Geotechnical Engineering Report

Yuma Road Improvements as Part of
Tom Jones Ford Dealership
Yuma Road from S. Apache Road to 247th Avenue
Buckeye, Arizona

March 18, 2014

Terracon Project No. 65145202

Prepared for:
Kimley-Horn and Associates
Phoenix, Arizona

Prepared by:
Terracon Consultants, Inc.
Tempe, Arizona

March 18, 2014

Kimley-Horn and Associates, Inc.
7740 N. 16th Street, Suite 300
Phoenix, Arizona 85020

Attn: Mr. Sterling Margetts

Re: Geotechnical Engineering Report
Yuma Road Improvements as Part of
Tom Jones Ford Dealership
Yuma Road from S. Apache Road to 247th Avenue
Buckeye, Arizona
Terracon Project No. 65145203

Dear Mr. Margetts:

Terracon Consultants, Inc. (Terracon) has completed the geotechnical engineering services for the above referenced project. These services were performed in general accordance with the Agreement for Professional Services between Kimley-Horn and Associates, Inc. and Terracon dated January 22, 2014. This geotechnical engineering report presents the results of the subsurface exploration and provides geotechnical recommendations concerning earthwork for the proposed off-site paving improvements along Yuma Road.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report, or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.

Jesse R. Huston, P.E.
Senior Project Manager

Scott D. Neely, P.E.
Principal

65145203.Kimly-Horn.Tom Jones Ford Off-Site.rpt

Copies to: Addressee (1 via email)

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TOM JONES FORD DEALERSHIP
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BUCKEYE, ARIZONA

Terracon Project No. 65145203
March 18, 2014

1.0 INTRODUCTION

This report presents the results of our geotechnical engineering services performed for the planned Yuma Road improvements in association with construction of the Tom Jones Ford Dealership in Buckeye, Arizona. The roadway widening is planned for an approximately 2,900 foot length along the north side of Yuma Road between 247th Avenue and S. Apache Road. The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- subsurface soil conditions
- groundwater conditions
- earthwork
- pavement design

Our geotechnical engineering scope of work for this project included drilling six (6) borings for subsurface exploration, laboratory testing, geotechnical engineering analysis, and preparation of this report. A Site Plan and Boring Locations diagram (Exhibits A-1) and boring logs are included in Appendix A of this report. The results of the laboratory testing performed on soil samples obtained from the site during the field exploration are included in Appendix B of this report. Descriptions of the field exploration and laboratory testing are included in their respective appendices.

2.0 PROJECT INFORMATION

2.1 Project Description

ITEM	DESCRIPTION
Site Layout	See Exhibit A-1 in Appendix A.
Description	Westbound Yuma Road will be widened for an approximately 2,900 foot length along the north side of Yuma Road between 247th Avenue and S. Apache Road.

ITEM	DESCRIPTION
Grading	We understand the finished grade of the planned pavement construction will be near (i.e., generally within 6 inches) of the existing unpaved shoulder surface.

2.2 Site Description

ITEM	DESCRIPTION
Location	Westbound Yuma Road between 247th Avenue and S. Apache Road in Buckeye, Arizona.
Existing site features	Yuma Road currently exists as an asphalt paved two-lane roadway with unpaved shoulders. The easternmost 400 feet of the north shoulder of Yuma Road is paved and tapers to meet the existing roadway configuration east of S. Apache Road.
Current ground cover	Bare soil and asphalt concrete.
Existing topography	Appears to fairly flat.

3.0 SUBSURFACE CONDITIONS

3.1 Site Geology

The project area is located in the Basin and Range physiographic province ([1]Cooley, 1967) of the North American Cordillera ([2]Stern, et al, 1979) of the southwestern United States. The southern portion of the Basin and Range province is situated along the southwestern flank of the Colorado Plateau and is bounded by the Sierra Nevada Mountains to the west. Formed during middle and late Tertiary time (100 to 15 million years ago), the Basin and Range province is dominated by fault controlled topography. The topography consists of mountain ranges and relatively flat alluviated valleys. These mountain ranges and valleys have evolved from generally complex movements and associated erosional and depositional processes.

Surficial geologic conditions mapped in the project vicinity ([3]Richard, et al, 2000) consist of Holocene surficial deposits. This unit is described as unconsolidated deposits associated with modern fluvial systems. These deposits consist primarily of fine-grained, poorly graded sediment on alluvial plains; but also include gravelly channel, terrace, and alluvial fan deposits on middle and upper piedmonts.

[1] Cooley, M.E., 1967, **Arizona Highway Geologic Map**, Arizona Geological Society.
[2] Stern, C.W., et al, 1979, **Geological Evolution of North America**, John Wiley & Sons, Santa Barbara, California.
[3] Richard, S. M., Reynolds, S.J., Spencer, J. E., and Pearthree, P. A., 2000, ***Geologic Map of Arizona***: Arizona Geological Survey Map 35, 1 sheet, scale 1:1,000,000.

3.2 Subsurface Soil Conditions

Specific conditions encountered at each boring location are indicated on the individual boring logs. Stratification boundaries on the boring logs represent the approximate location of changes in soil types; in-situ, the transition between materials may be gradual. Details for each of the borings can be found on the boring logs included in Appendix A of this report.

Based on conditions encountered in the borings, the subsurface conditions across the project site can be generalized as follows:

Description	Approximate Depth to Bottom of Stratum (feet)	Material Encountered	Relative Density
Stratum 1[1]	5½	Sand w/ variable amounts of clay, silt and gravel	Loose to Medium Dense

[1] In Boring B-6, an existing pavement section consisting of 3½ inches of asphalt concrete over 6½ inches of aggregate base course was encountered at the surface.

Laboratory tests were conducted on selected soil samples and the test results are presented in Appendix B. Moisture content and Atterberg limits test results are also presented on the boring logs at the sample depth. The laboratory tested R-Value for one sample from P-5 was 78. Laboratory test results indicate the sand soils are generally nonplastic.

