Roadway Geotechnical Engineering Report

Grand Avenue Frontage Road Improvements

US 60 – Greenway Road to Thompson Ranch TI

El Mirage, Arizona

ADOT Tracs No. 060 MA 145 H8874 01D

Federal Aid No. 060-B(224)s

Terracon Project No. 65165128

June 27, 2017

Prepared for:

Burgess & Niple, Inc.

Tempe, Arizona

Prepared by:

Terracon Consultants, Inc.

Tempe, Arizona

June 27, 2017

Burgess & Niple, Inc.
1500 North Priest Drive
Suite 101
Tempe, Arizona 85281

Attn: Mr. Todd Cencimino, P.E.

Re: Roadway Geotechnical Engineering Report
Grand Avenue Frontage Road Improvements
US 60 – Greenway Road to Thompson Ranch TI
El Mirage, Arizona
ADOT Project No. 060 MA 145 H8874 01D
Federal Aid No. 060-B(224)s
Terracon Project No. 65165128

Dear Mr. Cencimino:

Terracon Consultants, Inc. (Terracon) has completed geotechnical engineering services for the proposed Grand Avenue Frontage Road Improvements project located in El Mirage, Arizona. This study was performed in general accordance with our proposal number P65165128R1, dated May 4, 2016. Terracon has prepared a Pavement Design Summary and Materials Design Report for the project issued under separate cover.

We appreciate being of service to you in the pavement engineering phase of this project. If you have any questions concerning this report or any of our testing, inspection, design and consulting services, please do not hesitate to contact us.

Sincerely,
Terracon Consultants, Inc.

Ramon Padilla, P.E.
Geotechnical Project Manager

Donald R. Clark, P.E.
Senior Principal

Copies to: Addressee (1 via email)

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EL MIRAGE, ARIZONA

Terracon Project No. 65165128
June 27, 2017

1.0 INTRODUCTION

This report presents the results of our geotechnical engineering services for the proposed Grand Avenue Frontage Road Improvements project located from approximately Greenway Road to Thompson Ranch TI in El Mirage, Arizona. The purpose of these services is to provide information and geotechnical engineering recommendations relative to the planned earthwork and pavement improvements. The conclusions and recommendations in this report are based on the results of field and laboratory testing, experience with similar soil conditions and pavements, and our understanding of the proposed project.

Our geotechnical engineering scope of work for this project included the advancement of eight (8) shallow borings, laboratory testing, geotechnical engineering analysis, and preparation of this report. Logs of the borings along with a Site Plan and Boring Locations diagram (Exhibit A-1) 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
Improvements	Based on the Final Project Assessment, we understand the length of the proposed Frontage Road improvements is approximately 1.2 miles. The majority of the existing AC pavement is in fair apparent condition. The existing 11.5-inch pavement section consists of 7.5 inches of AC pavement and 4 inches of Class 2 aggregate base course (ABC). The following improvement options were evaluated: ■ ***Mill and Replace*** the existing top layer of AC pavement. This option is considered a feasible alternative for the majority of the existing AC pavement if existing curb on both sides of the pavement remains. ■ ***Full Depth Reconstruction*** of the existing pavement structural section. This option would update the roadway section width and cross slope and reconstruct the outside curb and gutter. **Note:** We understand ***Full Depth Reconstruction*** was selected for the project. The City's standard arterial roadway structural section consists of 5 inches of AC over 12 inches of ABC (with a total thickness of 17 inches), which varies considerably when compared to the existing pavement thickness (totaling 11.5 inches). The City's 17-inch pavement section consists of 1 ½-inch Asphalt-Rubber Asphaltic Concrete (ARAC) Surface Course on 3 ½-inch AC Base Course on 12 inches of ABC. In addition, we understand the project will include relocating the Frontage Road connection to US 60 at Acoma Drive by removing the existing midblock access connection south of the intersection to better align with Acoma Drive to complete a four way intersection. The new location of the connection will require that a portion of the raised median along US 60 be removed and paved to extend the US 60-to-connector left turn lane. We understand the length of this improvement will be less than 200 feet. At the current connection location, the concrete box culverts and channel lining will be removed. The concrete box culverts and channel lining will be reconstructed at the new location to match the previous drainage structure.
Grading	Finished grades are anticipated to generally remain the same with the proposed improvements. Therefore, no cuts and fills are anticipated for the project.
Traffic Loading	The following traffic data was provided to us for use in our pavement structure design: Frontage Road, NW of Acoma Drive, 2013 Average Daily Traffic (ADT) of 2,800 vehicles. Frontage Road, NW of Thompson Ranch Rd, 2011 ADT of 1,130 vehicles. Traffic volumes growth of less than 10 percent from 2011 to 2035. Five percent trucks was estimated.

2.2 Site Description

ITEM	DESCRIPTION
Location	The project site is located along Grand Avenue Frontage Road from approximately Greenway Road to Thompson Ranch TI in El Mirage, Arizona.
Existing Improvements	n We understand the existing Grand Avenue Frontage Road is classified as a collector street and consists of a two (2) lane roadway (1 lane in each direction) located adjacent and parallel to US 60 (Grand Avenue). Both the Frontage Road and US 60 are oriented northwest to southeast. n The Frontage Road pavement is bounded to the southwest by curb, gutter, sidewalk, landscaped areas, and generally followed by commercial developments and occasional vacant lots. The Frontage Road pavement is bounded to the northeast by curb, gutter, a relatively large storm-drainage canal (approximately 30 feet wide and 10 feet deep), and followed by US 60. n As previously mentioned, an existing box culvert bridge located approximately 150 feet southeast of Acoma Drive provides a midblock access connection between the Frontage Road and US 60.
Current Ground Cover	Asphalt concrete pavement on the roadway, Portland cement concrete sidewalks, landscaped areas, and adjacent storm drainage canal had a concrete cover.
Existing Topography	Appears to be relatively flat sloping gently down towards the southeast.

3.0 SUBSURFACE CONDITIONS

3.1 Subsurface Soil Conditions

Specific conditions encountered at each boring location are indicated on the individual boring logs included in Appendix A of this report. Stratification boundaries on the boring logs represent the approximate location of changes in soil types; in-situ, the transition between materials may be gradual. Based on conditions encountered in the borings, subsurface conditions on the project site can be generalized as follows:

Description	Approximate Depth to Bottom of Stratum (feet)	Material Encountered
Stratum 1[1]	1 to 4	FILL: Poorly graded gravel with clay and sand, well graded gravel with sand, and poorly graded sand with gravel.
Stratum 2	5 (maximum depth explored)	Clayey sand, silty clayey sand, sandy silty clay, and silty clay with sand.

[1] Fill was encountered at the location of Borings B-2, B-3, and B-6. Fill at the location of Boring B-2 extended beyond the depth of boring.

Laboratory tests consisting of dry unit weight, moisture content, Atterberg Limits, grain size distribution, R-value, and pH and resistivity were conducted on selected soil samples and the test results are summarized below and presented in Appendix B.

3.2 Existing Pavement Section

As previously outlined, the existing roadway consist of an asphalt concrete (AC) paved roadway. Based on the Final Project Assessment, we understand the existing pavement section for the Grand Avenue Frontage Road has a total thickness of 11.5-inches consisting of 7.5 inches of AC pavement and 4 inches of Class 2 aggregate base course (ABC).

