GEOTECHNICAL EXPLORATION REPORT
SR 69-SR 169 ROUNDABOUT
ADOT PROJECT NO. 069 YV 280 F0288 01C
ADOT CONTRACT NO. 2018-006.03
TASK ORDER NO. 21, CONTRACT MODIFICATION NO. 40
DEWEY-HUMBOLDT, ARIZONA

Prepared for:

AZTEC Engineering, Inc.
501 North 44th Street, Suite 300
Phoenix, Arizona 85008

Prepared by:

Ethos Engineering, LLC
9180 South Kyrene Road, #104
Tempe, Arizona 85284

Registered Professional Engineer (Civil)
CERTIFICATE NO.
47676
FRANCISCO J.
GARZA
Date Signed 8/30/2024
ARIZONA U.S.A.

Ethos Project No. 2022069
August 30, 2024

August 30, 2024
Ethos Project No.: 2022069

Eric Watkins, PE
Associate Vice President
AZTEC Engineering, Inc.
501 North 44th Street, Suite 300
Phoenix, Arizona 85008

SUBJECT: Geotechnical Exploration Report
SR 69 – SR 169 Roundabout
ADOT Project No. 069 YV 280 F0288 01C
ADOT Contract No. 2018-006.03
Task Order No. 21, Contract Modification No. 40
Dewey-Humboldt, Arizona

Dear Eric:

Ethos Engineering, LLC is pleased to present the findings of the geotechnical exploration for the proposed roundabout project located in Dewey-Humboldt, Arizona. Our services were conducted in general accordance with the scope of services presented in our proposal dated June 15, 2022. This report provides the results of our investigation and the results of subgrade testing for pavements planned within this project. This report complements the Pavement Design Summary and Materials Design Report submitted under separate cover (Ethos 2024).

We appreciate the opportunity to be of service on this project. If you have any questions regarding this evaluation, please do not hesitate to contact us.

Sincerely,
Ethos Engineering, LLC

Francisco J. Garza, P.E.
Principal/Senior Geotechnical Engineer

Reviewed By:

Keith Dahlen, P.E.
Principal/Senior Geotechnical Engineer

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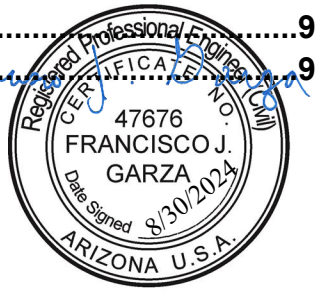
TABLE OF CONTENTS



FIGURES

APPENDICES

1.0 INTRODUCTION

1.1 GENERAL

This report presents the results of our geotechnical exploration for the proposed State Route 69 (SR 69) - State Route 169 (SR 169) roundabout project in Dewey-Humboldt in Yavapai County, Arizona. The boring locations are shown on the Site Plan presented on Figure 1.

The exploration included site reconnaissance, subsurface exploration, soil sampling, laboratory testing, engineering analyses, and preparation of this report. The purpose of this report is to provide information regarding the subsurface soil conditions and general site geology, and to provide geotechnical recommendations for design and construction for the proposed roundabout including roadway elements at the site.

1.2 PROJECT DESCRIPTION

The scope of this project is to reconstruct the SR 69 - SR 169 intersection with a roundabout. It is anticipated that the new roundabout will be re-built near existing site grades. The planned intersection is 3-legged. Within the study limits, SR 69 is a four-lane asphaltic concrete (AC)-paved major arterial street with left & right turn lanes. SR 169 is a two-lane AC-paved arterial street with left-turn lane. The current roadways appear to be constructed on embankment fill at or slightly above adjacent native grades.

The project is located in the ADOT Northwest District at the intersection of SR 69 and SR 169. The intersection is located at milepost 281 on SR 69 and at milepost 0 on SR 169 which is the western terminus of SR 169. SR 69 is classified as an “Other NHS Route” in the National Highway System. The posted speed limit on SR 69 is 55 miles per hour (mph), increasing to 65 mph approximately 2,000 feet south of the project intersection. The posted speed limit on SR 169 is 45 mph. The functional classification of SR 69 is listed as a Principal Arterial in the 2045 CYMPO Regional Transportation and SR 169 is classified as a Minor Arterial.

2.0 FIELD EXPLORATION

2.1 EXPLORATORY DRILLING

Prior to our field exploration, Ethos obtained an ADOT permit (No. 1231874), dated June 12, 2023. We staked the boring locations and coordinated clearing our work areas with Arizona 811. A traffic control plan was prepared for this work by Quail Construction LLC, as a subcontractor to Ethos.

Drilling of the exploratory borings was performed by ACS Services, LLC (ACS) on July 24, 2023. The field work was supervised by Magdaleno Meza, EIT, of Ethos. The subsurface soil conditions at the site were explored by drilling a total of three borings (designated as B-1 through B-3) to approximate depths of 11.5 feet. A summary of the field exploration program is provided in Table 2.1. The boring locations are shown on Figure 1.

Table 2.1 – Field Exploration Program

Boring ID	Element	Latitude (°N)	Longitude (°E)	Depth (feet)
B-1	Roadway	34.53073°	-112.24240°	11.5
B-2	Roadway	34.52930°	-112.24175°	11.5
B-3	Roadway	34.52977°	-112.24030°	11.5

The roadway borings were drilled with a truck-mounted CME 75 drill-rig advancing 8-inch outside diameter (OD) hollow-stem auger. All borings were oriented vertically. During the field exploration, the soils encountered were visually classified, logged, and sampled by the field engineer. Relatively undisturbed samples of the subsurface materials were obtained using a ring sampler with a 2.42-inch inside diameter (ID) and 3-inch OD. Disturbed samples of soils were obtained using a standard penetration test (SPT) split spoon sampler with a 1.375-inch ID and 2-inch OD. Bulk samples of drill cuttings were also collected at selected near-surface depths from the borings. The SPT and ring samplers were driven 18 and 12 inches or to refusal (i.e. 50 blows for less than a 6-inch interval), respectively, using an automatic hydraulic actuated 140-pound hammer (verified to exert an impact energy efficiency above 60%), free falling 30 inches. Unless noted otherwise on the boring logs, the sample driving resistance was recorded as number of blows per six inches of penetration. The penetration results are presented on the borings logs adjacent to each sample.

The recovered soil samples were removed from the sampler, sealed to reduce moisture loss, and submitted to the ACS Mesa laboratory. All borings were backfilled with cuttings upon completion. The logs of the exploratory borings are presented in Appendix A.

3.0 LABORATORY TESTING

Selected laboratory tests were assigned by Ethos and performed by ACS on representative samples or soil recovered from the borings to support our field classification and to provide information regarding engineering characteristics and properties of the subsurface materials. The laboratory testing program is listed in Table 3.1. The results of the laboratory tests are presented in Appendix B.

Table 3.1 – Laboratory Testing Program

Laboratory Test	Sample Type	Number of Tests	Purpose of Test
Moisture Content (ASTM 2937)	Bulk	3	Soil Moisture Conditions
Sieve Analysis (ASTM C136)	Bulk	3	Soil Classification
Atterberg Limits (ASTM D4318)	Bulk	3	Soil Classification
Proctor (AASHTO T190)	Bulk	1	Soil Compaction
Remolded Swell (ASTM D4546)	Bulk	1	Swell Characteristics
R-value (ASTM D2844)	Bulk	2	Pavement Support
pH & Resistivity (AZ 236)	Bulk	1	Metal Pipe/Soil Corrosion Potential
Sulfates & Chloride (AZ 733/736)	Bulk	1	Concrete/Soil Degradation Potential

4.0 GENERAL SITE CONDITION

4.1 SURFACE CONDITIONS

Within the study limits, there is mixed commercial along the west and northwest corners. The remaining land on the northeast corner is undeveloped and agricultural (Mortimer Farms) on the southeast corner. Along SR 69, the existing overall terrain is sloping upward generally to the north and along SR 169 the existing overall terrain is sloping upward generally to the west. The terrain is generally rolling with an average project elevation of 4,579 feet above mean sea level.

