

**GEOTECHNICAL EXPLORATION REPORT – REVISION 1
NORTHERN PARKWAY, 103RD AVENUE TO 91ST AVENUE
MCDOT PROJECT NO. TT0372
MCDOT CONTRACT NO. 2021-016
MARICOPA COUNTY, ARIZONA**

Prepared for:

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Ethos Project No. 2021015
November 6, 2024



November 6, 2024
Ethos Project No.: 2021015

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**SUBJECT: Geotechnical Exploration Report – Revision 1
Northern Parkway, 103rd Avenue to 91st Avenue
MCDOT Project No. TT0372
MCDOT Contract No. 2021-016
Maricopa County, Arizona**

Dear Mr. Barr:

Ethos Engineering, LLC is pleased to present the findings of the geotechnical exploration for the proposed Northern Parkway, 103rd Avenue to 91st Avenue project located in the cities of Glendale and Peoria in Maricopa County, Arizona. Our services were conducted in general accordance with the scope of services presented in the Subconsultant Agreement for Professional Services for Project No. TT0372, dated March 22, 2021, and contract modifications No.1 and No. 2. This report provides the results of our investigation and recommendations for foundation support for proposed retaining walls, roadway pavements, bridge, and drainage facility elements planned for this project.

The project limits for this project have been updated by MCDOT since the initial 60% submittal. The Fiscally Constrained Alternative of Project TT0600 will perform final design and prepare construction documents from the Agua Fria Bridge to 103rd Avenue. This TT0372 project will now encompass the geotechnical investigation results and recommendations for the segment originating from 103rd Avenue, including the New River Bridge, and terminating at 91st Avenue. The original eastern limit extended to 87th Avenue, so we will incorporate the geotechnical investigation results of this portion herein for documentation purposes.

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

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



Reviewed By:

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1.0 PROJECT DESCRIPTION

The Maricopa County Department of Transportation (MCDOT) is currently expanding the existing Northern Parkway to ultimately extend from State Route 303 (SR 303) to Grand Avenue (US 60). T.Y. Lin International, Inc, (TYLin) is the prime consultant in charge of design for this project. This segment of the planned Northern Parkway extends along existing Northern Avenue from 103rd Avenue to 91st Avenue. This project is located in Sections 32, 33, 34 of Township 3 North, Range 1 East and Sections 3, 4, 5 of Township 2 North, Range 1 East in the Cities of Glendale and Peoria, and the Tohono O'Odham Nation within Maricopa County, Arizona. The project includes the SR 101L interchange which is managed by the Arizona Department of Transportation (ADOT) and will require coordination within their right-of-way.

MCDOT Project TT0372 Northern Parkway 99th Avenue to 91st Avenue was initiated to perform final design and prepare construction documents. Due to limited funding availability and rising construction costs, the project team explored a Fiscally Constrained Alternative (FCA) to be implemented with the remaining funds available for the Northern Parkway Program. The FCA will construct roadway improvements from 103rd Avenue to 91st Avenue and aims to improve operations of Northern Avenue within the project area while minimizing impacts and costs. It was developed based on input from the project team and in conjunction with the adjacent MCDOT Project TT0600 Northern Parkway Final Design: Agua Fria Bridge to 103rd Avenue, ADOT Project Number T0188 03D, Federal Aid Number STBGP MMA-0(280)D.

The FCA will include final design and the preparation of construction documents from 103rd Avenue to 91st Avenue. MCDOT Project TT0600 will address improvements between the Agua Fria River and 103rd Avenue.

The Scoping Assessment (Burgess & Niple, Inc., 2019) recommended a 6-lane through section in the eastbound (EB) and westbound (WB) directions to handle an increased traffic volume projected in 2040. This 6-lane through section (3 lanes in each direction) will be constructed between 103rd Avenue and 99th Avenue. There will be 4 lanes in the WB direction from the diverging diamond interchange (DDI) to 91st Avenue and 4 lanes in EB direction from the DDI to 99th Avenue. East of the DDI to 93rd Avenue, there will be 3 EB lanes. The 3rd lane drops at 91st Avenue to match the existing 2 lanes in each direction along Northern Avenue.

The existing State Route 101L (SR 101L)/Northern Avenue traffic interchange (TI) overpass (OP) diamond interchange will be reconstructed as a DDI. The DDI configuration will improve traffic operations and throughput. Other intersection improvements including the addition of turn lanes will occur at 99th Avenue, 91st Avenue, and 89th Avenue.

The DDI will include significant pavement reconstruction within the TIOP limits including shifts in the alignment of the SR 101L on and off ramps. In order to construct the DDI, the slope paving at the abutments of the twin OP structures will be removed and soil nail retaining walls with cast-in-place fascia will be constructed in their place. The EB and WB (B1 and A) walls will vary from about 397 to 412 feet in length and will vary from about 3 feet to 16 feet in height, respectively. It is anticipated these will be soil-nail walls.

An additional portion of Wall A, approximately 475 feet in length, will be required to provide grade separation between southbound (SB) SR 101L and the SB on-ramp (denoted as Ramp A). The height of this wall will vary from 5 to 16 feet in height. We anticipate this wall will be a standard cantilevered structure supported on spread footings.

Geotechnical recommendations for the design and construction of the soil nail walls are submitted under separate cover in a report titled; Permanent Soil Nail Retaining Wall (Ethos 2024). Also submitted under separate cover is the Pavement Design Package which includes the Pavement Design Summary and Materials Design Report (Ethos 2024).

2.0 FIELD EXPLORATION

Ethos submitted a Field Investigation Plan (FIP), dated April 9, 2021, which was reviewed and approved by TYLin, ADOT and MCDOT. The planned boring spacings and depths were generally consistent with MCDOT guidelines, with modifications based on internal review comments provided by the TYLin design team. The FIP was used to obtain environmental clearance.

Upon receipt of environmental clearance and prior to our field exploration, Ethos obtained right-of-way use permits from MCDOT, ADOT, and the Cities of Glendale and Peoria. Ethos staked the boring locations and coordinated clearing of our work areas with Arizona 811. Various traffic control plans were prepared for this work by Roadsafet Traffic Systems, as a subcontractor to Ethos.

Ethos developed and submitted a second FIP for the investigation of the planned soil nail walls at the SR 101L, Northern Avenue TI. Additional borings were included to adequately address wall lengths which exceeded the initial estimates.

Drilling of the exploratory borings was performed by ACS Services, LLC (ACS) and Resilient Drilling Services, LLC (Resilient) from July to November 2022. The fieldwork was supervised by Magdaleno Meza, E.I.T. of Ethos. The subsurface soil conditions at the site were explored by drilling a total of 32 borings: 18 pavement borings (designated as NP-1 through NP-4 and NP-11 through NP-24) to depths ranging from 4 to 6.5 feet; 9 structure (wall) borings (designated as NP-5 through NP-8, NP-10, NP-11, and ADD-1 through ADD-3) to approximate depths ranging from 19 to 50 feet; and 5 bridge borings (designated as NR-1 to NR-5) to depths ranging from 106 to 116 feet.

Test borings NP-10 and NP-11 were drilled as angle borings through the SR 101L high occupancy vehicle (HOV) lane pavement and just beyond the Northern Avenue TIOP abutments. The intent was to locate the borings close to the planned locations of the soil nail walls that will be constructed in front of the abutments and to sample those embankment materials that will encase the nails. Wall borings NP-5 through NP-8 were drilled on approximate 150-foot spacings near the footprint of the planned retaining wall along the SB SR 101L entrance ramp. Borings NP-5, NP-7, and NP-8 encountered auger refusal on very dense gravel and cobble materials at depths ranging from 19 to 32 feet. Borings ADD-1 through ADD-3 were advanced to depths of 40 to 50 feet in the area of planned soil nail walls at the SR 101/Northern Avenue TI. The borings were added to fill in data gaps for the two planned walls. Pavement borings completed along Northern Avenue, the SR 101 ramps, 89th Avenue, and 91st Avenue, and were typically spaced from 500 to 800 feet.

Logs for borings NR-1 to NR-5 from Project TT0600 were added to this report due to the New River Bridge investigation being shifted into Project TT0372. A summary of the field exploration program is provided in Table 2.1. The boring locations are shown on Figures 2 through 6.

Ethos subcontracted ACS to perform double-ring infiltrometer tests and test pits (P-1/TP-1 and P-2/TP-2) at a planned stormwater retention basin located on City of Glendale property about ¼ mile south of Northern Avenue on the west side of 99th Avenue. ACS performed 2 double-ring infiltrometer tests in accordance with ASTM D3385. The tests were performed within backhoe test pits excavated by ACS. The number of tests

completed were in accordance with the current Maricopa County Drainage Design Manual (2018). In-lieu of adjacent test borings, ACS excavated backhoe test pits to depths ranging from 8 to 10 feet. All field work was supervised by Ethos field personnel. Logs of the test pits were prepared by Ethos. The test pit locations are shown on Figure 7.

The borings were drilled using truck-mounted CME 75 drill rigs utilizing hollow-stem auger and downhole percussion hammer (Tubex) drilling methods. During the field exploration, the soils encountered were visually classified, logged, and sampled by our 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, free falling 30 inches. Unless noted otherwise on the boring logs, the sample driving resistance was recorded as the 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 and grout for the bridge borings per ADWR and Flood Control District of Maricopa County (FCDMC) regulations. The logs of the exploratory borings are presented in Appendix A.