3.3 Laboratory Test Data – Subgrade Soils

For purposes of subgrade evaluation, the results of the laboratory testing, including tested and correlated R-Values, are summarized in the following table:

SUMMARY OF TESTED AND CORRELATED R-VALUES							
Boring	**Approximate Station; Offset**	**Depth (ft.)**	**LL**	**PI**	**-#200**	**R-Value Tested**	**R-Value Correlated**
B-1	108+00; ±20'R	1-4	30	11	47	24	34
B-2	116+00; ±20'R	1-3.5	31	12	8	---	56
B-3	123+00; ±110'L	1-2	26	9	26	---	49
B-4	130+00; ±20'R	1.5-4	25	7	41	---	43
B-5	138+00; ±20'R	1-4	23	6	45	32	42
B-6	145+70; ±15'R	2.5-5	23	7	57	---	35
B-7	153+60; ±20'R	0.5-5	25	5	81	34	27
B-8	162+00; ±20'R	1-3	22	4	43	---	47
					Count	**3**	**8**
					Average	**30**	**41.7**
					Standard Deviation	**5.3**	**9.4**
					Rmean	**35.3**	

4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

4.1 Geotechnical Considerations

Geotechnical engineering recommendations for design and construction of earth connected phases of the project are outlined below. The recommendations contained in this report are based upon the results of the test borings performed by Terracon (which are presented in

Appendix A) and laboratory testing (which is presented in Appendix B), engineering analyses, and our current understanding of the proposed project.

4.2 Pavement Subgrade Parameters

The laboratory test data was used to establish one mean R-Value for pavement design within the project limits. The data indicates the existing subgrade soils at the site have relatively good support characteristics for the planned pavement sections.

For purposes of pavement subgrade evaluation, the results of the laboratory testing, including correlated and tested R-Values, in accordance with the ADOT Preliminary Engineering and Design Manual (PEDM) were previously summarized in a table above. Based on the laboratory test results, the average R-value tested was 30 and the average correlated R-value was approximately 42. The calculated mean R-Value for the project is approximately 35. We understand no significant earthwork is anticipated and the existing subgrade is planned to support the proposed improvements. Therefore, we recommend a design R-value of 30 (of the existing subgrade soils) be used for design purposes. The corresponding resilient modulus is 17,875 pounds per square inch (psi) for a seasonal variation factor of 1.0 for Phoenix, Arizona.

4.3 General Earthwork Considerations

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.

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

Exposed areas which will receive fill or aggregate base course, once properly cleared and benched where necessary, should be scarified to a minimum depth of six (6) inches, moisture conditioned, and compacted in accordance with ADOT specifications. Exposed surfaces should be free of mounds and depressions which could prevent uniform compaction.

All fill that will be placed in the project should conform to the latest ADOT standard specifications for embankment material and have equal or greater support characteristics than the on-site soils. Finished grades after the proposed improvements are anticipated to remain approximately the same as existing grades; therefore, significant amounts of imported fill are not anticipated. Fill

soils placed within 3 feet of the finished roadway subgrade should exhibit an R-value of 35 or more. Fill soils to be utilized within the top 3 feet below the proposed pavement base should meet the requirements of the Subgrade Acceptance Chart provided in the Materials Design Report.

4.4 Earthwork Factors and Slopes

Based on the anticipated improvements, earthwork factors and ground compaction are estimated to be relatively small amounts and new cut or fill slopes are not anticipated. Recommended slopes and shrinkage due to re-compaction of materials is presented in the following table:

Location	Earthwork Factor	Ground Compaction (feet)	Recommend Slope (horizontal: vertical)
Grand Avenue Frontage Road and US 60-to-Connector Left Turn Lane	<5% shrink	<0.1	Fill Slopes: 3:1, or flatter Cut Slopes: 3:1, or flatter

Construction of fill slopes should be in accordance with Section 203-10 of the ADOT Standard Specifications (ADOT, 2008). Slopes constructed at slope inclinations steeper than 3H:1V should have surface erosion measures considered in the design.

The face of all slopes should be compacted to the minimum specification for fill embankments. Fill slopes can be over-built and trimmed to expose a compacted slope surface.

4.5 Water

For balancing grading plans, approximately 90 gallons of water per cubic yard should be estimated for compaction of base materials. Approximately 90 gallons of water per cubic yard should be estimated for compaction of subgrade materials.

The application of water estimated for subgrade materials is considerably higher than the amount calculated based upon the difference between in-situ and optimum compaction moisture content, and includes a conservative overrun for losses due to seepage, evaporation, inadequate mixing, spillage, etc. Precipitation during and/or before construction, or other weather conditions may reduce the required amount of water.

4.6 Corrosion Potential

Laboratory testing was performed on selected samples obtained from our borings and summarized in the table below:

Summary of Chemical Laboratory Testing						
Boring	**Depth (feet)**	**Approximate Station; Offset**	**pH**	**Minimum Resistivity (ohm-cm)**	**Sulfates (ppm)**	**Chlorides (ppm)**
B-3	1 – 2	123+00; ±110'L	8.4	1,815	193	39
B-4	1.5 – 4	130+00; ±20'R	8.3	859	164	63
B-6	2.5 – 5	145+70; ±15'R	8.2	859	284	38

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.

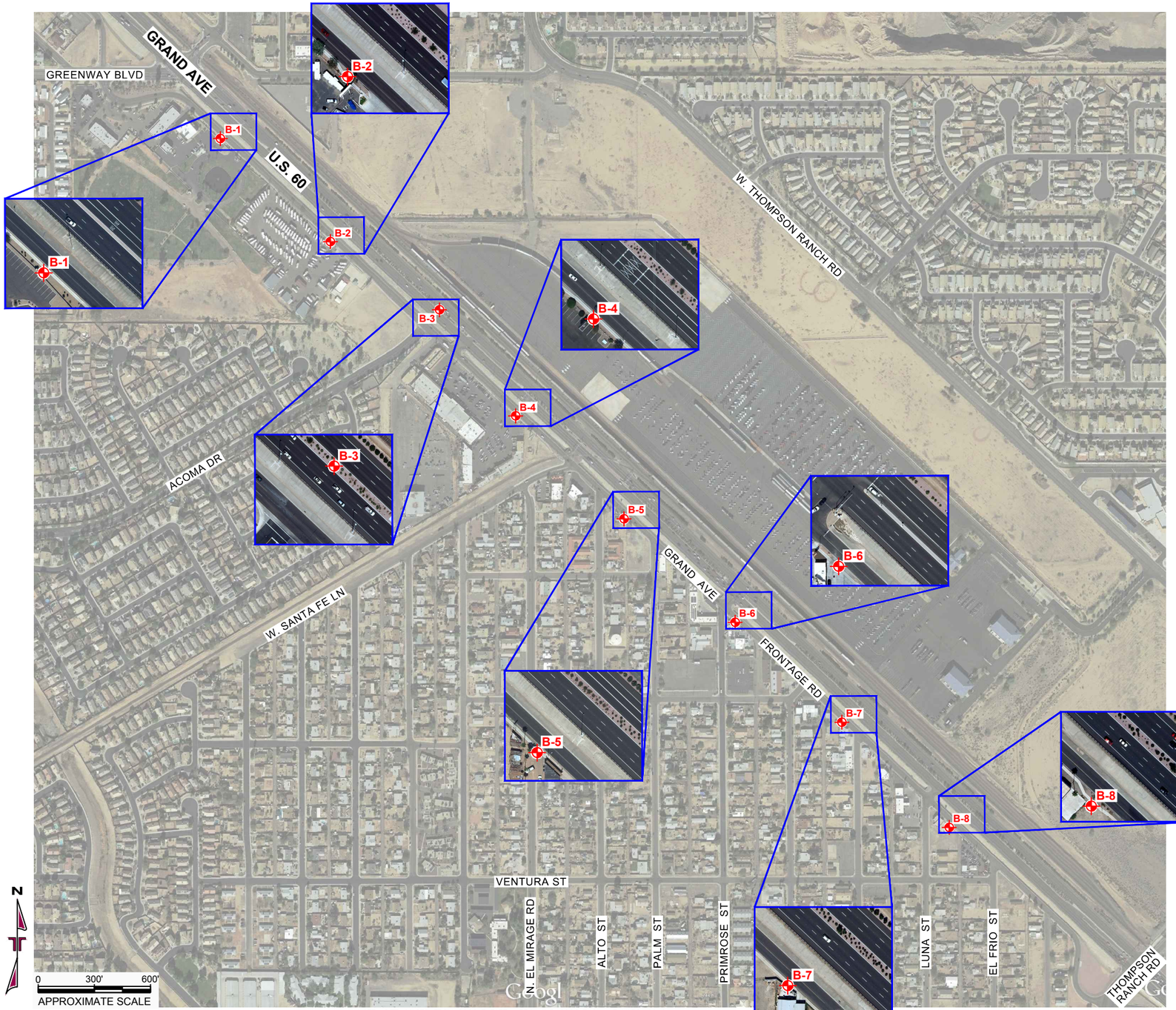
The analysis and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between boring locations, across the site, or due 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.

