Confidential

Navajo Tribal Utility Authority

TSAILE COMMUNTIY SYSTEM PUMPHOUSE

GEOTECHNICAL ENGINEERING REPORT

2025-06-18

Project No.: US0036797.3467

June 18, 2025

Confidential

Navajo Tribal Utility Authority
North Navajo Route 12
Fort Defiance,
Arizona 86504

Attention: **Mr. Bitsoi**

Re: **Geotechnical Engineering Report**
Tsaile Community System Pumphouse
Tsaile, Arizona

Dear Mr. Bitsoi,

WSP USA Environment & Infrastructure Inc. (WSP) is pleased to submit this report, describing our geotechnical engineering study of the above reference project. 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

Antionette Jim
Consultant, Geotechnical Engineering

Rashidatu Ossai, Ph.D.
Consultant, Geotechnical Engineering

Reviewed by:

John C. Lommler, Ph.D., P.E., BC.GE
Senior Vice President,
Principal Geotechnical Engineer

Geotechnical Engineering Report

Tsaile Community System Pumphouse
WSP Project # US0036797.3467

Prepared for:

Navajo Tribal Utility Authority

Prepared by:

WSP USA
4221 Balloon Park Rd. N.E.
Albuquerque, NM 87109

6/18/2025

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Third-party disclaimer

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TABLES

1 INTRODUCTION

WSP performed a geotechnical engineering evaluation for the proposed pumphouse for Tsaile Community System in Tsaile, Arizona. The objectives of this study were to evaluate the engineering properties of the soils underlying the proposed site and provide recommended criteria for foundation design per Indian Health Service standard detail (Two Room Precast Pumphouse W-29), slab support, reuse of on-site soils as structural fill, site preparations, and other related earthwork.

The scope of work for this project included:

- Field testing,
- Laboratory testing,
- Engineering analysis of the field test results,
- and Preparation of a written report.

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

2 PROPOSED CONSTRUCTION

The project site is located nearest to Sehili (road C443) along Indian Route 12 between mile markers 73 and 72 approximately 150-feet southwest of the highway located atop a small hillside. The proposed pumphouse is a 127 square foot single-story building consisting of installing a new concrete masonry unit (CMU) walled pumphouse. Table 1 shows loading condition assumptions made by WSP, to support the recommendations made in this report.

Table 1: Details Project Descriptions

CONDITIONS	DESCRIPTION
Site layout	See Appendix A, Figures, Site Map and Borehole Location,
Maximum wall loading[1]	2 kips per foot
Maximum allowable settlements	1 inch

Note(s):

1. If estimated loading is not correct, please notify author of this report.

Should final design details vary significantly from those outlined above, WSP's Project Manager should be notified for review and possible modification of recommendations.

3 SUBSURFACE INVESTIGATION

Our geotechnical field study was conducted on March 11, 2025. A single exploratory borehole was drilled to approximately 25 feet below existing grade. A truck mounted Central Mine Equipment Company CME-55 drill rig was equipped using a 7.25-inch outer diameter (O.D.), hollow-stemmed auger to drill. Standard penetration testing (ASTM D 1586) was performed at selected intervals in the subsurface. The soil samples were collected using split-spoon and California modified samplers. The soils were continuously examined, visually classified, and logged by WSP's field geologist. Neither bedrock, cobbles nor water were encountered during the field investigation.

The following laboratory tests were conducted on selected soil samples:

- Moisture Content and In-Situ Density (ASTM D2216-19),
- Sieve Analysis (ASTM C117-17/C1369-19),
- Atterberg Limits (ASTM D4318-17), and
- Collapse/Swell Potential of Soils (ASTM D5333-03),
- Direct Shear Test of Soils (ASTM D3080-1)
- Sulfate and Chlorides tests (AASHTO T290 and T291), and
- pH and Minimum Resistivity of Soils (ASTM D4972 and ASTM G187) and

It should be noted that the exploration performed and used for this report reveal subsurface conditions only at a discrete location of the project and that actual conditions in other locations could vary. Furthermore, the nature and extent of these variations would not become evident until additional explorations are performed or until construction activities have begun. If significant variations are observed at that time, we may need to modify our conclusions and recommendations contained in this report to reflect the actual site conditions.

4 SITE CONDITIONS AND GEOTECHNICAL PROFILE

4.1 SITE CONDITIONS

At the time of our field study, the project area was undeveloped, with vegetation consisting of native grasses, shrubs, and trees. The ground gently to moderately sloped down to a channel at the base of the hillside on the northeast; the weather was cool with a gentle breeze. Overhead cirrus scattered cloud coverage to clear skies were noted with obvious precipitation from snow fall. Small snow patches could be seen beneath the surrounding trees and hillsides and the ground surface was damp to wet. The highway and overhead powerline ran parallel northwest to southeast. The water line and concrete manhole was near the site location. Small outcrops of boulders were observed along the hillside; however, no cobbles nor boulders generated from the drilling operations.