4.2 SUBSURFACE CONDITIONS

The near-surface soils encountered in the borings varied from low plasticity silty to clayey sands with gravels (GC-GM) to medium plasticity clayey sand (SC) with some non-plastic

sand with silt (SP-SM), in the upper 3 to 10 feet. These soils varied from soft to very firm or dense (for the non-cohesive soils). Very soft to moderately firm medium plasticity sandy clays (CL) were encountered at depth within each of the three borings.

Groundwater was not encountered to the depths explored. The depth to groundwater in the general area, based on Arizona Department of Water Resources (2023), is on the order of 45 feet. However, based on the generally dry conditions encountered in the borings, the impact to construction from groundwater appears to be negligible.

4.3 PROBLEMATIC SOILS

There are areas within Dewey-Humboldt with medium to high plasticity clay soils that are potentially expansive. The near-surface soils encountered within the borings excavated for this project generally were medium plasticity clayey sands. These soils are considered to have moderate potential for expansion as indicated by laboratory swells around 3.5 percent. However, given the relatively thick pavement structural section, ranging from 18.5 to 22.5 inches, and generally a few feet of overlying lower plasticity soils, the confining pressure is considered enough to offset any potential expansion into a reasonable range (less than 2 percent). With proper site grading, these soils should be adequate for subgrade support of pavements.

5.0 ENGINEERING ANALYSES AND RECOMMENDATIONS

5.1 GENERAL

The following sections of this report present our recommendations for the pavement design, construction considerations, site preparation, slopes, grading, moisture protection, excavations and backfills. These recommendations are based on our understanding of the project, the results of our field explorations including test drilling, laboratory testing for the site and engineering analyses.

5.2 PAVEMENTS

Laboratory testing of subgrade samples for support of pavements was performed for project pavements. It is anticipated the new roundabout will be built near existing site grades. The existing subgrade was deemed moderately expansive with a tested swell value of 3.5 percent. However, the proposed pavement sections are nearly two feet thick and should offset any potential expansion.

The results of laboratory grain-size analysis and Atterberg limits testing are presented in Table 5.1.

Table 5.1 -Results of Subgrade Testing

Boring ID & Depth (feet)	USCS	%Passing #200 Sieve	Plasticity Index	Correlated R-Value	Tested R-value
B-1 (0.0-3.0)	SC	39	16	31	--
B-2 (1.0-3.0)	SC	31	16	35	82
B-3 (0.0-3.0)	GC-GM	18	9	64	30
			Average	43.4	56.0
			Standard Deviation	18.1	36.8

Two laboratory R-value tests ranged from 30 to 82. By comparison, three correlated R-values ranged from 31 to 64. The R_{mean} value of 34.5 translates to a resilient modulus (M_r) value of 11,414 psi based on a seasonal variation factor of 2.7 determined for Dewey-Humboldt, Arizona from Table 202.02-4. However, given two of three correlated R-values were in the range of 31 to 35, to be conservative a design R-value of 30 is recommended which translates to an M_r value of 9,850 psi. Additionally, a construction control R-value of 30 is recommended which should allow the majority of subgrade to remain in place.

5.2.1 Earthwork Factors

Earthwork (shrink/swell) factors were estimated based on the results of the laboratory and field testing, and from past experience with similar soils. The site surface soils to a depth of approximately 5 feet are estimated to have shrinkage on the order of 5 percent if overexcavated and re-used on the project for embankment. Ground compaction due to site preparation outside the limits of existing roadway prisms is expected to be about 0.1 foot within the project limits.

These estimates are general in nature, and are based on our experience, limited data from our field explorations, and the soil conditions we encountered at the site. Earthwork factors may vary dependent upon the actual subsurface conditions, which may include variations in soil gradations and gravel contents. The earthwork shrinkage values are expected to be larger in areas subjected to higher levels of compaction or where the existing natural soils are looser. The earthwork shrinkage values are also expected to be lower in areas subjected to lower levels of compaction or where the existing natural soils are denser.

5.2.2 Site Grading for Embankments and Pavement

The following site grading recommendations are intended to provide support for the proposed pavements, and associated embankments at the site. The grading activities at the site should be performed under observation and testing directed by a geotechnical engineer.

Trash, debris, vegetation (including roots) and other organics, any unstable (soft, loose, disturbed, water softened, etc.) soils, and other deleterious materials should be completely removed from proposed pavement areas prior to construction. This site grading should extend laterally a minimum of 2 feet beyond pavement areas. All areas of excavation should be observed and approved by a representative of the geotechnical engineer after clearing and before any filling operations begin at the site.

The subgrade preparation should be performed as outlined in Section 203 of the ADOT Standard Specifications except as noted herein. In proposed pavement areas, the ground surface should be prepared to a minimum depth of 6 inches below finished subgrade. Subgrade preparation should consist of over-excavating (if soft soils are encountered as described above), scarification, moisture conditioning, and compaction.

5.3 SLOPES

5.3.1 Permanent Slopes

No planned permanent cut slopes are anticipated within the limits of planned construction. Non-stabilized embankment fill slopes should be on the order of 3:1 (H:V) or flatter. Flatter fill slopes will promote re-vegetation and can accept landscaping.

5.3.2 Temporary Slopes

Temporary excavations for construction of footings, etc. can be made with conventional earthmoving equipment. Temporary slopes should be excavated in accordance with OSHA (2020). In accordance with Subpart P, Appendix A, any fills present on-site (although not encountered in our investigation) and the native granular soils are considered to be Type C soils. For excavations less than 20 feet in such soils, Subpart P, Appendix B indicates a maximum allowable unshored slope of 1.5H:1V for Type C soils. Flatter slopes may be required where either sandy soils are encountered or where the soils become excessively wet, and soft.

Should steeper slopes be required due to the proximity of existing structures or other contractor needs, the stability of the slopes should be verified by a registered geotechnical engineer (State of Arizona) who is proficient in slope stability analyses.

The perimeter of all excavations should be protected against water runoff and infiltration near the edges to maintain stability. Heavy equipment and spoil piles should not be allowed within 10 feet of the edge of the excavation. The perimeter of all excavations should be protected against water runoff and infiltration near the edges to maintain stability.

5.4 SURFACE DRAINAGE

Long-term performance of pavement and structures will require that the subgrade soils and backfill be protected against excessive water infiltration and/or saturation. Surface drainage should be established away from foundations and pavements to minimize moisture infiltration into the subgrade. Structural fill and backfill should be well compacted to reduce possible moisture infiltration through loose soil intervals.

5.5 PRELIMINARY SOIL CORROSION CHARACTERISTICS

5.5.1 Metal Pipes

One sample from the current investigation was used to evaluate the corrosion potential on corrugated metal pipe using laboratory pH and electrical resistivity testing, performed in accordance with Arizona Test Method 236. Results of the corrosion potential testing are presented in Appendix B.

