GEOTECHNICAL ENGINEERING REPORT

SHIPROCK SENIOR CENTER PARKING LOT ADDITION
SHIPROCK, NEW MEXICO

PREPARED FOR:

WILSON & COMPANY, INC., ENGINEERS AND ARCHITECTS

4401 MASTHEAD STREET NE #150 ALBUQUERQUE, NM 87109

PROJECT NO.: US0047144.1582

DATE: AUGUST 27, 2025

WSP USA EARTH & ENVIRONMENT INC.
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August 27, 2025

Confidential

Wilson & Company, Inc., Engineers and Architects
4401 Masthead St. NE, Suite 150
Albuquerque, NM 87109

Attention: **Mr. Derek Meier, P.E., Senior Project Manager**

Re: **Geotechnical Engineering Report**
Shiprock Senior Center Parking Lot Addition
Shiprock, New Mexico

Dear Mr. Meier,

WSP USA Earth & Environment (WSP) has performed a geotechnical investigation for the proposed Shiprock Senior Center Parking Lot project in Shiprock, New Mexico. The results of our field investigation and laboratory testing programs along with geotechnical engineering recommendations for the project are presented in this report.

Should you have any questions concerning the recommendations presented in this report, please do not hesitate in contacting us.

Sincerely,

WSP USA Environmental & Infrastructure Inc.

Rashidatu Ossai, Ph.D.
Staff Geotechnical Engineer

Reviewed by:

Ronald Eric Pease

R. Eric Pease, Ph.D., P.E.
Assistant Vice President

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TABLES

EXECUTIVE SUMMARY

This summary of geotechnical engineering considerations is presented for introductory purposes and should be used only in conjunction with the full text of this report.

Project Description: The project consists of paving the north side of the existing parking lot with new asphalt and placing a new concrete pad north of the existing building for the Senior Center parking lot improvements in Shiprock, New Mexico. The engineering properties of the soils underlying the site were evaluated to provide recommendations for pavement rehabilitation and construction. The location of the project is presented in the Site and Exploration Plan, Appendix A.

Exploratory Methods: We explored the subsurface by drilling two (2) hollow-stem-auger boreholes (designated B-01 and B-02) to depths of 5 feet. Standard Penetration Testing (SPT – ASTM D1586) was performed and split-barrel soil samples were taken at 2.5-foot intervals, advanced at the locations shown on the Site and Exploration Plan.

Groundwater Conditions: At the time of exploration (July 11, 2025), groundwater was not encountered in the exploration boreholes.

Pavement Design: We are providing recommendations for a flexible pavement design comprised of Hot Asphalt Mix (HMA) and Aggregate Base Course (ABC) for the roadway improvements. The in-situ site soils are clayey and have moisture contents near the tested plastic limits. Because of this, the bottom of excavation may become unstable and require stabilization to mitigate "pumping" effects. Recommendations for prepared and geogrid reinforced subgrade are provided in Section **Error! Reference source not found.**.

1 SITE AND PROJECT DESCRIPTION

This report presents the results of a subsurface investigation and makes recommendations for pavements at the Senior Center parking lot in Shiprock, New Mexico. The project consists of paving the north side of the existing parking lot with new asphalt and constructing a new concrete pad north of the existing building for use as a sidewalk.

The conclusions and recommendations contained in this report are based on our understanding of the project, written information, and verbal information supplied to us. Consequently, if any significant changes are made, we may need to modify our conclusions and recommendations contained herein to reflect those changes.

2 EXPLORATORY METHODS

The surface and subsurface conditions at the project site were explored by WSP on July 11th, 2025. Our exploration and testing program consisted of the following tasks.

- A visual surface reconnaissance of the site.
- Two (2) hollow-stem-auger boreholes (designated B-01 and B-02) with SPT samples taken at 2.5-foot intervals. Refer to Figure 1 in Appendix A for the Site Plan and borehole layout.
- Laboratory testing consisting of:
    - grain-size distribution analyses,
    - Atterberg limit tests,
    - moisture content and in-situ density tests,
    - moisture density relationship test,
    - soil collapse potential test,
    - sulfate and chlorides tests,
    - R-Value test, and
    - pH and soil resistivity tests.

Table 1 summarizes the locations, surface elevations, and termination depths of the boreholes. Appendix A includes the borehole logs and describes the field exploration procedures. Appendix B presents the laboratory testing procedures and results.

Table 1: Borehole Locations, Elevations, and Depths

Borehole	Proposed Facility Location	Latitude/Longitude	Surface Elevation (feet)	Termination Depth (feet)
B-01	North of Existing Parking Lot	36° 46' 25.40"N, 108° 41' 52.91"W	4,956	5
B-02	North of Building	36° 46'25.58"N, 108°41'54.58"W	4,957	5

Note(s): 1. Elevation datum: Google Earth Pro, accessed 8/15/2025.

The number and locations of our test boreholes were determined by the locations of the proposed pavement improvements as indicated on our site and exploration plan, Appendix A. Borehole locations shown in Appendix A and elevations shown in Table 1 are based on the Google Earth Pro (accessed August 15, 2025) and should be considered accurate only to the degree permitted by our data sources and implied by our measuring methods.

It should be noted that the test boreholes performed and used for this evaluation reveal subsurface conditions only at discrete locations across the project site, and that actual conditions in other locations could vary. Furthermore, the nature and extent of these variations will not become evident until construction activities have begun. If significant variations are observed, we may need to modify the conclusions and recommendations contained in this report to reflect the actual site conditions.

3 SITE CONDITIONS

This section presents our findings and interpretations supporting our pavement recommendations.

3.1 Existing Pavement Conditions

The project site is located on Highway 491 south, next to the Shiprock Post office. The proposed parking addition is currently unpaved. A visual evaluation of the existing parking lot shows cracks due to settlement. The following figures show the conditions of the existing pavement and project area.

Figure 1. North of Existing Parking Lot (B-01)

Figure 2. North of Building (B-02)

Figure 3. Existing Parking Lot

Figure 4. Existing Parking Lot

Figure 5. Northeast of Existing Parking Lot

Figure 6. Northeast of Existing Parking Lot

3.2 Surface Conditions

The site surface grades are relatively flat, with topographic relief of one to three feet. Vegetation within the project area consists of native grasses, and shrubs.

3.3 Soil Conditions

A generalized subsurface profile was developed using the boreholes for this project (Table 2). It is recognized that soil properties vary within short horizontal and vertical deviations from the locations drilled. The exploration logs included in Appendix A provide a description of the soil strata encountered in our borehole locations.

Laboratory tests revealed that the soils have high fines (silt and clay) content, ranging from 86 to 93 percent. Moisture content of these soils ranged from 6.6 to 14.8 percent and optimum moisture was estimated at 9.5 percent.