4.2 GEOTECHNICAL PROFILE

The soils encountered at the proposed pumphouse alternated between low to medium plasticity lean clay and silty sand or clayey silty sand (i.e. CL, SM, and SC-SM). A very dense fissile sandstone layer was encountered at 20-feet followed by clay generated from the auger cuttings.

Geotechnical laboratory tests revealed that the on-site soils had moderate to high fines (silt and clay) content, ranging from 38 to 72 percent. Moisture content of these soils ranged from 1.1 to 19.4 percent. The laboratory testing sheets presented in Appendix B show the laboratory test results, and Table 2 summarizes test results for selected samples upon which grain-size analyses were performed.

Table 2: Laboratory Test Results

Borehole, Depth (feet)	Soil Type (USCS Soil Type)	P.I.	Moisture Content (percent)	Grain Size Analysis		
				Gravel (percent)	Sand (percent)	Silt/Clay (percent)
TS-01, 7.5	CL	13	9.0	0	28	72
TS-01, 15.0	--	--	13.6	24	38	38

Note(s):

A collapse/swell upon wetting test was performed on a sample from a depth of 5 feet. Results of the collapse and expansion potential upon wetting test is summarized in Table 3. Results of the collapse and expansion test indicate the soil has potential to expand upon wetting. Laboratory test results are presented in Appendix B.

Table 3: Collapse/Expansion upon Wetting Test Samples

Sample	Collapse/ expansion	Comment
TS-01 @ 5.0 feet	+1.0%	Expanded upon wetting

A relatively undisturbed sample was subjected to direct shear testing. Table 4 summaries the test results.

Table 4: Direct Shear Test Results

Sample	Depth (ft)	Internal Friction Angle, φ (deg,)
TS-01	5.0	33.4

Abbreviations:

deg. = degree

Bulk samples, from a depth of 0 to 5 feet were tested to determine the electrical resistivity, pH, and sulfate and chloride of the soil in accordance with ASTM G187, ASTM D4972, AASHTO T290 and AASHTO T291, respectively. The results of electrical resistivity, pH, and sulfate and chloride tests are summarized in Table 5. Soils with resistivity between 2,001 to 10,000 ohms-centimeters are considered moderately corrosive. Based on the laboratory results, the soil in the upper 5 feet is moderately corrosive. Laboratory test results are presented in Appendix B.

Table 5: Chemical Test Results

Borehole, Depth	pH	Minimum Resistivity (Ω-cm)	Sulfate Content (ppm)	Chloride Content (ppm)
TS-01 @ 0 - 5.0 feet	8.0	2451	166	32

4.3 GROUNDWATER CONDITIONS

At the time of drilling (March 11th, 2025), groundwater was encountered at 15-feet within the exploration borehole. Auger cuttings were noted to be wet from 16-feet to 18.5-feet below ground surface.

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

5 DISCUSSION & RECOMMENDATIONS

5.1 Site Preparation

Our exploratory boring and laboratory testing indicate that the lean clay encountered in the proposed building area is of medium plasticity. Laboratory testing on the clayey material near the proposed bottom of over-excavation indicate that the soil has an expansion potential of about 1.0 percent when saturated under a surcharge load of 2000 pounds per square foot and swelled significantly when unloaded to 1000 pounds per square foot.

It should be noted that a degree of risk is involved with shallow foundations. Should a broken water line or other source of moisture occur, excessive movements of slabs and lightly loaded foundations could occur. The site preparation, drainage, and moisture protection provisions presented herein are considered critical design details.

Post-construction moisture increases in the supporting soils could cause some differential foundation movements and, thus, careful site drainage and moisture protection procedures as outlined in a following section of this report will be critical for the satisfactory performance of the structure.

On-site Soils: We offer the following evaluation of the on-site soils relative to potential use as structural fill (i.e. compacted fill).

- The soils encountered at the project site within the upper 10 feet are comprised of medium plasticity lean clay with a high percent of silt/clay content (i.e., greater than 30 percent). These clayey materials are not recommended to be used as compacted structural fill based on their percent of silt/clay content and potential to expand upon wetting. Accordingly, it is recommended that the foundations for the structures be supported on structural fill with special subgrade preparation at the bottom of over-excavation.

Bottom of Over-Excavation Subgrade Compaction: The exposed cut surfaces are indicated to be lean clay and silty sand at 5-foot depth. To receive fill, these exposed clayey surfaces should be scarified and mixed to a depth of 10 inches, moisture conditioned and recompacted. Moisture content at time of compaction should range from between optimum moisture content and 3 percent above optimum. A density of between 95 and 97 percent of maximum dry density within the building pad should be obtained. Optimum moisture content and maximum dry density for the exposed native clayey soils should be determined in accordance with ASTM D698. Any soft or pumping soils observed within the foundation subgrade should be over-excavated and replaced with suitable structural fill material.