The laboratory pH value was 8.3 and the minimum resistivity value was 1,290 ohm-centimeters (ohm-cm). Pipe locations where the pH is less than 6.0, greater than 9.0, and/or the resistivity is less than 2,000 ohm-cm require the use of special pipes and/or pipe coatings. The tested sample had a resistivity value of less than 2,000 ohm-cm. Therefore, based on limited testing, specialized piping or other corrosion mitigation measures such as corrosion monitoring will likely be necessary for metallic pipes.

5.5.2 Concrete Structures

One sample from the current investigation was used for soluble sulfates and chlorides (Arizona Test Method 733 and Arizona Test Method 736) to support design of concrete structures. The results of these laboratory tests are included in Appendix B.

The tested total soluble sulfate value was 5 parts per million (ppm). The sulfate test measures the water-leachable or "available" sulfate content. These results were compared to Table 19.3.1.1, "Exposure Categories and Classes," in Section 19.3.1 of the American Concrete Institute's (ACI's) Building Code Requirements for Structural Concrete (ACI 2019). All the samples fall within Exposure Class S0 for water-soluble sulfate (SO_4^{2-}) in soil by percent mass (SO4<0.1% or 1,000 ppm) with values of less than 5 ppm and are categorized with a severity level of "not applicable" in terms of sulfate exposure. Based on Table 19.3.2.1, "Requirements for Concrete by Exposure Class," in Section 19.3.2 (ACI 2019), there is no restriction on Portland cement type for concrete structures in contact with these materials.

The tested chloride value was 24 ppm. Regarding chloride attack, Section 19.3.2 indicates that when concrete is exposed to external sources of chlorides, concrete should be proportioned to satisfy the requirements for the applicable exposure class in Table 19.3.1.1 (ACI, 2019). The anticipated concrete exposure for this segment falls within Exposure Class C1 (ACI 2019). For Exposure Class C1, the minimum compressive strength of concrete specified for is 2,500 psi and the maximum water-soluble chloride ion content in concrete, by percent weight of cement, is 0.30% for non-prestressed concrete and 0.06% for prestressed concrete.

We recommend that the results of our laboratory testing be reviewed by a person or firm experienced in corrosion protection designs for the actual construction at the site, and/or by the appropriate pipe or material manufacturer. These results are general in nature and may not be representative of site conditions or the pipe trench backfill. A qualified corrosion engineer should be consulted if corrosion of underground utilities is a concern or if a detailed evaluation is necessary.

6.0 CLOSURE

The geotechnical services were performed in a manner consistent with that level of care and skill ordinarily exercised by other members of the geotechnical profession practicing in the same locality, under similar conditions and at the date the services are provided. Our conclusions, opinions and recommendations are based on the completed test borings, visual observations and the review of plans prepared by others. It is possible that conditions could vary beyond the data evaluated. Ethos makes no guarantee or warranty, express or implied, regarding the services, communication (oral or written), report, opinion, or instrument of service provided.

This report may be used only by the Client and their representatives, and only for the purposes stated, within a reasonable time from its issuance. Land use, site conditions (both on site and off site), or other factors may change over time, and additional work may be required with the passage of time. Any party other than the Client who wishes to use this report shall notify Ethos of such intended use. Based on the intended use of the report, Ethos may require that additional work be performed and that an updated report be issued. Non-compliance with any of these requirements by the Client or anyone else will release Ethos from any liability resulting from the use of this report by any unauthorized party.

7.0 REFERENCES

American Concrete Institute, 2019. *Building Code Requirements for Structural Concrete* (ACI 318-19) and Commentary. Reported by ACI Committee 318.

Arizona Department of Transportation (ADOT), 2017. *Pavement Design Manual.* Roadway Engineering Group, Pavement Design Section, September 29.

Arizona Department of Water Resources (ADWR). 2023. Groundwater Site Inventory Database. https://azwatermaps.azwater.gov/gwsi Accessed August 2023.

Occupational Safety and Health Administration (OSHA). 2020. Code of Federal Regulations (CFR), Standard Number 1926 Safety and Health Regulations for Construction, Subpart P – Excavations, Appendices A & B. February 18.

FIGURES

Source View: Latitude 34.52983°, Longitude -112.24210°. Airbus 2023 Imagery. Accessed on 8/11/2023.

Figure 1

Vicinity Map Showing Boring Locations

SR 69- SR 169 Roundabout

Dewey-Humboldt, Arizona

APPENDIX A

BORING LOGS

SOILS SAMPLING & BORING LOG INFORMATION

The material and in-situ moisture descriptions of soils presented on the boring logs are based on visual observation and classification in accordance with the Unified Soil Classification System (USCS), presented on the next page. The field logs were modified, where appropriate, based on laboratory testing of selected samples.

The relative density and firmness described on the test boring logs are generally based on standard penetration test (SPT) blows per foot (N) for mostly cohesionless and cohesive soils. 2-inch outside diameter (O.D.) SPT samplers are advanced up to 18 inches into undisturbed soils beyond the base of either a hollow stem auger or drill casing. The samplers are driven with a 140-pound hammer and a 30-inch drop. SPT values are recorded on the boring logs for each 6-inch increment of penetration with sampler refusal based on a penetration of less than 6 inches and a blowcount of 50.

Relative Density

Relative density for mostly cohesionless, uncemented sands and sand and gravel mixtures is described based on the following SPT blowcounts:

N	Relative Density
0-4	Very Loose
5-10	Loose
11-30	Medium Dense
31-50	Dense
>50	Very Dense

Relative Firmness

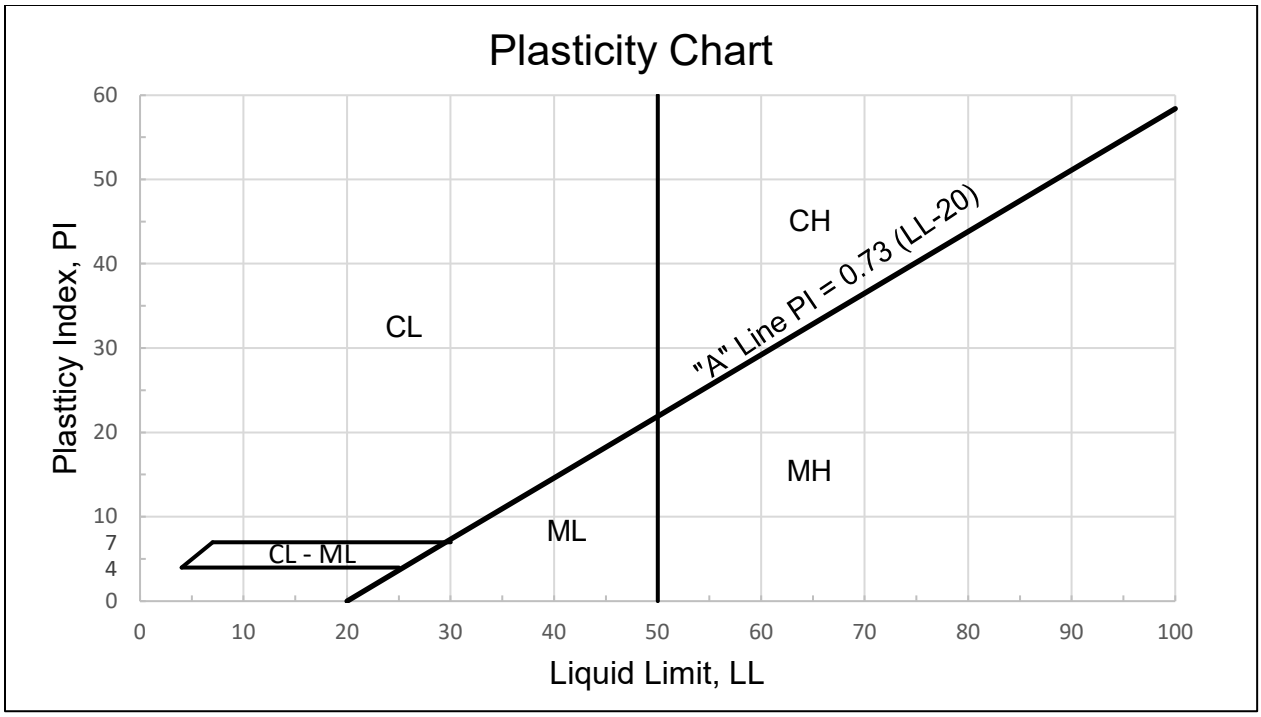
Relative Firmness for cohesive and/or cemented soils including silts, clays and silty to clayey sandy and gravelly soils is described based on the following SPT blowcounts:

N	Relative Firmness
0-4	Very Soft
5-8	Soft
9-15	Moderately Firm
16-30	Firm
31-49	Very Firm
50+	Hard

Undisturbed samples of firmer soils, typically present in the southwest, are obtained with 3-inch O.D. samplers lined with 2.42-inch inside diameter (I.D.) brass rings. The samplers are advanced up to 12 inches into undisturbed soils beyond the base of either a hollow stem auger or drill casing. The samplers are driven with a 140-pound hammer and a 30-inch drop. The N value blowcounts are recorded on the boring logs for each 6-inch increment of penetration with sampler refusal based on a penetration of less than 12 inches and a blowcount of 100.

Unified Soil Classification System
(ASTM D2487)

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests				Group Symbol	Group Description
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		GW	Well Graded Gravels, Gravel-Sand Mixtures or Sand-Gravel-Cobble Mixtures.
				GP	Poorly Graded Gravels, Gravel-Sand Mixtures or Sand-Gravel-Cobble Mixtures.
		Gravels with More than 12% Fines	Fines Classify as ML or MH	GM	Silty Gravels, Gravel-Sand-Silt Mixtures
			Fines Classify as CL or CH	GC	Clayey Gravels, Gravel-Sand-Clay Mixtures
	Sands 50% or More of Coarse Fraction Passes No. 4 Sieve	Clean Sands Less than 5% Fines		SW	Well Graded Sands, Gravelly Sands.
				SP	Poorly Graded Sands, Gravelly Sands.
		Sands with More than 12% Fines	Fines Classify as ML or MH	SM	Silty Sands, Sand-Silt Mixtures
			Fines Classify as CL or CH	SC	Clayey Sands, Sand-Clay Mixtures
Fine-Grained Soils (50% or More Passes No. 200 Sieve).	Silts and Clays (Liquid Limit less than 50)	PI > 7 and Plots on Above “A” Line		CL	Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays
		PI <4 or Plots Below “A” Line		ML	Inorganic Silts, Clayey Silts with Low Plasticity
	Silts and Clays (Liquid Limit 50 or More)	PI Plots on Above “A” Line		CH	Inorganic Clays of High Plasticity, Fat Clays, Silty and Sandy Clays of High Plasticity
		PI Plots Below “A” Line		MH	Inorganic Silts of High Plasticity, Silty Soils, Elastic Silts



Angularity	
Angular	
Subangular	
Subrounded	
Rounded	

Soil Particle Definitions	
Material	Particle Size Range
Boulders	Greater than 300 mm (12 in.)
Cobbles	300 mm to 75 mm (12 in. to 3
Coarse Gravel	75 mm to 19 mm (3 in. to ¾ in.)
Fine Gravel	19mm (3/4 in.) to No. 4 sieve
Coarse Sand	No. 4 Sieve to No. 10 Sieve
Medium Sand	No. 10 Sieve to No. 40 Sieve
Fine Sand	No. 40 Sieve to No. 200 Sieve
Fines (Silt or Clay)	Less than No. 200 Sieve

Plasticity	
PI = 0	Non-Plastic
1 ≤ PI ≤ 7	Low
8 ≤ PI ≤ 25	Medium
PI ≥ 26	High

Moisture
Slightly Moist
Moist
Wet
(Saturated)

Ethos Engineering, LLC
9180 S. Kyrene Road, Suite 104
Tempe, AZ 85284

BORING NUMBER B-1

CLIENT AZTEC Engineering Inc.
PROJECT NAME SR 69 at SR 169 Roundabout
PROJECT NUMBER 2022069
PROJECT LOCATION Dewey-Humboldt, Arizona
DATE STARTED 7/24/2023 **COMPLETED** 7/24/2023
BORING LOCATION STA 4219+15, 45' R SR 69 CST CL
DRILLER ACS Services **DRILLED BY** E. Velasquez
GPS COORDINATES 34.53073°N, -112.2424°E
DRILLING METHOD Hollow Stem Auger
GROUND ELEVATION --- **BOREHOLE DEPTH** 11.5 ft
RIG TYPE / # CME-75/ 154927
GROUNDWATER DEPTH ---
HAMMER TYPE Auto **HAMMER EFFICIENCY** 88.3
LOGGED BY M. Meza **CHECKED BY** P. Garza

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (N VALUE)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
			CLAYEY SAND WITH GRAVEL (SC), some subangular fine gravel, fine to medium sand, firm, medium plasticity, moist, light brown to brown	AU R	12-14		6.4	31	15	16	39
	5		SANDY CLAY (CL), occasional subangular fine gravel, considerable fine sand, soft to moderately firm, medium plasticity, moist, brown	SPT	2-4-6 (10)						
			Note: Reddish brown to brown below 5'	SPT	4-4-4 (8)						
	10		CLAY (CH), occasional subangular fine gravel, trace fine sand, soft, high plasticity, moist, reddish brown to brown	SPT	2-2-3 (5)						

Bottom of borehole at 11.5 feet. Backfilled with Cuttings.

Ethos Engineering, LLC
9180 S. Kyrene Road, Suite 104
Tempe, AZ 85284

BORING NUMBER B-2

CLIENT AZTEC Engineering Inc.
PROJECT NAME SR 69 at SR 169 Roundabout
PROJECT NUMBER 2022069
PROJECT LOCATION Dewey-Humboldt, Arizona
DATE STARTED 7/24/2023 **COMPLETED** 7/24/2023
BORING LOCATION STA 4213+50, 50' R SR 69 CST CL
DRILLER ACS Services **DRILLED BY** E. Velasquez
GPS COORDINATES 34.5293°N, -112.24175°E
DRILLING METHOD Hollow Stem Auger
GROUND ELEVATION --- **BOREHOLE DEPTH** 11.5 ft
RIG TYPE / # CME-75/ 154927
GROUNDWATER DEPTH ---
HAMMER TYPE Auto **HAMMER EFFICIENCY** 88.3
LOGGED BY M. Meza **CHECKED BY** P. Garza

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (N VALUE)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
			CLAYEY SAND WITH GRAVEL (SC), some subangular fine gravel, angular poorly graded sand, very firm, medium plasticity, moist, light brown	SPT AU	6-17-20 (37)		5.5	30	14	16	31
	5			SPT	17-26-18 (44)						
			SAND WITH SILT AND GRAVEL (SP-SM), some subangular fine gravel, angular fine to medium sand, medium dense, nonplastic, slightly moist, brown	R	26-18						
	10										
			CLAY WITH SAND (CL), trace subangular fine gravel, some fine sand, very soft, medium plasticity, moist, dark brown	SPT	1-1-1 (2)						

Bottom of borehole at 11.5 feet. Backfilled with Cuttings.

