Pavement Engineering Report

Revision No. 1

1st Street Improvements

1st Street - Between Main Street & AZ Route 79

Florence, Arizona

January 23, 2017

Terracon Project No. 65165303

Prepared for:
Wilson & Company, Inc.
Phoenix, Arizona

Prepared by:
Terracon Consultants, Inc.
Tempe, Arizona
480.897.8200

January 23, 2017

Wilson & Company, Inc.
410 North 44th Street, Suite 460
Phoenix, Arizona 85008

Attn: Dan Marum
P: (602)283-2718
E: dan.marum@wilsonco.com

Re: **Pavement Engineering Report – Revision No. 1**
1st Street Improvements
1st Street - Between Main Street & AZ Route 79
Florence, Arizona
Terracon Project No. 65165303

Dear Mr. Marum:

Terracon Consultants, Inc. (Terracon) has completed the pavement engineering services for the above referenced project. These services were performed in general accordance with our Proposal P65165303 dated November 1, 2016. This revised pavement engineering report presents the results of the subsurface exploration and provides engineering recommendations concerning earthwork and the design and construction of pavements for the proposed project.

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.

Katie P. Mackay, P.E.
Staff Engineer

Scott D. Neely, P.E.
Principal

65165303.Wilson.1stStreet.rpt.docx

Copies to: Addressee (1 via email)

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FLORENCE, ARIZONA

Terracon Project No. 65165303
January 23, 2017

1.0 INTRODUCTION

This report presents the results of our pavement engineering services performed for the proposed roadway at 1st Street Improvements that will be located between Main Street and Arizona Route 79 (AZ-79) in Florence, Arizona. The purpose of these services is to provide information and geotechnical/pavement engineering recommendations relative to:

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

Our geotechnical engineering scope of work for this project included drilling six (6) borings for subsurface exploration, laboratory testing, engineering analysis, and preparation of this report. Logs of the borings along with a Site Location diagram (Exhibit A-1) and Exploration Plan (Exhibit A-2) 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-2 in Appendix A.
Improvements	We understand the pavement rehabilitation project will consist of the design and reconstruction of 1st Street due to waterline improvements and drainage issues.

ITEM	DESCRIPTION
Traffic loading	Traffic Loading was not provided. The City of Florence (City) requested the pavement thickness design be performed using the 2016 MCDOT Roadway Design Manual and a roadway classification of Local Road (Residential).
Grading	Minor cuts and fills (less than 1-foot) are anticipated for the project.

2.2 Site Description

ITEM	DESCRIPTION
Location	The project includes 1st Street, roughly between AZ-79 and Main Street in Florence, Arizona (see Exhibit A-1).
Size	The overall project site encompasses approximately 0.5 miles of existing roadway.
Existing Improvements	1st Street is a local street with an approximate width of 32 feet and 4-inch roll curbs. On the western end of 1st Street, a retention area is located directly north of the roadway and culverts connect the retention area to the west side of Main Street. It is this area of the project we understand has drainage issues.
Current Ground Cover	Asphalt concrete and concrete curbs, gutters, and sidewalks.
Existing topography	The site appears to be relatively flat with a gradual slope towards the west.

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 at the site ([3]Richard, et al, 2000) consist of Holocene river alluvium. This unit consists of unconsolidated to weakly consolidated sand and gravel in river

[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.

channels and sand, silt, and clay on floodplains. This unit also includes young terrace deposits fringing floodplains.

Review of published maps available from the Arizona Geological Survey ([4]AZGS, 2013), indicates the project site is located in a broad general area of central Arizona known for historic ground subsidence due to groundwater withdrawal. This has historically resulted in the formation of earth fissures in certain parts of the region. The AZGS is actively updating their data base regarding earth fissuring. Based on our review of the available AZGS geological information, earth fissures have not been mapped at the location of the project site. The nearest location of a mapped earth fissure is approximately 7 miles southwest of the site according to the AZGS maps. Evidence of earth fissures was not observed on the site during the field exploration or site reconnaissance. However, continued groundwater withdrawal in the area may result in additional subsidence and the formation of new fissures or the extension of existing fissures.

The soils at the location of the site have been surveyed and classified by the U.S. Natural Resources Conservation Service (NRCS). The NRCS soil survey map for the site indicates that there are two mapped soil units within the project area as shown in the figure below:

A detailed summary of the NRCS mapped soil units is as follows:

Map Unit Symbol	Map Unit Name	Percentage of Site	USCS Classification	Percentage Passing #200 Sieve	Plasticity Index
41	Saminiego silty clay loam	30	CL, ML, CH	85 to 95	10 to 40
29	Marana silty clay loam	70	CL	85 to 95	10 to 15

[4]Arizona Geological Survey (AZGS) 2013, ***Earth Fissure Map of Pinal County*****,** Digital Map Series Earth Fissure Map 21, DM-EF-21.

3.2 Groundwater

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/gwsi/Default.aspx), the depth to groundwater was measured in January 2005 to be approximately 193 feet below the ground surface (approximate elevation of 1,295 feet above mean sea level) at an Arizona Department of Water Resources (ADWR) monitored well site located approximately 0.2 miles south of the site.

3.3 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	Consistency / Relative Density
Surface	1½ to 3 inches	Asphalt Concrete: 1½ to 3 inches	---
Stratum 1	0.8 to 2.5	FILL: Clayey Sand with varying amounts of Silt and Gravel, Silty Sand with Gravel, and Sandy Lean Clay	Very Stiff / Loose
Stratum 2	4 to 5 (maximum depth explored)	Lean Clay with varying amounts of Sand, and Fat Clay	Stiff to Very Stiff
Stratum 3[1]	5 (maximum depth explored)	Poorly Graded Sand with Silt, Silty Clayey Sand	Loose

1. Stratum 3 was encountered in Borings B-2 and B-5.

Laboratory tests were conducted on selected soil samples and the test results are presented in Appendix B. Test results indicate that the subgrade soils exhibit low to high plasticity characteristics. The fine fraction of the subgrade materials (i.e., minus #200 sieve) varied from 26 to 89 percent (average of 62 percent).