Bulk samples, from a depth of 0 to 5 feet of B-01, were tested to determine the electrical resistivity, R-Value, pH, sulfate, and chloride contents of the soil in accordance with ASTM G187, ASTM D2844, ASTM D4972, AASHTO T290 and AASHTO T291, respectively.

Collapse/swell upon wetting testing was performed at a depth of 2.5 feet for borehole B-02 in accordance with ASTM D5333.

The laboratory test results are presented in Appendix B.

Table 3 summarizes test results for selected samples, upon which grain-size analyses were performed.

Table 2: Subsurface Geotechnical Profile

Description of Soil Unit	Layer Thickness (Feet)[1]	Typical Soil
Medium stiff to stiff lean clay and medium plasticity	0 – 5	A-7 (CL)

Note(s):
1. Boreholes terminated at a depth of 5 feet with a 1.0-foot sampler extended to 6.0 feet.

2. Based on information from Borehole B-01 and B-02.

Table 3: Laboratory Test Results

Borehole, Depth (feet)	Soil Type (AASHTO Soil Type)	P.I.	Moisture Content (percent)	Grain Size Analysis		
				Gravel (percent)	Sand (percent)	Silt/Clay (percent)
B-01, 0-2.5	A-7	12	10.8	0	14	86
B-02, 2.5-5.0	A-7	12	9.2	0	7	93

Note(s):

The results of electrical resistivity, pH, sulfate, and chloride, tests are summarized in Table 4. Soils with resistivity within the range of 1,000 to 2,000 ohms-centimeters are considered corrosive. Based on the laboratory results, the soil in the upper 5 feet of the site is corrosive. Laboratory test results are presented in Appendix B.

Table 4: Chemical Test Results

Borehole, Depth	pH	Minimum Resistivity (Ω-cm)	R-Value	Sulfate Content (ppm)	Chloride Content (ppm)
B-01, @ 0 - 5.0 feet	7.7	1,026	15	163	14

Table 5 presents results of the collapse test for the clayey material at a depth of 2.5 feet for borehole B-02.

Table 5: Collapse/expansion upon Wettig Test Sample

Sample	Collapse/expansion	Comment
B-02, @ 2.5 feet	2.7	Collapsed upon wetting

Groundwater Conditions

At the time of exploration (July 11, 2025), groundwater was not encountered in the exploration boreholes.

Throughout the year, groundwater levels will fluctuate in response to changing precipitation patterns, construction activities, and site use.

4 ANALYSIS AND RECOMMENDATIONS

4.1 TRAFFIC ANALYSIS

Design vehicle information was provided to WSP by Wilson and Company Inc., on August 19th, 2025. The data was an estimated, average, weekday traffic of 144 trips/day. The information was classified in

accordance with AASHTO 1993 Guide for Design of Pavement Structures. The estimated total ESAL's for the project site using an AADT of 144, a 20-year pavement design life, and a 0% growth factor is 30,516. Assumed traffic percentages for each vehicle class and average ESAL factors are also presented below.

Table 6: Summary of Assumed Traffic Data

FHWA Vehicle Classification	Traffic Percentage	ESAL Equivalency Factor
Passenger Vehicles	85.0%	0.0008
Single Unit Trucks	15.0%	0.189

4.2 PAVEMENT AND SLAB DESIGN SECTION

Pavement thickness design for the project was evaluated using the most current version of the NMDOT Design Manual Section 620 and AASHTO 1993 Guide for Design of Pavement Structures methodology. The structural design of each pavement section was determined by performing calculations using the current NMDOT Design Manual Chapter 620 (Surfacing Materials and Pavement Design), AASHTO 1993, R-value value of 15, and 20-year design ESALs of 30,516.

The values for various parameters used in the calculations for the flexible pavement design are provided in Table 7. The following equation from NMDOT was used to estimate the resilient modulus based on the design R-value and is presented in the table below:

$$M_R = 10^{(Rvalue+222)/67}$$

The required pavement structural numbers (SN) for the roadway section were calculated using the AASHTO design equation for flexible pavement design.

Table 7: Flexible Pavement Design Parameters

Design Parameters	Value
Initial Serviceability	4.2
Terminal Serviceability	2.0
Reliability Level	75%
Overall Standard Deviation, S_o	0.40
Growth rate of vehicles (%)	0
Resilient Modulus, M_R (psi)	3,446
Structural Number, SN	2.3

Pavement layer thicknesses were calculated based on structural layer coefficients of 0.44 Asphalt Cement Pavement (ACP) and 0.11 for Aggregate Base Course.

4.2.1 FLEXIBLE PAVEMENT RECOMMENDATIONS

The following presents the pavement design options recommended for this project. The site is predominantly wet, clayey, soils. During the site reconnaissance, it appeared that the site had problems with drainage, and there were several distressed areas of the existing parking lot. Given these observations

and based on R-Value of less than 20, two pavement options are provided. The first option considers excavation, scarification, and drying, of the wet in-situ subgrade soils to facilitate proper moisture conditioning and re-compaction. The second option considers excavation, proof rolling, and placement of geogrid at grade (per manufacturer's instruction) to eliminate the need for subgrade preparation. The options are presented below and summarized in Table 8.

Option 1: Pavement section over prepared subgrade

- Excavate and grade site to accommodate the new pavement section
- Moisture condition and recompact the upper 6-inches of subgrade
- Place one (1) 6-inch layer of compacted aggregate base course (ABC).
- Place of two (2) layers of asphalt cement pavement (ACP) for a total thickness of 4-inches.
    - Base Layer: 2.5-inches of SP III
    - Surface Layer 2: 1.5-inches of SP IV

Option 2: Pavement section of stabilized subgrade (geogrid reinforcement)

- Excavate and grade site to accommodate the new pavement section.
- Proof roll the bottom of over-excavation and remove/replace soft zones with compacted ABC
- Place triaxial geogrid reinforcement at the bottom of excavation (i.e., above the untreated subgrade).
- Placement of (1) 4-inch layer of compacted ABC. A total thickness of 4-inches.
- Placement of one (1) layer of ACP for a total thickness of 3-inches.
    - Surface Layer: 3-inches of SP III

Table 8: Recommended Full Depth Flexible Pavement Sections

Option	Asphalt Cement Pavement (ACP) Thickness (inches)	Aggregate Base Course (ABC) Thickness (inches)	Subgrade Stabilization Method	Required Structural Number, SN	Resulting SN
Option 1: Prepared Subgrade	4	6	6-inches of subgrade prep (Per NMDOT Specification 207)	2.3	2.42
Option 2: Stabilized subgrade using Geogrid Reinforcement	3	4	Triaxial Geogrid – Tensar NX750 or Equivalent (per manufacturer's recommendations)		2.44

4.2.2 SLAB-ON-GRADE FLOORS

Soil-supported slab-on-grade floors can be used as the new concrete pad north of the existing building. We offer the following comments and recommendations concerning slab-on-grade floors.