3.3 Laboratory Test Data – Subgrade Soils

For purposes of pavement thickness design, the results of the laboratory testing, including the correlated R-Values and tested R-Values are summarized in the following table. Correlated R-Values were determined in accordance with the ADOT Materials Preliminary Engineering and Design Manual.

Boring	Depth (ft.)	LL	PI	-#200	R-Value Tested	R-Value Correlated
P-1	0.0	0	0	13	---	84
P-3	0.0	0	0	7	---	91
P-5	0.0	0	0	20	78	76

3.4 Groundwater Conditions

Groundwater was not observed in any test boring at the time of field exploration, nor when checked upon completion of drilling. These observations represent groundwater conditions at the time of the field exploration and may not be indicative of other times, or at other locations.

Groundwater conditions can change with varying seasonal and weather conditions, and other factors.

Based on information obtained from the Arizona Department of Water Resources – Groundwater Data website (https://gisweb.azwater.gov/waterresourcedata/GWSI.aspx), the depth to regional groundwater was measured in January 2014 to be approximately 155 feet below the ground surface (approximate elevation of 840 feet above mean sea level) at an Arizona Department of Water Resources (ADWR) monitored well site (Local I.D. B-01-21DBB) located approximately 1½ miles southeast of the site.

4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

4.1 Geotechnical Considerations

Based on the site explorations and results of the laboratory testing, the subgrade soils in the roadway paving areas are considered suitable for support of the new pavement section. The following sections present recommendations regarding design and construction of the proposed roadway widening.

4.2 Pavement Thickness Design

4.2.1 Pavement Subgrade Parameters

Subgrade parameters for use in the design of the roadway widening were determined in general accordance with the procedures of the ADOT Materials Preliminary Engineering and Design Manual. Three samples of anticipated subgrade material were tested for sieve analysis and plasticity index, and one of these samples was tested for R-value. The correlated R-values ranged from 76 to 91, with a tested R-Value of 78. As shown on Exhibit C-1 in Appendix C, the calculated mean R-value is 83. Using a Seasonal Variation Factor of 1.0, the calculated design Resilient Modulus is 61,706 psi. However, ADOT caps the maximum value of design Resilient Modulus at 26,000 psi. Therefore, a design Resilient Modulus value of 26,000 psi was used for this analysis.

4.2.2 Design ESALs

Traffic data for this segment of Yuma Road was not provided. Based on the Town of Buckeye Street Planning and Design Criteria, the Average Daily Traffic (ADT) for Arterial roadways ranges from 5,800 to 8,700. For this pavement design, we have used the median value design traffic of 7,250 vehicles per day, with one percent of the design traffic estimated to consist of truck traffic (i.e., 73 trucks per day). The factors used to calculate the design ESAL's from the estimated design traffic are presented in the following table:

Design Parameter	Value
Design Traffic (ADT)	7,250
Directional Distribution (percent)	100
Lane Distribution (percent)	100
% Trucks	1.0
Truck Factor	2.42
% Passenger Vehicles	99.0
Passenger Vehicle Factor	0.0008
Design ESALs per day	182
Design Life (years)	20
Total Design ESALs	1,328,600

4.2.3 Pavement Design Parameters

The roadway widening was designed following the procedures outlined in the ADOT Materials Preliminary Engineering and Design Manual. The following table present design parameters that were utilized for pavement thickness design on this project.

Design Parameter		Per ADOT Materials Preliminary Engineering and Design Manual
Mean R-value		83
Design Modulus of Subgrade (psi)		26,000 (ADOT maximum design value)
Level of Reliability		90%
Standard Normal Deviate		-1.282
Standard Deviation		0.35
Initial PSI		4.1
Terminal PSI		2.6
ΔPSI		1.5
Layer Coefficient	Asphalt Concrete (AC)	0.44
	Aggregate Base (Class 2)	0.14
Seasonal Variation Factor		1.0
Drainage Coefficient for Class 2 layer (fair)		1.0

4.2.4 Design Thickness Recommendations

We understand this section of Yuma Road to have a function classification as an arterial roadway. Based on the above described design criteria, the minimum Structural Number (SN) required for new pavement section at the site is 2.18. However, the Town of Buckeye requires a pavement section for an arterial roadway to consist of a minimum of 6 inches AC over a minimum 12 inches of ABC (refer to Town of Buckeye Standard Detail for Arterial roadways), which equates to an SN of 4.32. As this structural number of 4.32 exceeds that of the design structural number of 2.18, the Town of Buckeye minimum arterial roadway structural section governs the pavement section design for this project. The designed based and Town of Buckeye minimum sections are presented in the following table. Refer to Exhibit C-2 in Appendix C for the supporting design calculations.

Roadway	Method	AC Thickness (inches)	ABC Thickness (inches)	Structural Number
Yuma Road from S. Apache Road to 247th Avenue	Design Based	5.0	4.0	2.76
	Town of Buckeye Minimum	**6.0**	**12.0**	**4.32**

Based on the subgrade soils along the roadway alignment, the Town of Buckeye minimum pavement section for this section of Yuma road will support 75,190,000 ESALs over a design life of 20 years.

4.2.5 Pavement Specifications and Construction Considerations

Materials and construction of pavements for the project should be in accordance with the requirements and specifications of the Maricopa Association of Governments ([4]MAG, 2012).

Base course or pavement materials should not be placed when the surface is wet. Surface drainage should be provided away from the edge of paved areas to minimize lateral moisture transmission into the subgrade.

Future performance of pavements constructed on the soils at this site will be dependent upon several factors, including:

- maintaining stable moisture content of the subgrade soils; and,
- providing for a planned program of preventative maintenance.

Preventative maintenance should be planned and provided for through an on-going pavement management program in order to enhance future pavement performance. Preventative

[4]Maricopa Association of Governments, 2012, ***Uniform Standard Specifications and Details for Public Works Construction***, Arizona.

maintenance activities are intended to slow the rate of pavement deterioration, and to preserve the pavement investment.