Table 2.1 – Field Exploration Program

Location ID	Project Element	Northern Pkwy Cst CL Station	Drill Method	Depth
NR-1	West Abutment	500+00, 65' R	Tubex	116'0"
NR-2	Pier 1	501+00, 24' R	Tubex	106'6"
NR-3	Pier 2	501+80, 40' R	Tubex	106'6"
NR-4	Pier 3	502+90, 30' R	Tubex	106'0"
NR-5	East Abutment	503+80, 32' R	Tubex	106'3"
NP-1	Pavement/Drainage	100+53, 14' R	HSA	4'0"
NP-2	Pavement/Drainage	24+14, 4' R ⁽²⁾	HSA	6'6"
NP-3	Pavement/Drainage	107+03, 19' R	HSA	6'6"
NP-4	Pavement/Drainage	302+68, 3' ⁽³⁾ L	HSA	6'6"
NP-5	Retaining Wall	14+0, 135' R ⁽⁴⁾	HSA	19'2"
NP-6	Retaining Wall	15+00, 102' R ⁽⁴⁾	HSA	35'3"
NP-7	Retaining Wall	17+00, 95' R ⁽⁴⁾	HSA	32'0"
NP-8	Retaining Wall	18+50, 90' R ⁽⁴⁾	HSA	29'1"
NP-9	Pavement/Drainage	35+20, 32' R ⁽⁵⁾	HSA	6'0"
NP-10 ⁽¹⁾	Retaining Wall	207+80, 55' R ⁽⁶⁾	HSA ⁽¹⁾	50'0"
NP-11 ⁽¹⁾	Retaining Wall	309+87, 66' L ⁽³⁾	HSA ⁽¹⁾	50'1"
ADD-1	Retaining Wall	308+90, 65' L ⁽³⁾	HSA	50'0"
ADD-2	Retaining Wall	22+00, 50' R ⁽⁴⁾	HSA	50'0"
ADD-3	Retaining Wall	20+00, 78' R ⁽⁴⁾	HSA	40'10"
NP-12	Pavement/Drainage	26+10, 5' L ⁽⁷⁾	HSA	6'0"
NP-13	Pavement/Drainage	314+40, 29' R ⁽⁶⁾	HSA	6'6"
NP-14	Pavement/Drainage	45+72, 26' L ⁽⁸⁾	HSA	6'6"
NP-15	Pavement/Drainage	133+72, 44' R	HSA	6'6"
NP-16	Pavement/Drainage	140+60, 68' R	HSA	4'0"
NP-17	Pavement/Drainage	149+55, 41' R	HSA	6'0"
NP-18	Pavement/Drainage	155+25, 42' R	HSA	6'6"
NP-19	Pavement/Drainage	19+75, 5' R ⁽⁹⁾	HSA	5'0"
NP-20	Pavement/Drainage	13+30, 19' L ⁽⁹⁾	HSA	6'0"
NP-21	Pavement/Drainage	162+54, 28' R	HSA	6'0"
NP-22	Pavement/Drainage	169+15, 72' R	HSA	6'6"
NP-23	Pavement/Drainage	181+02, 46' R	HSA	5'0"
NP-24	Pavement/Drainage	16+05, 2' L ⁽¹⁰⁾	HSA	6'6"
P-1/TP-1	Retention Basin	16+00, 350' L ⁽²⁾	Backhoe/HSA	8'0"
P-2/TP-2	Retention Basin	16+00, 485' L ⁽²⁾	Backhoe/HSA	10'0"
⁽¹⁾ Drilled as angle boring towards abutment ⁽²⁾ 99 th Avenue Centerline Stationing ⁽³⁾ Northern Parkway DDI EB Stationing ⁽⁴⁾ SR 101L SB On-Ramp Centerline Stationing ⁽⁵⁾ SR 101L SB Off-Ramp Centerline Stationing			⁽⁶⁾ Northern Parkway DDI WB Stationing ⁽⁷⁾ SR 101L NB Off-Ramp Centerline Stationing ⁽⁸⁾ SR 101L NB On-Ramp Centerline Stationing ⁽⁹⁾ 91 st Avenue Centerline Stationing ⁽¹⁰⁾ 89 th Avenue Centerline Stationing	

3.0 LABORATORY TESTING

Selected laboratory tests were assigned by Ethos and performed by ACS and Motzz (corrosion tests) on representative samples recovered from the borings to support our field classification and to provide information regarding engineering characteristics and properties of the subsurface soils. 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
Sieve Analysis (ASTM C136)	Bulk/SPT	37	Soil Classification
Atterberg Limits (ASTM D4318)	Bulk/SPT	35	Soil Classification
Moisture (ASTM D2216)	Bulk/SPT	39	Moisture Conditions
Ring Density (ASTM D2937)	Ring	10	In-Situ Density and Moisture Conditions
Direct Shear (ASTM D3080)	Ring	4	Soil Strength Characteristics
Consolidation Test (ASTM D2435)	Ring	2	Soil Settlement Characteristics
One-dimensional swell (ASTM D4546)	Bulk	9	Soil Expansion Characteristics
Proctor (ASTM D698)	Bulk	9	Pavement Subgrade Support
R-Value (AASHTO T190)	Bulk	4	Pavement Subgrade Support
pH & Resistivity (AZ 236)	Bulk	9	Metal Pipe/Soil Corrosion Potential
Sulfates & Chloride (AZ 733/736)	SPT/Bulk	15	Concrete/Soil Corrosion Potential

Numerous rings were driven in an attempt to collect samples for direct shear and consolidation testing. However, given the generally dense embankment and native granular or sandy materials, several samples were disturbed and were only suitable for ring density and in-situ moisture testing.

4.0 GENERAL SITE CONDITION

4.1 SURFACE CONDITIONS

The planned Northern Parkway, within the project limits, is currently the alignment of Northern Avenue. Northern Avenue is a typically a four-lane divided roadway consisting

of two 12-foot lanes in each direction, a striped median and variable width outside shoulders. The overall terrain is relatively flat, sloping slightly to the west and south.

Development along Northern Avenue consists of mainly undeveloped land west of 99th Avenue which includes the New River, commercial development between 99th Avenue and SR 101L, and also on the north side of Northern Avenue east of SR 101L to 91st Avenue. Single-family homes are located both north and south of Northern Avenue east of 89th Avenue. Farm fields are located on the southwest side of 95th Avenue and along the south side of Northern Avenue from 91st Avenue to 89th Avenue. Desert Diamond Casino is located on the south side of Northern Avenue extending from roughly 95th Avenue to 91st Avenue.

SR 101L crosses the alignment east of 99th Avenue with twin, TIOP bridges and access to and from the freeway is accommodated by diamond TI's and exit and entrance ramps. SR 101L is elevated above Northern Avenue by approximately 25 feet. Northern Avenue, outside of ADOT right-of-way, is paved with asphalt concrete (AC). The SR 101 mainline, ramps and Northern Avenue (crossroad in the vicinity of the OP) are paved with Portland cement concrete pavement (PCCP).

At the New River crossing, Northern Avenue includes an existing 4-span bridge supported on drilled shaft foundations. New River is channelized in the area of the project and includes soil-cement bank protection along each embankment. The river channel is approximately 25 feet below the Northern Avenue pavement surface at New River.

The majority of vegetation consists of landscaped trees and shrubs with some wild grasses and weeds present adjacent to the farm fields. Concrete-lined irrigation ditches border the farm fields along the south of side of Northern Avenue and appear to go into underground pipes where open ditches are not present.

4.2 REGIONAL GEOLOGY

The project site is located in the Basin and Range Geologic Province of the southwestern United States. The Basin and Range Province is characterized by a modern landscape consisting of broad alluvial valleys interspersed with and bounded by uplifted and fault-block mountain ranges, often with well-developed pediments and alluvial fans. Generally, the mountain ranges and valleys trend in a north-south to northwest-southeast direction. The modern landscape was formed by late Tertiary (Miocene-Pliocene) extensional

tectonism and high-angle normal faulting, followed by subsequent erosion of the uplifted mountains and deposition of the sediments in the newly formed basins.

4.3 SITE SUBSURFACE CONDITIONS

4.3.1 East of New River Bridge

Near-surface native soils encountered in the test borings consisted mainly of finer grained, medium plasticity clayey sands (SC), with minor non-plastic to low plasticity silty sands (SM). These soils were typically firm to very firm over much of the project alignment but were soft to very soft adjacent to the farm field west of the SR101L. Similar soils encountered at depth were typically firm to hard. Embankment fill soils consisting of nonplastic silty to sandy gravel (GM/GP-GM) were encountered in wall borings NP-5 to NP-8, NP-10, NP-11 and ADD-1 to depths of about 10 to 25 feet. Similar, though more plastic clayey gravels to clayey sands (GC/SC) and sand with clay (SP-SC) were encountered in Borings ADD-2 and ADD-3 to depths of about 19 to 22 feet. The underlying native soils consisted mainly of firm to hard clayey sand (SC). The fill and native soils were typically weakly to moderately cemented with calcium carbonate (lime), though strongly cemented zones were encountered at depth. Individual boring logs with more detailed descriptions are presented in Appendix A of this report. A geotechnical profile showing USCS soil types and N-values are presented on Figures 11 and 12, respectively.

Groundwater was not encountered to the depths explored. The depth to groundwater, within 1 mile of the project site, based on Arizona Department of Water Resources (2021), is in excess of 160 feet. Groundwater should not impact construction of this project.

4.3.2 New River Bridge

Borings NR-1 through NR-5 were drilled for proposed foundations for the new 4-span eastbound Northern Parkway bridge at New River. Borings NR-1 and NR-5 were advanced from the west and east banks of New River, respectively, at the planned abutment locations. Borings NR-2 through NR-4 were advanced in the New River channel approximately 15 to 20 feet below the top of the adjacent river banks.

Based on the conditions encountered in the borings, the subsurface profile at New River is variable and includes interbedded layers of medium dense to very dense sand and gravel with cobbles and with lesser amounts of firm to hard silt and clay to an approximate

elevation of 1,020 feet. Below an approximate elevation of 1,020 feet, the subsurface conditions generally consist of interbedded layers of firm to hard clayey sand, silt and clay with variable amounts of medium dense sand, and lesser amounts of very dense gravel. The generalized subsurface profile is presented in Table 4.1.

Table 4.1: Generalized Subsurface Profile at the New River Bridge

Stratum	Approximate Stratum Elevation (feet)	USCS Material Types	Relative Firmness / Density
1	Above 1,020	Interbedded layers of Sand (SP) and Gravel (GP) w/ lesser amounts of Silt and Clay (SC-SM, SP-SM, SP-SC, SC and SM)	Generally Firm to Hard and Medium Dense to Very Dense with Isolated Moderately Firm Zones
2	Below 1,020	Interbedded layers of Clayey Sand (SC), Silt (ML) and Clay (CL) w/ Variable amounts of Sand and Lesser Amounts of Gravel	

The sand and gravel soils with low fines content were generally nonplastic to low plasticity, and typically included medium to coarse sand and fine to coarse gravel with occasional cobbles. The finer-grained clayey sand, silty sand, silt and clay soils were generally low to medium plasticity, and typically included fine to medium sand and variable amounts of fine gravel. The finer-grained soils included intermittent weakly to moderately cemented zones.

4.4 PERCOLATION

Test Pits (TP-1 and TP-2), completed at the planned stormwater retention basin site indicate near-surface alluvial soils consisting of silty sand (SM), which overlie silty gravels and sand (GM/SM) or sandy clay (CL) which were encountered at depths of about 3 feet. The double-ring infiltrometer percolation rates varied from 2.2 to 2.3 inches per hour (0.18 cubic feet per hour per square foot (ft³/hr/ft²) to 0.19 ft³/hr/ft²). The percolation rates generally coincide with what would be anticipated within weakly cemented, lenticular clayey (CL) to silty (SM) soils. The results of the ACS report are included in Appendix E. As indicated in the ACS reports, the reported rates have not been de-rated for potential silting.

4.5 SITE SEISMICITY

The project site is located in south-central Arizona which is an area of generally low seismic activity. From Table 3.10.3.1-1 of AASHTO (2012) and the average of N-values

from our test borings typically between 15 and 50 over the length of the borings, the Site Classification is D (stiff soil). In accordance with AASHTO (2018) the project site has the Horizontal Spectral Response Acceleration Coefficients with a 7 percent probability of exceedance in 75 years. The probabilistic horizontal spectral acceleration values for the designated return period and corresponding horizontal peak ground acceleration (PGA) were obtained from the United States Geological Survey (USGS) seismic hazards program website (USGS 2002). The values obtained from the website are based on 2009 AASHTO Guide Specifications for LRFD Seismic Bridge Design and use 2002 USGS seismic hazard data. For structural design, the seismic parameters in Table 4.1 should be used.