Floor Subbase: To reduce differential settlement and cracking, and improve construction conditions, we recommend a subbase of imported sand and gravel be placed above the subgrade soils. The subbase

should be at least 6 inches thick and meet the following grading requirements as determined in accordance with ASTM C136.

Table 9: Imported Structural Subbase Fill Grain Size Requirements

SIEVE SIZE (SQUARE OPENINGS)	PERCENT PASSING BY DRY WEIGHT
1-INCH	100
¾-INCH	85-100
NO. 4	45-95
NO. 200	0-8

Vertical Deflections: Soil-supported slab-on-grade floors can deflect downward when vertical loads are applied, due to elastic compression of the subgrade. It is recommended to use a subgrade modulus (k_1) of 100 pci (based on 1-ft by 1-ft square) for native compacted subgrades. For a square footing on sand, the subgrade modulus value may be modified for various foundation widths based upon the following equation:

$k_s = k_1\left[\frac{B+1}{2B}\right]^2$

B = foundation width (in feet)

For a rectangular footing on sand, the subgrade modulus value may be modified for various foundation widths based upon the following equation:

$k_s = k_1\left[\frac{m+0.5}{1.5m}\right]$

m = L/B

L = foundation length (in feet)

B = foundation width (in feet)

5 CONSTRUCTION REQUIREMENTS

5.1 ROADWAY SPECIFICATIONS

If the project will be governed by NMDOT criteria, project construction and material specifications should conform to New Mexico Department of Transportation's 2019 Standard Specifications for Highway and Bridge Construction. At a minimum, the following sections and divisions should apply:

- NMDOT Section 203 – Excavation, Borrow, and Embankment
- NMDOT Section 203-A – Unstable Subgrade Stabilization
- NMDOT Section 207 – Subgrade Preparation
- NMDOT Section 303 – Base Course
- NMDOT Division 400 – Surface Treatments and Pavements

Subgrade compaction is recommended to be per NMDOT Section 207. It is recommended that the upper 6 inches of subgrade be processed to 95 percent of maximum density (as determined according

Used 40101-1300 per NMDOT 416/423 spec that calls out sp-III at 1 inch to 3/4 inch aggregate and an ESAL of <300000 (0.3M). Used 1 inch for heavy vehicles for deliveries.

to AASHTO T 180 Method D). The moisture content is required to be between optimum moisture and plus 4 percent (for clayey soils).

Due to the inherent risk of variability across the project site, we suggest utilizing a small quantity of NMDOT Section 203-A Subgrade Stabilization for areas that are determined to be saturated, soft, gummy, pumping and/or displaces with applied loading as defined in the specification.

It is our recommendation that SP-III or SP-IV be selected for the asphalt pavement and a performance grade binder of PG 70-22 be used per NMDOT Specification Section 416. Additionally, we recommend a Type I untreated base course grading designation (NMDOT-19, Table 303.2.2:1) be specified for the aggregate base course.

The soils throughout the project area that will be encountered during earthwork operations can be excavated with normal earth moving equipment. Heavier equipment may be necessary if cobble and rock is to be excavated (neither bed rock nor cobbles were encountered during the geotechnical investigation). Proper drainage systems should be provided to minimize the risk of future moisture problems.

6 CLOSURE

The conclusions and recommendations presented in this report are based, in part, on the explorations WSP performed and used for this study; therefore, if variations in the subgrade conditions are observed, we may need to modify this report to reflect those changes. WSP is available to provide geotechnical engineering throughout the design process and to perform monitoring services throughout construction.

APPENDIX

A

FIELD EXPLORATION PROCEDURES, SITE LOCATION AND EXPLORATION PLAN, BOREHOLE LOGS

APPENDIX

Appendix A – Field Exploration Procedures and Logs

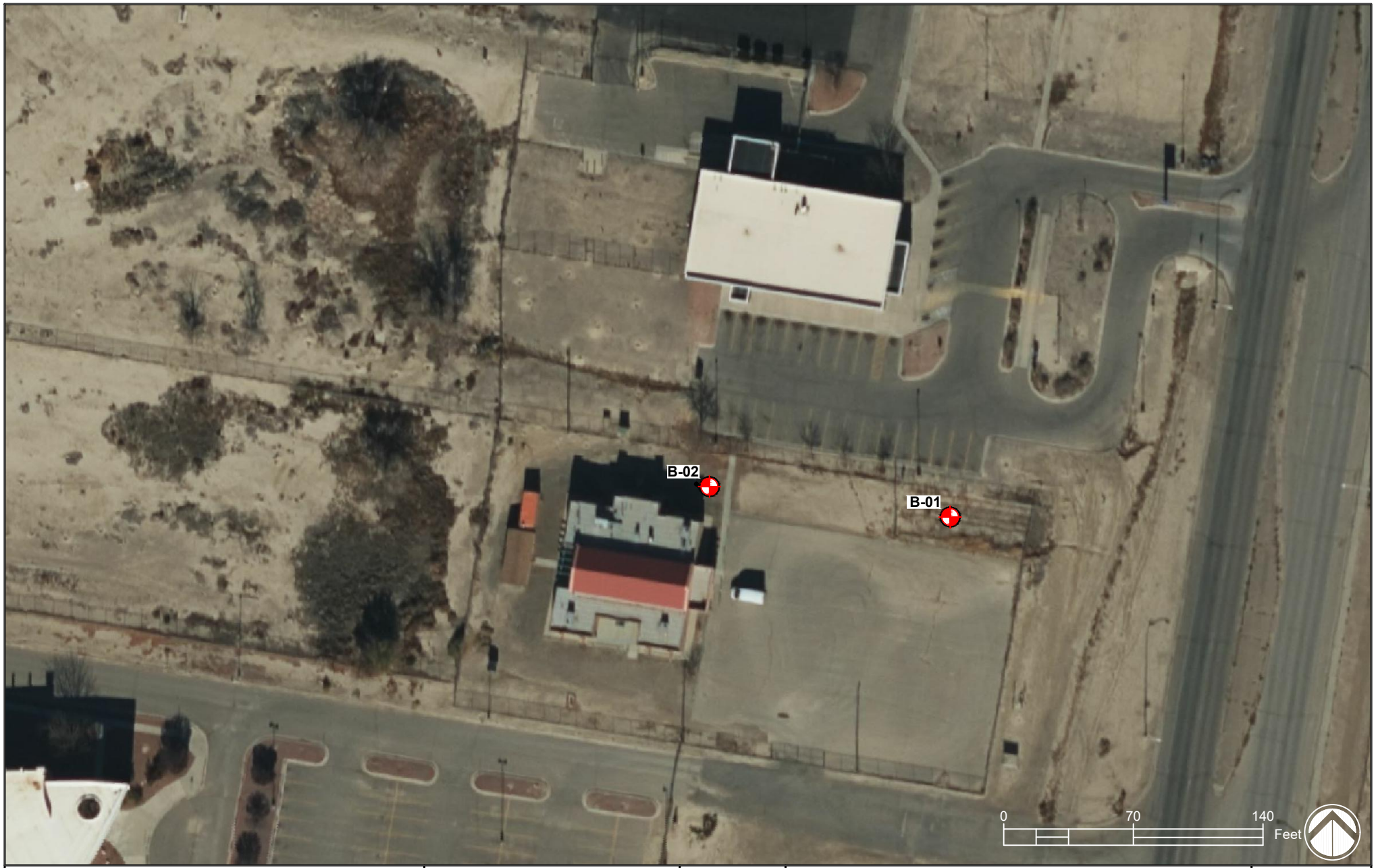
The following paragraphs describe the procedures used for field explorations and field tests that WSP conducted for this project. Descriptive logs of our explorations are enclosed in this appendix.