The results of the laboratory testing including the correlated R-Values (correlated in accordance with the MCDOT Roadway Design Manual procedures) and tested R-Value are summarized in the following table:

SUMMARY OF CORRELATED AND TESTED R-VALUES							
Boring No.	**Depth**	**USCS Soil Type**	**LL**	**PI**	**-#200**	**R-Value Tested**	**R-Value Correlated**
B-2	1-4	CL	33	17	72	--	17.8
B-3	1-2	CL	25	15	10	--	38.5
B-5	1-4	CL	43	25	70	--	12.8
B-6	1-4	CH	62	43	89	8.6	7.4
Average	**--**	**--**	**40.8**	**25**	**60.3**	**8.6**	**19.1**

According to the MCDOT Roadway Design Manual, subgrade soils having a plasticity index above 15 with more than 20% passing the #200 sieve should be considered potentially expansive. Three of the samples of subgrade material beneath the pavement met these requirements. Expansion tests were performed on the subgrade samples from boring locations B-2, B-5, and B-6. Test results indicate that B-5 and B-6 exhibited expansive behavior. For purposes of the design, the soils are considered expansive.

Based upon data provided by the NRCS, these laboratory results are consistent with historical information. However, results from Boring B-6 appear to be an anomaly for this project when compared to results from the other five borings and previous Terracon experience in the Town of Florence.

3.4 Existing Pavement Conditions

Based on limited field observations, the existing asphalt pavement along the alignment appears to be in very poor to failed condition with varying degrees of distress. Observed pavement distress included medium to high severity weathering, low to high severity block cracking, and low to high severity alligator cracking. Patching, raveling, and rutting were also observed in isolated locations.

The roadway of the project is currently surfaced with varying thicknesses of asphalt concrete. The asphalt concrete ranges in thickness from 1½

to 3 inches. Aggregate base course beneath the asphalt concrete was not identified in any of the boring locations.

4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

4.1 Pavement Design Parameters

As requested by the City of Florence, the 2016 MCDOT Roadway Design Manual was used for the design of the 1st Street Improvements with a roadway classification of Local Road (Residential).

According to Section 10.2.5 of the 2016 MCDOT Roadway Design Manual, if the expansive potential is equal to, or greater than 2%, Design Chart 101B should be used for local roads. Based on laboratory test results, the soils on the site are considered to be expansive, so Design Chart 101B was used in the analysis. The MCDOT Manual also recommends that for projects with less than 5 samples, the sample resulting in the highest thickness of base course should be used in design. Due to the high plasticity and high percentage of material passing the #200 sieve at Boring B-6 compared to the other boring locations, Boring B-6 is considered an anomaly on this project, and the sample with the second highest resulting thickness (Boring B-5) was used in design of the 1st Street Improvements. This approach was agreed upon with the City of Florence with the understanding that isolated areas with soil properties similar to those encountered in Boring B-6 will be treated on an individual basis. These areas are to be identified by the field technician performing the materials testing series during construction.

4.2 Design Thickness Recommendations

Due to the very poor to failing pavement conditions observed in the field, we recommend the existing roadway be reconstructed. Based on the above described design parameters, the design-based flexible pavement section should be supported by lime slurry stabilized subgrade (LSS) as specified in Design Chart 101B of the MCDOT Manual. The resulting flexible pavement design is shown in the following table:

Roadway Classification	Pavement Type	LSS Subgrade (inches)	ABC Thickness (Inches)	AC Thickness (Inches)	Total Thickness
Local Road	Flexible	6.0[1]	4.0	3.0[2]	13.0

Note: 1. This design is based on the general soils encountered on the site. These soil conditions should be confirmed by a representative of Terracon at the time of construction. For isolated areas with soil conditions similar to Boring B-6, alternative measures should be taken.

2. Terracon recommends a minimum AC thickness of 3 inches for increased performance of the AC.

Isolated areas with poor soil conditions such as those encountered in Boring B-6 may be encountered on the site. Unfortunately, Terracon is unable to determine the extents of these soil conditions based upon existing information. During the time of construction, a representative of

Terracon should be present at the site to assist in determining the extent of the poorer subgrade material. Where these conditions are found, one of the following alternatives should be used to mitigate the issue and increase pavement performance:

Alternative 1: Increase the LSS depth from 6 inches to 12 inches below the bottom of the ABC.

Alternative 2: Remove subgrade soils to a depth of 24 inches below the bottom the ABC and replace with non-expansive engineered fill.

Alternative 3: Treat the soil with 6 inches of LSS, overlay with a layer of Type III geogrid (TX5), and increase the ABC from 4 inches to 6 inches.

For this project, Terracon recommends an asphalt concrete mix designation of ½-inch. We recommend that asphalt concrete utilized for the project should be designed using Marshall compaction methods for low traffic conditions in accordance with Section 710 of the 2016 MAG specifications.

5.0 MATERIALS DESIGN

5.1 Materials Specifications

The use of Maricopa Association of Governments (MAG) 2016 Uniform Standard Specifications and Details for Public Works Construction is recommended for all work on the project. We recommend the following comments/recommendations be incorporated into project specifications.

MAG Specification	Specification Title	Comments/Recommendations
201	Clearing and Grubbing	--
205	Roadway Excavation	--
206	Structure Excavation and Backfill	--
210	Borrow Excavation	Imported fill should not have a Plasticity Index exceeding 15 or an expansive potential exceeding 1.5%.
211	Fill Construction	All fills placed on the project should be compacted to a minimum of 95% of the maximum density determined in accordance with ASTM D698. The moisture content of the fill soils during compaction should be specified as -2% to +2% of the optimum moisture determined in accordance with ASTM D698.
301	Subgrade Preparation	The depth of subgrade scarification and re-compaction should be increased to a minimum depth of 10 inches provided there is sufficient clearance above utilities to do so. All subgrade on the project should be compacted to a minimum of 95% of the maximum density determined in accordance with ASTM D698. The moisture

MAG Specification	Specification Title	Comments/Recommendations
		content of the subgrade soils during compaction should be specified as -2% to +2% of the optimum moisture determined in accordance with ASTM D698.
309	Lime Slurry Stabilization	Lime slurry with a minimum compressive strength of 160 psi is recommended.
310	Untreated Base	Aggregate Base Course specified for the project should be in accordance with Table 702.2 of the specifications.
317	Asphalt Milling	--
321	Placement and Construction of Asphalt Concrete Pavement	½-inch Marshall Asphalt Mix for Low Traffic Conditions are recommended for the asphalt concrete on this project in accordance with Table 710-3.
329	Tack Coat	--
601	Trench Excavation, Backfilling and Compaction	--
702	Base Materials	Aggregate Base Course on the project should conform to the requirements of Table 702.2.
710	Asphalt Concrete	½-inch Marshall Asphalt Mix for Low Traffic Conditions are recommended for the asphalt concrete on this project in accordance with Table 710-3.

5.2 Site Preparation and Earthwork

We recommend that all site preparation and earthwork on the project be undertaken under the applicable portions of MAG specifications. Recommended changes to these specifications as outlined in the preceding table should be included in the specific specifications or special provisions for the project.