Table 4.1: Summary of Seismic Parameters

Parameter	Value	AASHTO Reference
Latitude 33.55152° N, Longitude 112.26667° W		
Site Class Definition	D	Table 3.4.2.1-1
Site Coefficient, F_{PGA}	1.6	Table 3.4.2.3-1
Site Coefficient, F_a	1.6	Table 3.4.2.3-1
Site Coefficient, F_v	2.4	Table 3.4.2.3-2
PGA_M	0.13	
Spectral Acceleration, S_{DS}	0.197 g	Equation 3.4.1-2
Spectral Acceleration, S_{D1}	0.114 g	Equation 3.4.1-3

5.0 ENGINEERING ANALYSES AND RECOMMENDATIONS

5.1 GENERAL

The following sections of this report present our recommendations regarding foundation design for drilled shafts at the New River Bridge, and retaining walls beneath the SR 101L bridges and along the SB SR 101L entrance ramp to accommodate the new DDI configuration. Soil nail walls are anticipated beneath the bridges and a standard cantilever wall is anticipated along SR 101L.

Recommendations for pavement subgrade, site grading for walls and roadway and other elements including construction considerations, moisture protection, excavations and corrosion are included. These recommendations are based on our understanding of the project, the results of our field exploration, laboratory testing for the site and engineering analyses.

5.2 DRILLED SHAFT FOUNDATIONS

The axial compression capacities of the drilled-shaft foundations were determined using ADOT's Geotechnical Design Policy DS-1 memorandum (ADOT, 2010a). The ADOT memorandum outlines the development of drilled-shaft axial resistance charts based on methods specified in AASHTO LRFD Bridge Design Specifications, 5th Edition (AASHTO, 2010). The 6th Edition of the AASHTO LRFD Bridge Design Specifications (AASHTO, 2012) has been published, and was used for this foundation design.

A minimum drilled-shaft diameter of 4 feet is recommended to facilitate construction of the shafts given the coarse-grained soils encountered in the borings. The recommended design criteria presented herein are applicable to drilled, cast-in-place concrete shaft foundations. The drilled-shaft foundations for the project were designed using the Beta method outlined for cohesionless soils based on the subsurface profile at New River.

A summary of the drilled shaft design charts is presented in Table 5.1. The drilled shaft design charts (Figures C-1 through C-11) are presented in Appendix C. Development of strength and service limit charts is further discussed in the following sections.

Table 5.1: Summary of Drilled Shaft Design Charts

Structure	Axial Resistance Design Charts		
	Strength Limit State	Service Limit State	Extreme Limit State
New River Bridge – Piers	C-1	C-2 through C-5	C-11
New River Bridge – Abutments	C-6	C-7 through C-10	C-11

5.2.1 Scour Elevations

Final design scour depths were provided in the Bridge Hydraulic & Scour Report by J2 Engineering and Environmental Design, Inc. (J2) (J2, 2024) and incorporated into this report. Scour depths utilized in the development of drilled shaft axial capacity charts were provided by the hydraulic designer. To determine corresponding design scour elevations, Ethos utilized an estimated thalweg (bottom of river channel) elevation of 1,059.1 feet and determined scour elevations presented in Table 5.2.

Table 5.2: Design Scour Elevations

Substructure Element	Thalweg Elevation (feet)	Limit State	Scour Depth (feet)	Scour Elevation (feet)
Piers	1,059.1	Strength & Service	30.1	1,029
Abutments w/ Scour Protection	---	Strength & Service	0.0	n/a
Abutments and Piers	1,059.1	Extreme	35.1	1,024

5.2.2 Axial Resistance

The axial resistance design charts presented in Appendix C were developed using both tip and side resistance and are applicable for redundant conditions. For non-redundant conditions, the resistance should be reduced by 20 percent. The provided design charts in Appendix C can be used for non-redundant conditions by increasing the applied loads by a factor that is the inverse of the reduction factor, and then entering the charts with the increased loads. A resistance factor of 0.8 (i.e., 80 percent) for non-redundant conditions corresponds to a load factor of 1.25 (i.e., $1/0.8 = 1.25$) or an increase in the load by 25 percent.

Axial resistance above the scour elevation of 1,029 feet was neglected for development of axial resistance. The N values used for development of tip resistance were taken as the average of the value at that depth and the next 10 feet below the tip. The N values were normalized to a 60 percent hammer efficiency and limited to a maximum value of 50 (60 ksf of tip resistance) in accordance with the design procedure.

5.2.2.1 Strength Limit State

Resistance factors used in the determination of the vertical resistance for drilled shafts are a function of the design methodology. The drilled-shaft capacities were calculated using the beta method for side resistance and tip resistance. The corresponding resistance factors for geotechnical resistance of drilled shafts are 0.55 and 0.5 for beta method side and tip resistance, respectively, as presented in Table 10.5.5.2.4-1 of AASHTO (2012). These resistance factors assume redundant foundations as defined in Section 10.5.5.2.4 of AASHTO (2012) and Section 10.5.5.2.4 of the ADOT Bridge Practice Guidelines (2011).

5.2.2.2 Service Limit State

The vertical resistance provided by the soil is a function of the relative movement between the drilled shaft and the surrounding soil. Article 10.8.2.2.2 of AASHTO (2012) and ADOT (2010a) provide relationships for the development of skin friction and tip resistance as a function of settlement normalized to the drilled-shaft diameter for various soil types. The trend line normalized load transfer curves were used in the analyses. The vertical resistances for the drilled shafts at settlements of 0.1, 0.25, 0.5, 0.75, and 1 inch were calculated using these relationships.

5.2.2.3 Extreme Limit State

Scour elevations at the check flood 500-year event were evaluated at the extreme limit state. The corresponding resistance factors for geotechnical resistance of drilled shafts at the extreme limit are 1.0 for both side and tip resistance, as specified in Section 10.5.5.3.2 of AASHTO (2012).

5.2.2.4 Group Effects – Axial

Design criteria for reductions in axial resistance resulting from group effects are presented in Section 10.8.3.6 of the AASHTO (2012) manual. For cohesionless materials, the individual nominal resistance of each shaft in a group should be reduced by a factor, η , presented in Table 10.8.3.6.3-1 of AASHTO (2012) and reproduced in Table 5.3:

Table 5.3: Group Reduction Factors for Drilled Shafts

Shaft Group Configuration	Shaft Center-to-Center Spacing	Special Conditions	Reduction Factor for Group Effects (η)
Single Row	2D	---	0.90
	3D or more	---	1.0
Multiple Row	2.5D	---	0.67
	3D	---	0.80
	4D or more	---	1.0
Single and Multiple Rows	2D or more	Shaft group cap in intimate contact with ground consisting of medium dense or denser soil, and no scour below the shaft cap is anticipated	1.0
Single and Multiple Rows	2D or more	Pressure grouting is used along the shaft sides to restore lateral stress losses caused by shaft installation, and the shaft tip is pressure grouted	1.0

The design charts presented in Appendix C apply to single shafts, and therefore do not include a group reduction factor. For axial capacity reductions due to group effects, the factored loads should be increased by the inverse of the appropriate reduction factor when using the design charts.

For a single row of drilled shafts, the minimum center-to-center spacing should be two diameters, and the appropriate reduction factors determined by linear interpolation for center-to-center spacing between two and three diameters. The reduction factors should be applied equally to all shafts within the group regardless of location within the group.

5.2.3 Lateral Resistance

Lateral soil-structure interaction analyses of single shafts are typically performed by modeling the lateral load-displacement behavior using a finite difference technique based on elastic beam column theory and soil reaction (p)-displacement (y) curves. The p-y curves define the behavior of the soil surrounding the laterally loaded shaft. These curves are nonlinear and are developed using soil strength, depth below ground and shaft diameter amongst other parameters. Many programs are available that use this approach with the most common locally being LPILE. The soil input parameters below are for use in LPILE.

5.2.3.1 LPILE Input Parameters

Recommended soil input parameters for use in LPILE analyses are provided in Table 5.4a and 5.4b for the New River Bridge. The soil input parameters were developed using the LPILE technical manual (Ensoft, 2019) and results of the geotechnical investigation.

Table 5.4a: LPILE Input Parameters – New River Bridge

Stratum	Elevation [feet]	Soil Type in LPILE	Effective Unit Weight [pcf]	Friction Angle [degrees]	Cohesion [psf]	Soil Strain Ratio ϵ_{50}	Horizontal Subgrade Modulus, k [pci]
1a	> 1,060	Sand	120	34	---	---	110
1b	1,060 to 1,020	Sand	58	34	---	---	70
2	< 1,020	Silt	53	32	300	0.007	350

Notes: pcf – pounds per cubic foot; psf – pounds per square foot; pci – pounds per cubic inch.

Table 5.4b: LPILE Input Parameters – New River Bridge (Dry Condition Only)

Stratum	Elevation [feet]	Soil Type in LPILE	Effective Unit Weight [pcf]	Friction Angle [degrees]	Cohesion [psf]	Soil Strain Ratio ϵ_{50}	Horizontal Subgrade Modulus, k [pci]
1	>1,020	Sand	120	34	---	---	110
2	< 1,020	Silt	115	32	300	0.007	410

Notes: pcf – pounds per cubic foot; psf – pounds per square foot; pci – pounds per cubic inch.

Lateral resistance of drilled shafts should be neglected above the design scour elevation. Where embankments in front of drilled shafts slope downward away from the bridge abutment, the lateral soil resistance against drilled shafts should be reduced. It is conservatively recommended that lateral soil pressures (for loading normal to the column line) be neglected within the zone above the catch point (on the slope) of a horizontal line projected outward a distance of three shaft diameters (e.g., a horizontal distance of 12 feet to the catch point on the slope for a 4-foot-diameter shaft) from the front of the shafts.

5.2.3.2 Group Effects – Lateral

The design of laterally loaded drilled shafts must account for the influence from adjacent shafts in a group. Article 10.7.2.4 (AASHTO, 2012) defines a drilled-shaft group with respect to lateral loading as drilled shafts spaced less than five diameters center-to-center (CTC) in the direction parallel and normal to the applied load. When the drilled shafts are in a group, the lateral resistance of the soil is reduced to account for the influence of adjacent drilled shafts by multiplying the p values of the p-y curves by P-multiplier values (P_m). The values of P_m vary as a function of the CTC spacing and the drilled shaft position within the group. The loading direction and spacing are shown on Figure 10.7.2.4.1 from AASHTO (2012). Recommendations for P_m are shown in Table 5.5, based on AASHTO Table 10.7.2.4 1 (AASHTO, 2012) for CTC spacing of 3B and 5B. When determining P-multiplier values for two shafts of different diameters, the larger shaft diameter should be used to calculate the CTC spacing.

Table 5.5: P-Multipliers for Multiple Row Shading

Center-to-Center (CTC) Spacing in the Direction of Loading	P-Multipliers, P_m		
	Row 1	Row 2	Row 3
3B	0.8	0.4	0.3
5B	1.0	0.85	0.7

Notes:

(1) B = drilled shaft diameter.

5.2.4 Drilled Shaft Construction

Variable subsurface conditions were encountered at the New River Bridge location. The conditions include coarse-grained soils with little fines that could cave or slough during excavation, cobble and cemented zones that may require increased effort, and finer-grained soils that may be able to remain open temporarily without support.