Auger borehole procedures

Exploratory boreholes were advanced with a hollow-stem auger using a truck-mounted drill rig operated by an independent drilling firm working under subcontract to WSP. An engineer from WSP continuously observed the boreholes, logged the subsurface conditions, and collected representative soil samples. All samples were stored in watertight containers and later transported to the laboratory for further visual examination and testing. After each borehole was completed, the borehole was backfilled with a mixture of bentonite chips and soil cuttings, and the surface was patched with asphalt or concrete (where appropriate).

Throughout the drilling operation, soil samples were obtained at 2.5- or 5-foot depth intervals by means of the Standard Penetration Test (SPT) per ASTM D-1586. This testing and sampling procedure consists of driving a standard 2-inch-diameter steel split-spoon sampler 18 inches into the soil with a 140-pound hammer free-falling 30 inches. The number of blows required to drive the sampler through each 6-inch interval was counted, and the total number of blows struck during the final 12 inches was recorded as the Standard Penetration Resistance, or "SPT blow count." If a total of 50 blows were struck within any 6-inch interval, the driving was stopped and the blow count was recorded as 50 blows for the actual penetration distance. The resulting Standard Penetration Resistance values indicate the relative density of granular soils and the relative consistency of cohesive soils.

The enclosed Borehole Logs describe the vertical sequence of soils and materials encountered in each borehole, based primarily on field classifications and supported by subsequent laboratory examination and testing. Where a soil contact was observed to be gradational, borehole logs indicate the average contact depth. Where a soil type changed between sample intervals, we inferred the contact depth. The borehole logs also graphically indicate the blow count, sample type, sample number, and approximate depth of each soil sample obtained from the boreholes, as well as any laboratory tests performed on these soil samples. If any groundwater was encountered in a borehole, the approximate groundwater depth is depicted on the borehole log. Groundwater depth estimates are typically based on the moisture content of soil samples, the wetted height on the drilling rods, and the water level measured in the borehole after the auger has been extracted.



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CLIENT: Wilson & Company, Inc., Engineers and Architects

Global Inc.
4221 Balloon Park Rd. N.E.
Albuquerque, NM 87109

LEGEND

B-01 Sample Number and Approximate Location

DWN BY:	RO
CHK'D BY:	BT
DATUM:	NAD83
PROJECTION:	N/A
SCALE:	AS SHOWN

PROJECT: Shiprock Senior Center Parking Lot
Shiprock, New Mexico

TITLE: Site and Exploration Plan

REV. NO.:	
DATE:	08/18/2025
PROJECT NO:	US0047144.1582
CONTRACT NO:	N/A
FIGURE NO:	1

RECORD OF BOREHOLE: BH-01

CLIENT:	Wilson & Company	DATE:	July 11, 2025	ELEVATION:	Data Not Available
PROJECT:	Shiprock Senior Center Parking Lot			COORDINATES:	Lat: 36.773723° Long: -108.698030°
PROJECT NO:	US0047144.1582	INCLINATION:	90.0°	COORD SYS:	Geographical Coordinates
LOCATION:	Shiprock, New Mexico	CONTRACTOR:	GEOMAT INC.	HORZ DATUM:	NAD83 VERT DATUM: NAVD88
NOTES:	Driller: Fernando E.				

DEPTH (ft)	DRILL RIG	DRILL METHOD	MATERIAL PROFILE: DESCRIPTION	USCS	STRATA PLOT	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC %	BLOWS	N-VALUE	GROUNDWATER OBSERVATIONS	ADDITIONAL OBSERVATIONS
0	CME 55	Hollow Stem Auger	(CL) Sandy lean clay, mostly medium plasticity FINES, some fine SAND; light brown.	CL		0.0		AS					0.00 - 5.00 ft: Auger sample collected from 0.0' to 5.0'. Moisture: 6.7%.
1			(CL) Sandy lean clay, mostly medium plasticity FINES, some SAND; light brown, no odor, weak cementation, weak HCL reaction; dry to moist, firm, trace caliche.					SS		5-4-4	8		0.00 ft: Moisture: 6.6%
2													
3			(CL) Lean clay, mostly medium plasticity FINES, little fine sand; light brown, pool water odor; moist, soft.			2.5		MC		2-3	5		2.50 ft: Moisture: 10.8%, 89.9 pcf
4			(CL-ML) Silty clay, mostly medium plasticity FINES, trace sand; light brown, pool water odor, weak HCL reaction; moist, soft.	CL-ML		3.5		MC		2-4	6		3.50 ft: Moisture: 14.8%
5			(CL-ML) Silty clay, mostly medium plasticity FINES, trace sand; light brown, no odor, weak cementation, weak HCL reaction; moist, firm, Trace caliche.			5.0		MC		6-5	11		5.00 ft: Moisture: 14.8%, 107.1 pcf
6			End of hole at 6.00 ft. Backfilled with Anger Cuttings										
7													
8													
9													
10													
11													
12													
13													
14													
15													
16													
17													
18													
19													
20													
21													
22													
23													
24													
25													

HAMMER TYPE:

REV: 2

SS: Split Barrel Sampler
MC: Modified California Sampler
AS: Auger Sample

LOGGED: Antionette Jim DATE: Jul 11, 2025

CHECKED: DATE:

RECORD OF BOREHOLE: BH-02

CLIENT:	Wilson & Company	DATE:	July 11, 2025	ELEVATION:	Data Not Available
PROJECT:	Shiprock Senior Center Parking Lot			COORDINATES:	Lat: 36.773773° Long: -108.698494°
PROJECT NO:	US0047144.1582	INCLINATION:	90.0°	COORD SYS:	Geographical Coordinates
LOCATION:	Shiprock, New Mexico	CONTRACTOR:	GEOMAT INC.	HORZ DATUM:	NAD83 VERT DATUM: NAVD88
NOTES:	Driller: Fernando E.				