5.3 Earthwork Factors

For balancing grading plans, the estimated shrinkage of the site soils when used as compacted fill is expected to be in the range of 5 to 10 percent based on compacting the materials to a minimum of 95 percent of the maximum dry density determined in accordance with ASTM D698. A ground compaction factor of approximately 0.10 feet should be applied when estimating the change in elevation of the native soil surface due to scarification, moisture conditioning and re-compaction prior to fill placement.

6.0 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, pavement construction and other earth-related construction phases of the project.

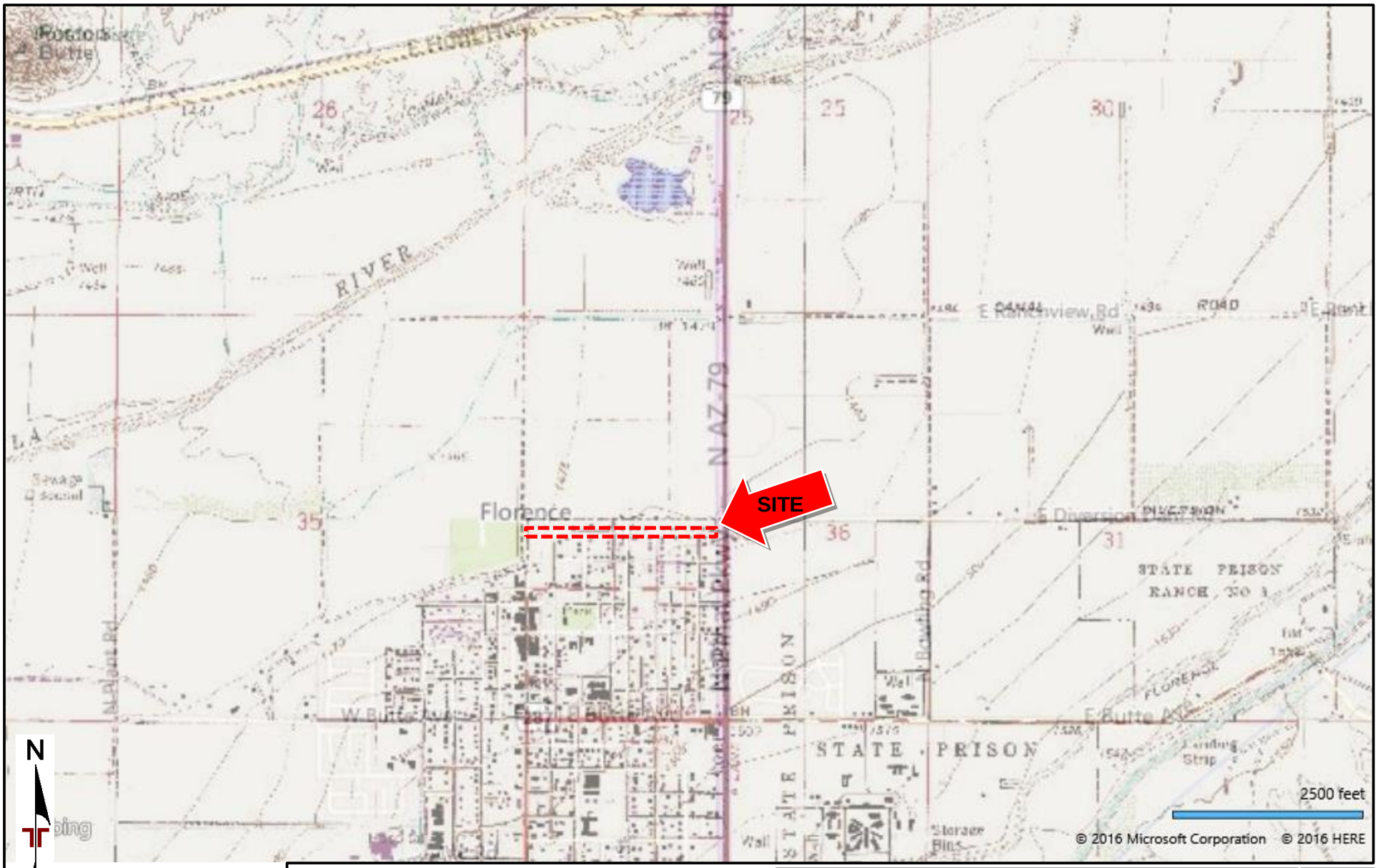
The analysis and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, or due to the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



N

TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY QUADRANGLES INCLUDE: FLORENCE, AZ (1/1/1981) and FLORENCE SE, AZ (1/1/1965).

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager:	KPM
Drawn by:	KPM
Checked by:	SDN
Approved by:	SDN

Project No.	65165303
Scale:	1"=2,000'
File Name:	A-1
Date:	12/15/16

Terracon
4685 S Ash Ave Ste H-4
Tempe, AZ 85282-6767

SITE LOCATION

1st Street Improvements

1st Street – Between Main Street & AZ Route 79
Florence, AZ

Exhibit

A-1

AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager:	KPM
Drawn by:	KPM
Checked by:	SDN
Approved by:	SDN

Project No.	65165303
Scale:	AS SHOWN
File Name:	A-1
Date:	12/15/16

Terracon
4685 S Ash Ave Ste H-4
Tempe, AZ 85282-6767

EXPLORATION PLAN

1st Street Improvements
1st Street – Between Main Street & AZ Route 79
Florence, AZ

Exhibit
A-2

Field Exploration Description

A total of six (6) test borings were drilled at the site on November 23, 2016. The borings were drilled to an approximate depth of 5 feet below the ground surface. The approximate boring locations are shown on the attached Exploration Plan, Exhibit A-2.

The test borings were advanced with a truck-mounted D-50 drill rig utilizing 8-inch outside diameter hollow-stem augers. The borings were located in the field utilizing an aerial photograph. Latitude and longitude coordinates for each boring were obtained from Google Earth Pro and should be considered approximate.

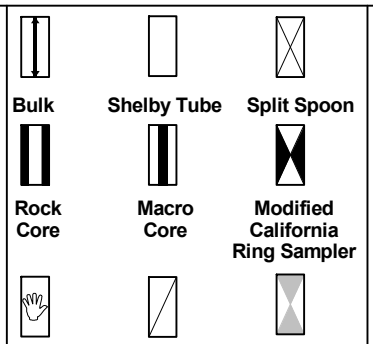
A continuous lithologic log of each boring was recorded by the field geologist during the drilling operations. At selected intervals, samples of the subsurface materials were taken by driving ring-lined barrel samplers in general accordance with ASTM Standards. Penetration resistance measurements were obtained by driving the 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.