Temporary casing and/or slurry may be needed to advance drilled shafts. All construction techniques should be in accordance with Section 609 of the *ADOT Standard Specifications* (ADOT 2021) and the project-specific special provisions. Quality control during the drilled-shaft construction should include those items specifically called out in the ADOT Standard Specifications (ADOT 2021), Section 609. A quality control report should be submitted for each shaft, stating that all details were monitored and meet the project requirements.

Straight, drilled shaft excavations will likely be advanced with single-flight-auger or bucket auger bits to the recommended depth. Cleaning of the drilled-shaft excavations should be performed in accordance with Section 609 of the *ADOT Standard Specifications* (ADOT 2021). It should be verified by inspection and measurement that the excavation is open to that depth. The shaft excavation should be cleaned so no more than 2 inches of slough or loose material is present in the bottom of the excavation.

5.3 FOUNDATION RECOMMENDATIONS

The foundation recommendations provided in this section are based on the AASHTO Load Resistance Factor Design (LRFD), dated 2020. The recommendations presented in this section are based on the six wall borings (NP-5 to NP -8, NP-10, and NP-11).

Our understanding, based on discussions with the design team, is that grade separating retaining walls (abutment walls and SB SR 101L Ramp A wall) will be required. Given the generally dense bearing conditions present within the SR 101 embankments, various wall types including soil nail, standard cantilever and mechanically stabilized earth (MSE) wall options are considered feasible. Included herein, based on direction from the design team, are spread footing design recommendations for the Ramp A wall. It is understood the entirety of the abutment walls will be soil-nail walls given the limited space. Recommendations for soil nail walls will be submitted separately. Based on the field

investigation, box culvert extensions may be designed assuming adequate bearing conditions.

5.3.1 Recommendations for Retaining Wall Spread Footings

5.3.1.1 Bearing Resistance

The strength and service limit state design analyses for spread footings were completed per the methods presented in Sections 10.5 and 10.6, respectively, of AASHTO (2020), and ADOT Geotechnical Design Policy SF-1 (2010b). The following recommendations can be applied to the SR 101 Ramp A wall (Wall B2) assuming the provisions in Section 5.2.2.5 are followed.

The factored net bearing resistance, q_{Rn} , for the strength limit state design was determined using the net nominal bearing resistance (ultimate bearing capacity), q_{nn} , calculated per Section 10.6.3.1.2a and bearing resistance factor, ϕ_b , from Section 10.5.5.2.2 of AASHTO (2020). The parameters presented below in Table 5.6 were assumed for the nominal resistance and strength limit state analyses. The parameters used, particularly the angle of internal friction and cohesion, are considered to be conservative for the soil conditions encountered.

The footing length and depth were assumed based on information provided by the project team. The resulting factored net bearing resistance, q_{Rn} , versus effective footing width, B' , is shown as the “Strength Limit State” line in Appendix D.

Table 5.6
Spread Footing Analysis Parameters Strength Limit State Design for Bearing

Parameter	Symbol	Value - Wall Footings
Soil Angle of Internal Friction	ϕ_f	32 degrees
Soil Total Unit Weight	γ	120 pcf
Cohesion	C	0 psf
Assumed Footing Length	L	60 ft
Footing Bearing Depth	D_f	2.5 to 5 ft
Effective Footing Width	B_f	5 to 15 ft
Bearing Resistance Factor	ϕ_b	0.45

Per the ADOT Geotechnical Design Policy SF-1 (2010b), the modified Schmertmann method presented in Section 8.5 of the Federal Highway Administration (FHWA 2006) Soils and Foundation Reference Manual was used to calculate settlements for the service limit state analysis. The parameters assumed for this analysis are presented in Table 5.7.

Table 5.7
Spread Footing Analysis Parameters Service Limit State Design for Bearing

Parameter	Symbol	Depth Interval (ft) ⁽¹⁾		
		>0 ⁽²⁾	0-10	Below 10
Soil Type	--	Embankment Fill - Sand	Clayey Sand	Clayey Sand
Soil Unit Weight (pcf)	γ	120	100	115
Corrected SPT N-value	N_{60}	12 to 50+	45 to 50+	25 to 50+
Elastic Modulus (ksf)	E_s	$5N_{60}$	$5N_{60}$	$5N_{60}$

(1) Depth of 0 assumed to be original ground.

(2) Applicable to walls (if founded in embankment fill) along SR 101L

The parameters are based on the measured soil densities, distribution of N values and on the E_s -N correlations from FHWA (2006). Appendix D presents the family of service limit state curves developed per ADOT Geotechnical Design Policy SF-1 (2010b) for design settlements of 0.25, 0.5, 0.75, and 1.0 inches and effective footing widths, B_f , ranging from 5 to 15 feet for the Ramp A retaining wall founded on either native soils or existing embankment fill.

5.3.1.2 Sliding

The factored sliding resistance, R_R , for limit state design should be determined using the nominal sliding resistance between soil and foundation, R_τ , and nominal passive resistance, R_{ep} , per Section 10.6.3.4, and corresponding resistance factors, ϕ_τ and ϕ_{ep} , from Section 10.5.5.2.2 of AASHTO LRFD (2012). We recommend the parameters presented in Table 5.8 be used for analyzing sliding resistance.

Passive lateral soil resistance should typically be neglected in the upper 3 feet of finished grade due to the potential for disturbance. Below a depth of 3 feet, the nominal passive resistance can be estimated assuming a hydrostatic pressure distribution of 300 psf per foot.

Table 5.8
Spread Footing Analysis Parameters - Strength Limit State Design for Sliding

Parameter	Symbol	Value
Factored Sliding Resistance		
Resistance Factor for Shear Between Soil and Foundation	ϕ_{τ}	0.90 ⁽¹⁾
Resistance Factor for Passive Resistance	ϕ_{ep}	0.50
Nominal Sliding Resistance		
Soil Angle of Internal Friction	ϕ_f	30 degrees
Soil Total Unit Weight	γ	100 pcf
Cohesion	C	0
Shear Resistance Between Soil and Foundation	δ	30 deg = ϕ_f
Passive Earth Pressure Coefficient	K_p	3.0

⁽¹⁾ Use resistance factor of 0.90 for soil-on-soil interface for the bottom horizontal plane of footing between toe and front of key. For remainder of footing bottom use values provided in AASHTO, 2012 Table 10.5.5.2.2-1.

5.3.1.3 Eccentricity

The eccentricity in the L (long) dimension of an abutment or wall footing is typically negligible, such that $L = L'$. The effective footing length (B') in the B (short) dimension is calculated as $B' = B - 2e_B$, where e_B is the B dimension eccentricity determined by the structural engineer. The maximum allowable eccentricity at the strength limit state should be calculated in accordance with ADOT Geotechnical Design Policy SF-2 (ADOT 2010c).

5.3.1.4 Nominal Lateral Loads Acting on Retaining Walls

Walls retaining soils should be designed for the lateral earth pressure imposed by the soils. The magnitude of the lateral earth pressure is a function of the backfill material, imposed surcharge loads, drainage accommodations and the rigidity of the retaining structure. The recommended lateral earth pressure values presented below assume the backfill will be structure backfill comprised of granular soils which meet the requirements of Section 203 of the current ADOT Standard Specifications. The limits of structure backfill placement are assumed to be the entire limits of excavations for the abutments and abutment wingwalls, and in all cases the structure backfill should extend a minimum of 3 feet laterally from the back edge of all walls.

Walls which are free to deflect a minimum of 0.1 percent of the wall height should be designed for the full active earth pressure condition and an active equivalent fluid unit weight on the order of 35 psf per foot of wall height. Walls which are restrained from lateral movement should be designed for the at rest condition using an equivalent fluid unit weight of 55 psf per foot of wall height. Retaining walls should be designed to drain water and avoid hydrostatic pressures. These recommendations assume a horizontal backfill surface, no surcharge loadings and adequate drainage. Surcharge loads from traffic, sloped backfills, or other sources, will impose additional pressures.

Horizontal loads acting on foundations cast in open excavations against undisturbed native soil or properly placed and compacted fill will be resisted by friction acting along the base of the footing and by passive earth pressures against the loaded side of the footing. If design makes use of passive earth pressure against backfill, it is important that a representative of the geotechnical engineer be present to monitor and test backfill placement and compaction in order to develop passive resistance with low strains.

5.3.1.5 Foundation Subgrade Preparation

It appears that foundation elements for the Ramp A stepped wall will be constructed on a combination of native site soils and roadway embankment. Trash, debris, vegetation (including roots) and other organics, any existing loose fill, any unstable (soft, loose, disturbed, water softened, sedimentation, collapsible, expansive, etc.) soils, and other deleterious materials should be removed from proposed structure foundation areas prior to construction. This site grading should extend laterally a minimum of 2 feet beyond structure areas. All areas of excavation should be observed and approved by the geotechnical engineer after clearing and before any placement of foundations or backfilling operations begin at the site.

Subgrade preparation should be performed as outlined in Section 203 of the current ADOT Standard Specifications. In proposed foundation areas, the ground surface should be prepared to a minimum depth of 6 inches below finished subgrade. Subgrade preparation should consist of scarification of 6 inches, moisture conditioning to within 2 percent of the optimum moisture content, and compaction to a minimum of 95 percent of the maximum ASTM D698 Standard Proctor density.

If soft, loose, disturbed, water softened, low density, collapsible, expansive, or other undesirable materials are encountered in proposed footing areas at the exposed depth of

excavation, the area should be deepened to extend through these undesirable materials. A lean concrete (Controlled Low Strength Material – MAG Section 728, 1-sack slurry mix) may be used to backfill. Alternatively, the deepened area could be backfilled with structure backfill. The extent of removal of unsuitable materials should be as directed by the geotechnical engineer.

5.3.1.6 Structure Backfill

All backfill placed for this project to build the site to final design grades (following foundation excavations) should consist of structure backfill meeting the requirements of Section 203 of the current ADOT Standard Specifications. All structure backfill should be moisture conditioned to within 2 percent of the optimum moisture content and compacted to a minimum of 95 for general embankment and 100 percent (within 50 feet of abutment approach slabs) of maximum ASTM D698 Standard Proctor density. Consideration should be made at the time of construction in terms of compaction equipment to be used and the level of effort, lift thickness etc., for compaction immediately adjacent to walls.

5.4 SOIL NAIL WALLS

Soil nail walls are planned beneath the existing twin SR 101L OP structures at Northern Avenue to accommodate the planned widened footprint of the DDI interchange (as compared to existing Northern Avenue). A portion of the existing concrete slope paving will be removed ahead of each abutment and top-down constructed soil nails will be installed within the existing embankment. The nails placed in front of the existing pile supported stub abutments will be positioned to miss the existing piles. Recommendations for the soil nail walls will be provided in a separate document.

5.5 SLOPES

5.5.1 Permanent Slopes

Non-stabilized embankment fill slopes should be on the order of 3:1 (H:V) or flatter. Flatter slopes will promote re-vegetation and can accept landscaping. Slopes protected with slope paving or rock armored slopes should be no steeper than 2:1 (H:V).