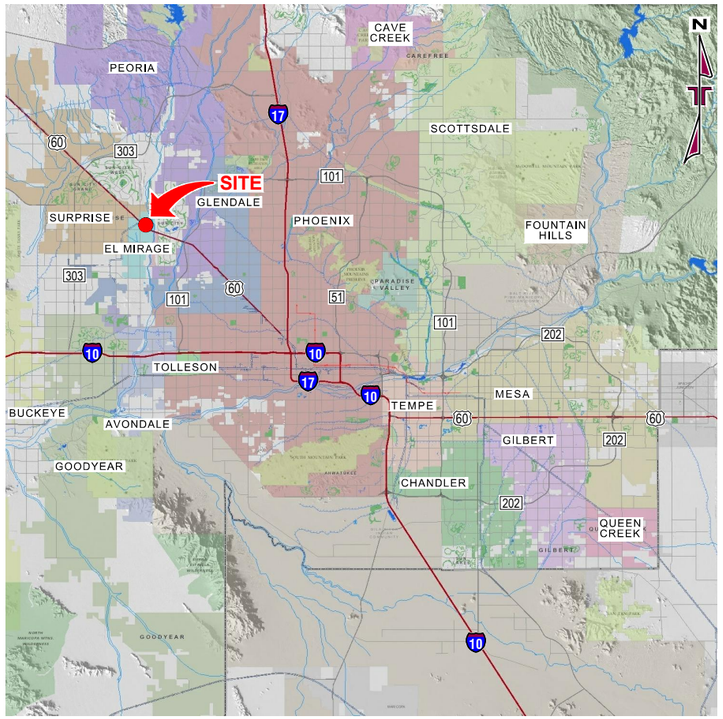
This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. Site safety, excavation support, 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.

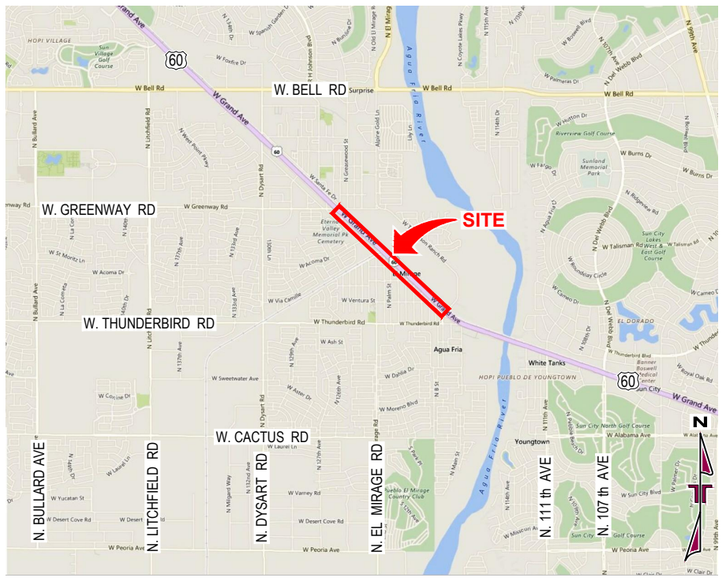
APPENDIX A

FIELD EXPLORATION



NOTE: SITE IMAGES FROM GOOGLE EARTH, PRO, AND GOOGLE ONLINE MAPS, 2016





VICINITY MAPS
NOT TO SCALE

LEGEND:

APPROXIMATE LOCATION OF HAND AUGER BORINGS

ZOOMED IN VIEW

Project Mngr:	RP	Project No.	65165128
Drawn By:	KLJ	Scale:	AS SHOWN
Checked By:	RP	File No.	65165128.DWG
Approved By:	DRC	Date:	08/22/2016

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

Grand Avenue Frontage Road
US60 - Greenway Road to Thompson Ranch TI, El Mirage, Arizona

ADOT Project No.: 060 MA 145 H8874 01D Federal Aid No.: 060-B(224)s

EXHIBIT A-1

Field Exploration Description

A total of eight (8) test borings were advanced at the site on July 29, 2016. The borings were advanced utilizing hand auger methods to depths of up to approximately five (5) feet below the existing ground surface. The approximate boring locations are shown on the attached Site Plan and Boring Locations diagram, Exhibit A-1.

The borings were located in the field utilizing an aerial photograph and a hand held GPS unit. Latitude and longitude coordinates for each boring were obtained from Google Earth Pro and should be considered approximate. The borings were backfilled with cuttings.

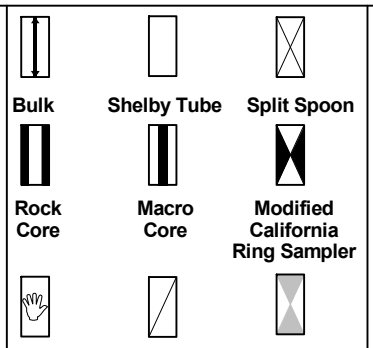
Continuous lithologic logs of each boring were recorded by the field engineer during the drilling operations. Penetration resistance measurements were also obtained by driving a Dynamic Cone Penetrometer at selected depths. Blows for three (3) consecutive 1.75-inch penetrometer drives totaling 5.25-inches of penetration (unless otherwise noted) were measured and are presented on the boring logs at the corresponding depths. These penetration resistance values subjected to empirical correlations and used in estimating the consistency or relative density of materials encountered. The correlation of dynamic cone penetrometer tests to N-Value is based on a paper prepared by Sowers and Hedges, Special Technical Bulletin 399, dated 1966. 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.

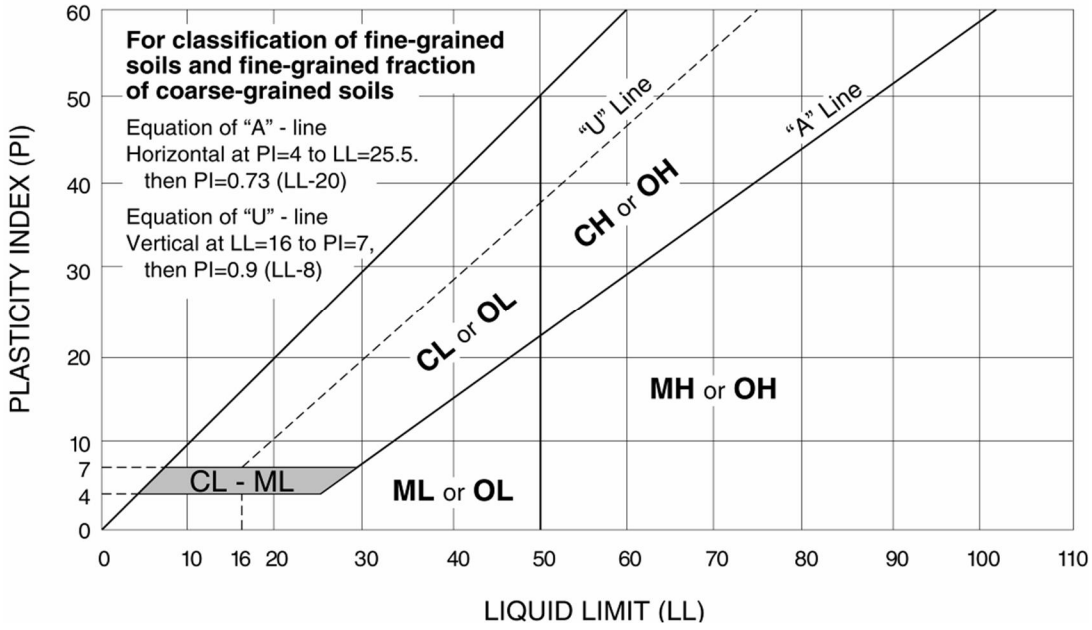
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[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. B-1