Erosion Control Measures: Prior to disturbing the ground surface with earthwork, temporary erosion and sediment controls should be implemented. The project civil engineer should prepare plans and specifications to prevent erosion and runoff during construction. The contractor will need to understand that design plans and specifications represent the minimum requirements and additional measures, and modifications may be needed throughout the construction period that are specific to the construction activities and the weather.

Clearing and Stripping: After temporary erosion and sediment controls are in place, construction areas should be cleared and stripped of all vegetation, topsoil, and debris. Furthermore, it should be noted that if the stripping operation proceeds during wet weather, a generally greater stripping depth might be necessary to remove disturbed, wet soils; therefore, stripping is best performed during a period of dry weather.

5.2 Excavation

Excavation: The on-site soils within the building footprint should be excavated and replaced with imported structural fill. The lateral extents of the excavation should extend at least 3-feet beyond the edges of the building. The recommended depth of the proposed excavation is 5-feet below the existing ground surface (which will provide about 2.5 feet of structural fill beneath footings). The soils encountered can be excavated with conventional earth moving equipment. Our boring did not encounter rubble, cobbles, or boulders.

Temporary Cut Slopes: Temporary open cuts and utility trenches can be made where adequate lateral space is available, but all excavation sidewalls should be adequately sloped back to minimize sloughing and erosion. All temporary sloping and temporary shoring are required to adhere to the Occupational Safety and Health Administration (OSHA) requirements. Table 6 presents our interpretations of soil types based on our explorations, and corresponding OSHA cut slope inclinations when workers are below. In all cases, however, the appropriate angle will be dictated by actual soil and groundwater conditions exposed in the excavation.

Table 6: Estimated Soil Types and Recommended Slope Inclination for Temporary Excavations

SOIL TYPE	TYPICAL DEPTH INTERVAL (FEET)	OSHA SOIL TYPE	MAXIMUM INCLINATION
Medium stiff to hard lean clay, medium	0 to 20	C	1.5H:1V

dense to very dense silty sand			

Abbreviations
H = horizontal
OSHA = Occupational Safety and Health Administration
V = vertical

Note(s):
1. Slopes are recommended for temporary cuts to depths of up to 20 feet.

During construction, the Contractor should realize that temporary cuts in loose materials may result in sloughing and raveling, and the Contractor should be prepared to flatten slopes as needed.

Safety Considerations: The stability of temporary excavation slopes is a function of many factors, including soil type, soil density, slope inclination, slope height, the presence of groundwater, and the duration of exposure. Generally, the likelihood of slope failure increases as the cut is deepened and as the duration of exposure increases. For this reason, we recommend that during construction the contractor maintain adequate slopes and/or setbacks. Temporary slope safety should remain the responsibility of the contractor, who is continually present at the site and is able to monitor the performance of the excavation and modify his activities to reflect varying conditions. In all cases, cut-slope inclinations should conform to applicable governmental safety guidelines.

Slope Protection: Regardless of inclination, temporary slopes should be protected from surface-runoff erosion. Typically, this can be accomplished by means of berms or swales located along the top of the slope, and possibly by means of plastic tarpaulins placed over the slope.

5.3 Foundations

We recommend the use of a spread or continuous type (i.e. strip) footings bearing at 2.5 feet or deeper below finished grade for frost protection, in conjunction with the recommended site preparation and moisture protection provisions (Section 5.5), for support of the structure.

A safe soil bearing pressure of 3,000 pounds per square foot (psf) is recommended for the design of spread footings or strip footings supported on 2.5 feet of structural or suitable compacted fill. The bearing pressure recommended above applies to dead load plus realistic live loads (i.e. service loads).

Based on the bearing resistance the total vertical movements (i.e. settlement) of the proposed foundations will be within one (1) inch. Differential movements are estimated to be 50% of maximum vertical movements. Significant moisture increases above these contents could create additional collapse upon wetting movements and could create excessive movement in some areas of the site. To avoid wetting of foundation support soils, site drainage should be maintained as recommended in Section 5.5 below.

5.4 Slab-on-Grade Floors

In our opinion, soil-supported slab-on-grade floors can be used in the proposed structure if the excavation and fill for the building is properly prepared in accordance with Section 5.6. 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 used. The subbase should be at least 6 inches thick and meet the following grading requirements as determined in accordance with ASTM C136.

