEST ❑ HERB ❑ TCLP-METALS ❑ RCRA 8 ❑ TX-11 ❑ Pb ❑ RCI ❑ TOX ❑ FLASHPOINT ❑ TDS ❑ TSS ❑ % MOISTURE ❑ CYANIDE ❑ Sulfate

Field Sample I.D.	DHL Lab #	Date	Time	Matrix	Container Type	# of Containers	HCl	HNO_3	H_2SO_4 ❑ NaOH ❑	ICE	UNPRESERVED	Sulfate	FIELD NOTES
B-1 4-6	01	5/2/12	11:00	S	shelbie	1					X	X	
B-6 4-6	02	↓	↓	↓	↓	1					X	X	
TOTAL													

RELINQUISHED BY: (Signature) Jason Schwarz DATE/TIME 5/3/12 8:40 AM RECEIVED BY: (Signature)
RELINQUISHED BY: (Signature) DATE/TIME RECEIVED BY: (Signature)
RELINQUISHED BY: (Signature) DATE/TIME RECEIVED BY: (Signature)

❑ DHL DISPOSAL @ $5.00 each ❑ Return

TURN AROUND TIME
RUSH ❑ CALL FIRST
1 DAY ❑ CALL FIRST
2 DAY ❑
NORMAL ☒
OTHER ❑ ____

LABORATORY USE ONLY:
RECEIVING TEMP: 25.3°C THERM #: 57
CUSTODY SEALS: ❑ BROKEN ❑ INTACT ☒ NOT USED
❑ CARRIER BILL #: ____
❑ APC DELIVERY
☒ HAND DELIVERED

DHL Analytical

Sample Receipt Checklist

Client Name HVJ Associates, Inc. Date Received: 5/3/2012

Work Order Number 1205038 Received by JGD

Checklist completed by: Signature 5/3/2012 Date Reviewed by Initials 5/3/2012 Date

Carrier name: Hand Delivered

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on shippping container/cooler?	Yes ☐	No ☐	Not Present ☑
Custody seals intact on sample bottles?	Yes ☐	No ☐	Not Present ☑
Chain of custody present?	Yes ☑	No ☐	
Chain of custody signed when relinquished and received?	Yes ☑	No ☐	
Chain of custody agrees with sample labels?	Yes ☑	No ☐	
Samples in proper container/bottle?	Yes ☑	No ☐	
Sample containers intact?	Yes ☑	No ☐	
Sufficient sample volume for indicated test?	Yes ☑	No ☐	
All samples received within holding time?	Yes ☑	No ☐	
Container/Temp Blank temperature in compliance?	Yes ☑	No ☐	25.3 °C
Water - VOA vials have zero headspace?	Yes ☐	No ☐	No VOA vials submitted ☑
Water - pH acceptable upon receipt?	Yes ☐	No ☐	Not Applicable ☑

Adjusted? _____ Checked by _____

Any No response must be detailed in the comments section below.

Client contacted _____ Date contacted: _____ Person contacted _____

Contacted by: _____ Regarding: _____

Comments: _____

Corrective Action _____

Page 1 of 1

DHL Analytical **Date:** *10-May-12*

CLIENT: HVJ Associates, Inc.
Project: Perimeter Road SAT
Lab Order: 1205038

CASE NARRATIVE

Samples were analyzed using the methods outlined in the following references:

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW846, 3rd Edition.

All method blanks, laboratory spikes, and/or matrix spikes met quality assurance objectives.

DHL Analytical

Date: *10-May-12*

CLIENT:	HVJ Associates, Inc.	**Client Sample ID:**	B-1 4-6
Project:	Perimeter Road SAT	**Lab ID:**	1205038-01
Project No:	AG0624042	**Collection Date:**	05/02/12 11:00 AM
Lab Order:	1205038	**Matrix:**	SOLID

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
ANIONS BY IC METHOD - SOIL		**SW9056**					Analyst: **JBC**
Sulfate	ND	9.65	9.65		mg/Kg	1	05/08/12 02:31 PM

Qualifiers:				
	*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
	C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
	E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
	MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
	RL	Reporting Limit	S	Spike Recovery outside control limits
	N	Parameter not NELAC certified		

DHL Analytical

Date: *10-May-12*

CLIENT:	HVJ Associates, Inc.	**Client Sample ID:**	B-6 4-6
Project:	Perimeter Road SAT	**Lab ID:**	1205038-02
Project No:	AG0624042	**Collection Date:**	05/02/12 11:00 AM
Lab Order:	1205038	**Matrix:**	SOLID

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
ANIONS BY IC METHOD - SOIL		**SW9056**					Analyst: **JBC**
Sulfate	58.5	9.67	9.67		mg/Kg	1	05/08/12 03:35 PM

Qualifiers:				
	*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
	C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
	E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
	MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
	RL	Reporting Limit	S	Spike Recovery outside control limits
	N	Parameter not NELAC certified		

DHL Analytical

Date: *10-May-12*

CLIENT: HVJ Associates, Inc.
Work Order: 1205038
Project: Perimeter Road SAT

ANALYTICAL QC SUMMARY REPORT

RunID: **IC_120508A**

The QC data in batch 51791 applies to the folowing samples: 1205038-01A, 1205038-02A

Sample ID: **LCS-51791** Batch ID: **51791** TestNo: **SW9056** Units: **mg/Kg**
SampType: **LCS** Run ID: **IC_120508A** Analysis Date: **5/8/2012 1:56:16 PM** Prep Date: **5/8/2012**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Sulfate	151	10.0	150.0	0	101	80	120			