Preventative maintenance consists of both localized maintenance (e.g. crack sealing and patching) and global maintenance (e.g. surface sealing). Preventative maintenance is usually the first priority when implementing a planned pavement maintenance program and provides the highest return on investment for pavements.

4.3 Earthwork

The following presents recommendations for excavation and subgrade preparation on the project. Earthwork on the project should be observed and evaluated by a licensed geotechnical engineer. The evaluation of earthwork should include observation and testing of engineered fill, subgrade preparation, and other geotechnical conditions exposed during the construction of the project.

4.3.1 Site Preparation

Remove all existing surface vegetation, any uncontrolled fill, and any loose or unstable materials from the pavement widening areas.

It is anticipated that excavations for the proposed construction can be accomplished with conventional earthmoving equipment. Based upon the subsurface conditions determined from the geotechnical exploration, the subgrade soils exposed during construction are expected to be relatively stable. However, the stability of the subgrade may be affected by repetitive construction traffic or other factors.

Exposed areas which will receive fill or aggregate base course should be scarified to a minimum depth of eight inches, moisture conditioned, and compacted. Exposed surfaces should be free of mounds and depressions which could prevent uniform compaction. Anticipated ground compaction for this project is 0.1 feet.

4.3.2 Fill Materials and Placement

All fill materials should be inorganic soils free of vegetation, debris, and fragments larger than four inches in size. Pea gravel or other similar non-cementitious, poorly-graded materials should not be used as fill or backfill without the prior approval of the geotechnical engineer.

The existing subgrade soils are considered suitable for use as engineered fill in all areas of the site. Imported soils (if required) for use as fill on the site should conform to the following specifications:

Gradation	Percent Finer by Weight (ASTM C 136)
4"	100
3"	70-100
No. 4 Sieve	40-75
No. 200 Sieve	20 (max)

- Liquid Limit ..... 15 (max)
- Plasticity Index ..... 3 (max)

Engineered fill should be placed and compacted in horizontal lifts, using equipment and procedures that will produce recommended moisture contents and densities throughout the lift. Fill lifts should not exceed ten inches loose thickness.

4.3.3 Compaction Requirements

Recommended compaction and moisture content criteria for engineered fill materials are as follows:

Material Type and Location	Per the Standard Proctor Test (ASTM D 698)		
	Minimum Compaction Requirement (%)	Range of Moisture Contents for Compaction (referenced from optimum moisture content)	
		Minimum	Maximum
On-site and approved imported soils:			
Roadway Subgrade:	95	-2%	+2%
Aggregate base (beneath asphalt pavements)	100	-3%	+3%

4.3.4 Grading and Drainage

Positive drainage should be provided during construction and maintained throughout the life of the development. All grades must provide effective drainage away from the pavement during and after construction.

5.0 GENERAL COMMENTS

Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. Terracon also should be retained to provide observation and testing services during grading, excavation, foundation construction and other earth-related construction phases of the project.

The analysis and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

The scope of services for this project does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.

APPENDIX A

FIELD EXPLORATION

LEGEND:

PAVEMENT BORING LOCATION

N

(Feet)

0 250

APPROXIMATE SCALE
1" = 250'

NOTE: SITE PLAN BASE MAP PROVIDED BY GOOGLE EARTH.

Project Mngr:	JRH
Drawn By:	CRS
Checked By:	SDN
Approved By:	SDN

Project No.	65145203
Scale:	AS SHOWN
File No.	52145203.DWG
Date:	01/29/2014

Terracon
Consulting Engineers and Scientists
4685 South Ash Avenue, Suite H-4 Tempe, AZ 85282
PH. (480) 897-8200 FAX. (480) 897-1133

SITE PLAN AND BORING LOCATIONS

YUMA ROAD IMPROVEMENTS FOR

TOM JONES FORD DEALERSHIP

YUMA ROAD FROM S. APACHE ROAD TO 247th AVENUE

BUCKEYE ARIZONA

EXHIBIT

A-1

Field Exploration Description

A total of six (6) test borings were drilled at the site on January 17, 2014. The borings were advanced to a depth of approximately 5.5 feet below the ground surface. The approximate boring locations are shown on the attached Site Plan and Boring Locations diagram, Exhibits A-1.

The test borings were advanced with a truck-mounted Diedrich D-50 drill rig utilizing 8-inch diameter hollow-stem augers. The borings were located in the field utilizing an aerial photograph.

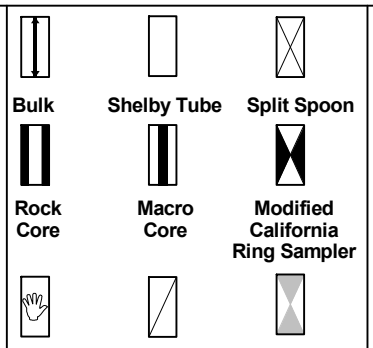
A continuous lithologic log of each boring was recorded by our field geologist during the drilling operations. At selected intervals, samples of the subsurface materials were taken by driving ring-lined barrel or standard penetration test (SPT) samplers in general accordance with ASTM Standards. Penetration resistance measurements were obtained by driving the split-spoon and ring-lined barrel samplers into the subsurface materials with a 140-pound automatic hammer falling 30 inches. The penetration resistance value is a useful index in estimating the consistency or relative density of materials encountered. Bulk samples of subsurface materials were also obtained from the auger cuttings.

Groundwater conditions were evaluated in the borings at the time of site exploration.