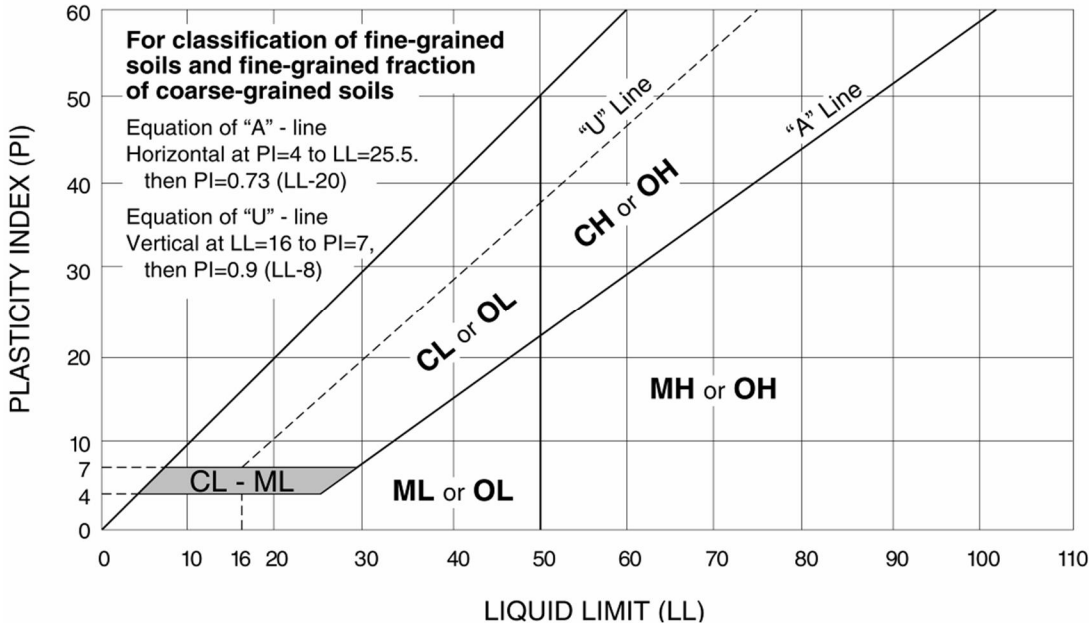
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[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

BORING LOG NO. B-1

PROJECT: 1st Street Improvements

CLIENT: Wilson & Company
Phoenix, AZ

SITE: 1st Street Between Main St & AZ Rt 79
Florence, Arizona

LOCATION See Exhibit A-2

Latitude: 33.03809° Longitude: -111.38665°

GRAPHIC LOG	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" AC								
	FILL - CLAYEY SAND WITH GRAVEL (SC), brown, loose, pieces of wood and other debris								
					5-12	24	98		26
	2.5 **LEAN CLAY WITH SAND (CL)**, brown, stiff								
					7-10	24	93		
	5.0 ***Boring Terminated at 5 Feet***	5							

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 and patched with asphalt cold patch upon completion.

See Exhibit A-3 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 Ste H-4
Tempe, AZ

Boring Started: 11/23/2016 Boring Completed: 11/23/2016

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

Project No.: 65165303 Exhibit: A-6

BORING LOG NO. B-2

PROJECT: 1st Street Improvements

CLIENT: Wilson & Company
Phoenix, AZ

SITE: 1st Street Between Main St & AZ Rt 79
Florence, Arizona

LOCATION See Exhibit A-2

Latitude: 33.03797° Longitude: -111.38546°

GRAPHIC LOG	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	0.1 **ASPHALT CONCRETE**, 1½" AC **FILL - SILTY CLAYEY SAND WITH GRAVEL (SC-SM)**, brown, ~8"								
	0.8 **LEAN CLAY WITH SAND (CL)**, brown, stiff				4-6	10	102		
								33-16-17	72
	4.0 **POORLY GRADED SAND WITH SILT (SP-SM)**, brown, loose				4-7	4	96		
	5.0 ***Boring Terminated at 5 Feet***	5							

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 and patched with asphalt cold patch upon completion.

See Exhibit A-3 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 Ste H-4
Tempe, AZ

Boring Started: 11/23/2016 Boring Completed: 11/23/2016

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

Project No.: 65165303 Exhibit: A-7

BORING LOG NO. B-3

PROJECT: 1st Street Improvements

CLIENT: Wilson & Company
Phoenix, AZ

SITE: 1st Street Between Main St & AZ Rt 79
Florence, Arizona

LOCATION See Exhibit A-2

Latitude: 33.03802° Longitude: -111.38414°

DEPTH	GRAPHIC LOG		DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.2		**ASPHALT CONCRETE**, 1¾" AC								
		FILL - SANDY LEAN CLAY (CL), brown, very stiff								
						18-20	10	114	25-15-10	51
2.0		**SANDY LEAN CLAY (CL)**, brown, very stiff								
						9-14	20	95		
5.0		***Boring Terminated at 5 Feet***	5							

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 and patched with asphalt cold patch upon completion.

See Exhibit A-3 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 Ste H-4
Tempe, AZ

Boring Started: 11/23/2016 Boring Completed: 11/23/2016

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

Project No.: 65165303 Exhibit: A-8

BORING LOG NO. B-4

PROJECT: 1st Street Improvements

CLIENT: Wilson & Company
Phoenix, AZ

SITE: 1st Street Between Main St & AZ Rt 79
Florence, Arizona

LOCATION See Exhibit A-2

Latitude: 33.03796° Longitude: -111.38273°

GRAPHIC LOG	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	0.2 **ASPHALT CONCRETE**, 2½" AC								
	FILL - SILTY CLAYEY SAND (SC-SM), brown, ~8"								
	0.8 **SANDY LEAN CLAY (CL)**, brown, stiff				6-6	8	107		
					6-9	17	92		
	5.0 ***Boring Terminated at 5 Feet***	5							

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 and patched with asphalt cold patch upon completion.

See Exhibit A-3 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 Ste H-4
Tempe, AZ

Boring Started: 11/23/2016 Boring Completed: 11/23/2016

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

Project No.: 65165303 Exhibit: A-9

BORING LOG NO. B-5

PROJECT: 1st Street Improvements

CLIENT: Wilson & Company
Phoenix, AZ

SITE: 1st Street Between Main St & AZ Rt 79
Florence, Arizona

LOCATION See Exhibit A-2

Latitude: 33.03796° Longitude: -111.38123°

GRAPHIC LOG	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	0.2 **ASPHALT CONCRETE**, 2½" AC								
	FILL - SILTY SAND WITH GRAVEL (SM), brown, ~8½"								
	0.9 **SANDY LEAN CLAY (CL)**, brown, stiff				6-9	15	105		
								43-18-25	70
	4.0 **SILTY CLAYEY SAND (SC-SM)**, brown, loose				6-10	14	99		
	5.0 ***Boring Terminated at 5 Feet***	5							

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 and patched with asphalt cold patch upon completion.