PROJECT: Grand Avenue Frontage Road Improvements

CLIENT: Burgess & Niple, Inc.
Tempe, Arizona

SITE: From Greenway Rd to Thompson Ranch Tl
El Mirage, Arizona

LOCATION See Exhibit A-1

Latitude: 33.62258° Longitude: -112.33021°

DEPTH	GRAPHIC LOG	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	DCP (blows/5.25 inches)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
						7-15-14			30-19-11	47
4.0						70/1.75"				

CLAYEY SAND (SC), red to brown, medium dense, trace gravel

dense to very dense

Auger Refusal at 4 Feet

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

Hammer Type: Dynamic Cone Penetrometer (DCP)

Advancement Method:
Hand 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).

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
4685 S Ash Ave Ste H-4
Tempe, AZ

Boring Started: 7/29/2016 Boring Completed: 7/29/2016

Drill Rig: Hand Auger Driller: Terracon

Project No.: 65165128 Exhibit: A-5

BORING LOG NO. B-2

PROJECT: Grand Avenue Frontage Road Improvements

CLIENT: Burgess & Niple, Inc.
Tempe, Arizona

SITE: From Greenway Rd to Thompson Ranch Tl
El Mirage, Arizona

LOCATION See Exhibit A-1

Latitude: 33.62107° Longitude: -112.32828°

GRAPHIC LOG	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	DCP (blows/5.25 inches)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	FILL - POORLY GRADED GRAVEL WITH CLAY AND SAND (GP-GC), brown, dense to very dense, with cobbles									
									31-19-12	8
						25-52-75				
	3.8									
	Auger Refusal at 3.8 Feet									

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

Hammer Type: Dynamic Cone Penetrometer (DCP)

Advancement Method:
Hand 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).

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
4685 S Ash Ave Ste H-4
Tempe, AZ

Boring Started: 7/29/2016 Boring Completed: 7/29/2016

Drill Rig: Hand Auger Driller: Terracon

Project No.: 65165128 Exhibit: A-6

BORING LOG NO. B-3

PROJECT: Grand Avenue Frontage Road Improvements

CLIENT: Burgess & Niple, Inc.
Tempe, Arizona

SITE: From Greenway Rd to Thompson Ranch Tl
El Mirage, Arizona

LOCATION See Exhibit A-1

Latitude: 33.62007° Longitude: -112.32636°

GRAPHIC LOG	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	DCP (blows/5.25 inches)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	FILL - WELL GRADED GRAVEL WITH SAND (GW), brown, dense to very dense									
	1.0									
	CLAYEY SAND WITH GRAVEL (SC), brown, dense to very dense					75/1.5" 75/0.25"			26-17-9	26
	2.0									
	Auger Refusal at 2 Feet									

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

Hammer Type: Dynamic Cone Penetrometer (DCP)

Advancement Method:
Hand 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).

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
4685 S Ash Ave Ste H-4
Tempe, AZ

Boring Started: 7/29/2016 Boring Completed: 7/29/2016

Drill Rig: Hand Auger Driller: Terracon

Project No.: 65165128 Exhibit: A-7

BORING LOG NO. B-4

PROJECT: Grand Avenue Frontage Road Improvements

CLIENT: Burgess & Niple, Inc.
Tempe, Arizona

SITE: From Greenway Rd to Thompson Ranch Tl
El Mirage, Arizona

LOCATION See Exhibit A-1

Latitude: 33.61851° Longitude: -112.32504°

GRAPHIC LOG	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	DCP (blows/5.25 inches)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SILTY CLAYEY SAND (SC-SM), brown, loose to medium dense									
						8-10-12			25-18-7	41
	medium dense					18-18-27				
	4.0									
	Auger Refusal at 4 Feet									

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

Hammer Type: Dynamic Cone Penetrometer (DCP)

Advancement Method:
Hand 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).

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
4685 S Ash Ave Ste H-4
Tempe, AZ

Boring Started: 7/29/2016 Boring Completed: 7/29/2016

Drill Rig: Hand Auger Driller: Terracon

Project No.: 65165128 Exhibit: A-8

BORING LOG NO. B-5

PROJECT: Grand Avenue Frontage Road Improvements

CLIENT: Burgess & Niple, Inc.
Tempe, Arizona

SITE: From Greenway Rd to Thompson Ranch Tl
El Mirage, Arizona

LOCATION See Exhibit A-1

Latitude: 33.61706° Longitude: -112.32317°

GRAPHIC LOG	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	DCP (blows/5.25 inches)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SILTY CLAYEY SAND (SC-SM), trace gravel, brown, loose to medium dense									
						7-8-10			23-17-6	45
	dense to very dense									
	4.0					75/1"				
	Auger Refusal at 4 Feet									

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

Hammer Type: Dynamic Cone Penetrometer (DCP)

Advancement Method:
Hand 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).

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
4685 S Ash Ave Ste H-4
Tempe, AZ

Boring Started: 7/29/2016 Boring Completed: 7/29/2016

Drill Rig: Hand Auger Driller: Terracon

Project No.: 65165128 Exhibit: A-9

BORING LOG NO. B-6

PROJECT: Grand Avenue Frontage Road Improvements

CLIENT: Burgess & Niple, Inc.
Tempe, Arizona

SITE: From Greenway Rd to Thompson Ranch Tl
El Mirage, Arizona

LOCATION See Exhibit A-1

Latitude: 33.6156° Longitude: -112.32127°

GRAPHIC LOG	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	DCP (blows/5.25 inches)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	FILL - POORLY GRADED SAND WITH GRAVEL (SP-SM), brown, with cobbles									
	2.5									
	SANDY SILTY CLAY (CL-ML), brown, trace gravel								23-16-7	57
	5.0									
	Boring Terminated at 5 Feet	5								

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

Hammer Type: Dynamic Cone Penetrometer (DCP)

Advancement Method:
Hand 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).

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
4685 S Ash Ave Ste H-4
Tempe, AZ

Boring Started: 7/29/2016 Boring Completed: 7/29/2016

Drill Rig: Hand Auger Driller: Terracon

Project No.: 65165128 Exhibit: A-10

BORING LOG NO. B-7

PROJECT: Grand Avenue Frontage Road Improvements

CLIENT: Burgess & Niple, Inc.
Tempe, Arizona

SITE: From Greenway Rd to Thompson Ranch Tl
El Mirage, Arizona

LOCATION See Exhibit A-1

Latitude: 33.61408° Longitude: -112.31937°

GRAPHIC LOG	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	DCP (blows/5.25 inches)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SILTY CLAY WITH SAND (CL-ML), brown, medium stiff					4-6-6				
									25-20-5	81
	5.0	5				9-20-17				
	Boring Terminated at 5 Feet									

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

Hammer Type: Dynamic Cone Penetrometer (DCP)

Advancement Method:
Hand 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).