Table 7: Imported structural subbase fill grain size requirements

SIEVE SIZE (SQUARE OPENINGS)	PERCENT PASSING BY DRY WEIGHT
1 INCH	100

3/4 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. In our opinion, a subgrade reaction modulus of 200 pci can be used to estimate such deflections.

5.5 Drainage Systems

The structure should be provided with permanent drainage systems to minimize the risk of future moisture problems. We offer the following recommendations and comments for drainage design and construction purposes.

Runoff Water: Roof and surface water runoff should not be allowed to flow into the foundation drainage systems. Instead, these sources should flow into separate tight line pipes and be routed away from the structure. In addition, final site grades should be sloped downward away from the structure so that runoff water will flow by gravity to suitable collection points, rather than ponding near the structure. Ideally, the area surrounding the structure would be capped with concrete, asphalt, or low-permeability (silty clayey) soils to minimize surface-water infiltration next to the footings.

Construction Considerations: Positive site drainage should be provided during construction and maintained thereafter. Where pavements or sidewalks do not immediately adjoin the structure, the ground surface should be sloped away from the structure perimeter in a manner to allow flow along the drainage lines at a minimum grade of 5 percent to points at least 15 feet away. A minimum grade of at least 1 percent should be provided from these points to streets or natural water courses. In no case should long-term ponding of water be allowed around the perimeter of the structure.

5.6 Structural Fill

The term "structural fill" refers to any materials used for structure pads, as well as materials placed under foundations and interior slab-on-grade floor. This section presents our comments, conclusions, and recommendations concerning use of structural fill.

Materials: We recommend the on-site clayey materials in the upper five (5) feet be excavated and replaced with imported structural fill.

Fill Placement: Structural fill should be placed in horizontal lifts not exceeding 8 inches in loose thickness, and each lift should be thoroughly compacted with a mechanical vibratory compactor. Other procedures may be appropriate for some materials.

Compaction Criteria: The structural fill shall be moisture conditioned as necessary, and compacted. Moisture content at time of compaction shall be within 2 percent ($^{+}$/-) of optimum moisture content. A density of not less than 95 percent of maximum dry density within the building pad shall be obtained. Fill outside the building pad shall be compacted to 90 percent of maximum dry density. Optimum moisture content and maximum dry density for the imported structural fill shall be determined in accordance with ASTM D1557.

Subgrade Verification and Compaction Testing: Regardless of material or location, all structural fill should be placed over dense, unyielding subgrades. The condition of all subgrades should be verified by a WSP representative before filling or construction begins. In addition, fill soil compaction should be verified by means of in-place density tests performed during fill placement so the adequacy of the soil compaction efforts may be evaluated as earthwork progresses.

Soil Moisture Considerations: The suitability of soils used for structural fill depends primarily on their grain-size distribution and moisture content when they are placed. As the "fines" content (the soil fraction passing the U.S. No. 200 sieve) increases, soils become more sensitive to small changes in moisture content.

Import Fill Considerations: We recommend using a well-graded sand and gravel meeting the following grading requirements as determined in accordance with ASTM C136.

Table 8: Imported Structural Fill Grain Size Requirements

SIEVE SIZE (SQUARE OPENINGS)	PERCENT PASSING BY DRY WEIGHT
1 INCHES	100
¾ INCH	85 - 100
NO. 4	45 – 95
NO. 200	0 - 30

The plasticity index of the material, as determined in accordance with ASTM D 4318, shall not exceed 15. The structural fill material shall be free from roots, grass, other vegetable matter, clay lumps, rocks larger than 3 inches in any dimension, or other deleterious materials.

5.7 Construction Observations & Testing

Recommendations presented in previous sections of this report are predicated on the fact that there will be continuous observation and testing by the geotechnical engineer's representative during earthwork operations. Verification of recommended excavation and required degree of compaction should be performed in accordance with the specifications outlined in this report.

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.

A

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

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 boring procedures

Exploratory borings were advanced with a hollow-stem auger using a truck-mounted drill rig operated by an independent drilling firm working under subcontract to WSP. A geologist from WSP continuously observed the borings, 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 boring was completed, the borehole was backfilled soil cuttings.

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. "Undistrubed" samples of firmer soils are often obtained with 3-inch O.D. samplers lined with 2.42-inch I.D. brass rings with the same driving energy and recording of blows in 6-inch increments. However in stratified soils, driving resistance is sometimes recorded in 2 or 3-in increments so that soil changes and presence of scattered gravel or cemented layers can be readily detected and realistic penetration values obtained for consideration in design. Taking larger bulk samples from auger cuttings is also necessary for testing.

The enclosed Boring Logs describe the vertical sequence of soils and materials encountered in each boring, based primarily on field classifications and supported by subsequent laboratory examination and testing. Where a soil contact was observed to be gradational, boring logs indicate the average contact depth. Where a soil type changed between sample intervals, we inferred the contact depth. The boring logs also graphically indicate the blow count, sample type, sample number, and approximate depth of each soil sample obtained from the borings, 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 boring 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.