DEPTH (ft)	DRILL RIG	DRILL METHOD	MATERIAL PROFILE: DESCRIPTION	USCS	STRATA PLOT	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC %	BLOWS	N-VALUE	GROUNDWATER OBSERVATIONS	ADDITIONAL OBSERVATIONS
0	CME 55	Hollow Stem Auger - 7.25-in Hole Dia.	(CL) Sandy lean clay, mostly medium plasticity FINES, some fine SAND; light brown; dry.			0.0		AS					0.00 - 5.00 ft: Auger sampled collected from 0.0' to 5.0'. Moisture: 9.0%.
1			(CL) Sandy lean clay, mostly medium plasticity FINES, some fine SAND; light blue banded reddish brown, lens, no odor, weak HCL reaction; moist, stiff, Trace caliche.			0.0		SS		4-4-7	11		0.00 ft: Moisture: 12.0%
2													
3			(CL) Sandy lean clay, mostly medium plasticity FINES, some SAND; light brown, weak cementation, weak HCL reaction; moist, firm.	CL		2.5		MC		6-4	10		2.50 ft: Moisture: 9.2, 108.2 pcf
4			(CL) Sandy lean clay, mostly medium plasticity FINES, some SAND; light brown, solvent odor, weak cementation, weak HCL reaction; moist, soft.			3.5		SS		1-2-2	4		3.50 ft: Moisture: 9.3%
5			(CL) Lean clay, mostly medium plasticity FINES, few sand; light brown, weak cementation, weak HCL reaction; moist, firm.			5.0		MC		3-6	9		5.00 ft: Moisture: 9.2%, 97.2 pcf
6			End of hole at 6.00 ft. Backfilled with Auger cuttings										
7													
8													
9													
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17													
18													
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20													
21													
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23													
24													
25													

HAMMER TYPE:

REV: 2

SS: Split Barrel Sampler
MC: Modified California Sampler
AS: Auger Sample

LOGGED: Antionette Jim DATE: Jul 11, 2025
CHECKED: DATE:

APPENDIX

B

LAB PROCEDURES & RESULTS

APPENDIX

Appendix B – Laboratory Testing Procedures and Results

This appendix describes procedures associated with the laboratory tests WSP assigned for this project. Geotechnical laboratory testing was performed by a local, accredited geotechnical testing laboratory, subcontracted to WSP. Results of certain laboratory tests are enclosed in this appendix.

Visual Classification Procedures

Visual soil classifications were conducted on all samples in the field and on selected samples in the laboratory. All soils were classified in general accordance with the Unified Soil Classification System, which includes color, relative moisture content, primary soil type (based on grain size), and any accessory soil types. The resulting soil classifications are presented on the exploration logs contained in Appendix A.

Moisture Content Determination Procedures

Moisture content determinations were performed on representative samples to aid in identification and correlation of soil types. All determinations were made in general accordance with ASTM D-2216. The results of these tests are shown on the exploration logs contained in Appendix A.

Grain-size Analysis Procedures

A grain-size analysis indicates the range of soil particle diameters included in a particular sample. Grain-size analyses were performed on representative samples in general accordance with ASTM D-422. The results of these tests are presented on the enclosed grain-size distribution graphs and were used in soil classifications shown on the exploration logs contained in Appendix A.

Client: Wilson & Company
4401 Masthead St. NE, Suite 150
Albuquerque, NM 87109

Attn: Conrad Ley

Project Name: Shiprock Senior Center Parking Lot Addition

Shiprock, NM

Project Manager: Bardia Tabiatnejad

Report Date: August 01, 2025

Project #: US0047144.1582
Report #: 2636
Work Order #: 1
Sampled By: Toni Jim
Date Sampled: 7/11/2025

SOILS / AGGREGATES

MOISTURE CONTENT OF SOIL (ASTM D2216-19) AND IN-SITU DENSITY

Lab #	Color & Type of Material	Sample Source	Test Method	Oven Temp. (C)	Mass less than Min Req.	Material Type *	Moisture (%)	Dry Density (pcf)
25-0395-01	See Boring Log	B-01 @ 0-5.0'	B	110	☐	☐	6.7	
25-0395-02	See Boring Log	B-01 @ 0'	B	110	☐	☐	6.6	
25-0395-03	See Boring Log	B-01 @ 2.5'	B	110	☐	☐	10.8	89.9
25-0395-04	See Boring Log	B-01 @ 3.5'	B	110	☐	☐	14.8	
25-0395-05	See Boring Log	B-01 @ 5.0'	B	110	☐	☐	14.8	107.1

***Sample contains more than one type of material.**

Distribution: **Client:** ☐ **File:** ☐ **Supplier:** ☐ **Email:** ☐ **Other:**

WSP USA Inc.
4221 Balloon Park Rd NE
Albuquerque, NM 87109
Tel 5058211801

www.wsp.com

Client: Wilson & Company
4401 Masthead St. NE, Suite 150
Albuquerque, NM 87109

Attn: Conrad Ley

Project Name: Shiprock Senior Center Parking Lot Addition

Shiprock, NM

Project Manager: Bardia Tabiatnejad

Report Date: August 01, 2025

Project #: US0047144.1582
Report #: 2635
Work Order #: 2
Sampled By: Toni Jim
Date Sampled: 7/11/2025

SOILS / AGGREGATES

MOISTURE CONTENT OF SOIL (ASTM D2216-19) AND IN-SITU DENSITY

Lab #	Color & Type of Material	Sample Source	Test Method	Oven Temp. (C)	Mass less than Min Req.	Material Type *	Moisture (%)	Dry Density (pcf)
25-0396-01	See Boring Log	B-02 @ 0-5.0'	B	110	☐	☐	9.0	
25-0396-02	See Boring Log	B-02 @ 0'	B	110	☐	☐	12.0	
25-0396-03	See Boring Log	B-02 @ 2.5'	B	110	☐	☐	9.2	108.2
25-0396-04	See Boring Log	B-02 @ 3.5'	B	110	☐	☐	9.3	
25-0396-05	See Boring Log	B-02 @ 5.0'	B	110	☐	☐	9.2	97.2

***Sample contains more than one type of material.**

Distribution: **Client:** ☐ **File:** ☐ **Supplier:** ☐ **Email:** ☐ **Other:**

WSP USA Inc.
4221 Balloon Park Rd NE
Albuquerque, NM 87109
Tel 5058211801

www.wsp.com

Client:	Wilson & Company 4401 Masthead St. NE, Suite 150 Albuquerque, NM 87109	**Report Date:**	August 01, 2025
		Project #:	US0047144.1582
		Work Order #:	1
Attn:	Conrad Ley	**Lab #:**	25-0395-03
Project Name:	Shiprock Senior Center Parking Lot Addition	**Sampled By:**	Toni Jim
		Date Sampled:	7/11/2025
	Shiprock, NM	**Visual Description of Material:**	See Boring Log
		Sample Source:	B-01 @ 2.5'
Project Manager:	Bardia Tabiatnejad	**SOILS / AGGREGATES**	

No Project Specification was Provided.