Sample ID: **LCSD-51791** Batch ID: **51791** TestNo: **SW9056** Units: **mg/Kg**
SampType: **LCSD** Run ID: **IC_120508A** Analysis Date: **5/8/2012 2:07:52 PM** Prep Date: **5/8/2012**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Sulfate	153	10.0	150.0	0	102	80	120	1.31	15	

Sample ID: **MB-51791** Batch ID: **51791** TestNo: **SW9056** Units: **mg/Kg**
SampType: **MBLK** Run ID: **IC_120508A** Analysis Date: **5/8/2012 2:19:29 PM** Prep Date: **5/8/2012**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Sulfate	ND	10.0								

Sample ID: **1205038-01A DUP** Batch ID: **51791** TestNo: **SW9056** Units: **mg/Kg**
SampType: **DUP** Run ID: **IC_120508A** Analysis Date: **5/8/2012 2:46:21 PM** Prep Date: **5/8/2012**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Sulfate	0	9.98	0	0				0	10	

Sample ID: **1205038-01A MS** Batch ID: **51791** TestNo: **SW9056** Units: **mg/Kg**
SampType: **MS** Run ID: **IC_120508A** Analysis Date: **5/8/2012 2:57:57 PM** Prep Date: **5/8/2012**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Sulfate	151	9.65	144.8	0	104	80	120			

Sample ID: **1205038-01A MSD** Batch ID: **51791** TestNo: **SW9056** Units: **mg/Kg**
SampType: **MSD** Run ID: **IC_120508A** Analysis Date: **5/8/2012 3:09:33 PM** Prep Date: **5/8/2012**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Sulfate	151	9.65	144.8	0	104	80	120	0.262	15	

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAC certified

APPENDIX B

DARWIN OUTPUT

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product

Rigid Structural Design Module

Perimeter Road Est. Phase 2
San Antonio Internation Airport (SAT)
HVJ Project No: AG0624042
HMAC Base (Non-erodable Base)

Rigid Structural Design

Pavement Type	JRCP
18-kip ESALs Over Initial Performance Period	3,420,449
Initial Serviceability	4.5
Terminal Serviceability	2.5
28-day Mean PCC Modulus of Rupture	600 psi
28-day Mean Elastic Modulus of Slab	4,000,000 psi
Mean Effective k-value	68 psi/in
Reliability Level	90 %
Overall Standard Deviation	0.35
Load Transfer Coefficient, J	3.6
Overall Drainage Coefficient, Cd	1
Calculated Design Thickness	9.74 in

Effective Modulus of Subgrade Reaction

Period	Description	Roadbed Soil Resilient Modulus (psi)	Base Elastic Modulus (psi)
1	-	2,300	500,000

Base Type	HMAC Base
Base Thickness	4 in
Depth to Bedrock	100 ft
Projected Slab Thickness	10 in
Loss of Support Category	1
Effective Modulus of Subgrade Reaction	68 psi/in

Rigorous ESAL Calculation

Performance Period (years)	20
Two-Way Traffic (ADT)	80
Number of Lanes in Design Direction	1
Percent of All Trucks in Design Lane	100 %
Percent Trucks in Design Direction	50 %

Vehicle Class	Percent of ADT	Annual % Growth	Average Initial Truck Factor (ESALs/ Truck)	Annual % Growth in Truck Factor	Accumulated 18-kip ESALs over Performance Period
6	25	4	3.96	0	399,204
7	25	4	5.93	0	597,797
8	25	4	6.63	0	668,364
9	25	4	17.41	0	1,755,085
Total	100	-	-	-	3,420,449

Growth	Simple
Total Calculated Cumulative ESALs	3,420,449

Layer Information

Layer	Material Description	Thickness (in)	One Dir Width (ft)
1	JRCP	9.7430526	12
2	HMAC	4	12
3	Lime Stabilized Subgrade	8	12
Total	-	20.69	-

*Note: These values are not represented by the inputs or an error occurred in calculation.

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product

Rigid Structural Design Module

Perimeter Road Est. Phase 2
San Antonio Internation Airport (SAT)
HVJ Project No: AG0624042
Flex Base option - requires protection of erodable base under concrete

Rigid Structural Design

Pavement Type	JRCP
18-kip ESALs Over Initial Performance Period	3,420,449
Initial Serviceability	4.5
Terminal Serviceability	2.5
28-day Mean PCC Modulus of Rupture	600 psi
28-day Mean Elastic Modulus of Slab	4,000,000 psi
Mean Effective k-value	27 psi/in
Reliability Level	90 %
Overall Standard Deviation	0.35
Load Transfer Coefficient, J	3.6
Overall Drainage Coefficient, Cd	1
Calculated Design Thickness	10.02 in

Effective Modulus of Subgrade Reaction

Period	Description	Roadbed Soil Resilient Modulus (psi)	Base Elastic Modulus (psi)
1	-	2,300	50,000

Base Type	Flex Base
Base Thickness	8 in
Depth to Bedrock	100 ft
Projected Slab Thickness	10 in
Loss of Support Category	2
Effective Modulus of Subgrade Reaction	27 psi/in

Layer Information

Layer	Material Description	Thickness (in)	One Dir Width (ft)
1	JRCP	9	12
2	Flex Base	8	12
3	Lime Stabilized Subgrade	6	12
Total	-	23.00	-

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