See Exhibit A-3 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 Ste H-4
Tempe, AZ

Boring Started: 11/23/2016 Boring Completed: 11/23/2016

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

Project No.: 65165303 Exhibit: A-10

BORING LOG NO. B-6

PROJECT: 1st Street Improvements

CLIENT: Wilson & Company
Phoenix, AZ

SITE: 1st Street Between Main St & AZ Rt 79
Florence, Arizona

LOCATION See Exhibit A-2

Latitude: 33.03795° Longitude: -111.3797°

GRAPHIC LOG	DEPTH		DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	0.2	**ASPHALT CONCRETE**, 2"AC								
		SILTY CLAYEY SAND WITH GRAVEL (SC-SM), ~8"								
	0.8	**FAT CLAY (CH)**, brown, stiff				9-12				
									62-19-43	89
		medium stiff				4-5	24	87		
	5.0		5							
		Boring Terminated at 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 and patched with asphalt cold patch upon completion.

See Exhibit A-3 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 Ste H-4
Tempe, AZ

Boring Started: 11/23/2016 Boring Completed: 11/23/2016

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

Project No.: 65165303 Exhibit: A-11

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.

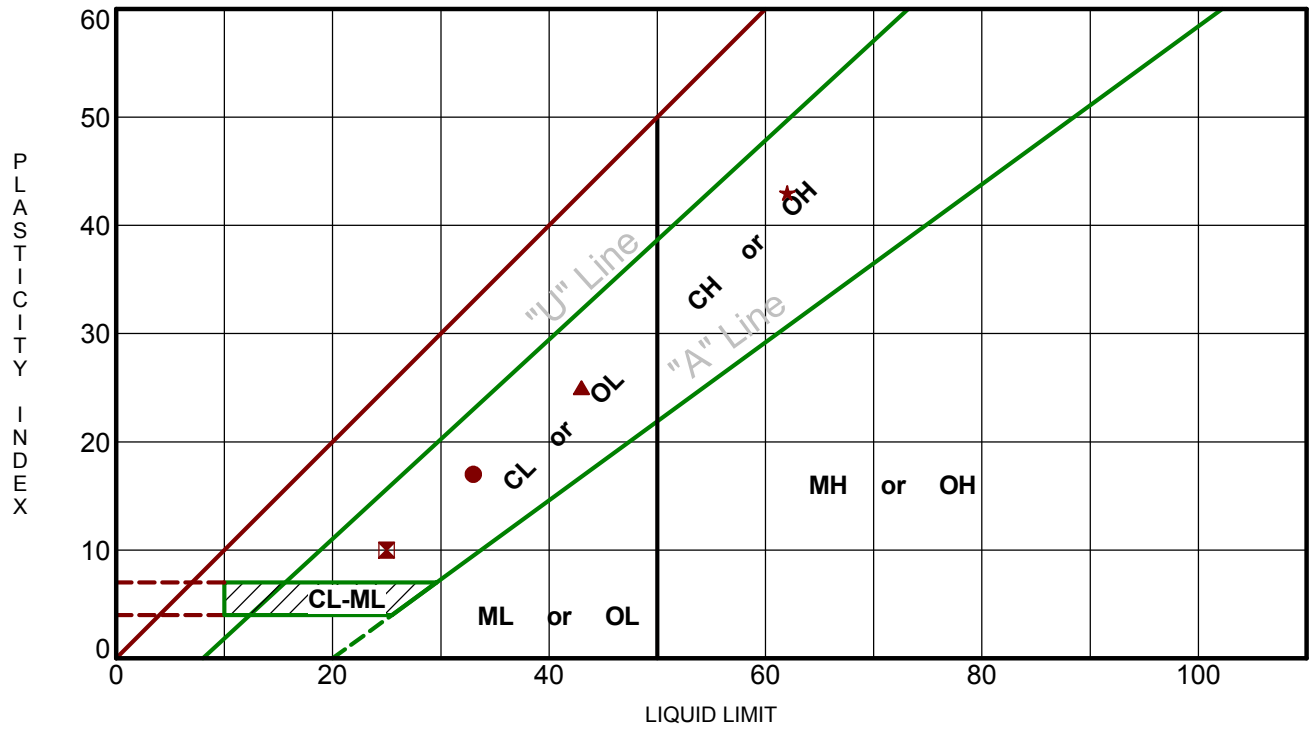
Laboratory tests were conducted on selected soil samples and the test results are presented in this appendix. The laboratory test results were used for the geotechnical engineering analyses, and the development of pavement recommendations. Laboratory tests were performed in general accordance with the 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
- Remolded Swell
- Soluble Sulfates
- pH
- Resistivity
- Sieve Analysis
- Dry Density
- Moisture-Density Relationship
- R-Value
- Soluble Chlorides

ATTERBERG LIMITS RESULTS

ASTM D4318



Boring ID	Depth	LL	PL	PI	Fines	USCS	Description
● B-2	1 - 4	33	16	17	72	CL	LEAN CLAY with SAND
⊠ B-3	1 - 2	25	15	10	51	CL	SANDY LEAN CLAY
▲ B-5	1 - 4	43	18	25	70	CL	SANDY LEAN CLAY
★ B-6	1 - 4	62	19	43	89	CH	FAT CLAY