Sieve Analysis (ASTM C117-17/C136-19)

200 Wash Procedure: A

Sieve Size	Passing
#16	100%
#30	99%
#40	98%
#50	97%
#100	94%
#200	86%

Plasticity Index (ASTM D4318-17)

Preparation Method: Dry

Liquid Limit Method: A

Soil Classification (ASTM D2487-17) CL

Liquid Limit: 27

Plastic Limit: 15

Plasticity Index: 12

PI Sample Was Air Dried.

Distribution: **Client:** ☐ **File:** ☐ **Supplier:** ☐ **Email:** ☐ **Other:**

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4221 Balloon Park Rd NE
Albuquerque, NM 87109
Tel 5058211801

Client: Wilson & Company
4401 Masthead St. NE, Suite 150
Albuquerque, NM 87109

Attn: Conrad Ley

Project Name: Shiprock Senior Center Parking Lot Addition

Shiprock, NM

Project Manager: Bardia Tabiatnejad

Report Date: August 01, 2025

Project #: US0047144.1582
Work Order #: 2
Lab #: 25-0396-05
Sampled By: Toni Jim
Date Sampled: 7/11/2025
Visual Description of Material: See Boring Log
Sample Source: B-02 @ 5.0'

SOILS / AGGREGATES

No Project Specification was Provided.

Sieve Analysis (ASTM C117-17/C136-19)

200 Wash Procedure: A

Sieve Size	Passing
#50	100%
#100	99%
#200	93%

Plasticity Index (ASTM D4318-17)

Preparation Method: Dry
Liquid Limit Method: A
Soil Classification (ASTM D2487-17) CL

Liquid Limit: 24
Plastic Limit: 12
Plasticity Index: 12

PI Sample Was Air Dried.

Distribution: **Client:** ☐ **File:** ☐ **Supplier:** ☐ **Email:** ☐ **Other:**

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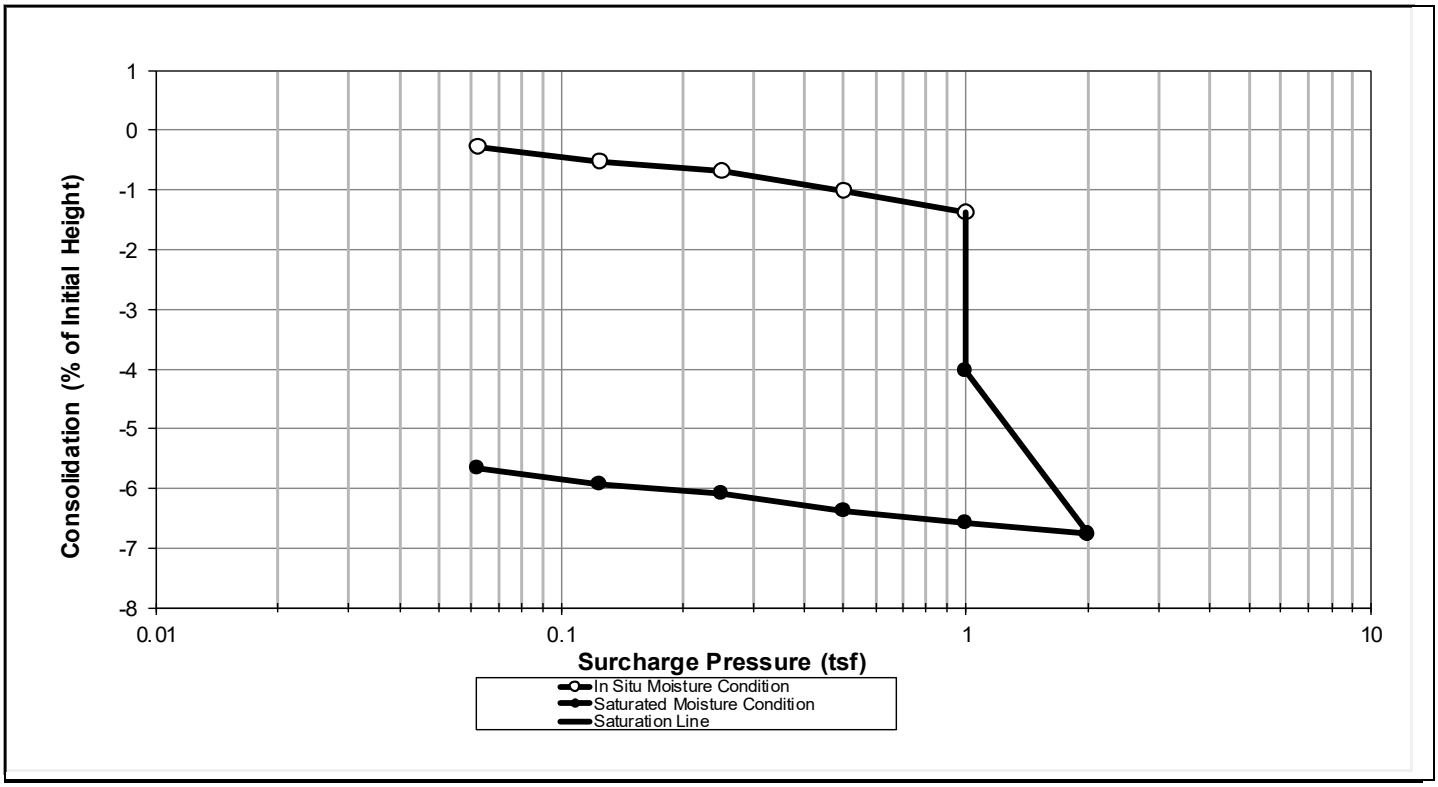
4221 Balloon Park Rd NE
Albuquerque, NM 87109
Tel 5058211801

Client:	Wilson & Company 4401 Masthead St. NE, Suite 150 Albuquerque, NM 87109	**Report Date:**	August 06, 2025
		Project #:	US0047144.1582
		Work Order #:	2
Attn:	Conrad Ley	**Lab #:**	25-0396-03
Project Name:	Shiprock Senior Center Parking Lot Addition	**Sampled By:**	Toni Jim
		Date Sampled:	7/11/2025
	Shiprock, NM	**Visual Description of Material:**	See Boring Log
		Sample Source:	B-02 @ 2.5'
Project Manager:	Bardia Tabiatnejad	**SOILS / AGGREGATES**	