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAMPLING



WATER LEVEL

- Water Initially Encountered
- Water Level After a Specified Period of Time
- Water Level After a Specified Period of Time

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

FIELD TESTS

(HP)	Hand Penetrometer
(T)	Torvane
(b/f)	Standard Penetration Test (blows per foot)
N	N value
(PID)	Photo-Ionization Detector
(OVA)	Organic Vapor Analyzer

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance Includes gravels, sands and silts.			CONSISTENCY OF FINE-GRAINED SOILS (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance			
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Ring Sampler Blows/Ft.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength, Qu, psf**	**Standard Penetration or N-Value Blows/Ft.**	**Ring Sampler Blows/Ft.**
Very Loose	0 - 3	0 - 6	Very Soft	less than 500	0 - 1	< 3
Loose	4 - 9	7 - 18	Soft	500 to 1,000	2 - 4	3 - 4
Medium Dense	10 - 29	19 - 58	Medium-Stiff	1,000 to 2,000	4 - 8	5 - 9
Dense	30 - 50	59 - 98	Stiff	2,000 to 4,000	8 - 15	10 - 18
Very Dense	> 50	≥ 99	Very Stiff	4,000 to 8,000	15 - 30	19 - 42
			Hard	> 8,000	> 30	> 42

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 - 29
Modifier	> 30

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300 mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm
Silt or Clay	Passing #200 sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 - 12
Modifier	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1 - 10
Medium	11 - 30
High	> 30

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]					Soil Classification	
					Group Symbol	Group Name [B]
Coarse Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]		GW	Well-graded gravel [F]
			$Cu < 4$ and/or $1 > Cc > 3$ [E]		GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH		GM	Silty gravel [F,G,H]
			Fines classify as CL or CH		GC	Clayey gravel [F,G,H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]		SW	Well-graded sand [I]
			$Cu < 6$ and/or $1 > Cc > 3$ [E]		SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH		SM	Silty sand [G,H,I]
			Fines classify as CL or CH		SC	Clayey sand [G,H,I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots on or above "A" line [J]		CL	Lean clay [K,L,M]
			PI < 4 or plots below "A" line [J]		ML	Silt [K,L,M]
		Organic:	Liquid limit - oven dried	< 0.75	OL	Organic clay [K,L,M,N]
			Liquid limit - not dried			Organic silt [K,L,M,O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line		CH	Fat clay [K,L,M]
			PI plots below "A" line		MH	Elastic Silt [K,L,M]
		Organic:	Liquid limit - oven dried	< 0.75	OH	Organic clay [K,L,M,P]
			Liquid limit - not dried			Organic silt [K,L,M,Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor				PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

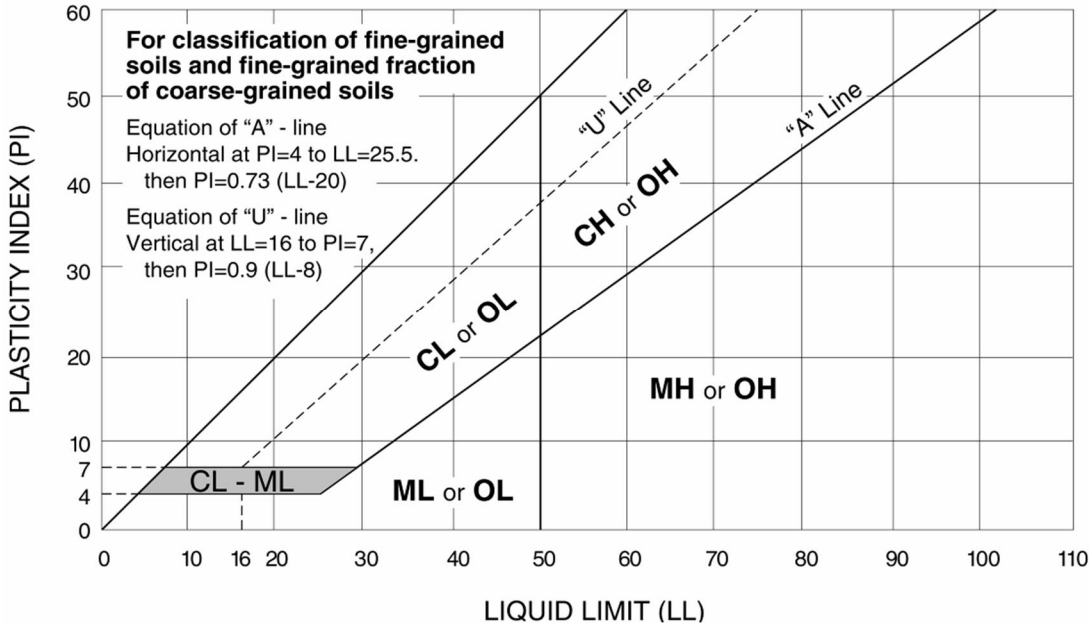
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



Terracon

Exhibit A-4

BORING LOG NO. P-1

PROJECT: Tom Jones Ford Dealership (Off-Site)

CLIENT: Kimley-Horn and Associates, Inc.
Phoenix, Arizona

SITE: Yuma Rd. from S. Apache Rd. to 247th Ave.
Buckeye, Arizona

GRAPHIC LOG	LOCATION See Exhibit A-1 DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SILTY SAND WITH GRAVEL (SM), brown, loose to medium dense								
					4-2-2 N=4			NP	13
		5			5-7-7 N=14				
	5.5 ***Boring Terminated at 5.5 Feet***								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-2 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix A for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
4685 S. Ash Ave., Suite H-4
Tempe, Arizona

Boring Started: 1/17/2014 | Boring Completed: 1/17/2014

Drill Rig: D-50 | Driller: D&S Drilling

Project No.: 65145203 | Exhibit: A-5

BORING LOG NO. P-2

PROJECT: Tom Jones Ford Dealership (Off-Site)