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
4685 S Ash Ave Ste H-4
Tempe, AZ

Boring Started: 7/29/2016 Boring Completed: 7/29/2016

Drill Rig: Hand Auger Driller: Terracon

Project No.: 65165128 Exhibit: A-11

BORING LOG NO. B-8

PROJECT: Grand Avenue Frontage Road Improvements

CLIENT: Burgess & Niple, Inc.
Tempe, Arizona

SITE: From Greenway Rd to Thompson Ranch Tl
El Mirage, Arizona

LOCATION See Exhibit A-1

Latitude: 33.61257° Longitude: -112.31742°

GRAPHIC LOG	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	DCP (blows/5.25 inches)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SILTY CLAYEY SAND (SC-SM), brown, loose to medium dense, trace gravel									
						8-10-10			22-18-4	43
	dense to very dense									
	3.0					75/1"				
	Auger Refusal at 3 Feet									

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

Hammer Type: Dynamic Cone Penetrometer (DCP)

Advancement Method:
Hand 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).

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
4685 S Ash Ave Ste H-4
Tempe, AZ

Boring Started: 7/29/2016 Boring Completed: 7/29/2016

Drill Rig: Hand Auger Driller: Terracon

Project No.: 65165128 Exhibit: A-12

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.

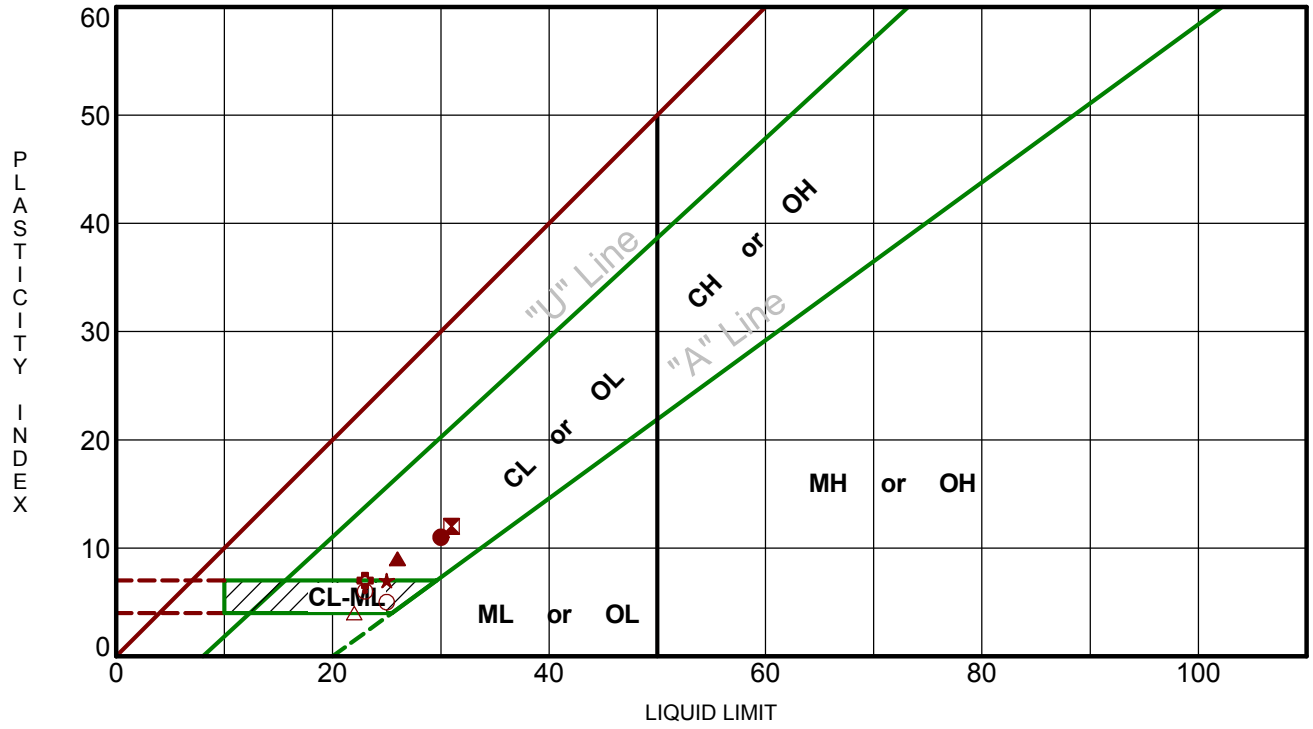
Laboratory tests were conducted on selected soil samples and the test results are presented in this appendix. The laboratory test results were used for the geotechnical engineering analyses, and the development of recommendations. Laboratory tests were performed in general accordance with the applicable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

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

- Sieve Analysis
- Atterberg Limits
- R-value
- pH & Minimum Resistivity
- Soluble Sulfates and Chlorides

ATTERBERG LIMITS RESULTS

ASTM D4318



Boring ID	Depth	LL	PL	PI	Fines	USCS	Description
B-1	1 - 4	30	19	11	47	SC	CLAYEY SAND
B-2	1 - 3.5	31	19	12	8	GP-GC	POORLY GRADED GRAVEL with CLAY and SAND
B-3	1 - 2	26	17	9	26	SC	CLAYEY SAND with GRAVEL
B-4	1.5 - 4	25	18	7	41	SC-SM	SILTY, CLAYEY SAND
B-5	1 - 4	23	17	6	45	SC-SM	SILTY, CLAYEY SAND
B-6	2.5 - 5	23	16	7	57	CL-ML	SANDY SILTY CLAY
B-7	0.5 - 5	25	20	5	81	CL-ML	SILTY CLAY with SAND
B-8	1 - 3	22	18	4	43	SC-SM	SILTY, CLAYEY SAND