Measurement of Collapse Potential of Soils (ASTM D5333-03)

Initial Volume (cu.in.):	4.60	**Final Volume (cu.in.):**	4.35
Initial Moisture (%):	11.1%	**Final Moisture (%):**	18.4%
Initial Dry Density (pcf):	105.6	**Final Dry Density (pcf):**	111.6
Initial Degree of Saturation:	52%	**Final Degree Saturation:**	102%
Initial Void Ratio:	0.57	**Final Void Ratio:**	0.48
Estimated Specific Gravity:	2.650	**Saturated at:**	1 tsf
Soil Classification:		**Consolidation at Max Load:**	6.77%



Distribution: **Client:** ☐ **File:** ☐ **Supplier:** ☐ **Email:** ☐ **Other:**

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Tel 5058211801

Client: Wilson & Company
4401 Masthead St. NE, Suite 150
Albuquerque, NM 87109

Attn: Conrad Ley

Project Name: Shiprock Senior Center Parking Lot Addition

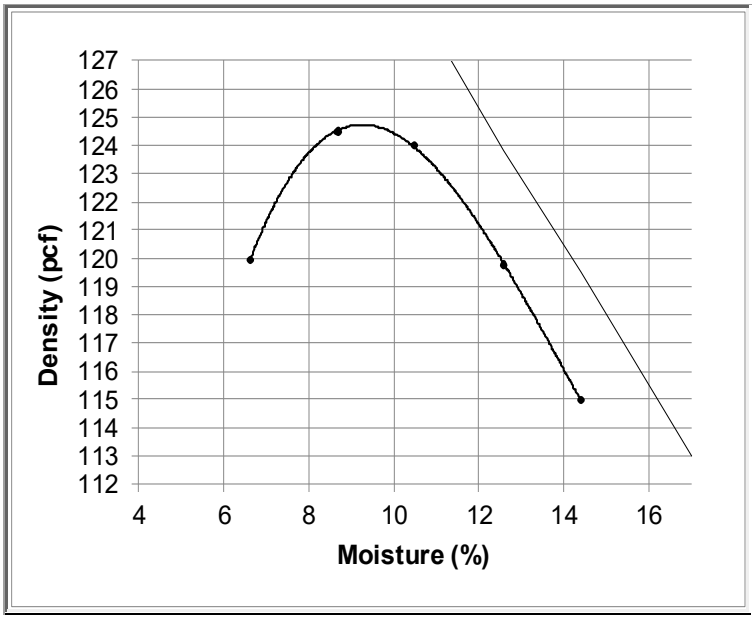
Project Manager: Bardia Tabiatnejad

Report Date: August 01, 2025

Project #: US0047144.1582
Work Order #: 2
Lab #: 25-0396-01
Sampled By: Toni Jim
Date Sampled: 7/11/2025
Color & Type of Material: See Boring Log

Sample Source: B-02 @ 0-5.0'

SOILS / AGGREGATES



Moisture Density Relationship: **(ASTM D1557-21)** **Method:** B
Preparation Method: Dry **Rammer Type:** Manual
Specific Gravity: 2.65 **Assumed**

Maximum Density: 124.5
Optimum Moisture: 9.5

Distribution: **Client:** ☐ **File:** ☐ **Supplier:** ☐ **Email:** ☐ **Other:**

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4221 Balloon Park Rd NE
Albuquerque, NM 87109
Tel 5058211801

Client:	Wilson & Company 4401 Masthead St. NE, Suite 150 Albuquerque, NM 87109	**Report Date:**	August 01, 2025
		Project #:	US0047144.1582
		Work Order #:	1
Attn:	Conrad Ley	**Lab #:**	25-0395-01
Project Name:	Shiprock Senior Center Parking Lot Addition	**Sampled By:**	Toni Jim
		Date Sampled:	7/11/2025
	Shiprock, NM	**Visual Description of Material:**	See Boring Log
		Sample Source:	B-01 @ 0-5.0'
Project Manager:	Bardia Tabiatnejad	**SOILS / AGGREGATES**	

Determining Soil Resistivity Using the Two-Electrode Soil Box Method (ASTM G187-20)

Soil Resistivity: 1026 Ωcm

Distribution: **Client:** ☐ **File:** ☐ **Supplier:** ☐ **Email:** ☐ **Other:**

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Client: Wilson & Company
4401 Masthead St. NE, Suite 150
Albuquerque, NM 87109

Attn: Conrad Ley

Project Name: Shiprock Senior Center Parking Lot Addition

Report Date: August 01, 2025

Project #: US0047144.1582
Work Order #: 1
Lab #: 25-0395-01
Sampled By: Toni Jim
Date Sampled: 7/11/2025
Color & Type of Material: See Boring Log

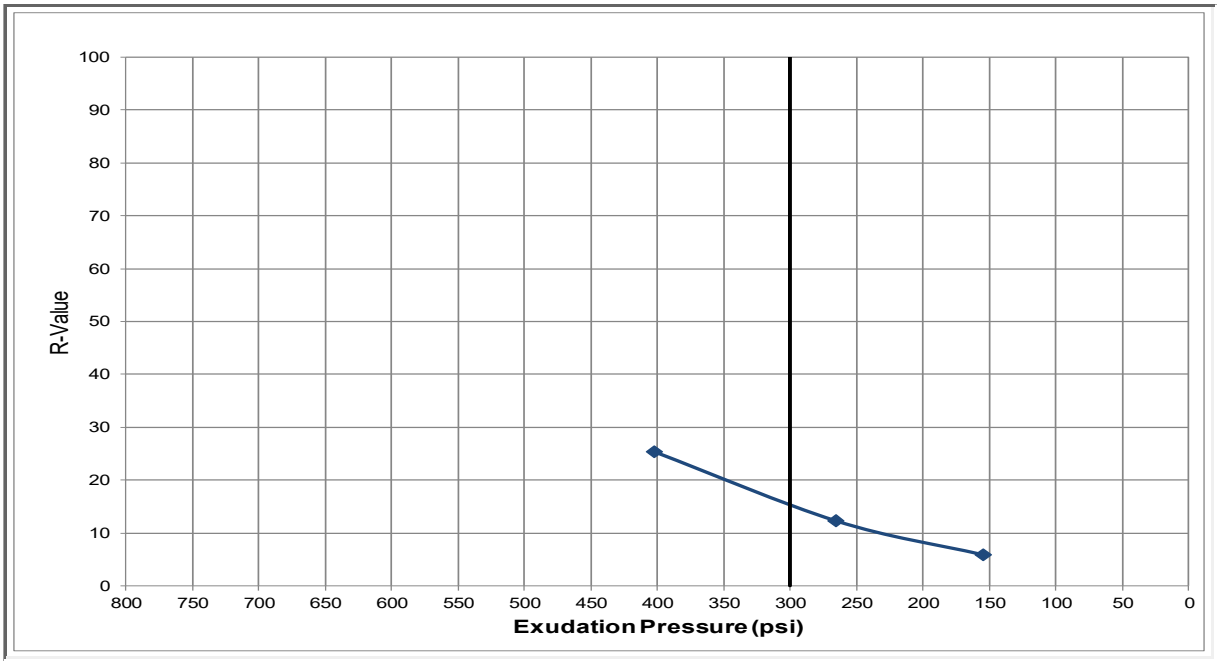
Sample Source: B-01 @ 0-5.0'