CLIENT: Kimley-Horn and Associates, Inc.
Phoenix, Arizona

SITE: Yuma Rd. from S. Apache Rd. to 247th Ave.
Buckeye, Arizona

GRAPHIC LOG	LOCATION See Exhibit A-1 DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SILTY SAND WITH GRAVEL (SM), brown, medium dense								
					7-7-7 N=14	3			
	4.0								
	CLAYEY SAND (SC), brown, very dense	5			19-27-35 N=62				
	5.5								
	Boring Terminated at 5.5 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-2 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix A for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
4685 S. Ash Ave., Suite H-4
Tempe, Arizona

Boring Started: 1/17/2014 | Boring Completed: 1/17/2014

Drill Rig: D-50 | Driller: D&S Drilling

Project No.: 65145203 | Exhibit: A-6

BORING LOG NO. P-3

PROJECT: Tom Jones Ford Dealership (Off-Site)

CLIENT: Kimley-Horn and Associates, Inc.
Phoenix, Arizona

SITE: Yuma Rd. from S. Apache Rd. to 247th Ave.
Buckeye, Arizona

GRAPHIC LOG	LOCATION See Exhibit A-1 DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM), brown, loose to medium dense								
					6-5-5 N=10	2		NP	7
	4.0								
	SILTY CLAYEY SAND (SC-SM), brown, dense	5			14-18-21 N=39				
	5.5								
	Boring Terminated at 5.5 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-2 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix A for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
4685 S. Ash Ave., Suite H-4
Tempe, Arizona

Boring Started: 1/17/2014 | Boring Completed: 1/17/2014

Drill Rig: D-50 | Driller: D&S Drilling

Project No.: 65145203 | Exhibit: A-7

BORING LOG NO. P-4

PROJECT: Tom Jones Ford Dealership (Off-Site)

CLIENT: Kimley-Horn and Associates, Inc.
Phoenix, Arizona

SITE: Yuma Rd. from S. Apache Rd. to 247th Ave.
Buckeye, Arizona

GRAPHIC LOG	LOCATION See Exhibit A-1 DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SILTY SAND WITH GRAVEL (SM), brown, loose								
					5-4-3 N=7	3			
	4.0								
	CLAYEY SAND WITH GRAVEL (SC), brown, medium dense	5			8-11-12 N=23				
	5.5								
	Boring Terminated at 5.5 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-2 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix A for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
4685 S. Ash Ave., Suite H-4
Tempe, Arizona

Boring Started: 1/17/2014 | Boring Completed: 1/17/2014

Drill Rig: D-50 | Driller: D&S Drilling

Project No.: 65145203 | Exhibit: A-8

BORING LOG NO. P-5

PROJECT: Tom Jones Ford Dealership (Off-Site)

CLIENT: Kimley-Horn and Associates, Inc.
Phoenix, Arizona

SITE: Yuma Rd. from S. Apache Rd. to 247th Ave.
Buckeye, Arizona

GRAPHIC LOG	LOCATION See Exhibit A-1 DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SILTY SAND WITH GRAVEL (SM), brown, loose								
					2-3-3 N=6	7			
								NP	20
		5			6-4-3 N=7				
	5.5								
	Boring Terminated at 5.5 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-2 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix A for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
4685 S. Ash Ave., Suite H-4
Tempe, Arizona

Boring Started: 1/17/2014 | Boring Completed: 1/17/2014

Drill Rig: D-50 | Driller: D&S Drilling

Project No.: 65145203 | Exhibit: A-9

BORING LOG NO. P-6

PROJECT: Tom Jones Ford Dealership (Off-Site)

CLIENT: Kimley-Horn and Associates, Inc.
Phoenix, Arizona

SITE: Yuma Rd. from S. Apache Rd. to 247th Ave.
Buckeye, Arizona

GRAPHIC LOG	LOCATION See Exhibit A-1 DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	0.3 **ASPHALT CONCRETE**, 3-1/2 inches								
	0.8 **AGGREGATE BASE COURSE**, 6-1/2 inches								
	SILTY SAND (SM), brown, medium dense				7-8-8 N=16	8			
	4.0								
	CLAYEY SAND (SC), brown, medium dense	5			24-15-13 N=28				
	5.5								
	Boring Terminated at 5.5 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-2 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix A for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
4685 S. Ash Ave., Suite H-4
Tempe, Arizona

Boring Started: 1/17/2014 | Boring Completed: 1/17/2014

Drill Rig: D-50 | Driller: D&S Drilling

Project No.: 65145203 | Exhibit: A-10

APPENDIX B

LABORATORY TESTING

Laboratory Testing

Samples retrieved during the field exploration were taken to the laboratory for further observation by the project geotechnical engineer and were classified in accordance with the Unified Soil Classification System (USCS) described in Appendix A. At that time, the field descriptions were confirmed or modified as necessary and an applicable laboratory testing program was formulated to determine engineering properties of the subsurface materials.