PROJECT: 1st Street Improvements

SITE: 1st Street Between Main St & AZ Rt 79
Florence, Arizona

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

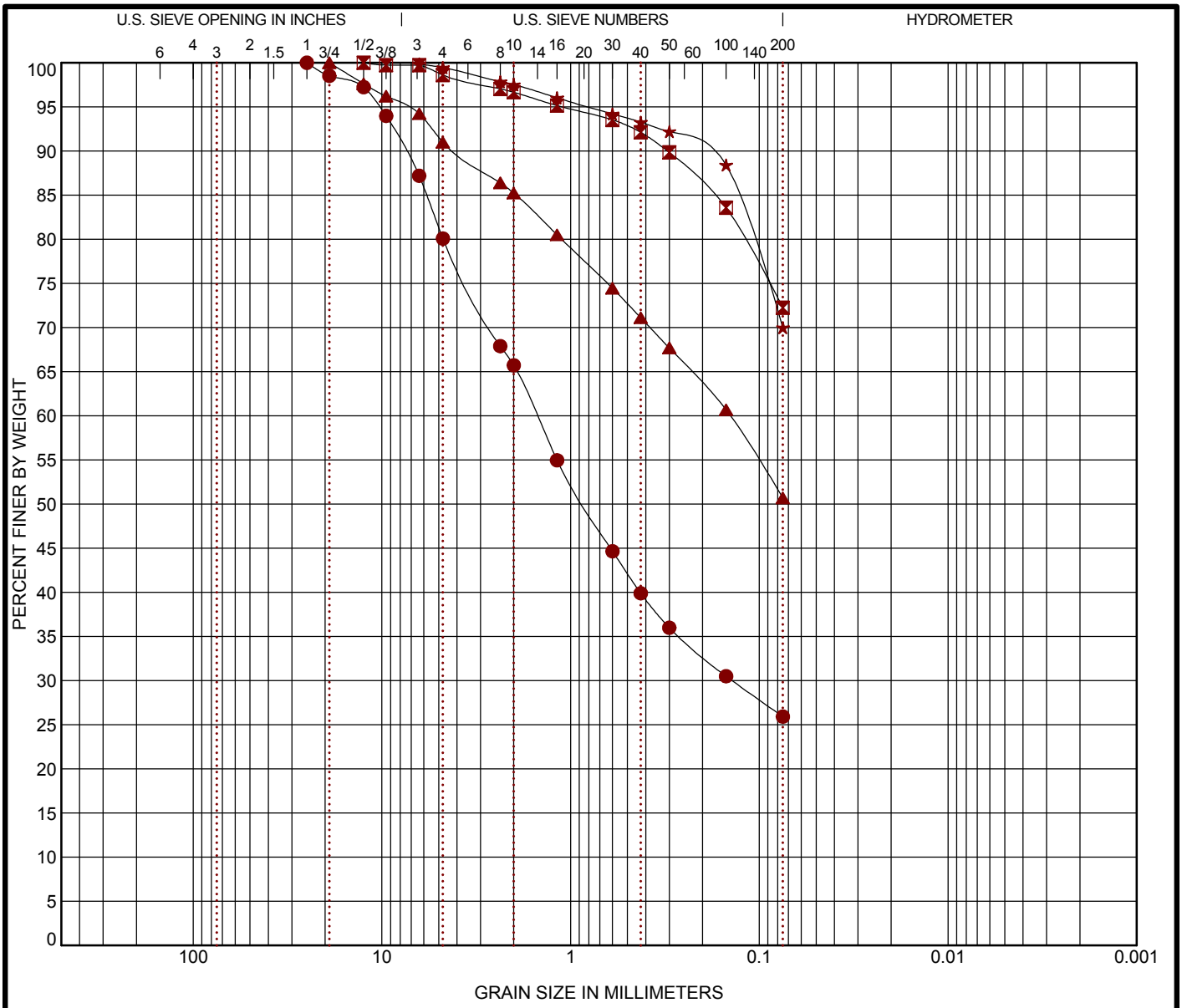
PROJECT NUMBER: 65165303

CLIENT: Wilson & Company
Phoenix, AZ

EXHIBIT: B-2

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring ID	Depth	USCS Classification	AASHTO Classification	WC (%)	LL	PL	PI	Cc	Cu
●	B-1	0.5 - 2.5	CLAYEY SAND WITH GRAVEL (SC)							
⊠	B-2	1 - 4	LEAN CLAY with SAND (CL)	A-6 (10)		33	16	17		
▲	B-3	1 - 2	SANDY LEAN CLAY (CL)	A-4 (2)		25	15	10		
★	B-5	1 - 4	SANDY LEAN CLAY (CL)	A-7-6 (16)		43	18	25		

	Boring ID	Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Gravel	%Sand	%Silt	%Fines	%Clay
●	B-1	0.5 - 2.5	25	1.511	0.139		19.9	54.2	25.9		
⊠	B-2	1 - 4	12.5				1.4	26.4	72.2		
▲	B-3	1 - 2	19	0.143			9.0	40.3	50.7		
★	B-5	1 - 4	6.35				0.4	29.5	70.0		