PROJECT: Grand Avenue Frontage Road Improvements

SITE: From Greenway Rd to Thompson Ranch TI
El Mirage, Arizona

Terracon
4685 S Ash Ave Ste H-4
Tempe, AZ

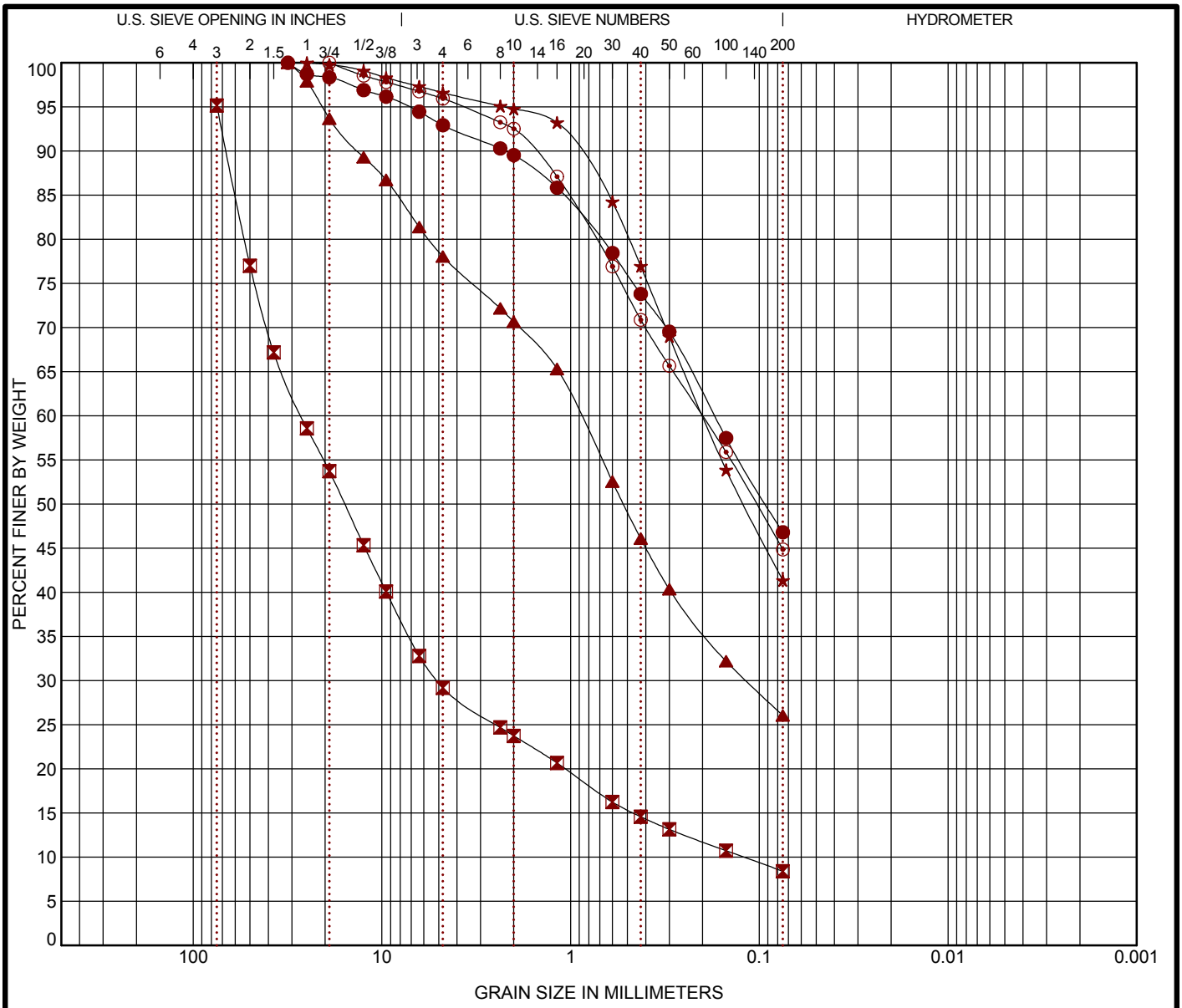
PROJECT NUMBER: 65165128

CLIENT: Burgess & Niple, Inc.
Tempe, Arizona

EXHIBIT: B-2

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



Boring ID		Depth	USCS Classification	LL	PL	PI	Cc	Cu
●	B-1	1 - 4	CLAYEY SAND (SC)	30	19	11		
⊠	B-2	1 - 3.5	POORLY GRADED GRAVEL with CLAY and SAND (GP-GC)	31	19	12	7.98	221.63
▲	B-3	1 - 2	CLAYEY SAND with GRAVEL (SC)	26	17	9		
★	B-4	1.5 - 4	SILTY, CLAYEY SAND (SC-SM)	25	18	7		
⊙	B-5	1 - 4	SILTY, CLAYEY SAND (SC-SM)	23	17	6		

Boring ID		Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Gravel	%Sand	%Fines
●	B-1	1 - 4	31.5	0.173			7.1	46.1	46.8
⊠	B-2	1 - 3.5	75	26.743	5.075	0.121	66.0	20.8	8.4
▲	B-3	1 - 2	31.5	0.891	0.117		22.0	52.0	26.0
★	B-4	1.5 - 4	25	0.199			3.4	55.2	41.4
⊙	B-5	1 - 4	19	0.201			4.1	51.1	44.9

PROJECT: Grand Avenue Frontage Road Improvements

SITE: From Greenway Rd to Thompson Ranch TI
El Mirage, Arizona

Terracon
4685 S Ash Ave Ste H-4
Tempe, AZ

PROJECT NUMBER: 65165128

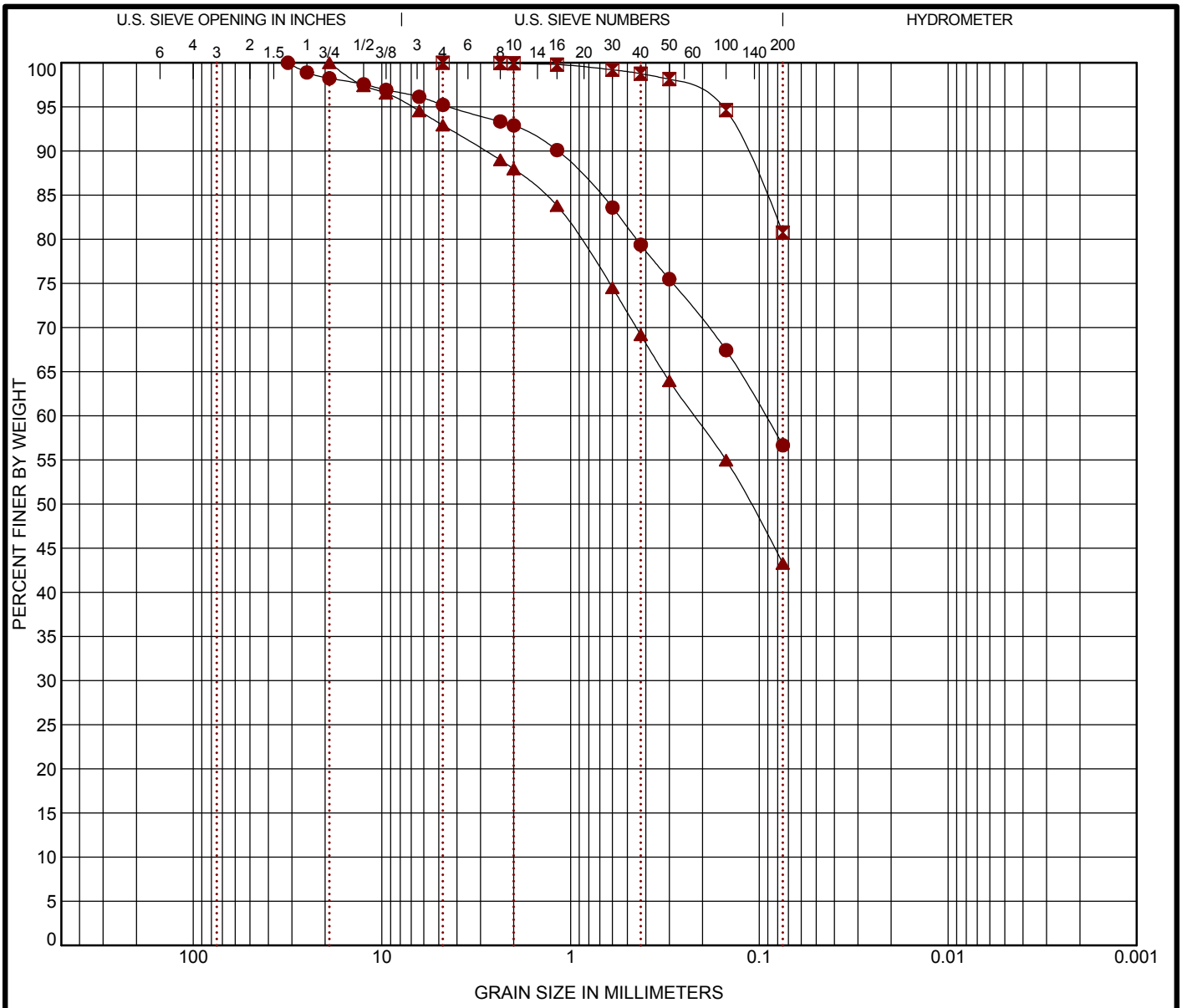
CLIENT: Burgess & Niple, Inc.
Tempe, Arizona

EXHIBIT: B-3

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS-2 65165128.GPJ TERRACON2015.GDT 8/22/16

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Boring ID		Depth	USCS Classification	LL	PL	PI	Cc	Cu
●	B-6	2.5 - 5	SANDY SILTY CLAY (CL-ML)	23	16	7		
⊠	B-7	0.5 - 5	SILTY CLAY with SAND (CL-ML)	25	20	5		
▲	B-8	1 - 3	SILTY, CLAYEY SAND (SC-SM)	22	18	4		

Boring ID		Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Gravel	%Sand	%Fines
●	B-6	2.5 - 5	31.5	0.093			4.8	38.6	56.7
⊠	B-7	0.5 - 5	4.75				0.0	19.3	80.7
▲	B-8	1 - 3	19	0.221			7.1	49.6	43.3