CLIENT:
NAVAJO TRIBAL UTILITY AUTHORITY

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

LEGEND

TS-01 Completed Boring Number and Approximate Location

Project Location

DWN BY:	AJ
CHK'D BY:	AJ
DATUM:	NAD27
PROJECTION:	N/A
SCALE:	AS SHOWN

PROJECT:
Geotechnical Exploration
TSAILE PUMPHOUSE
Tsaile, Arizona

TITLE:
Site and Exploration Plan

REV. NO.:	1
DATE:	04/03/25
PROJECT NO:	US0036797.3467
CONTRACT NO:	N/A
FIGURE NO:	1

C:\Users\USAJ716450\OneDrive - WSP O365\Documents\Navajo Reservation Projects\US0036797.3467 Tsaile Pumphouse\Site and Exploration Plan – Template.dwg

RECORD OF BOREHOLE: TS-01

CLIENT:	Navajo Tribal Utility Authority	DATE:	March 11, 2025	ELEVATION:	Data Not Available
PROJECT:	Tsaile Community System Pump House			COORDINATES:	Lat: 36.281944° Long: -109.177083°
PROJECT NO:	US0036797.3467	INCLINATION:	90.0°	COORD SYS:	Geographical Coordinates
LOCATION:	Tsaile, AZ	CONTRACTOR:	GEOMAT, INC.	HORZ DATUM:	NAD83 VERT DATUM: NAVD88
NOTES:	DRILLER: Fernando E.			HOLE LOC:	Approx. 15' SW of water line

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) Lean clay, mostly medium plasticity FINES, few sand; reddish brown; wet to moist, no cementation, clay clusters.	CL		0.0		AS					0.00 ft: Auger sample collected from 0.0'-5.0'. Moisture: 16.7%
2.5			(CL) Lean clay, mostly medium plasticity FINES, few sand; reddish brown, weak HCL reaction; moist, very stiff, thin beds of fine gravel to coarse sand.			2.5	B-08	SS		2-2-3	5		2.50 ft: Moisture: 19.4%
5			(SM) Silty sand, mostly SAND; compact, material varies within rings, from clay (CL) to silty sand (SM); no to low to medium PI; dark brown, brown, grayish; moist.	SM		5.0	B-09	MC		13-18/6"	31		5.00 ft: Moisture: 10.3%, Dry Density: 119.3 pcf
													6.50 ft: auger cuttings: material change (CL), medium to high P.I., grey
7.5			(CL) Lean clay with sand, mostly medium plasticity FINES, little sand; light gray, slickensided, no odor, moderate cementation, weak HCL reaction; moist, very stiff, trace fine sand.	CL		7.5	B-10	SS		8-16-22	38		7.50 ft: Moisture: 9.0%
10			(SC-SM) Silty, clayey sand, mostly SAND, little non plastic fines; hard, material varies within sampler; CL, SM, fissled sandstone; grey, brown, olive yellow.	SC-SM		10.0	B-11	MC		25-50/4"			10.00 ft: Moisture: 5.2%, Dry Density: 118.9 pcf
													14.00 ft: auger binding up with clay clusters <0.5" in size.
15			(CL) Lean clay with gravel, mostly medium plasticity FINES, few gravel, trace coarse sand; brown gray; wet, hard, fine grained gravel to coarse sand.	CL		15.0	B-12	SS		50/5"		25Nov03 15:30	15.00 - 16.00 ft: sampler wet, auger cuttings dry Moisture: 13.6%
													16.00 ft: Auger cuttings wet from 16.0' to 18.5' 11/25/2003 3:30:00 PM
													18.50 ft: auger cuttings: back to being dry
20			(SM) Silty sand, mostly fine SAND, little non plastic fines; white to grayish white, weak cementation, no HCL reaction; dry to moist, very dense, fissled sandstone.	SM		20.0	B-13	SS		50/2"			20.00 ft: Moisture: 1.1%
													23.00 ft: auger cuttings: (CL), grayish brown, medium P.I.
													24.00 ft: auger cuttings: 1" - 0.5" subrounded gravel generated from cuttings
25													

Continued on Next Page

25.0

HAMMER TYPE: Automatic

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

REV: 3

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

RECORD OF BOREHOLE: TS-01

CLIENT:	Navajo Tribal Utility Authority	DATE:	March 11, 2025	ELEVATION:	Data Not Available
PROJECT:	Tsaile Community System Pump House			COORDINATES:	Lat: 36.281944° Long: -109.177083°
PROJECT NO:	US0036797.3467	INCLINATION:	90.0°	COORD SYS:	Geographical Coordinates
LOCATION:	Tsaile, AZ	CONTRACTOR:	GEOMAT, INC.	HORZ DATUM:	NAD83 VERT DATUM: NAVD88
NOTES:	DRILLER: Fernando E.			HOLE LOC:	Approx. 15' SW of water line