Ethos Engineering, LLC
9180 S. Kyrene Road, Suite 104
Tempe, AZ 85284

BORING NUMBER B-3

CLIENT AZTEC Engineering Inc.
PROJECT NAME SR 69 at SR 169 Roundabout
PROJECT NUMBER 2022069
PROJECT LOCATION Dewey-Humboldt, Arizona
DATE STARTED 7/24/2023 **COMPLETED** 7/24/2023
BORING LOCATION STA 4215+50, 550' R SR 69 CST CL
DRILLER ACS Services **DRILLED BY** E. Velasquez
GPS COORDINATES 34.52977°N, -112.2403°E
DRILLING METHOD Hollow Stem Auger
GROUND ELEVATION --- **BOREHOLE DEPTH** 11.5 ft
RIG TYPE / # CME-75/ 154927
GROUNDWATER DEPTH ---
HAMMER TYPE Auto **HAMMER EFFICIENCY** 88.3
LOGGED BY M. Meza **CHECKED BY** P. Garza

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (N VALUE)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
			SILTY, CLAYEY GRAVEL WITH SAND (GC-GM), considerable angular fine to coarse sand, subangular poorly graded gravel, very firm, low plasticity, slightly moist, whitish brown to light brown	AU SPT	9-15-16 (31)		5.0	21	16	5	16
	5		CLAYEY SAND WITH GRAVEL (SC), some subangular fine gravel, fine sand, soft, medium plasticity, moist, brown to light brown	R	5-4						
			SANDY CLAY (CL), trace subangular fine gravel, considerable fine sand, very soft, medium plasticity, moist, dark brown to brown	SPT	2-1-2 (3)						
	10		CLAY WITH SAND (CL), occasional subangular fine gravel, trace fine sand, very firm, medium plasticity, moist, dark brown to brown	SPT	1-0-1 (1)						

Bottom of borehole at 11.5 feet. Backfilled with Cuttings.

APPENDIX B

LABORATORY TEST RESULTS

Table B-1: Summary of Laboratory Test Results

Boring Number	Depth (ft)		USCS/Group Symbol (ASTM D2487)	Percent Fines (minus #200) (ASTM C136)	Liquid Limit (ASTM D4318)	Plasticity Index (ASTM D4318)	Moisture Content (%) (ASTM D2216/ D2937)	Optimum Moisture Content (%) (by ASTM D698A)	Maximum Dry Density (pcf)[1] (by ASTM D698A)	Expansion % (ASTM D4546)	R-Value at 300 PSI (AASHTO T-190)	pH (AZ 236)	Resistivity ohm-cm (AZ 236)	Sulfates (ppm)[2] (AZ 733)	Chlorides (ppm)[2] (AZ 736)
	Begin	End													
B-1	0.0	2.5	SC	39	31	16	6.4	11.7	122	3.5		8.3	1,290	5	21
B-2	1.0	3.0	SC	31	30	16	5.5				82				
B-3	0.0	3.0	GC-GM	16	21	5	5.0				30				
Average				**28.7**	**27.3**	**12.3**	**5.6**	**11.7**	**122.0**	**3.5**	**56.0**	**8.3**	**1,290**	**5**	**21**
Standard Deviation				**11.7**	**5.5**	**6.4**	**0.7**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**36.8**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**
Maximum				**39**	**31**	**16**	**6.4**	**11.7**	**122.0**	**3.5**	**82**	**8.3**	**1,290**	**5**	**21**
Minimum				**16**	**21**	**5**	**5.0**	**11.7**	**122.0**	**3.5**	**30**	**8.3**	**1,290**	**5**	**21**
Count				**3**	**3**	**3**	**3**	**1**	**1**	**1**	**2**	**1**	**1**	**1**	**1**

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2301708	Material Type:	Soil
ACS Lab #	23-3788-1	Supplier:	-
Client:	Ethos Engineering, LLC	Sample Date:	7/24/2023
Project Name:	SR 69 at SR 169 Roundabout	Sampled By:	Client
Project Address:	SR-69 and SR-169	Test Date:	7/27/2023
Project City	Dewey	Tested By:	Mahalia Davis
Sample Location:	B-1 @ 0.0 - 2.5	Reviewed By:	Dylan Ward

Sieve Analysis (ASTM C-136 / AASHTO T 27 / ARIZ 201)			
Sieve Size	**% Retained**	**% Passed**	**Specs**
6"	0	100	
3"	0	100	
2 1/2"	0	100	
2"	0	100	
1 1/2"	0	100	
1"	0	100	
3/4"	1	99	
1/2"	3	96	
3/8"	3	93	
1/4"	6	87	
#4	4	82	
#8	8	74	
#10	2	73	
#16	6	67	
#30	8	59	
#40	4	55	
#50	4	51	
#100	7	44	
#200	6	39	

Liquid Limit (AASHTO T-89)	31
Plastic Limit (AASHTO T-90)	15
Plasticity Index (AASHTO T-90)	16
Moisture Content (AASHTO T-265)	6.4
USCS Soil Classification	SC

Group Name (ASTM D2487)
Clayey SAND with gravel

Dylan Ward
Laboratory Manager

Dylan Ward
Signature

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2301708	Material Type:	Soil
ACS Lab #	23-3788-3	Supplier:	-
Client:	Ethos Engineering, LLC	Sample Date:	7/24/2023
Project Name:	SR 69 at SR 169 Roundabout	Sampled By:	Client
Project Address:	SR-69 and SR-169	Test Date:	7/27/2023
Project City	Dewey	Tested By:	Mahalia Davis
Sample Location:	B-2 @ 1.0 - 3.0	Reviewed By:	Dylan Ward

Sieve Analysis (ASTM C-136 / AASHTO T 27 / ARIZ 201)			
Sieve Size	**% Retained**	**% Passed**	**Specs**
6"	0	100	
3"	0	100	
2 1/2"	0	100	
2"	0	100	
1 1/2"	0	100	
1"	1	99	
3/4"	2	97	
1/2"	6	91	
3/8"	5	86	
1/4"	7	79	
#4	5	73	
#8	7	66	
#10	2	64	
#16	7	57	
#30	8	49	
#40	4	45	
#50	4	41	
#100	6	35	
#200	5	31	

Liquid Limit (AASHTO T-89)	30
Plastic Limit (AASHTO T-90)	14
Plasticity Index (AASHTO T-90)	16
Moisture Content (AASHTO T-265)	5.5
USCS Soil Classification	SC

Group Name (ASTM D2487)
Clayey SAND with gravel

Dylan Ward
Laboratory Manager

Dylan Ward
Signature

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2301708	Material Type:	Soil
ACS Lab #	23-3788-4	Supplier:	-
Client:	Ethos Engineering, LLC	Sample Date:	7/24/2023
Project Name:	SR 69 at SR 169 Roundabout	Sampled By:	Client
Project Address:	SR-69 and SR-169	Test Date:	7/27/2023
Project City	Dewey	Tested By:	Mahalia Davis
Sample Location:	B-3 @ 0.0 - 3.0	Reviewed By:	Dylan Ward

Sieve Analysis (ASTM C-136 / AASHTO T 27 / ARIZ 201)			
Sieve Size	**% Retained**	**% Passed**	**Specs**
6"	0	100	
3"	0	100	
2 1/2"	0	100	
2"	0	100	
1 1/2"	6	94	
1"	8	86	
3/4"	8	79	
1/2"	12	66	
3/8"	8	58	
1/4"	9	49	
#4	5	44	
#8	7	37	
#10	1	36	
#16	4	32	
#30	5	27	
#40	3	24	
#50	2	22	
#100	4	18	
#200	3	16	