5.5.2 Temporary Slopes

Temporary excavations for construction of footings, utilities, etc. can be made with conventional earthmoving equipment. Temporary slopes should be excavated in accordance with OSHA (1995). In accordance with Subpart P, Appendix A, the embankment 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. The site soils consist of a combination of Type B native clayey sands to sandy clays and Type C native silty sands and sandy gravel fill. The Type B soils, where present may be cut to 1H:1V slopes for depths which do not exceed 20 feet. Given the combined soil types, it is recommended the steeper slopes be verified on-site by the geotechnical engineer. Flatter slopes may be required where either clean, 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.

5.6 PAVEMENTS

The subgrade soils along the Northern Avenue alignment are considered to be of fair quality for pavement support given the fines content and plasticity of some of the tested soils. The summary of subgrade testing is presented in Tables 5.9a to 5.9c.

Based on the evaluation, the following segments have been identified for pavement design purposes:

- Segment 1 – 103rd Avenue
- Segment 2 – 103rd Avenue to New River Bridge
- Segment 3 – East of New River Bridge

Table 5.9a: Results of Subgrade Testing – Segment 1

Boring ID	Sample Depth (feet)	USCS Group Symbol	Percent Fines	Plasticity Index	Correlated R-Value	Tested R-Value
P-7	1.0-5.0	SC-SM	23	9	42	--
P-8	1.5-5.0	SC	20	8	47	57
P-9	2.0-6.0	SM	38	0	70	--
P-10	1.0-5.0	SC	39	14	23	30
P-11	1.0-5.0	SC	41	15	21	--
P-12	1.5-2.5	SC-SM	14	6	59	77
P-13	1.0-5.0	SC	38	15	22	--
P-14	1.0-5.0	SC	36	14	24	38
P-15	1.0-5.0	SC	26	17	22	--
P-16	1.0-5.0	GC	26	21	17	--
Number of Tests					10	4
Average					34.7	50.5
Standard Deviation					18.5	21.0

Table 5.9b: Results of Subgrade Testing – Segment 2

Boring ID	Sample Depth (feet)	USCS Group Symbol	Percent Fines	Plasticity Index	Correlated R-Value	Tested R-Value
P-1	0.0-5.0	SP	4.1	0	70	--
P-2	0.0-5.0	SM	13	0	70	73
P-3	0.0-5.0	SM	20	0	70	--
P-4	0.0-5.0	SM	34	0	70	--
P-5	0.0-5.0	SM	33	0	70	68
P-6	1.0-5.0	SM	13	0	70	--
Number of Tests					6	2
Average					70.0	70.5
Standard Deviation					0.0	3.5

Table 5.9c - Results of Subgrade Testing – Segment 3

Boring ID & Depth (feet)	USCS	%Passing #200 Sieve	Plasticity Index	Correlated R-Value	Tested R-value
NP-1 (0.0-2.5)	SC-SM	44	6	43	--
NP-2 (0.0-2.5)	CL	65	11	26	22
NP-3 (0.0-2.5)	SC	33	8	46	--
NP-4 (0.0-2.5)	SC	33	9	45	--
NP-9 (0.0-2.5)	SC	34	9	44	--
NP-12 (0.0-2.5)	SC-SM	40	7	44	--
NP-13 (0.0-2.5)	SC	26	12	44	35
NP-14 (0.0-2.5)	SC	43	13	34	--
NP-15 (0.0-2.5)	CL-ML	58	7	34	--
NP-17 (0.0-2.5)	SC	45	9	38	--
NP-19 (0.5-2.5)	SC-SM	47	7	40	--
NP-20 (1.0-2.5)	SC	28	10	46	--
NP-21 (1.0-2.5)	GC	25	17	46	26
NP-22 (0.0-2.5)	SC	34	14	36	--
NP-23 (0.5-2.0)	SM	45	3	48	--
NP-24 (0.0-2.5)	CL	52	9	34	32
Average				39.9	28.8
Standard Deviation				6.0	5.9

Based on the results of subgrade testing, the design R-value and corresponding resilient modulus (MR) were calculated utilizing a seasonal variation factor of 1.0. The results are presented in Table 5.10.

Table 5.10: Design R-Value and Resilient Modulus

Segment	Limits	Design R_{mean}	Resilient Modulus (psi)
1	103 rd Avenue	28	16,661
2	103 rd Avenue to New River Bridge	43	26,000
3	East of New River Bridge	30	17,785

5.6.1 Discussion of Alternatives and Recommendations

This section addresses pavements within MCDOT, Glendale, and Peoria right-of-way, including Northern Avenue, 99th Avenue, 91st Avenue and 89th Avenue. Additionally, this section includes turn lanes for collector roadways at 89th Avenue, 93rd Avenue, and 98th Avenue. The pavement sections within ADOT right-of-way are addressed in the Pavement Design Summary & Materials Design Report submitted separately (Ethos 2024). In accordance with the AASHTO method for layered thickness design, and based on the above design parameters, pavement section alternatives for flexible pavements were determined as presented below. As indicated in the MCDOT Roadway Design Manual (2024), structural coefficients of 0.42, 0.42, and 0.12, were utilized for Polymer Modified Terminal blend (PMTR) asphalt concrete (AC), AC, and aggregate base (AB), respectively. The summary of the pavement analyses is included in Table 5.11.

Table 5.11 – Summary of Pavement Analyses

Location	Roadway Type	AC (in)	AB (in)	Total	Required SN
Northern Avenue – Segment 1	Arterial	5	17	22	3.51
Northern Avenue – Segment 2	Arterial	5	12	17	4.11
Northern Avenue – Segment 3	Arterial	6	13	19	4.00
99 th Avenue	Arterial	5	12	17	2.95
98 th Avenue	Collector	4	12	16	2.88
93 rd Avenue	Collector	4	12	16	3.01
91 st Avenue	Arterial	5	12	17	3.52
89 th Avenue	Collector	4	12	16	2.88

Using the MCDOT procedures we calculated the required structural number (SN) for the various roadways. The minimum SN for a Principal Arterial and Collector classification is 2.88. Therefore, the higher required SN was utilized per Chapter 10 of the MCDOT Roadway Design Manual (2024). Additionally, Glendale and Peoria have minimum AC and AB sections of 4" AC over 8" AB (Glendale) or 12" AB (Peoria), and 5" AC over 12" AB for collectors and arterials, respectively. The minimum AC, minimum AB, and SN were utilized to appease the various requirements. The Pavement Design Analyses are included in Appendix F.

The required layered design analysis considers fatigue and indicates that the minimum required thickness of AC is 3.0 inches for the project segments. Three inches of AC represents a pavement structural section equivalent to an SN contribution of 1.26.

Northern Avenue is the major pavement cost for this project and was the only segment evaluated for costs. Three options for AC over AB, AR-AC over AC over AB (Alternate 2), and full-depth AC (Alternate 3) are provided in Table 5.12. Some constraints are in place due to the minimum asphalt concrete thickness obtained from the layered design analysis and minimum lift thickness obtained from Maricopa Association of Governments (MAG) Uniform Standard Specifications and Details for Public Works Construction (2024).

Table 5.12 – Northern Avenue Pavement Section Alternatives

Segment	Northern Avenue, 103 rd Avenue to 91st Avenue Alternate Lift Thickness		
	1	2	3
Alternate No.	1	2	3
Asphalt Concrete (½" mix) Superpave – High Traffic	3.0"	2.0" PMTR AC	2.0" PMTR AC
Asphalt Concrete (¾" mix) Superpave – High Traffic	3.0"	4.0"	3.5" lift & 4.0" lift
Aggregate Base Course	13" AB	13" AB	--
Design Subgrade M_R, psi	17,875		
Design Section Structural Number	4.08	4.16	4.07
Minimum Structural No.	4.00	4.00	4.00

For locations within MCDOT right of way, the AC, AB and PMTR AC should be constructed and placed as outlined the MAG Standard Specifications (MAG 2024). The AC should be constructed and placed as outlined in Section 321 and 710, the AB constructed and placed as outlined in Sections 310 and 702, and the PMTR AC constructed and placed as outlined in Sections 326 and 719.

The 20-year pavement design life is based on the premise that the materials are properly designed and constructed, and that normal maintenance of the pavement will be performed. This may include crack sealing, slurry sealing, chip sealing, minor repairs and patching as deemed necessary by a pavement management plan.

The cost comparison may indicate otherwise, but for the project segment, we recommend selection of the alternative consisting of AC over AB which matches the existing AC pavement thickness.

5.6.2 Opinion of Costs

Provided in the tables below are cost assessments presented in a cost per lane-mile format for the three alternate pavement sections provided previously for Northern Avenue. It should be noted this is an estimate only, certain assumptions were made, and this estimate should not be used other than for cost comparison between the alternative pavement section designs provided. The unit costs for asphalt rubber, asphalt concrete, and aggregate base were obtained from TYLin/MCDOT and cost comparison of recent projects. Actual unit costs may vary depending on supplier, time of year, and other factors.

Table 5.13 – Northern Avenue Estimate of Unit Costs

Alternate 1 – AC over AB over Native Subgrade				
Pavement Construction Item	Unit	Quantity	Unit Price	Cost per lane-mile
321.01300 Asphalt Concrete Pavement (Superpave 1/2" Mix, High Traffic), 3" depth @ 145 pcf	ton	1,436	\$130.00	\$186,680.00
321.01300 Asphalt Concrete Pavement (Superpave 3/4" Mix, High Traffic), 3" depth @ 145 pcf	ton	1,436	\$130.00	\$186,680.00
329.01000 Bituminous Tack Coat SS-1h, Diluted @ (0.07 gal/sy)	ton	3	\$1,500.00	\$4,500.00
310.03000 Aggregate Base Course, 13" @ 135 pcf	cy	3,178	\$58.00	\$184,324.00
Total Cost per lane-mile				\$562,184.00

Alternate 2 – PMTR AC over AC over AB over Native Subgrade				
Pavement Construction Item	Unit	Quantity	Unit Price	Cost per lane-mile
325.02202 PMTR AC Pavement (Superpave 1/2 in High Traffic), 2.0" @ 142 pcf	ton	938	\$140.00	\$131,320.00
321.01300 Asphalt Concrete Pavement (Superpave 3/4" Mix, High Traffic), 4" depth @ 145 pcf	ton	1,914	\$130.00	\$248,820.00
329.01000 Bituminous Tack Coat SS-1h, Diluted @ (0.07 gal/sy)	ton	3	\$1,500.00	\$4,500.00
310.03000 Aggregate Base Course, 13" @ 135 pcf	cy	3,178	\$58.00	\$184,324.00
Total Cost per lane-mile				\$568,964.00

Alternate 3 – Full-Depth AC over Native Subgrade				
Pavement Construction Item	Unit	Quantity	Unit Price	Cost per lane-mile
325.02202 PMTR AC Pavement (Superpave 1/2 in High Traffic), 2.0" @ 142 pcf	ton	938	\$140.00	\$131,320.00
321.01300 Asphalt Concrete Pavement (Superpave 3/4" Mix, High Traffic), 7.5" depth @ 145 pcf	ton	3,589	\$130.00	\$466,570.00
329.01000 Bituminous Tack Coat SS-1h, Diluted @ (0.07 gal/sy)	ton	6	\$1,500.00	\$9,000.00
Total Cost per lane-mile				\$606,890.00

Items required for pavement construction which have not been included herein should be considered prior to final selection of an alternative. The construction items and unit rates presented in the opinion of cost table above represent estimated unit costs as determined from an average of the unit costs in Chapter 10 of the MCDOT Roadway Design Manual (2024).