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
25			No Recovery				SS			50/2"			
			End of hole at 25.00 ft.										
			Rig stuck in mud, drilled in place . BH offset due to incident. Backfilled with cuttings.										
26													
27													
28													
29													
30													
31													
32													
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45													
46													
47													
48													
49													
50													

HAMMER TYPE: Automatic

REV: 3

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

LOGGED: Antionette Jim DATE: Mar 11, 2025

CHECKED: DATE:

B

LAB PROCEDURES & RESULTS

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: Navajo Tribal Utility Authority
P.O. Box 170
Ft. Defiance, AZ 86504-

Attn: Dave Shoultz

Project Name: NTUA Tsaile

Tsaile, AZ

Project Manager: Bardia Tabiatnejad

Report Date: May 06, 2025

Project #: US0036797.3467
Report #: 2621
Work Order #: 1
Sampled By: Toni Jim
Date Sampled: 3/11/2025

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)
25-0200-01	See Boring Log	TS-01 @ 0-5.0'	B	110	☐	☐	16.7	
25-0200-02	See Boring Log	TS-01 @ 2.5'	B	110	☐	☐	19.4	
25-0200-03	See Boring Log	TS-01 @ 5.0'	B	110	☐	☐	10.3	119.3
25-0200-04	See Boring Log	TS-01 @ 7.5'	B	110	☐	☐	9.0	
25-0200-05	See Boring Log	TS-01 @ 10.0'	B	110	☐	☐	5.2	118.9
25-0200-06	See Boring Log	TS-01 @ 15.0'	B	110	☐	☐	13.6	
25-0200-07	See Boring Log	TS-01 @ 20.0'	B	110	☐	☐	1.1	

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

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Client: Navajo Tribal Utility Authority
P.O. Box 170
Ft. Defiance, AZ 86504-

Attention: Dave Shoultz

Project Name: NTUA Tsaile

Tsaile, AZ

Project Manager: Bardia Tabiatnejad

Report Date: May 12, 2025

Project #: US0036797.3467
Work Order #: 1
Sampled By: Toni Jim
Date Sampled: 3/11/2025

Sieve Analysis (ASTM C117-17/C136-19)
Plasticity Index (ASTM D4318-17)
Soil Classification (ASTM D2487-17)

SOILS / AGGREGATES

				Sieve Sizes																				Sieve Result are as Percent Passing.
Sample Location	Soil Class.	L.L.	P.I.	#200	#100	#50	#40	#30	#16	#10	#8	#4	1/4"	3/8"	1/2"	3/4'	1"	1 1/4"	1 1/2"	2"	2 1/2"	3"	6"	12"	Lab Number
TS-01 @ 7.5'	CL	29	13	72	84	89	92	95	98	99	100														25-0200-04
TS-01 @ 15.0'				38	50	56	58	59	63	66	68	76		85	93	100									25-0200-06

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Client: Navajo Tribal Utility Authority
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Attention: Dave Shoultz

Project Name: NTUA Tsaile

Tsaile, AZ

Project Manager: Bardia Tabiatnejad

Report Date: May 12, 2025

Project #: US0036797.3467
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Sampled By: Toni Jim
Date Sampled: 3/11/2025

Sieve Analysis (ASTM C117-17/C136-19)
Plasticity Index (ASTM D4318-17)
Soil Classification (ASTM D2487-17)

SOILS / AGGREGATES

Lab Number	Sample Location	Soil Class.	L.L.	P.I.	D10	D20	D30	D50	D60	D70	CC	CU	Cmu
25-0200-04	TS-01 @ 7.5'	CL	29	13	0	0	0	0	0	0	0	0	0
25-0200-06	TS-01 @ 15.0'				0	0	0	0.148	0.701	2.829	0	0	0