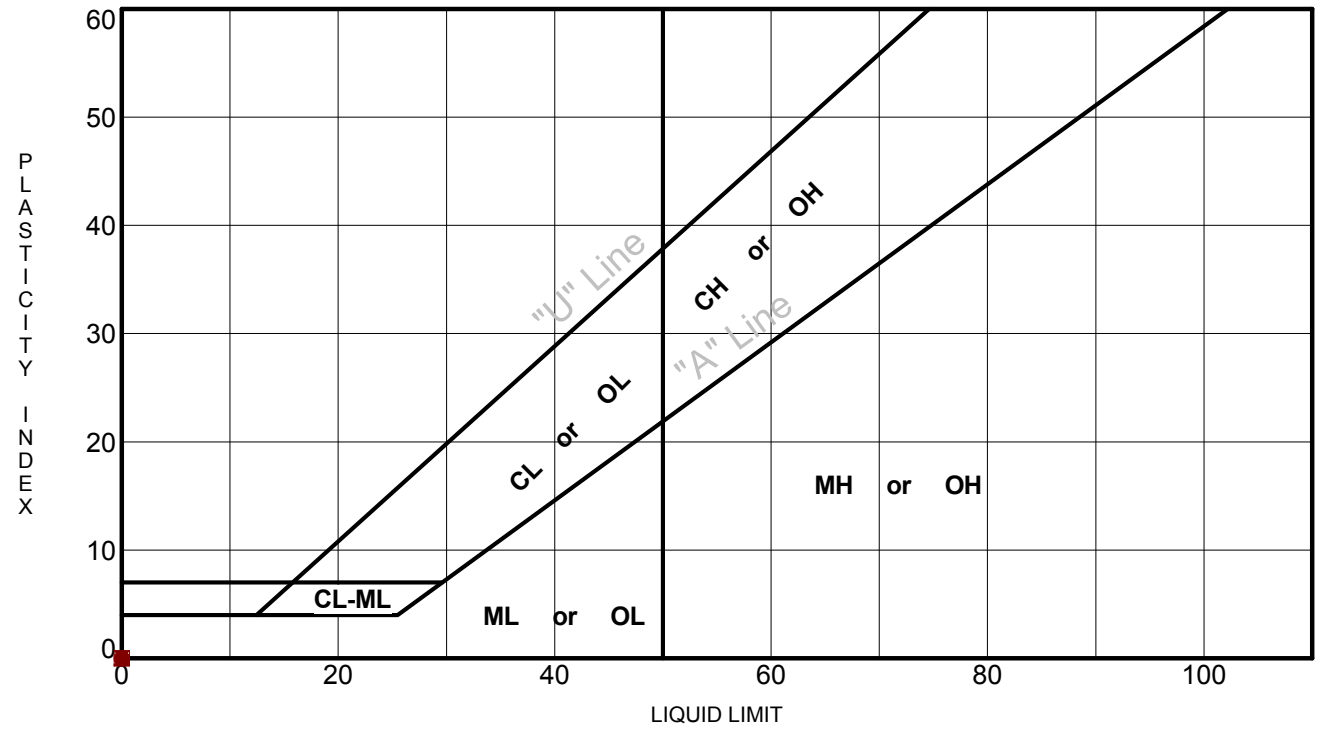
Laboratory tests were conducted on selected soil samples and the test results are presented in this appendix. The laboratory test results were used for the geotechnical engineering analyses, and the development of foundation recommendations. Laboratory tests were performed in general accordance with the applicable ASTM, local or other accepted standards.

Selected soil samples obtained from the site were tested for the following engineering properties:

- Atterberg Limits
- Moisture Content
- R-Value
- Sieve Analysis
- Dry Density

ATTERBERG LIMITS RESULTS

ASTM D4318



Boring ID	Depth	LL	PL	PI	Fines	USCS	Description
● P-1	0.0	NP	NP	NP	13	SM	SILTY SAND with GRAVEL
⊠ P-3	0.0	NP	NP	NP	7	SW-SM	WELL-GRADED SAND with SILT and GRAVEL
▲ P-5	0.0	NP	NP	NP	20	SM	SILTY SAND with GRAVEL

PROJECT: Tom Jones Ford Dealership (Off-Site)