If any of the work items are incomplete or the associated unit rates are not accurate, we should be notified immediately so that appropriate changes can be made prior to final design.

Based on the opinion of cost analysis above which does not consider the associated pavement management/life-cycle costs or the cost of changing the alignment grade, Alternative 1 – AC over AB represents the most economical alternative for construction of the proposed improvements.

5.6.3 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 native site surface soils on the median to a depth of approximately 5 feet are estimated to have shrinkage on the order of 5 percent. Ground compaction due to site preparation outside the limits of existing roadway prisms is estimated at 0.1 feet within the project limits.

These estimates are general in nature and are based on guidance provided by the ADOT Geotechnical Project Development Manual (ADOT 2024), limited data from our field explorations, and the soil conditions we encountered at the site. Earthwork factors may vary depending upon actual subsurface conditions, which may include variations in soil gradations and gravel contents. The earthwork shrinkage values are expected to be different for areas where compaction requirements are either greater or less than 95 percent of ASTM D698.

5.6.4 Site Grading for Embankments and Pavement

The following site grading recommendations are intended to provide support for the proposed Northern Parkway 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 current 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.

Within all pavement areas, we recommend the existing site soils that will be within 3 feet of base of the pavement section and that do not meet the minimum correlated R-value of

30, be overexcavated and replaced with soils which meet or exceed the design R-value of 30. An acceptable alternative, given the spotty, marginally low R-values, would be the use of geogrid placed at the base of the pavement section. In accordance with past ADOT practice, this would effectively increase the R-value by 10, given any existing soil with a correlated R-value of 30 or more a modified subgrade R-value of at least 20.

We recommend that the soft soils which were encountered in borings adjacent to the farm fields located south of Northern Avenue between New River and SR 101 be overexcavated a minimum of 2.0 feet below existing site grade. The exposed surface should be proof rolled, as recommended below. Proof rolling should be accomplished with a filled 4,000-gallon water truck and observed by the geotechnical engineer. The water truck should make a sufficient number of passes to verify all subgrade, as directed by the engineer. If any soft or pumping subgrade is observed, mitigation options should be developed by the geotechnical engineer. Options could include additional overexcavation, the use geogrid, or lime stabilization. The limits of overexcavation should include all new pavement areas south of existing roadway centerline and extend 2 feet beyond the edge of pavement, at a minimum.

An alternative to overexcavation to a depth of 2.0 feet with proof rolling would be to overexcavate to a depth of 1.0 foot (or to the bottom of the planned pavement section whichever is deeper) and modify the exposed surface with a 9-inch-thick lift of lime or a layer of geogrid. Further recommendations for these options can be provided upon request.

5.7 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.

5.8 PRELIMINARY SOIL CORROSION CHARACTERISTICS

5.8.1 Metal Pipes

Nine samples (pH) and (resistivity) from the current investigation were used to evaluate the corrosion potential on corrugated metal pipe. The corrosion potential for the site was

characterized using laboratory pH and electrical resistivity testing, performed in accordance with Arizona Test Method 236. Results of the corrosion potential testing are summarized in Table B-1.

The laboratory pH values ranged from 8.0 to 8.8 with an average of 8.3 with a standard deviation of 0.3. The resistivity values ranged from 450 to 3,114 ohm-centimeters (ohm-cm) with an average value of 1,658 ohm-cm and a standard deviation of 795 ohm-cm. Pipe locations where the pH is 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. Six of the samples tested had resistivity values less than 2,000 ohm-cm. Therefore, specialized piping or other corrosion mitigation measures such as corrosion monitoring may be necessary for metallic pipes.

5.8.2 Concrete Structures

A total of fifteen samples from the current investigation were 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.

Total soluble sulfate values ranged from 3 to 29 parts per million (ppm) with an average of 9 and standard deviation of 8 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 318-19, 2014). All of the samples fall within Exposure Class S0 for water-soluble sulfate (SO_4^{2-}) in soil by percent mass ($\text{SO}_4 < 0.1\%$ or 1,000 ppm) with values less than 29 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 of ACI 318-19, there is no restriction on Portland cement type for concrete structures in contact with these materials.

Chloride test results at fourteen locations for soils encountered during the current investigation had values ranging from less than 3 to 464 ppm with an average of 89 and standard deviation of 143 ppm. Regarding chloride attack, Section 19.3.2 of ACI 318-19/318R-19 (2014) 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 of ACI 318-19/318R-19. The anticipated concrete

exposure for this segment falls within Exposure Class C1. Table 19.3.2.1 of ACI 318-19/318R-19 should be referenced for requirements for concrete by exposure class. 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. 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.

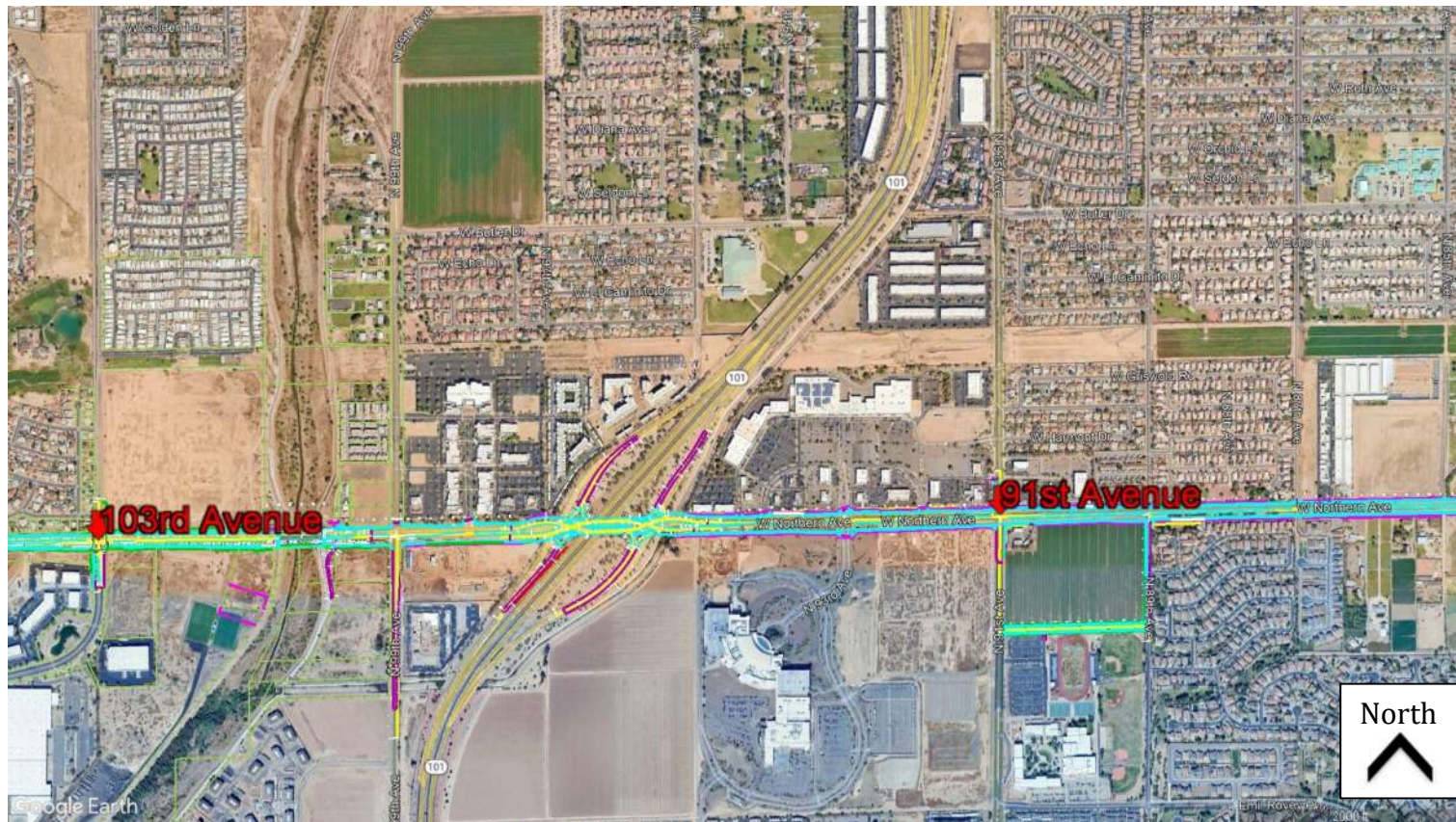
7.0 REFERENCES

- American Association of State Highway and Transportation Officials (AASHTO), 2012, AASHTO LRFD Bridge Design Specifications, 6th Edition, Washington, D.C.
- 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). 2011, As-built Drawings, State Highway SR 303L, Lake Pleasant Parkway to I-17, Project No. 303 MA 130 H715701C, Federal Aid No. 303-A(200)A, September 12, Maricopa County, AZ.
- Arizona Department of Transportation (ADOT). 2017, Pavement Design Manual, Roadway Engineering Group, Pavement Design Section, September 29, 2017, Phoenix, AZ.
- Arizona Department of Transportation (ADOT). 2024, Geotechnical Project Development Manual, Bridge Group, Geotechnical Services Section, March 2024, Phoenix, AZ.
- Arizona Department of Transportation (ADOT), DS-1 (2010a), Development of Drilled Shaft Axial Resistance Charts for Use by Bridge Engineers Based on Load and Resistance Factor Design (LRFD) Methodology, December 1, Phoenix, AZ.
- Arizona Department of Transportation (ADOT). SF-1 (2010b), Development of Factored Bearing Resistance Chart by a Geotechnical Engineer for Use by a Bridge Engineer to Size Spread Footings on Soils for Service and Strength Limit States Based on Load and Resistance Factor Design (LRFD) Methodology, December 1, 2010, Phoenix, AZ.
- Arizona Department of Transportation (ADOT). SF-2 (2010c). Limiting Eccentricity Criteria for Spread Footings Based on Load and Resistance Factor Design (LRFD) Methodology, December 1, 2010, Phoenix, AZ.
- Arizona Department of Transportation (ADOT). 2021. 2021 Standard Specifications for Road and Bridge Construction, Phoenix, AZ.
- J2 Engineering and Environmental Design, Inc. 2024. Northern Avenue Bridge a New River, Bridge Hydraulic & Scour Report. J2 Project 21.1470, November 2024.
- Burgess & Niple, Inc. 2019. Northern Parkway: Loop 101 to Grand Avenue Scoping Assessment, Scoping and Design Report. September 2019 and Revised December 2019.
- Federal Highway Administration (FHWA), 2006, Soils and Foundation Reference Manual.
- Maricopa Association of Governments (MAG), 2024, 2024 Revision to the 2020 Edition, Uniform Standard Specifications for Public Works Construction. January.
- Maricopa County Department of Transportation (MCDOT), 2024, Roadway Design Manual. March 27.
- United States Geological Survey (USGS). 2002. Seismic Design Parameters, Version 2.10.