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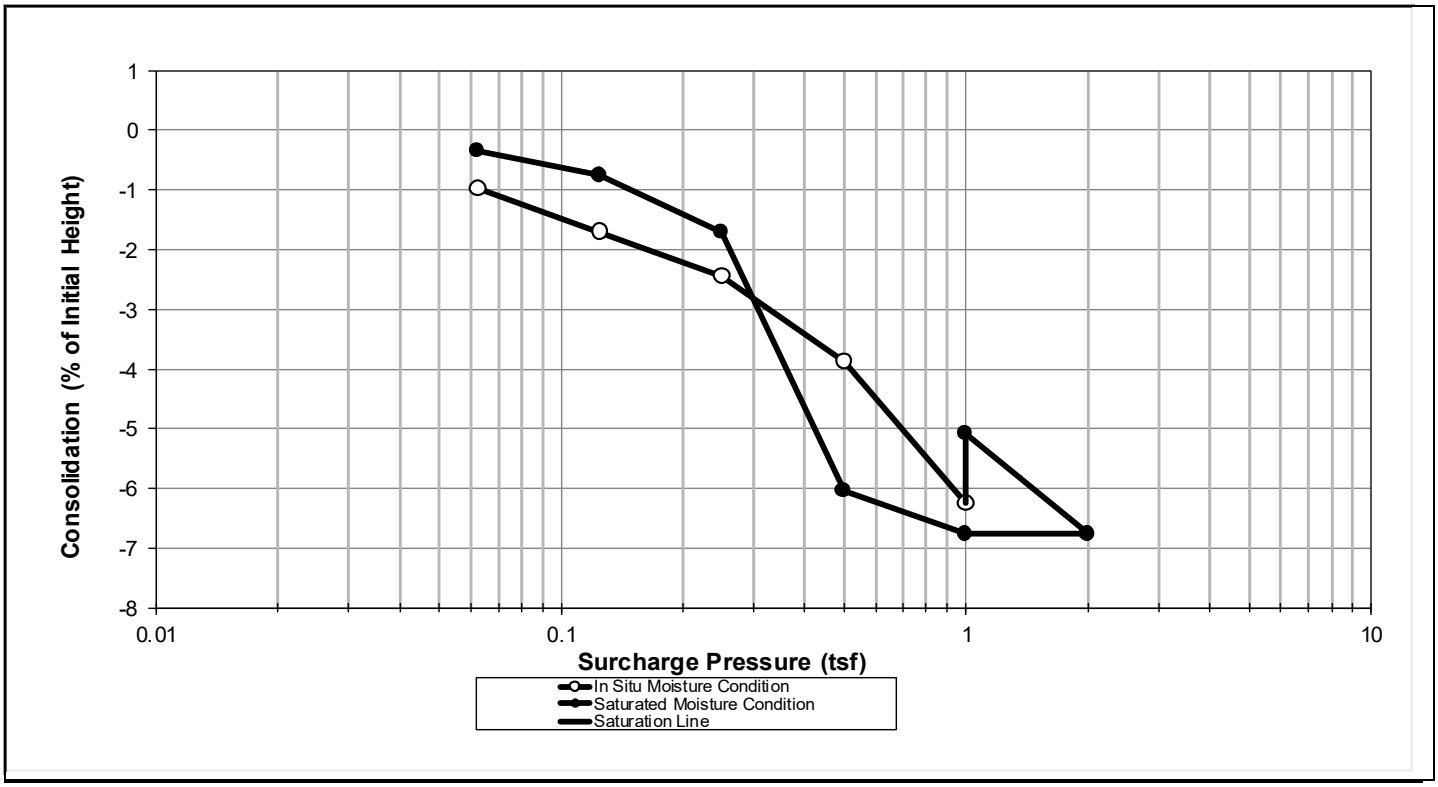
Tel 5058211801

Client:	Navajo Tribal Utility Authority P.O. Box 170 Ft. Defiance, AZ 86504-	**Report Date:**	May 08, 2025
		Project #:	US0036797.3467
		Work Order #:	1
Attn:	Dave Shoultz	**Lab #:**	25-0200-03
Project Name:	NTUA Tsaile	**Sampled By:**	Toni Jim
		Date Sampled:	3/11/2025
	Tsaile, AZ	**Visual Description of Material:**	See Boring Log
		Sample Source:	TS-01 @ 5.0'
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.):**	4.63
Initial Moisture (%):	12.6%	**Final Moisture (%):**	16.9%
Initial Dry Density (pcf):	118.3	**Final Dry Density (pcf):**	117.6
Initial Degree of Saturation:	85%	**Final Degree Saturation:**	111%
Initial Void Ratio:	0.40	**Final Void Ratio:**	0.41
Estimated Specific Gravity:	2.651	**Saturated at:**	1 tsf
Soil Classification:		**Consolidation at Max Load:**	6.76%