PROJECT: Grand Avenue Frontage Road Improvements

SITE: From Greenway Rd to Thompson Ranch TI
El Mirage, Arizona

Terracon
4685 S Ash Ave Ste H-4
Tempe, AZ

PROJECT NUMBER: 65165128

CLIENT: Burgess & Niple, Inc.
Tempe, Arizona

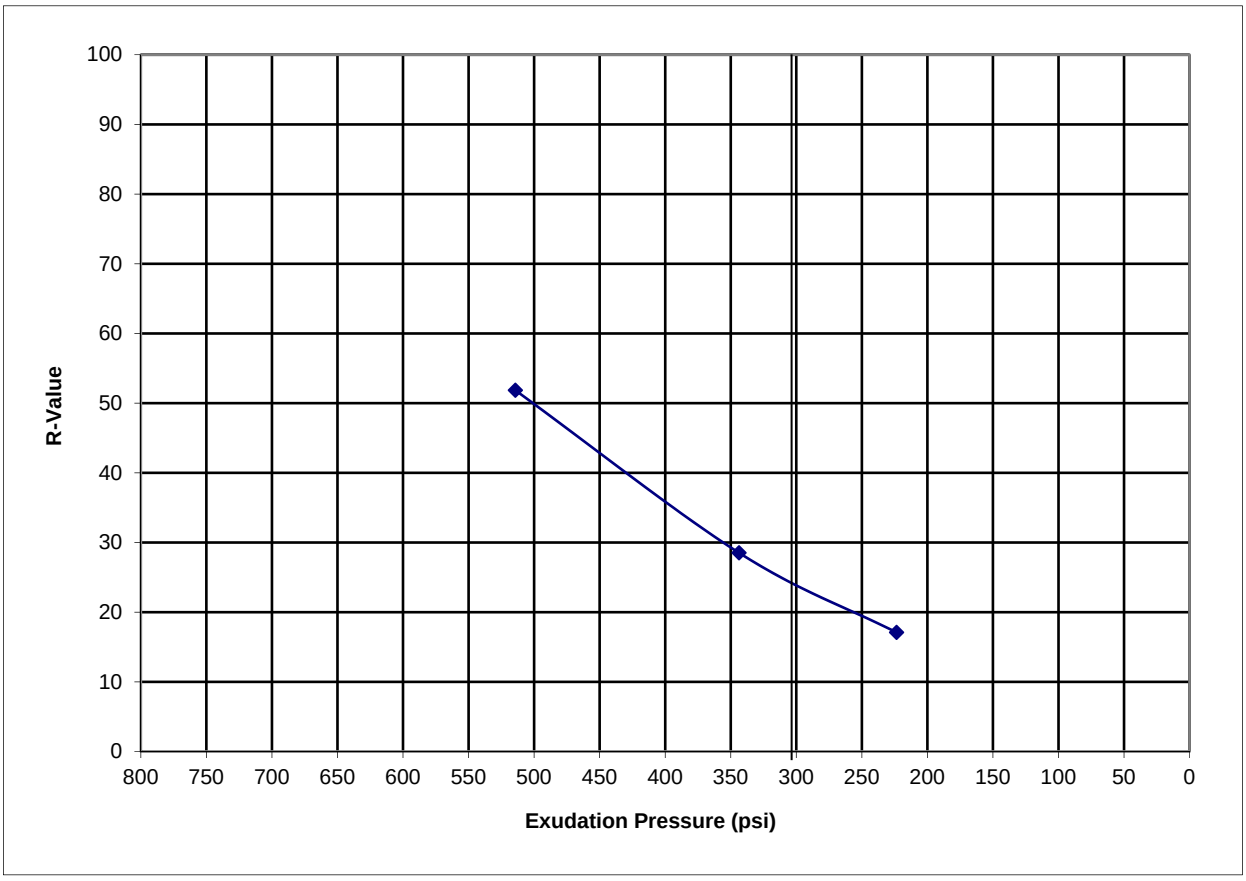
EXHIBIT: B-4

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS-2 65165128.GPJ TERRACON2015.GDT 8/22/16

PROJECT:	Grand Avenue Frontage Road	**JOB NO:**	65165128
LOCATION:	US60-Greenway Rd to Thompson Ranch TI, El Mirage, AZ	**WORK ORDER NO:**	65165128
MATERIAL:	Clayey Sand (SC)	**LAB NO:**	B-1
SAMPLE SOURCE:	B-1 @ 1-4	**DATE SAMPLED:**	08/08/16

RESISTANCE R-VALUE AND EXPANSION PRESSURE OF COMPACTED SOILS (ASTM D2844)

SPECIMEN I. D.	**A**	**B**	**C**
Moisture Content	16.3%	15.0%	13.7%
Compaction Pressure (psi)	100	150	325
Specimen Height (inches)	2.59	2.53	2.45
Dry Density (pcf)	114.1	117.3	122.3
Horiz. Pres. @ 1000lbs (psi)	51.0	37.0	24.0
Horiz. Pres. @ 2000lbs (psi)	122.0	97.0	60.0
Displacement	4.12	4.07	3.87
Expansion Pressure (psi)	0.3	0.7	3.1
Exudation Pressure (psi)	224	344	514
R Value	17	29	52