Liquid Limit (AASHTO T-89)	21
Plastic Limit (AASHTO T-90)	16
Plasticity Index (AASHTO T-90)	5
Moisture Content (AASHTO T-265)	5.0
USCS Soil Classification	GC-GM

Group Name (ASTM D2487)
Silty, clayey GRAVEL with sand

Dylan Ward
Laboratory Manager

Dylan Ward
Signature

ACS Services LLC

Job #	2301708	Material Type:	Soil
Lab #	23-3788	Extraction Date:	7/24/2023
Client:	Ethos Engineering, LLC	Extracted By:	Client
Project Name:	SR 69 at SR 169 Roundabout	Laboratory Test Date	7/27/2023
Project Address:	SR-69 and SR-169	Laboratory Tested By:	Keagen Mayfield
Project City:	Dewey	Reviewed By:	Dylan Ward
Material Source:	-		

Density of Soil in Place by the Drive-Cylinder Method (ASTM D2937)

ID #	Sample Location	Wet Wt. (g)	Moisture Dry Wt. (g)	**Moist Content**	# Of Rings	Wet Wt'+Rings (g)	Wt. of Rings (g)	**Dry Density (pcf)**
23-3788-2	B-1 @ 1.0 - 2.0	711.0	683.3	4.1%	5	927.7	216.7	113.2

ACS Services LLC

Maximum Dry Density & Optimum Moisture

☐ AASHTO T 99 | ☐ AASHTO T 180 | ☑ ASTM D698 | ☐ ASTM D1557

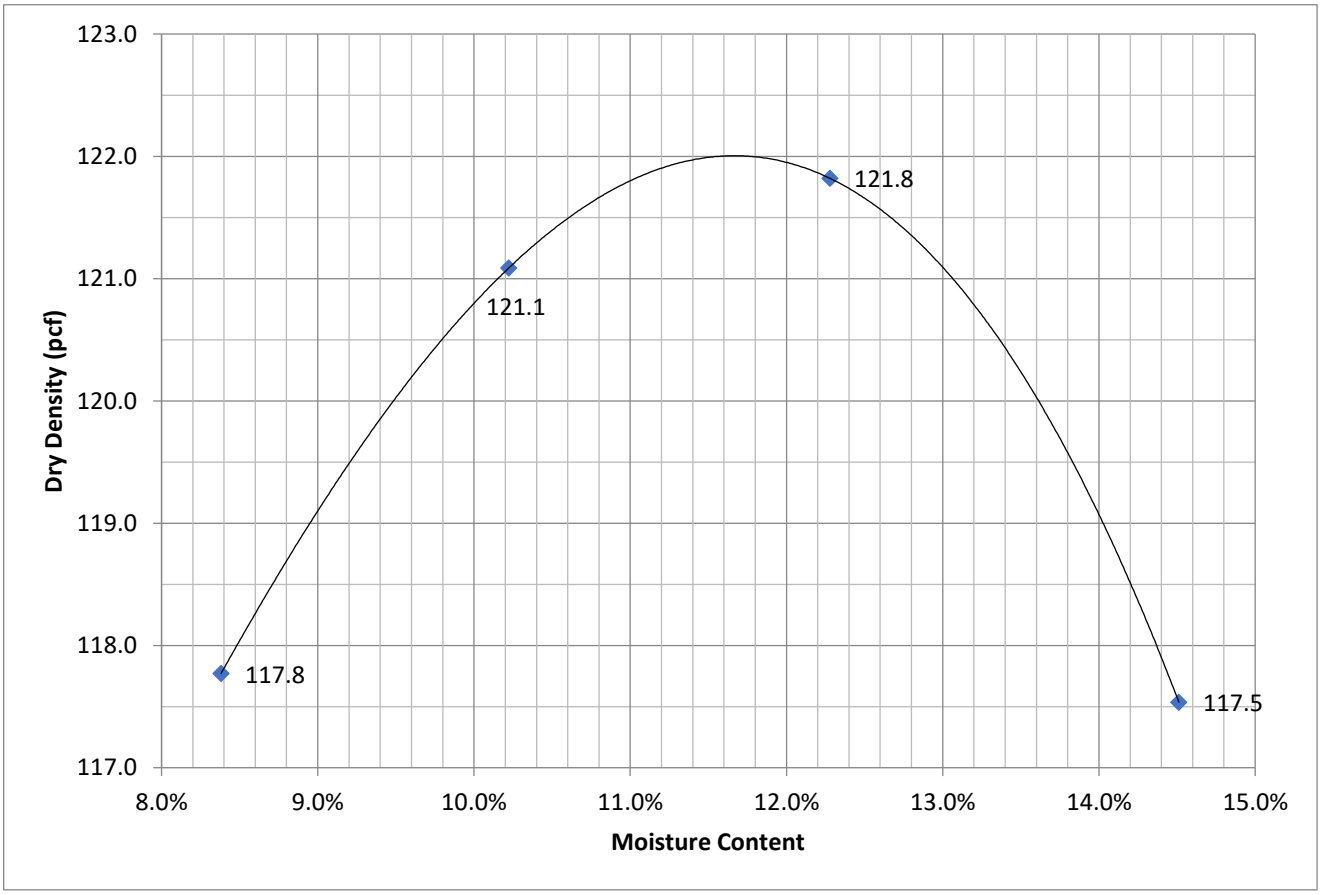
ACS Project #	2301708	Material Type:	Soil
ACS Lab #	23-3788-1	Material Supplier:	-
Client Name:	Ethos Engineering, LLC	Sample Date:	7/24/2023
Project Name:	SR 69 at SR 169 Roundabout	Sampled By:	Client
Project Address:	SR-69 and SR-169	Date Tested:	7/26/2023
Project City:	Dewey	Tested By:	Mahalia Davis
		Reviewed By:	Dylan Ward

Sample Location: B-1 @ 0.0 - 2.5

Method: ☑ A ☐ B ☐ C ☐ D

Dry Density	117.8	121.1	121.8	117.5
Moisture Content	8.4%	10.2%	12.3%	14.5%

Uncorrected Dry Density	122	Uncorrected Moisture Content	11.7
% Rock	18	% Passing	82
Rock Corrected Dry Density	**127.8**	Rock Corrected Moisture Content	**9.7**
Specific Gravity of Oversize Aggregate	**2.600**		



Dylan Ward

Project Manager

ACS Services LLC

Swell / Settlement Potential of Soils
ASTM D4546-03

ACS Project #	**2301708**	Material Type:	Soil
ACS Lab #	23-3788-1	Sample Date:	7/24/2023
Client Name:	Ethos Engineering, LLC	Sampled By:	Client
Project Name:	SR 69 at SR 169 Roundabout	Laboratory Test Date:	7/27/2023
Project Address:	SR-69 and SR-169	Laboratory Test By:	Mahalia Davis
Project City:	Dewey	Reviewed By:	Dylan Ward
Sample Source:	B-1 @ 0.0 - 2.5		