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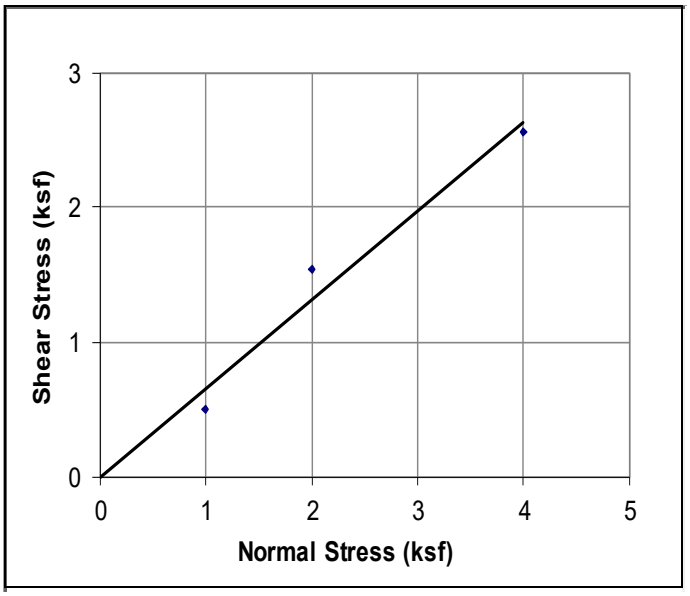
Client:	Navajo Tribal Utility Authority P.O. Box 170 Ft. Defiance, AZ 86504-	**Report Date:**	May 02, 2025
		Project #:	US0036797.3467
		Work Order #:	1
Attn:	Dave Shoultz	**Lab #:**	25-0200-03
Project Name:	NTUA Tsaile	**Sampled By:**	Toni Jim
		Date Sampled:	3/11/2025
	Tsaile, AZ	**Visual Description of Material:**	See Boring Log
		Sample Source:	TS-01 @ 5.0'
Project Manager:	Bardia Tabiatnejad	**SOILS / AGGREGATES**	

Direct Shear Test of Soils Under Consolidated Drained Conditions (ASTM D3080-11)

Direct Shear Point Number:	1	2	3
Initial Diameter of specimen (in.):	2.42	2.42	2.42
Initial Thickness of specimen (in.):	1.00	1.00	1.00
Dry Mass of Specimen (g):	140.3	140.6	140.6
Initial Moisture (%):	14.7%	14.8%	16.1%
Initial Wet Density (pcf):	133.2	133.6	135.2
Initial Dry Density (pcf):	116.2	116.5	116.5
Final Thickness of specimen (in.)::	1.01	1.00	0.98
Final Moisture (%):	17.0%	15.7%	16.6%
Final Wet Density (pcf):	134.8	134.5	139.3
Final Dry Density (pcf):	115.2	116.3	119.4
Normal Stress (ksf):	1.00	2.00	4.00
Maximum Shearing Stress (ksf):	0.508	1.538	2.563
Vertical Deformation @ Max Shear (in.):	0.001	0.001	-0.008
Horizontal Deformation @ Max Shear (in.):	0.090	0.090	0.155



Shearing Device Used:
Humboldt Direct Shear Apparatus, Model HM-5760

Sample Preparation:
Insitu

Rate of Deformation (in./min.): 0.002

Internal Friction Angle (deg.): 33.4

Cohesion (kips/sq.ft.): 0.0000

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Client:	Navajo Tribal Utility Authority P.O. Box 170 Ft. Defiance, AZ 86504-	**Report Date:**	May 15, 2025
		Project #:	US0036797.3467
		Work Order #:	1
Attn:	Dave Shoultz	**Lab #:**	25-0200-01
Project Name:	NTUA Tsaile	**Sampled By:**	Toni Jim
		Date Sampled:	3/11/2025
	Tsaile, AZ	**Visual Description of Material:**	See Boring Log
		Sample Source:	TS-01 @ 0-5.0'
Project Manager:	Bardia Tabiatnejad	**SOILS / AGGREGATES**	

Determining Minimum Laboratory Soil Resistivity (AASHTO T288-16)

Soil Resistivity: 2451 Ωcm

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Client:	Navajo Tribal Utility Authority P.O. Box 170 Ft. Defiance, AZ 86504-	**Report Date:**	May 15, 2025
		Project #:	US0036797.3467
		Work Order #:	1
Attn:	Dave Shoultz	**Lab #:**	25-0200-01
Project Name:	NTUA Tsaile	**Sampled By:**	Toni Jim
		Date Sampled:	3/11/2025
	Tsaile, AZ	**Visual Description of Material:**	See Boring Log
		Sample Source:	TS-01 @ 0-5.0'
Project Manager:	Bardia Tabiatnejad	**SOILS / AGGREGATES**	

pH of Soils (ASTM D4972)

Method Used: A

pH Value Tested In Water: 8.0

Reviewed By:_____

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MOTZZ LABORATORY, INC.

Report: 955651
Reported: 5/21/2025
Received: 5/19/2025
PO: C012800826

Laboratory Analysis Report

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

Project: US0036797.3467

Lab Number	Sample ID	
955651-1	25-0200-01	TS-01 (0-5.0')

Test Parameter

Test	*Method*	*Result*	*Units*
Sulfate	AASHTO T290	166	ppm
Chloride	AASHTO T291	32	ppm