AASHTO R18

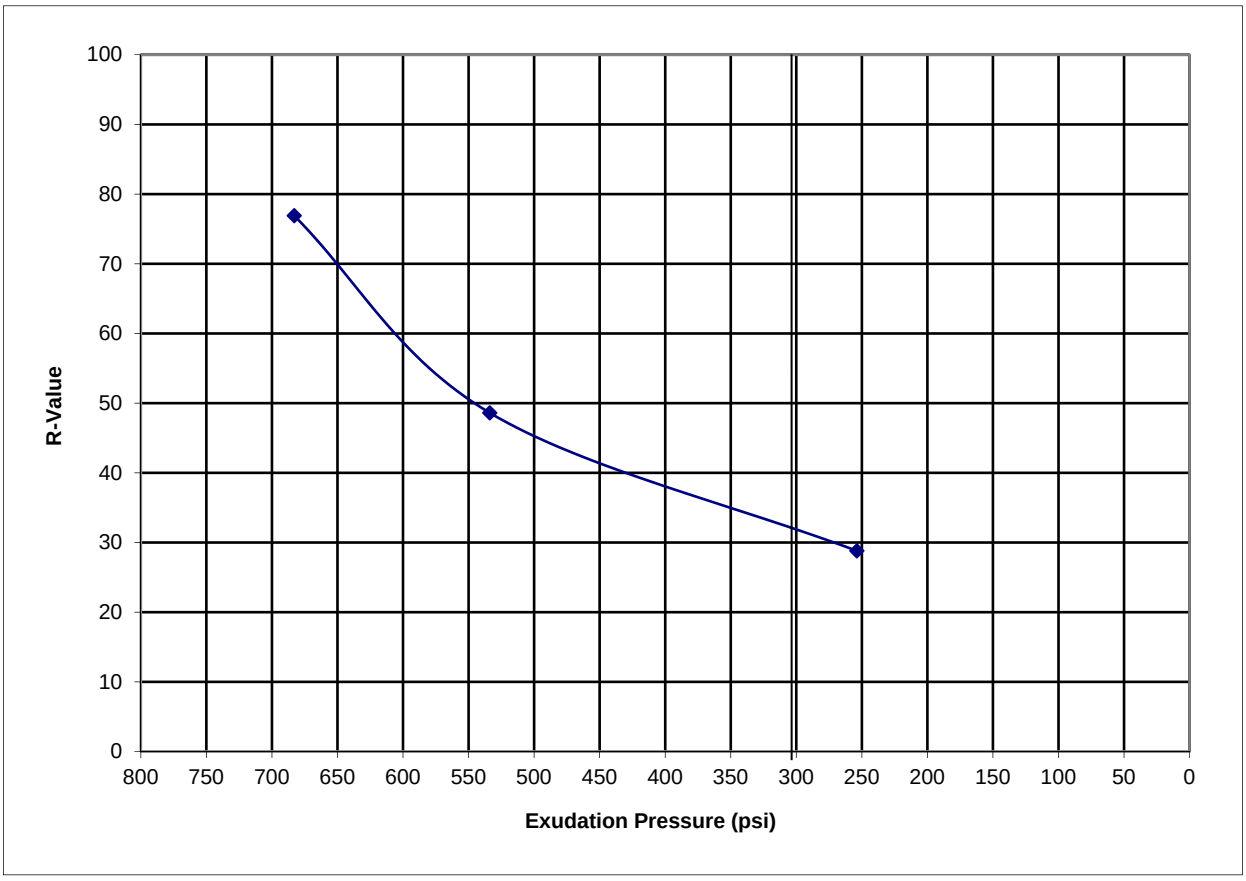
R Value at 300 PSI = 24

Exhibit: B-5

PROJECT:	Grand Avenue Frontage Road	**JOB NO:**	65165128
LOCATION:	US60-Greenway Rd to Thompson Ranch TI, El Mirage, AZ	**WORK ORDER NO:**	65165128
MATERIAL:	Silty, Clayey Sand (SC-SM)	**LAB NO:**	B-5
SAMPLE SOURCE:	B-5 @ 1-4	**DATE SAMPLED:**	08/08/16

RESISTANCE R-VALUE AND EXPANSION PRESSURE OF COMPACTED SOILS (ASTM D2844)

SPECIMEN I. D.	**A**	**B**	**C**
Moisture Content	10.6%	9.8%	8.9%
Compaction Pressure (psi)	100	225	350
Specimen Height (inches)	2.59	2.51	2.49
Dry Density (pcf)	128.6	132.0	133.5
Horiz. Pres. @ 1000lbs (psi)	42.0	30.0	14.0
Horiz. Pres. @ 2000lbs (psi)	95.0	63.0	26.0
Displacement	4.62	4.07	3.87
Expansion Pressure (psi)	0.0	0.0	0.9
Exudation Pressure (psi)	254	534	683
R Value	29	49	77



AASHTO R18

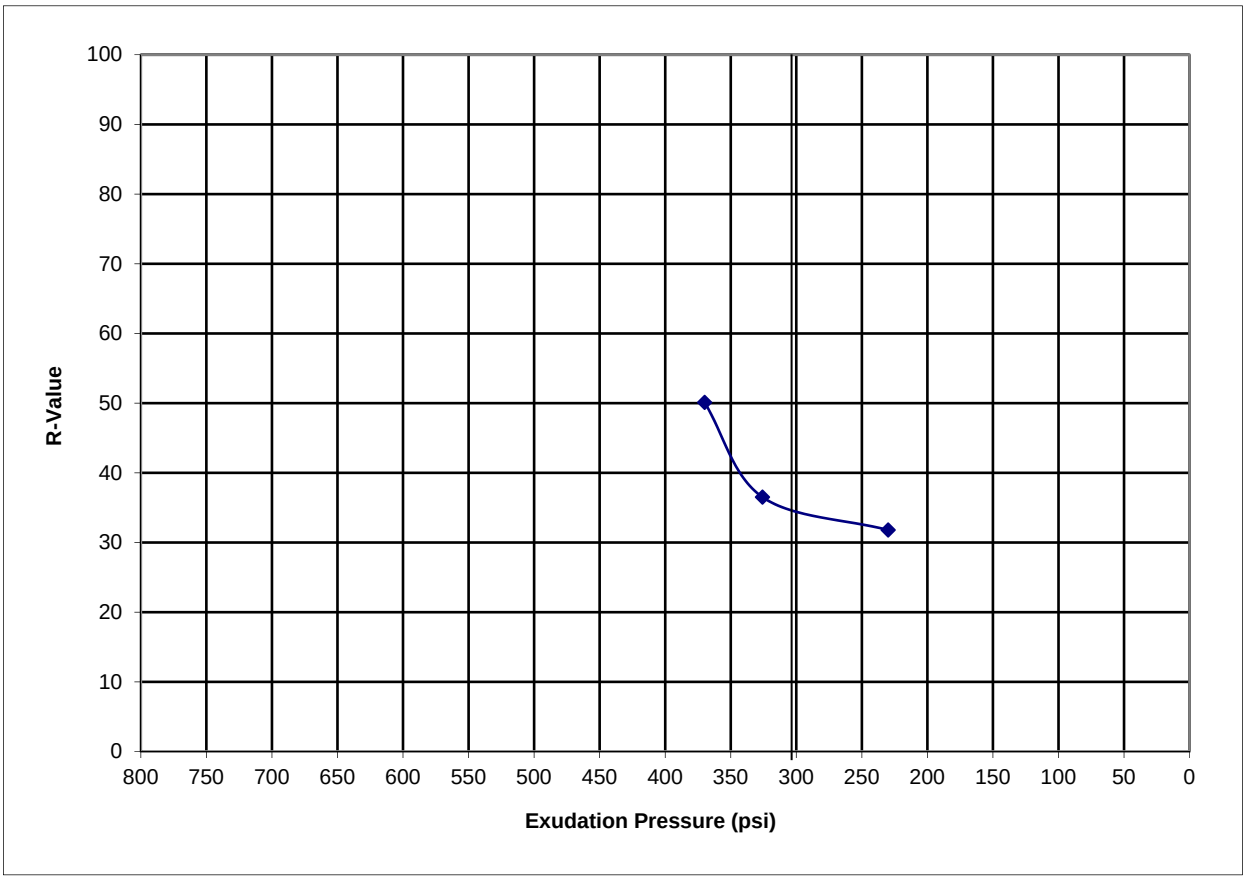
R Value at 300 PSI = 32

Exhibit: B-6

PROJECT:	Grand Avenue Frontage Road	**JOB NO:**	65165128
LOCATION:	US60-Greenway Rd to Thompson Ranch TI, El Mirage, AZ	**WORK ORDER NO:**	65165128
MATERIAL:	Silty, Clayey Sand (SC-SM)	**LAB NO:**	B-7
SAMPLE SOURCE:	B-7 @ 0.5-5.0	**DATE SAMPLED:**	08/08/16

RESISTANCE R-VALUE AND EXPANSION PRESSURE OF COMPACTED SOILS (ASTM D2844)

SPECIMEN I. D.	**A**	**B**	**C**
Moisture Content	15.8%	15.0%	14.1%
Compaction Pressure (psi)	100	125	350
Specimen Height (inches)	2.54	2.57	2.57
Dry Density (pcf)	112.9	115.6	118.3
Horiz. Pres. @ 1000lbs (psi)	36.0	34.0	25.0
Horiz. Pres. @ 2000lbs (psi)	75.0	71.0	53.0
Displacement	6.08	5.84	5.39
Expansion Pressure (psi)	0.3	0.8	1.6
Exudation Pressure (psi)	230	326	370
R Value	32	37	50



AASHTO R18

R Value at 300 PSI = 34

Exhibit: B-7

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										
B-1	1.0 - 4.0	SC			47	30	19	11										
B-2	1.0 - 3.5	GP-GC			8	31	19	12										
B-3	1.0 - 2.0	SC			26	26	17	9						8.4	1815	193	39	
B-4	1.5 - 4.0	SC-SM			41	25	18	7						8.3	859	164	63	
B-5	1.0 - 4.0	SC-SM			45	23	17	6										
B-6	2.5 - 5.0	CL-ML			57	23	16	7						8.2	859	284	38	
B-7	0.5 - 5.0	CL-ML			81	25	20	5										
B-8	1.0 - 3.0	SC-SM			43	22	18	4										

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: Grand Avenue Frontage Road Improvements

SITE: From Greenway Rd to Thompson Ranch Tl
El Mirage, Arizona

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

PROJECT NUMBER: 65165128

CLIENT: Burgess & Niple, Inc.
Tempe, Arizona

EXHIBIT: B-8