Test Method: [ ] A [ ] B [x] C

Standard Proctor Information

Maximum Dry Density:	122.0	pcf
Optimum Moisture Content:	11.7	%

Specimen Preparation

95% of Maximum Dry Density:	115.9	pcf
-2% of Optimum Moisture Content:	9.7	%
Wet Density of Sample:	127.1	pcf
Test Weight (Wet):	153.5	g
Test Weight (Dry):	139.9	g
Moisture Sample (Wet):	100.0	g
Moisture Sample (Dry):	93.0	g
Sample Moisture Content:	7.5	%
Sample Weight (In situ):	150.5	g
Additional Moisture Needed:	3.0	ml
Ring Weight:	45.5	g
Total Weight Ring + Sample:	199.0	g
Initial Sample Saturation:	49	%

Specimen Test Data Post-Swell Test

Initial Specimen Height:		in
Final Specimen Height:		in
Final Specimen Weight:		g
Final Specimen Moisture Content:		%
Final Sample Saturation:		%

Final Wet Weight

Final Dry Weight

Swell / Settlement Potential Results

Load at Inundation (ksf)	
% Strain Before Inundation:	
% Strain After Inundation:	
Percent Heave:	

Correction Factor

Calibration Correction Factor	NONE

Corrected Swell	3.5

Dylan Ward
Laboratory Manager

Dylan Ward
Signature

Ring Mold Information

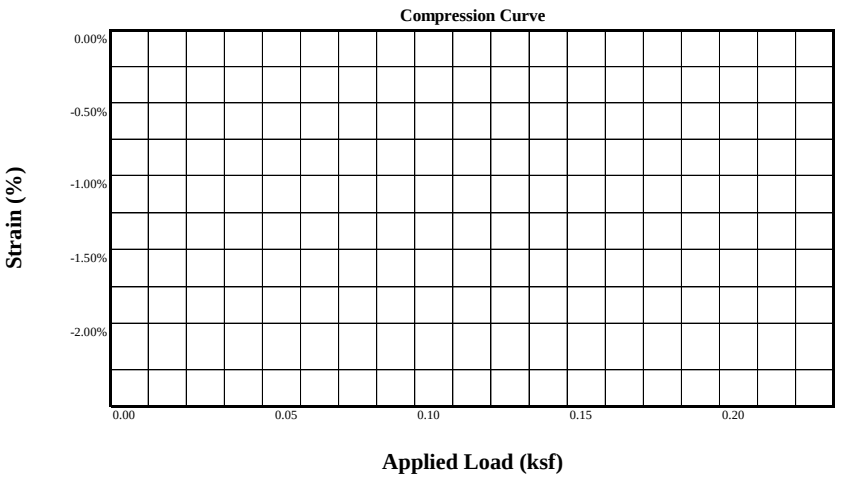
Ring Weight (g)	45.5
Ring Height (in)	1.000
Ring Diameter (in)	2.421
Ring Area (in^2)	4.604

Weight Used in Swell Test

Load Weight:	144 psf

Dial Readings During Test

Time Elapsed	Dial Reading (0.001")
0 (w/ seating pressure)	0.000
0 (w/ load applied)	0.000
30 Seconds	0.007
1 Minute	0.011
2 Minutes	0.018
4 Minutes	0.029
8 Minutes	0.029
15 Minutes	0.030
30 Minutes	0.032
1 Hour	0.033
2 Hours	0.033
4 Hours	0.034
8 Hours	0.034
15 Hours	0.035
24 Hours	0.035

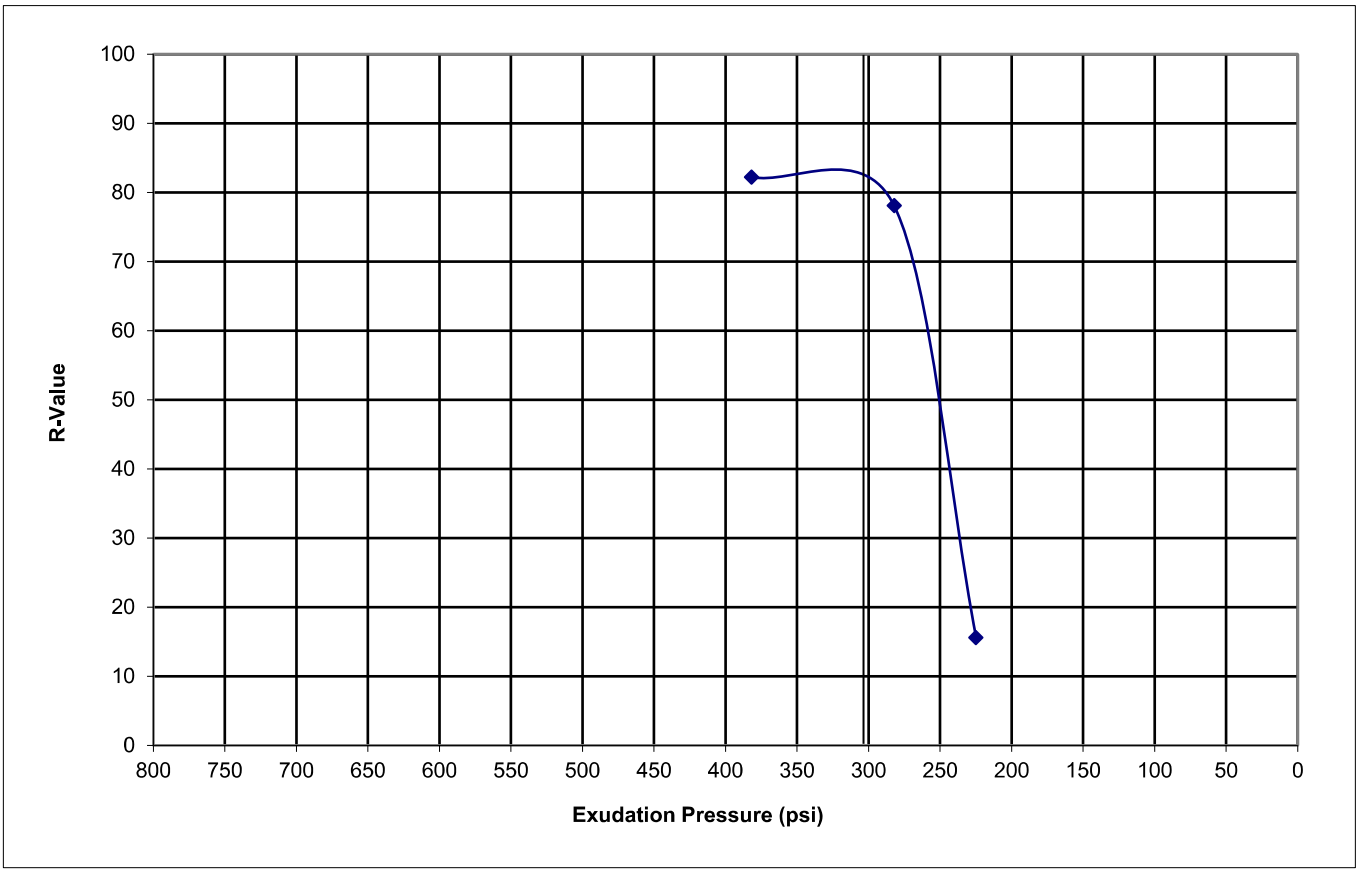


PROJECT: ACS - Lab Testing Services, Project #2301708
LOCATION: Mesa, AZ
MATERIAL: Native Soil
SAMPLE SOURCE: B-2 (1.0-3.0') - ACS Lab No. 23-3788-3