SITE: Yuma Rd. from S. Apache Rd. to 247th Ave. Buckeye, Arizona

Terracon

4685 S. Ash Ave., Suite H-4
Tempe, Arizona

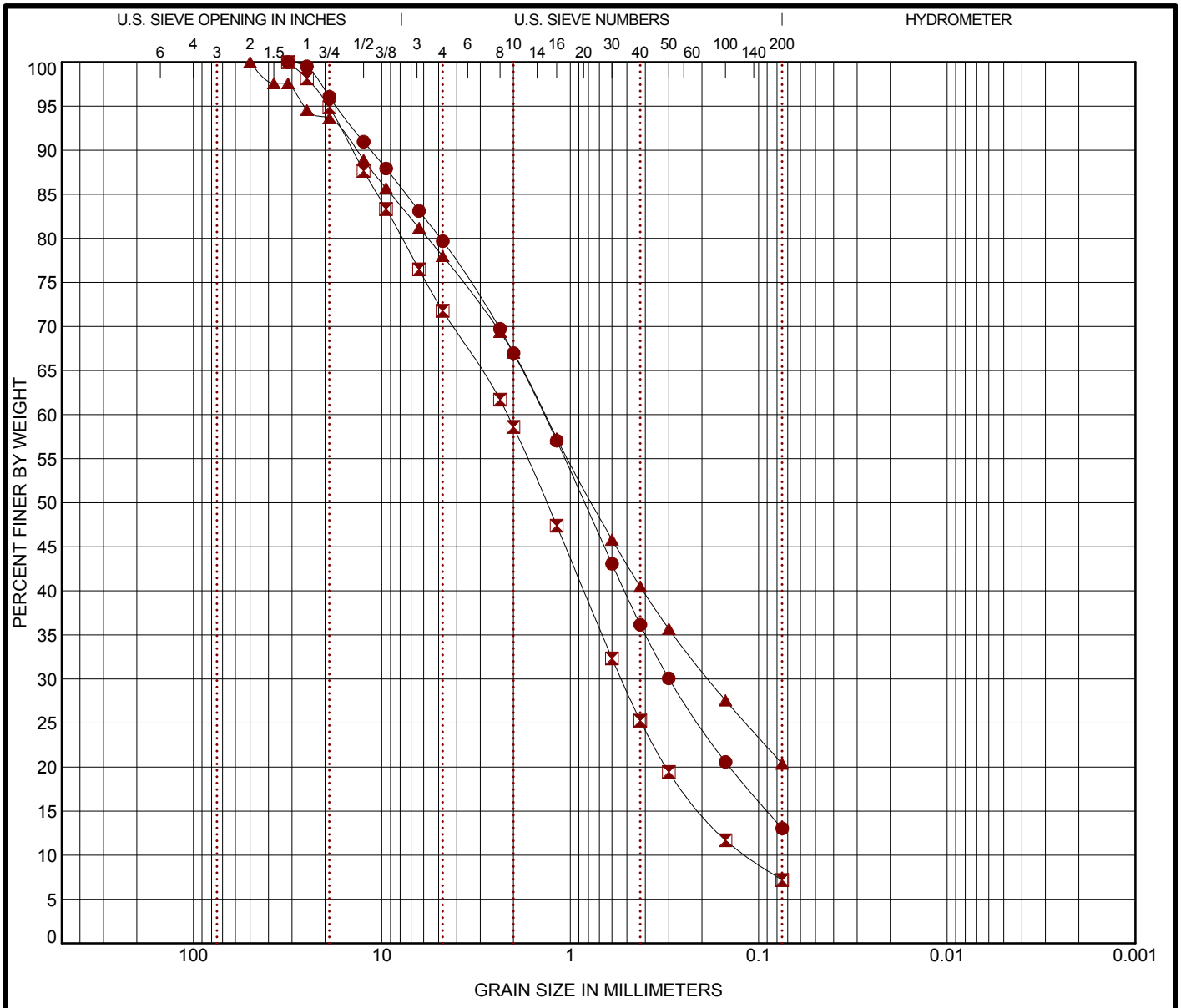
PROJECT NUMBER: 65145203

CLIENT: Kimley-Horn and Associates, Inc. Phoenix, Arizona

EXHIBIT: B-2

GRAIN SIZE DISTRIBUTION

ASTM D422



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Boring ID		Depth	USCS Classification	LL	PL	PI	Cc	Cu
●	P-1	0.0	SILTY SAND with GRAVEL(SM)	NP	NP	NP		
⊠	P-3	0.0	WELL-GRADED SAND with SILT and GRAVEL(SW-SM)	NP	NP	NP	1.15	18.66
▲	P-5	0.0	SILTY SAND with GRAVEL(SM)	NP	NP	NP		

Boring ID		Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Gravel	%Sand	%Silt	%Clay
●	P-1	0.0	31.5	1.381	0.298		20.3	66.6	13.0	
⊠	P-3	0.0	31.5	2.155	0.535	0.115	28.2	64.6	7.2	
▲	P-5	0.0	50	1.365	0.185		22.0	57.6	20.4	

PROJECT: Tom Jones Ford Dealership (Off-Site)

SITE: Yuma Rd. from S. Apache Rd. to 247th Ave.
Buckeye, Arizona

Terracon
4685 S. Ash Ave., Suite H-4
Tempe, Arizona

PROJECT NUMBER: 65145203

CLIENT: Kimley-Horn and Associates, Inc.
Phoenix, Arizona

EXHIBIT: B-3

Terracon

4685 South Ash Avenue, Suite H-4
Tempe, Arizona 85282
(480) 897-8200 FAX(480) 897-1133

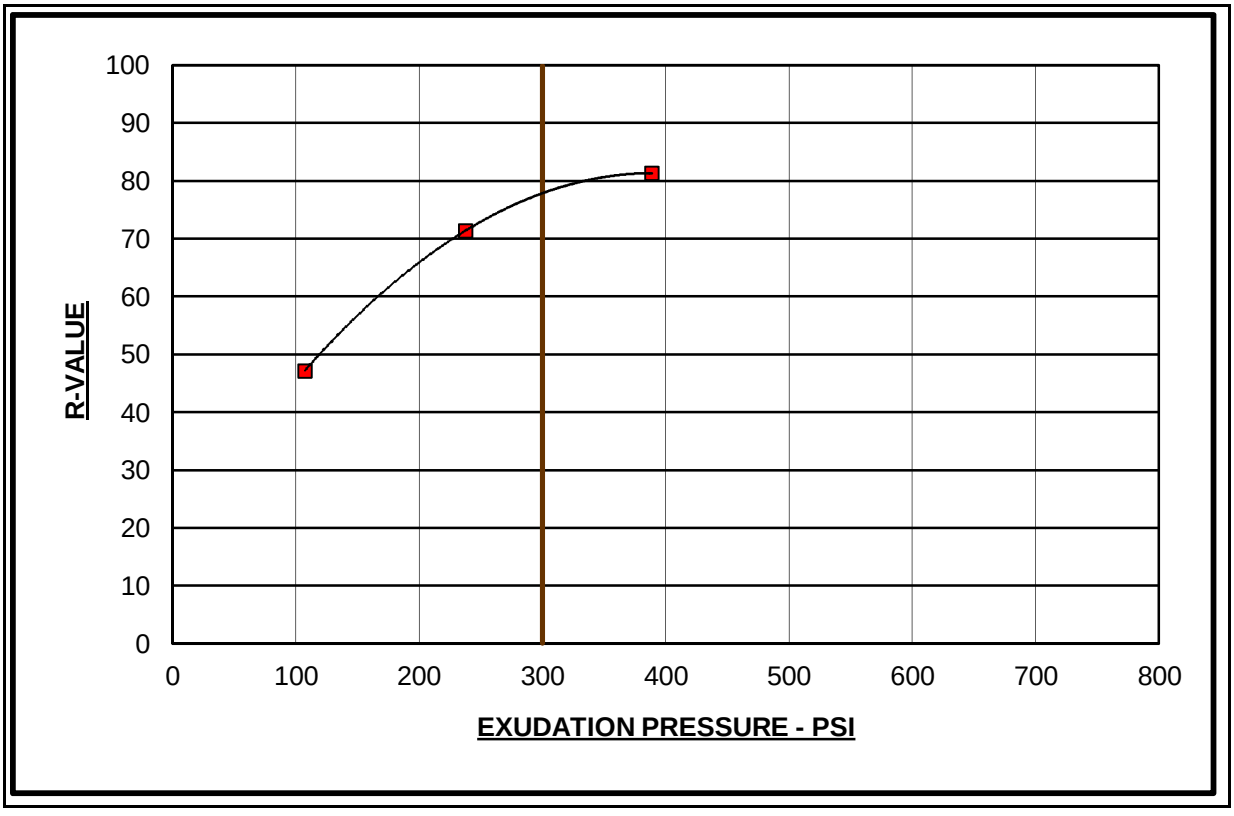
RESISTANCE R-VALUE & EXPANSION PRESSURE OF COMPACTED SOIL ASTM D2844

PROJECT:	Tom Jones Ford Dealership (Off-Site)
LOCATION:	Yuma Road from S. Apache Rd. to 247th Ave.
PROJECT NO.	65145203
CLASSIFICATION:	Silty Sand with Gravel (SM)
SAMPLE:	P-5 @ 0'