7.0 REFERENCES

- American Association of State Highway and Transportation Officials (AASHTO), 2012, AASHTO LRFD Bridge Design Specifications, 6th Edition, Washington, D.C.
- 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). 2011, As-built Drawings, State Highway SR 303L, Lake Pleasant Parkway to I-17, Project No. 303 MA 130 H715701C, Federal Aid No. 303-A(200)A, September 12, Maricopa County, AZ.
- Arizona Department of Transportation (ADOT). 2017, Pavement Design Manual, Roadway Engineering Group, Pavement Design Section, September 29, 2017, Phoenix, AZ.
- Arizona Department of Transportation (ADOT). 2024, Geotechnical Project Development Manual, Bridge Group, Geotechnical Services Section, March 2024, Phoenix, AZ.
- Arizona Department of Transportation (ADOT), DS-1 (2010a), Development of Drilled Shaft Axial Resistance Charts for Use by Bridge Engineers Based on Load and Resistance Factor Design (LRFD) Methodology, December 1, Phoenix, AZ.
- Arizona Department of Transportation (ADOT). SF-1 (2010b), Development of Factored Bearing Resistance Chart by a Geotechnical Engineer for Use by a Bridge Engineer to Size Spread Footings on Soils for Service and Strength Limit States Based on Load and Resistance Factor Design (LRFD) Methodology, December 1, 2010, Phoenix, AZ.
- Arizona Department of Transportation (ADOT). SF-2 (2010c). Limiting Eccentricity Criteria for Spread Footings Based on Load and Resistance Factor Design (LRFD) Methodology, December 1, 2010, Phoenix, AZ.
- Arizona Department of Transportation (ADOT). 2021. 2021 Standard Specifications for Road and Bridge Construction, Phoenix, AZ.
- J2 Engineering and Environmental Design, Inc. 2024. Northern Avenue Bridge a New River, Bridge Hydraulic & Scour Report. J2 Project 21.1470, November 2024.
- Burgess & Niple, Inc. 2019. Northern Parkway: Loop 101 to Grand Avenue Scoping Assessment, Scoping and Design Report. September 2019 and Revised December 2019.
- Federal Highway Administration (FHWA), 2006, Soils and Foundation Reference Manual.
- Maricopa Association of Governments (MAG), 2024, 2024 Revision to the 2020 Edition, Uniform Standard Specifications for Public Works Construction. January.
- Maricopa County Department of Transportation (MCDOT), 2024, Roadway Design Manual. March 27.
- United States Geological Survey (USGS). 2002. Seismic Design Parameters, Version 2.10.

FIGURES



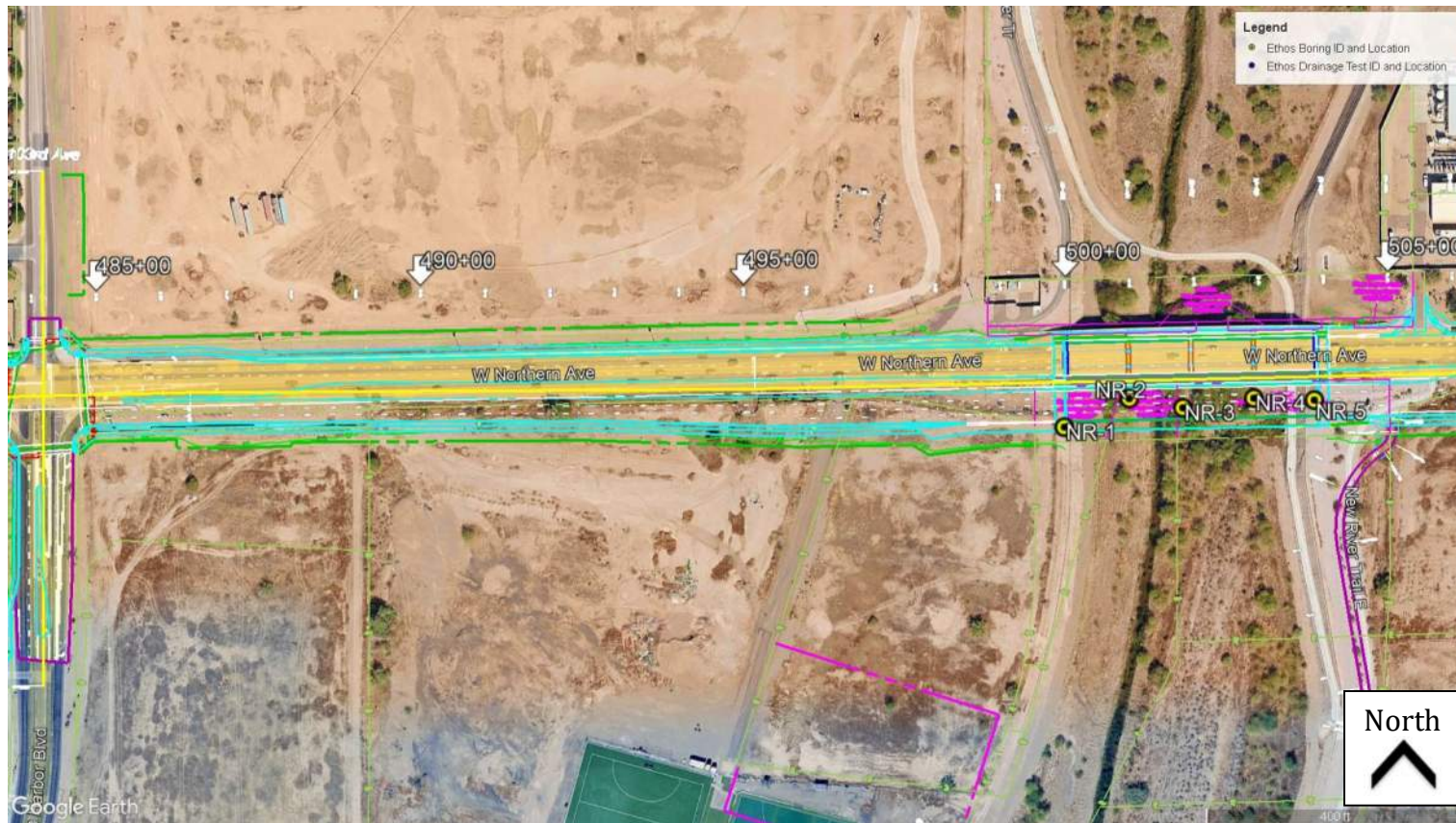
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Figure 1

Vicinity Map Showing Project Location

MCDOT Northern Parkway (TT0372); 103rd Avenue to 91st Avenue

Maricopa County, Arizona



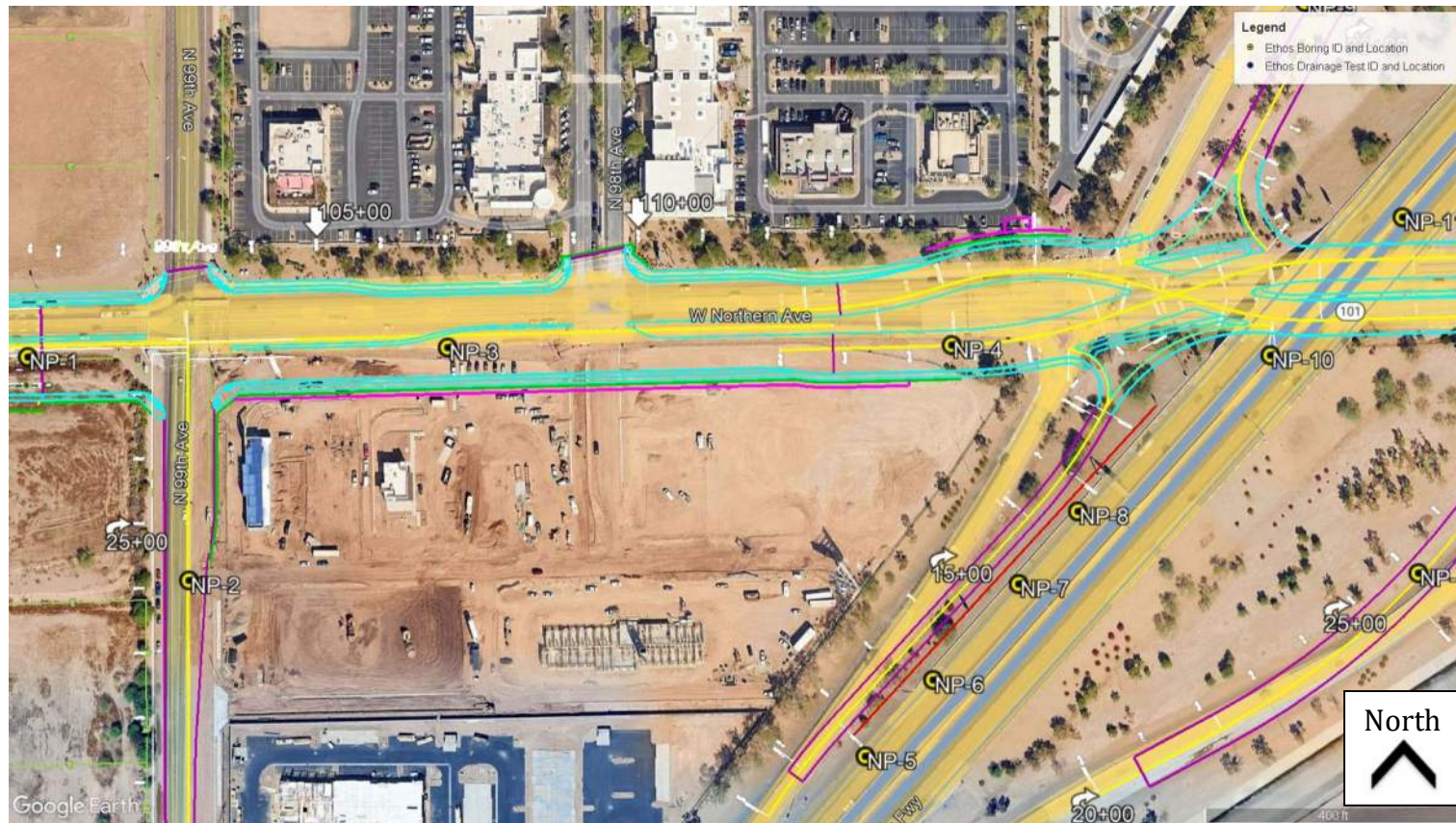
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Figure 2