JOB NO: 19-2012-2017
WORK ORDER NO: N/A
LAB NO: 23-1596
DATE ASSIGNED: 07/28/23

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

SPECIMEN ID	A	B	C
Moisture Content	12.5%	11.7%	10.8%
Compaction Pressure (psi)	30	30	30
Specimen Height (inches)	2.44	2.53	2.49
Dry Density (pcf)	127.1	128.1	131.3
Horiz. Pres. @ 1000lbs (psi)	52.0	14.0	8.0
Horiz. Pres. @ 2000lbs (psi)	117.0	24.0	19.0
Displacement	4.68	3.98	4.01
Expansion Pressure (psi)	0.0	0.0	0.0
Exudation Pressure (psi)	225	282	382
R Value	16	78	82



R Value at 300 PSI = 82

WSP USA
3630 E Wier Ave.
Phoenix, AZ 85040

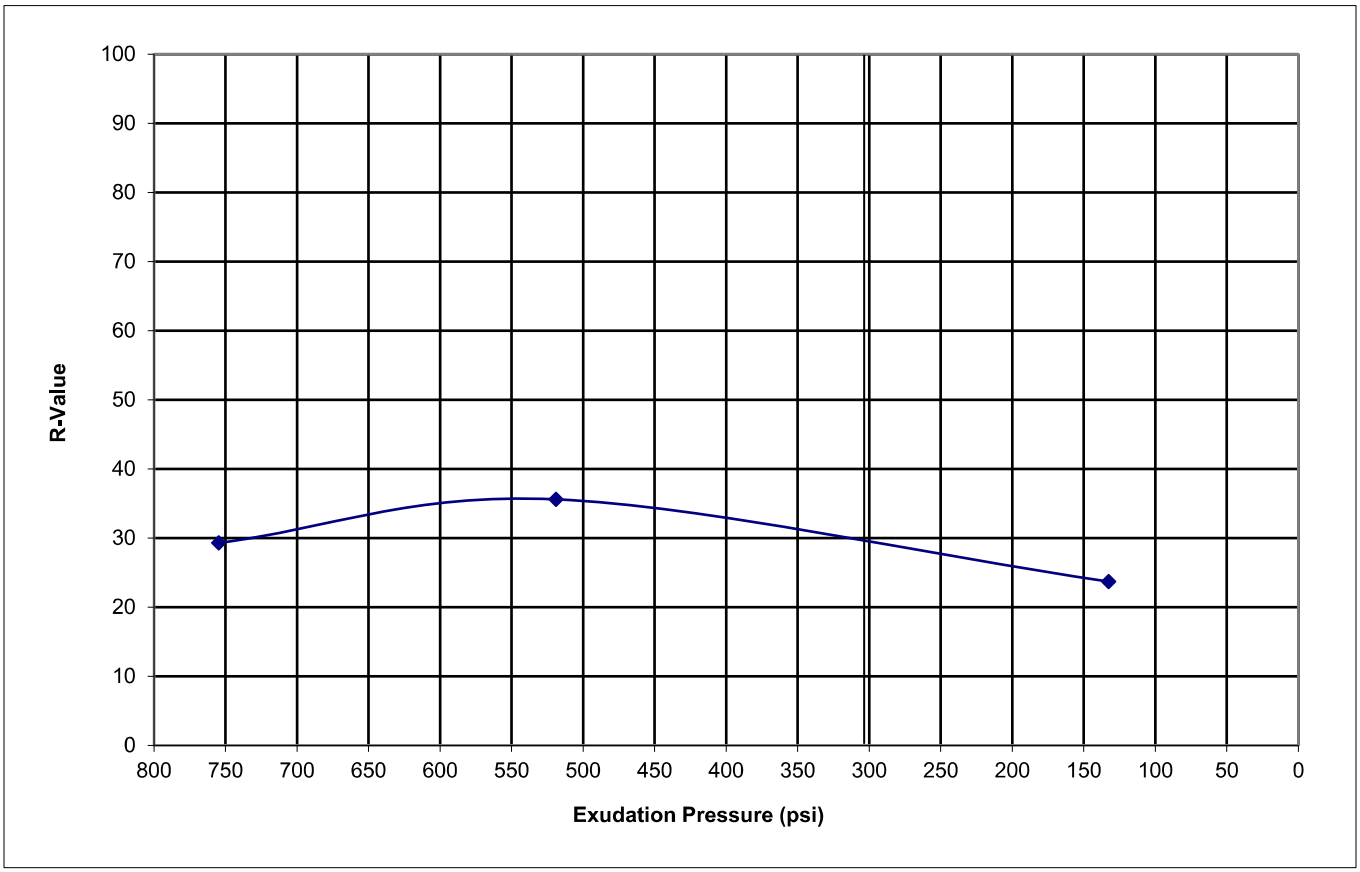
REVIEWED BY rob.kostelny 2023.08.03 07:22:56 -07'00'

PROJECT: ACS - Lab Testing Services, Project #2301708
LOCATION: Mesa, AZ
MATERIAL: Native Soil
SAMPLE SOURCE: B-3 (0.0-3.0') - ACS Lab No. 23-3788-4

JOB NO: 19-2012-2017
WORK ORDER NO: N/A
LAB NO: 23-1597
DATE ASSIGNED: 07/28/23

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

SPECIMEN ID	A	B	C
Moisture Content	9.9%	9.0%	8.2%
Compaction Pressure (psi)	35	50	60
Specimen Height (inches)	2.51	2.49	2.46
Dry Density (pcf)	133.4	135.5	134.8
Horiz. Pres. @ 1000lbs (psi)	43.0	33.0	37.0
Horiz. Pres. @ 2000lbs (psi)	107.0	88.0	96.0
Displacement	3.99	3.70	4.02
Expansion Pressure (psi)	0.0	0.0	0.0
Exudation Pressure (psi)	133	519	755
R Value	24	36	29



R Value at 300 PSI = 30

WSP USA
3630 E Wier Ave.
Phoenix, AZ 85040

REVIEWED BY rob.kostelny 2023.08.03 07:24:06 -07'00'

ACS Services LLC

Soil pH and Resistivity Determination

AASHTO T-289 AASHTO T-288 / ARIZ 236

Project #	2301708	Material Type:	Soil
Lab #	23-3788-1	Supplier:	-
Client:	Ethos Engineering, LLC	Sample Date:	7/24/2023
Project Name:	SR 69 at SR 169 Roundabout	Sampled By:	Client
Project Address:	SR-69 and SR-169	Test Date:	Thursday, July 27, 2023
Project City:	Dewey	Tested By:	Mahalia Davis
Sample Source:	B-1 @ 0.0 - 2.5	Resistivity Box:	-
		Reviewed By:	Dylan Ward

pH Reading = 8.3

P = (SBF) x R x M

Where:

SBF = Soil Box Factor, cm
R = Dial Reading, OHMS
M = Multiplier

Water Added	SBF (cm)	Dial Reading (OHMS)	Multiplier	**P** (OHM-cm)
200 mL	6.77	3.1	100	2100
50	6.77	1.9	100	1290
50	6.77	2.0	100	1350

Fernando Montero
Lab Supervisor

Dylan Ward
Laboratory Manager

MOTZZ LABORATORY, INC.

Report: 947552
Reported: 7/31/2023
Received: 7/27/2023
PO: 2301708

Laboratory Analysis Report

ACS Services LLC
Jeffry L. Donkersley
2235 W Broadway Road
Mesa, AZ 85202

Project: 2301708

Lab Number	Sample ID	
947552-1	23-3788-1	B-1(0.0-2.5)

Test Parameter

Test	Method	Result.	Units
Sulfate	ARIZ 733b	5	ppm
Chloride	ARIZ 736b	21	ppm