Project Manager: Bardia Tabiatnejad

SOILS / AGGREGATES

RESISTANCE R-VALUE AND EXPANSION PRESSURE OF COMPACTED SOILS (ASTM D2844-18)

Specimen Id.	A	B	C
Moisture (%):	16.1%	17.5%	19.0%
Compactor Pressure (psi):	120	100	40
Specimen Height (in):	2.45	2.45	2.45
Dry Density (pcf):	111.3	110.8	101.0
Horizontal Pressure @ 1000lbs (psi):	40	53	63
Horizontal Pressure @ 2000lbs (psi):	101	127	143
Displacement:	4.30	4.64	4.75
Expansion Pressure (psi):	0.601	0.541	0.000
Exudation Pressure (psi):	402	265	155
R-Value:	25	12	6



R-Value at 300psi: 15

Distribution: **Client:** ☐ **File:** ☐ **Supplier:** ☐ **Email:** ☐ **Other:**

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Client:	Wilson & Company 4401 Masthead St. NE, Suite 150 Albuquerque, NM 87109	**Report Date:**	August 01, 2025
		Project #:	US0047144.1582
		Work Order #:	1
Attn:	Conrad Ley	**Lab #:**	25-0395-01
Project Name:	Shiprock Senior Center Parking Lot Addition	**Sampled By:**	Toni Jim
		Date Sampled:	7/11/2025
	Shiprock, NM	**Visual Description of Material:**	See Boring Log
		Sample Source:	B-01 @ 0-5.0'
Project Manager:	Bardia Tabiatnejad		

SOILS / AGGREGATES

pH of Soils (ASTM D4972)

Method Used: A

pH Value Tested In Water: 7.7

Distribution: **Client:** ☐ **File:** ☐ **Supplier:** ☐ **Email:** ☐ **Other:**

WSP USA Inc.
4221 Balloon Park Rd NE
Albuquerque, NM 87109
Tel 5058211801

MOTZZ LABORATORY, INC.

Report: 956785
Reported: 7/30/2025
Received: 7/25/2025
PO: C012800826

Laboratory Analysis Report

WSP USA Environment & Infrastructure Inc.
Jesse Boam
8519 Jefferson NE
Albuquerque, NM 87113

Project: US0047144.1582

Lab Number	Sample ID	
956785-1	25-0395-01	B-1 (0-5.0')

Test Parameter

Test	*Method*	*Result*	*Units*
Sulfate	AASHTO T290	163	ppm
Chloride	AASHTO T291	14	ppm

C

TENSAR GEORGRID DESIGN

Asphalt Pavement
Design Analysis

Tensar
A Division of CMC

Design	Shiprock Senior Center Parking Lot Pavement Design	**Reference**	
Project		**Location**	
Customer		**Designer**	Rashidatu Ossai
Company	WSP Global Inc.	**Date**	August 26, 2025

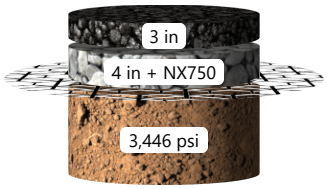
Method of analysis

The calculation method used to create this Tensar software output is the design method for flexible pavements given in the AASHTO Guide for Design of Pavement Structures 1993. The enhancement of performance due to the inclusion of Tensar geogrids in the stabilised layer is derived empirically from full scale pavement tests and trafficking trials carried out by independent authorities.

Results

Stabilized

44,900 ESALs

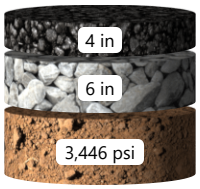


Mechanically stabilized layer thickness less than 6 in is not recommended.

	Thickness	Coeff.	SN
HMA layer 1	3 in	0.440	1.320
Aggregate base (NX750)	4 in	0.281	1.124
Structural number (SN)			2.444

Unstabilized

42,200 ESALs



	Thickness	Coeff.	SN
HMA layer 1	4 in	0.440	1.760
Aggregate base	6 in	0.110	0.660
Structural number (SN)			2.420

Parameters

Project Information

Target ESALs	Subgrade resilient modulus	Reliability	Standard deviation	Serviceability	
				Initial	Terminal
30,516	3,446 psi	75%	0.4	4.2	2

Asphalt Pavement
Cost Analysis

Tensar
A Division of CMC

Design	Shiprock Senior Center Parking Lot Pavement Design	**Reference**	
Project		**Location**	
Customer		**Designer**	Rashidatu Ossai
Company	WSP Global Inc.	**Date**	August 26, 2025

Results

Construction Cost

	Stabilized	Unstabilized
HMA layer 1	$115,638	$154,184
Aggregate base	$35,148	$52,722
Geogrid	$41,667	
Excavation	$13,856	$19,795
Total cost	$206,309	$226,701
Unit cost	$29.71/yd²	$32.64/yd²
Savings	$20,392 (9%)	

Additional Considerations

	Stabilized	Unstabilized
Construction time	7.6 days	9 days
Dump truck visits	279	397
Fuel required	1,488 gal	2,117 gal
Water required	19,294 gal	28,940 gal
Carbon emissions	81 tonnes CO_2e	100 tonnes CO_2e

Construction Cost

YOU SAVE
$20,392 (9%)

Stabilized: $206,309

Unstabilized: $226,701

Construction Time

YOU SAVE
1.2 days (14%)

Stabilized: 7.6 days

Unstabilized: 8.8 days

Environmental Cost

YOU SAVE
19 tonnes CO_2e (19%)

Stabilized: 81 tonnes CO_2e

Unstabilized: 100 tonnes CO_2e

Parameters

Dimensions

Project area	62,500 ft²

Grading Requirements

Grade offset	Meet existing grade
Excavation cost	$8/ton

Stabilized Pavement Section Costs (Installed)

HMA layer 1	$100/ton
Aggregate base	$25/ton

Geosynthetic Costs (Installed)

NX750	$6.00/yd²

Unstabilized Pavement Section Costs (Installed)

HMA layer 1	$100/ton
Aggregate base	$25/ton