PROJECT: 1st Street Improvements

SITE: 1st Street Between Main St & AZ Rt 79
Florence, Arizona

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

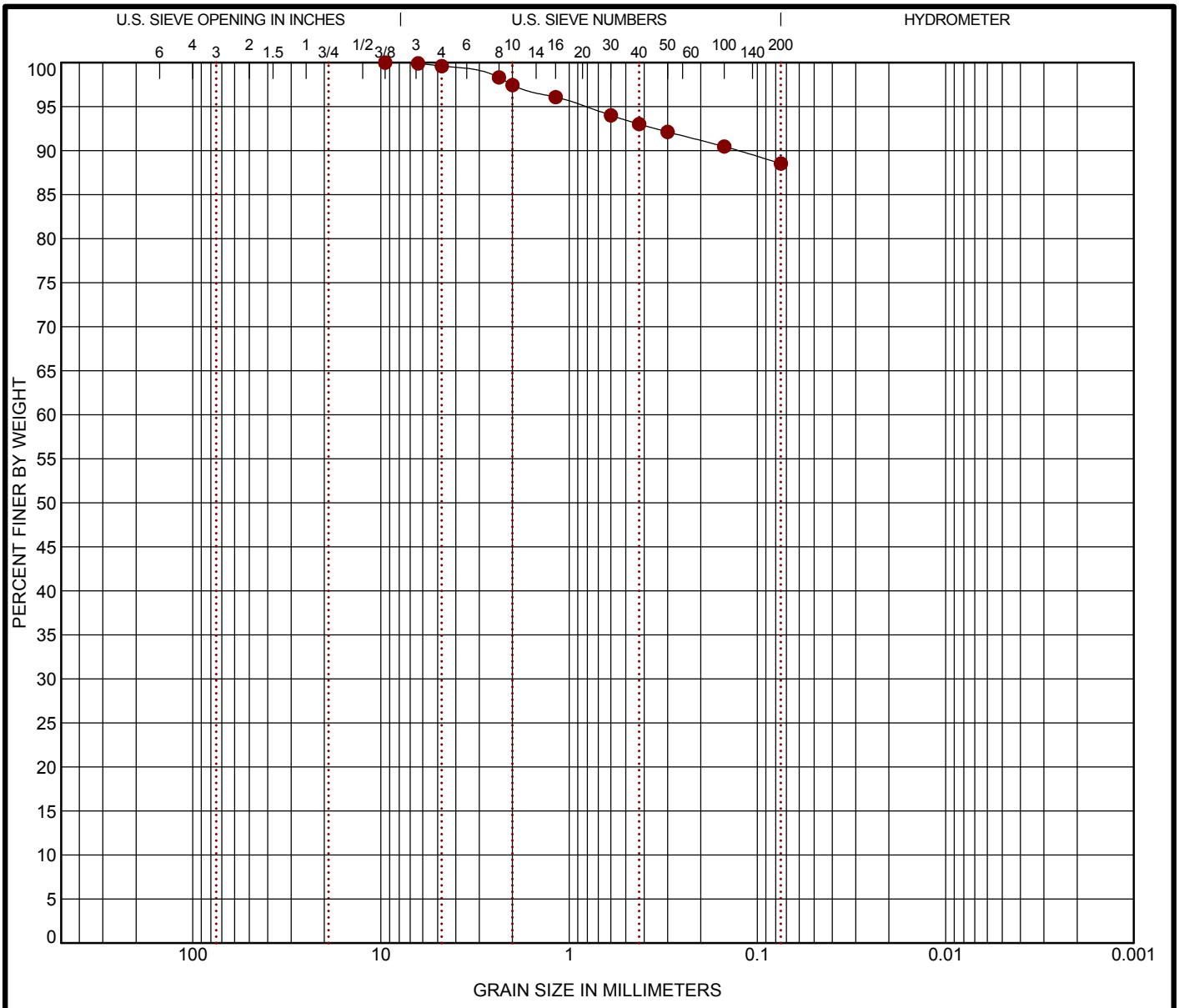
PROJECT NUMBER: 65165303

CLIENT: Wilson & Company
Phoenix, AZ

EXHIBIT: B-3

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Boring ID	Depth	USCS Classification	AASHTO Classification	WC (%)	LL	PL	PI	Cc	Cu
B-6	1 - 4	FAT CLAY (CH)	A-7-6 (41)	10	62	19	43		

Boring ID	Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Gravel	%Sand	%Silt	%Fines	%Clay
B-6	1 - 4	9.5				0.4	11.1	88.5		

PROJECT: 1st Street Improvements

SITE: 1st Street Between Main St & AZ Rt 79
Florence, Arizona

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

PROJECT NUMBER: 65165303

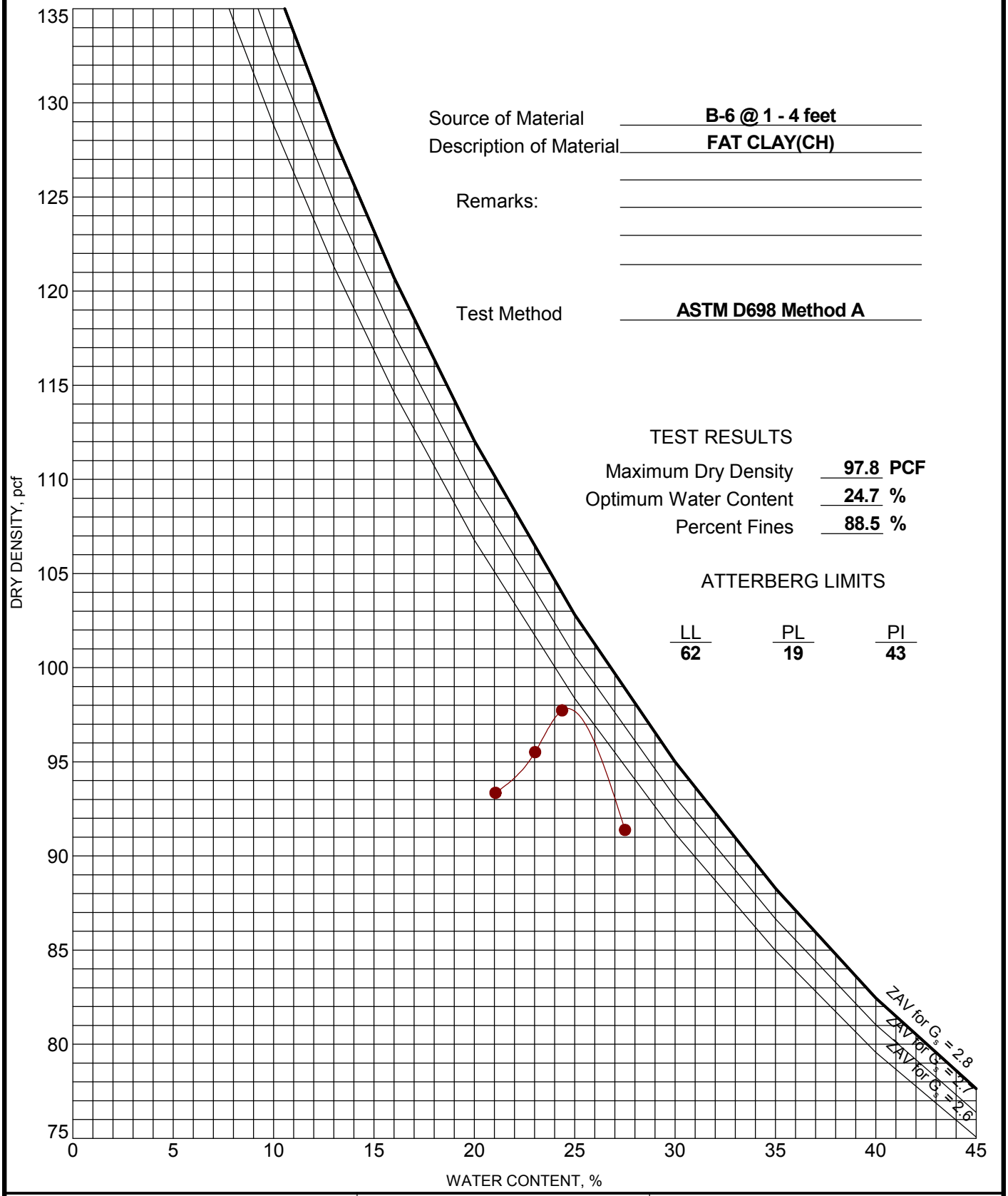
CLIENT: Wilson & Company
Phoenix, AZ

EXHIBIT: B-4

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS & AASHTO COMBINED 65165303.GPJ TERRACON2015.GDT 12/20/16

MOISTURE-DENSITY RELATIONSHIP

ASTM D698/D1557



Source of Material: **B-6 @ 1 - 4 feet**

Description of Material: **FAT CLAY(CH)**

Remarks:

Test Method: **ASTM D698 Method A**

TEST RESULTS

Maximum Dry Density	**97.8**	**PCF**
Optimum Water Content	**24.7**	**%**
Percent Fines	**88.5**	**%**

ATTERBERG LIMITS

LL	PL	PI
62	**19**	**43**

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. COMPACTION - V2 65165303.GPJ TERRACON2012.GDT 12/14/16

PROJECT: 1st Street Improvements

SITE: 1st Street Between Main St & AZ Rt 79
Florence, Arizona

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

PROJECT NUMBER: 65165303

CLIENT: Wilson & Company
Phoenix, AZ

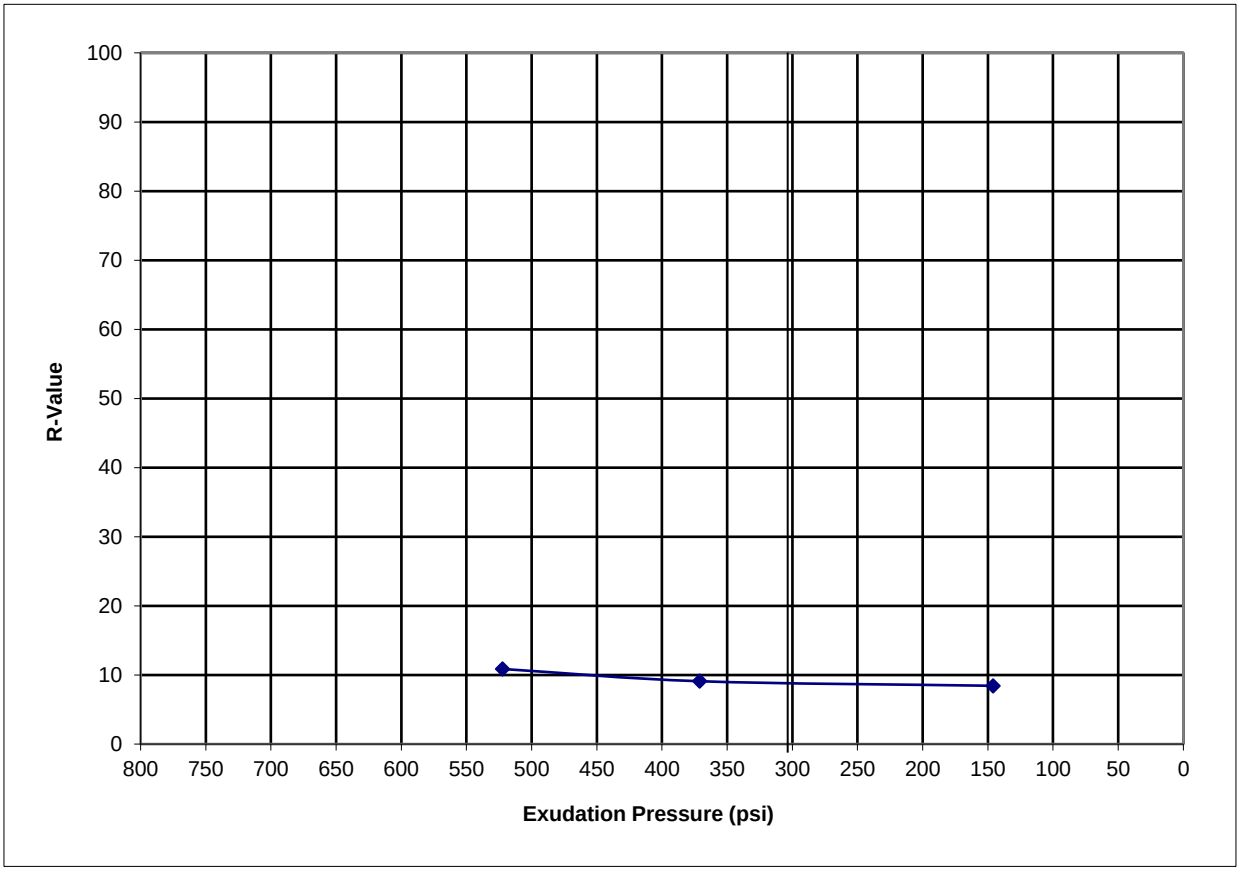
EXHIBIT: B-4

PROJECT:	1st Street Improvements	**JOB NO:**	65165303
LOCATION:		**WORK ORDER NO:**	65165303
MATERIAL:	Fat Clay	**LAB NO:**	
SAMPLE SOURCE:	B-6 @ 1'-4'	**DATE RECEIVED:**	

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

SPECIMEN I. D.	**A**	**B**	**C**
Moisture Content	30.7%	28.1%	25.5%
Compaction Pressure (psi)	*	*	*
Specimen Height (inches)	2.58	2.51	2.55
Dry Density (pcf)	90.7	94.5	99.2
Horiz. Pres. @ 1000lbs (psi)	67.0	63.0	58.0
Horiz. Pres. @ 2000lbs (psi)	140.0	140.0	138.0
Displacement	4.19	3.57	3.27
Expansion Pressure (psi)	0.0	0.0	0.0
Exudation Pressure (psi)	146	371	522
R Value	8	9	11

* HAND TAMPED



AASHTO R18

R Value at 300 PSI = 8.6

Exhibit B-5

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	0.5 - 2.5	SC			26									8.6	3536	86	33	2
B-1	1.0 - 2.0	SC	98	24														1, 2
B-1	4.0 - 5.0	CL	93	24														1, 2
B-2	1.0 - 4.0	CL			72	33	16	17	105	14.5	144	0.0						
B-2	1.0 - 2.0	CL	102	10														1, 2
B-2	4.0 - 5.0	SP-SM	96	4														1, 2
B-3	1.0 - 2.0	CL	114	10	51	25	15	10										1
B-3	4.0 - 5.0	CL	95	20														1, 2
B-4	1.0 - 2.0	CL	107	8														1, 2
B-4	4.0 - 5.0	CL	92	17														1, 2
B-5	1.0 - 4.0	CL			70	43	18	25	96	18.8	144	2.0						
B-5	1.0 - 2.0	CL	105	15														1, 2
B-5	4.0 - 5.0	SC-SM	99	14														1, 2
B-6	1.0 - 4.0	CH			89	62	19	43	93	22.7	144	1.3						
B-6	4.0 - 5.0	CH	87	24														1, 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: 1st Street Improvements

SITE: 1st Street Between Main St & AZ Rt 79
Florence, Arizona

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

PROJECT NUMBER: 65165303

CLIENT: Wilson & Company
Phoenix, AZ

EXHIBIT: B-6