SAMPLE DATA TEST RESULTS

TEST SPECIMEN NO.	1	2	3
COMPACTION PRESSURE (PSI)	100	240	300
DENSITY (PCF)	126.3	127.7	129.9
MOISTURE CONTENT (%)	10.3	9.5	7.3
EXPANSION PRESSURE (PSI)	-0.28	-0.25	0.00
HORIZONTAL PRESSURE @ 160 PSI	56	30	22
SAMPLE HEIGHT (INCHES)	2.40	2.45	2.50
EXUDATION PRESSURE (PSI)	107.4	237.5	388.6
CORRECTED R-VALUE	47.2	71.4	81.3
UNCORRECTED R-VALUE	49.2	71.4	81.3

R-VALUE @ 300 PSI EXUDATION PRESSURE = **78**



SUMMARY OF LABORATORY RESULTS

Borehole No.	Depth (ft.)	USCS Soil Class.	In-Situ Properties		Classification				Expansion Testing					Corrosivity				Remarks
			Dry Density (pcf)	Water Content (%)	Passing #200 Sieve (%)	Atterberg Limits			Dry Density (pcf)	Water Content (%)	Surcharge (psf)	Expansion (%)	Expansion Index EI_{50}	pH	Resistivity (ohm-cm)	Sulfates (ppm)	Chlorides (ppm)	
						LL	PL	PI										
P-1	0	SM			13	NP	NP	NP										
P-2	1	SM		3														2
P-3	0	SW-SM			7	NP	NP	NP										
P-3	1	SW-SM		2														2
P-4	1	SM		3														2
P-5	0	SM			20	NP	NP	NP										
P-5	1	SM		7														2
P-6	1	SM		8														2

REMARKS

1. Dry Density and/or moisture determined from one or more rings of a multi-ring sample.
2. Visual Classification.
3. Submerged to approximate saturation.
4. Expansion Index in accordance with ASTM D4829-95.
5. Air-Dried Sample

PROJECT: Tom Jones Ford Dealership (Off-Site)

SITE: Yuma Rd. from S. Apache Rd. to 247th Ave.
Buckeye, Arizona

Terracon
4685 S. Ash Ave., Suite H-4
Tempe, Arizona
PH. 480-897-8200 FAX. 480-897-1133

PROJECT NUMBER: 65145203

CLIENT: Kimley-Horn and Associates, Inc.
Phoenix, Arizona

EXHIBIT: B-5

APPENDIX C

PAVEMENT DESIGN CALCULATIONS

Design Resilient Modulus Analysis

Project Data

PROJECT NAME, LOCATION and SEASONAL VARIATION FACTOR

Project Name:	Yuma Road
Location:	
Seasonal Variation Factor:	1.0

Laboratory Test Data

Boring No. Point ID	Boring Location	Depth (ft)	LL	PI	-#200	Laboratory R-Value	Correlated R-Value
P-1	See Exhibit A-1	0	0	0	13		84
P-3	See Exhibit A-1	0	0	0	7		91
P-5	See Exhibit A-1	0	0	0	20	78	76

Mean R-Value and Modulus Calculations

Number of Laboratory Tested R-Values:	1 (Nt)	
Average of Laboratory Tested R-Value Results:	78.00 (Rt)	
Standard Deviation of Laboratory Tested R-Values:	11.70 (SDt)	Note: A Standard Deviation of 15% was used for
Number of Correlated R-Value:	3 (Nc)	the Laboratory Tested R-Value.
Average of Correlated R-Value Results:	83.40 (Rc)	
Standard Deviation of Correlated R-Values:	7.46 (SDc)	
Adjusted Average of Correlated R-Values:	83.40 (Rc)	
Calculation for Mean R-Value:		

$$R_{mean} = \frac{N_t \times R_t \times SD_c^2 + N_c \times R_c \times SD_t^2}{N_t \times SD_c^2 + N_c \times SD_t^2}$$

R_{mean} = **82.8**

Seasonal Variation Factor for Project Location=	**1.0**	
Design Resilient Modulus M_r (adjusted for SVF)=	**26,000** psi	Note: The Design Resilient Modulus is capped at a maximum of 26,000 psi per ADOT.

Flexible Pavement Design Analysis

Design Criteria

PROJECT DATA

Pavement Designation	Yuma Road
Design Life (years)	20
Equivalent Axle Loads/Day	182
Total EAL's	1,328,600
Seasonal Variation Factor	1.0
Reliability	90%
Overall Standard Deviation	0.35

SUBGRADE CONDITIONS

Mean R-Value, R_{Mean}	83.0
Resilient Modulus MR (psi)	61,706
Design Modulus (psi)	26,000

SERVICEABILITY

Initial Design Serviceability Index	4.1
Terminal Design Serviceability Index	2.6

LAYER COEFFICIENTS	Structural	Drainage
Asphalt Concrete Surface Course	0.44	N/A
Aggregate Base Course	0.14	1.00
CTB or Bituminous Treated Base	0.20	1.00

Design Calculations

Target Structural Number SN: 2.18

Alternative	Recommended Pavement Section Thickness Inches				Total Structural Number	Δ Structural Number
	Asphalt Concrete Surface	Aggregate Base Course	CTB or Bituminous Base	Total		
A	5.0	4.0		9.0	2.76	0.58