Site Map Showing Test Locations

MCDOT Northern Parkway (TT0372); 103rd Avenue to 91st Avenue

Maricopa County, Arizona



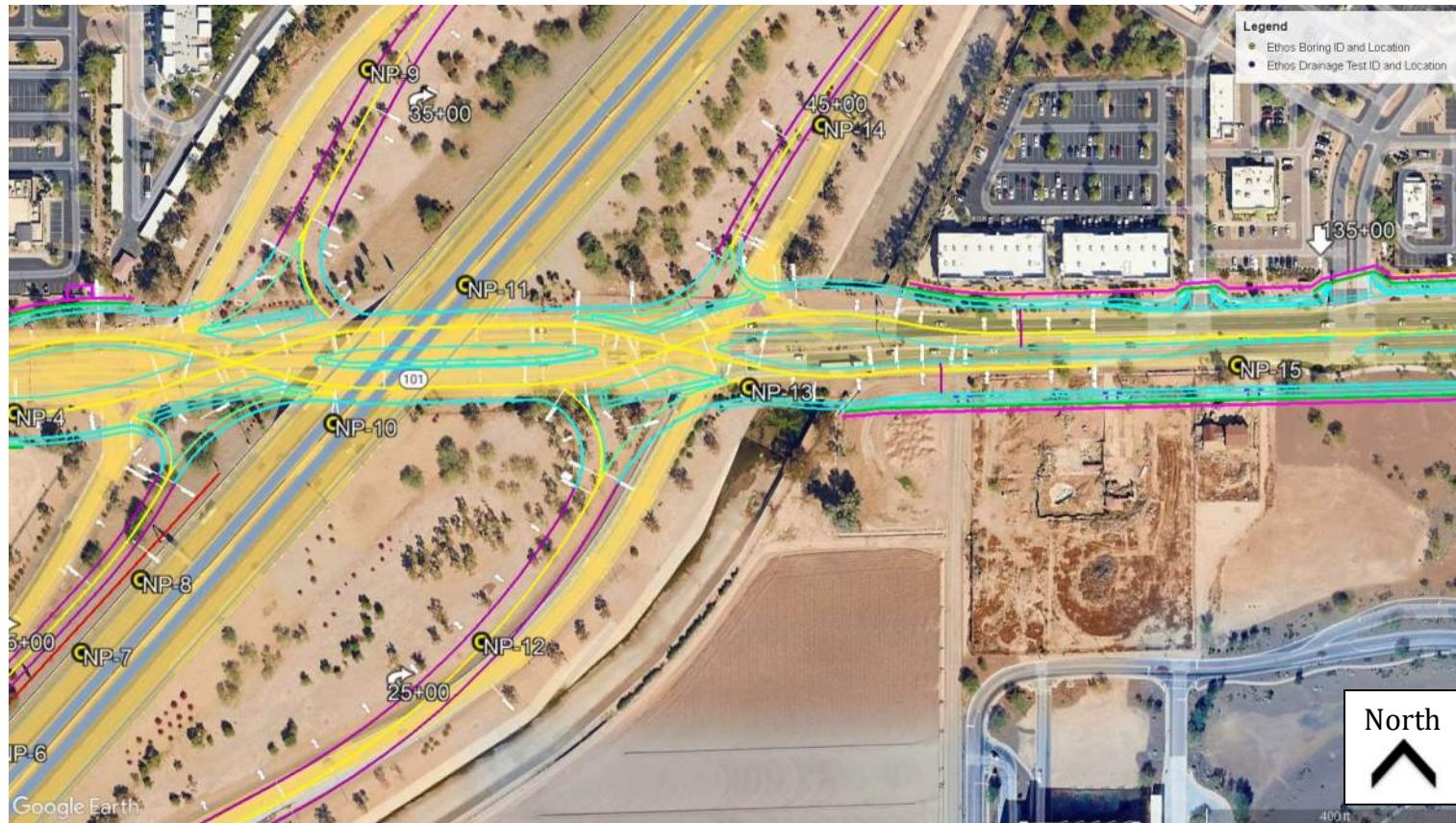
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Figure 3

Site Map Showing Test Locations

MCDOT Northern Parkway (TT0372); 103rd Avenue to 91st Avenue

Maricopa County, Arizona



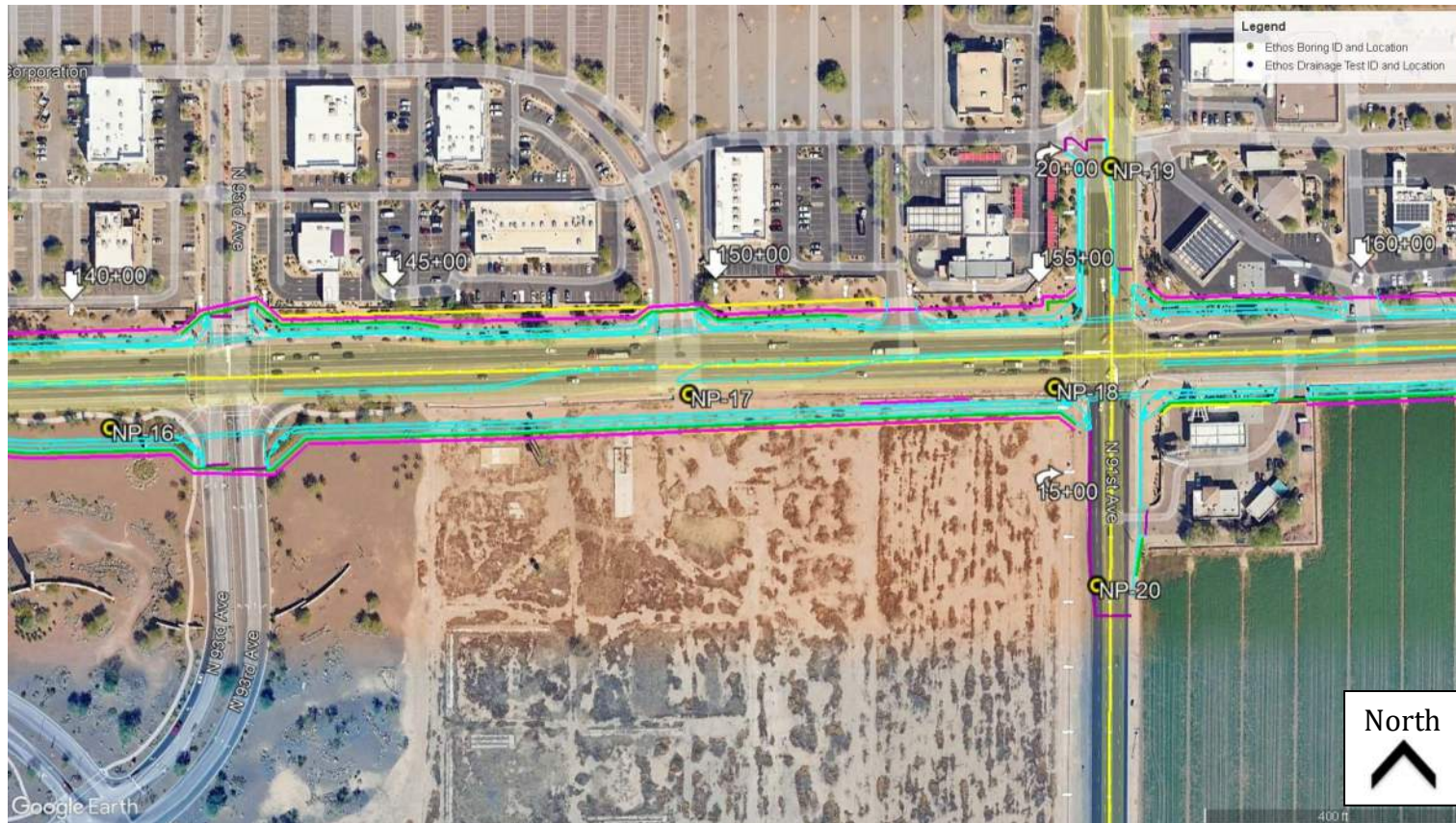
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Figure 4

Site Map Showing Test Locations

MCDOT Northern Parkway (TT0372); 103rd Avenue to 91st Avenue

Maricopa County, Arizona



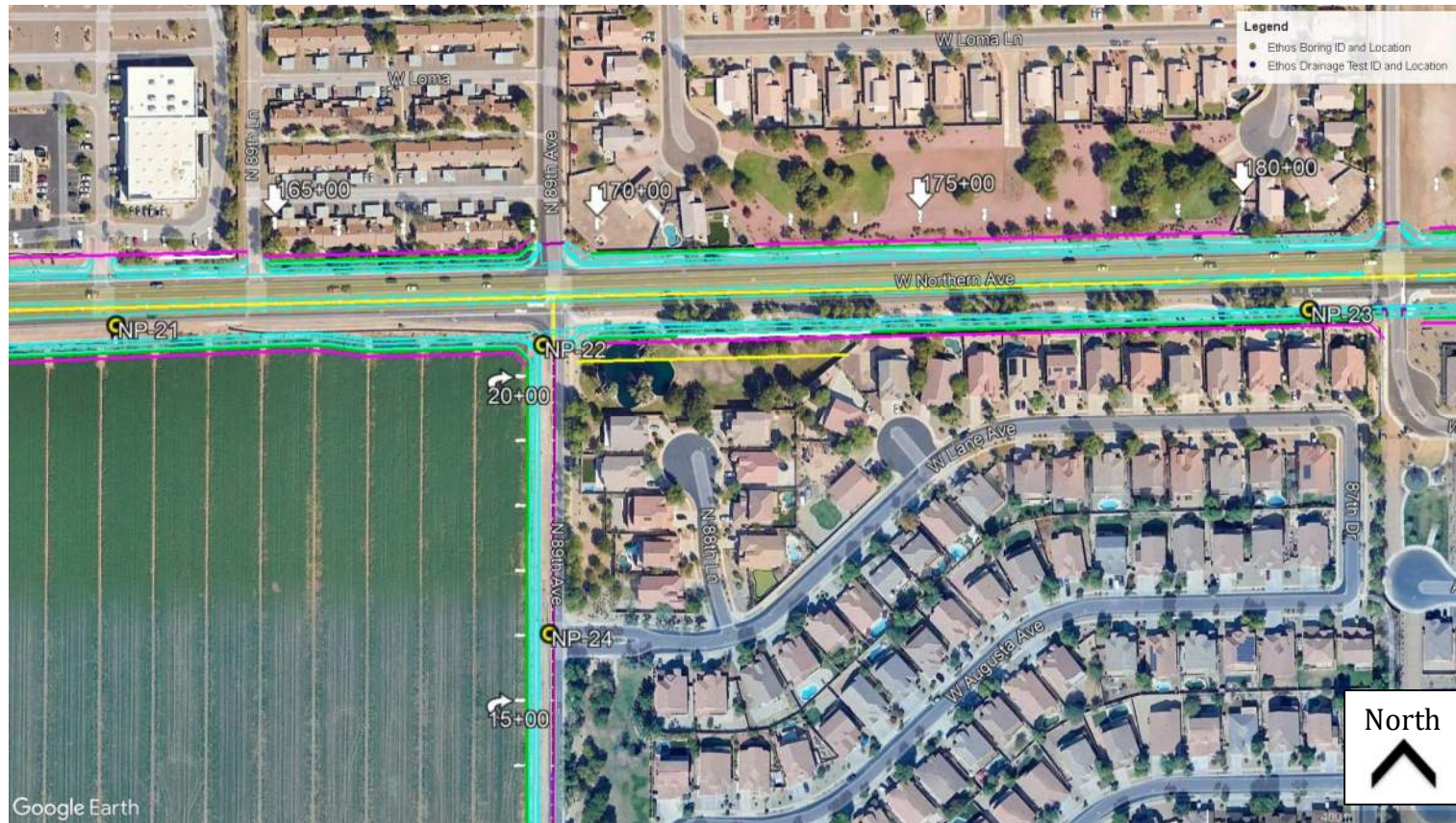
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Figure 5

Site Map Showing Test Locations

MCDOT Northern Parkway (TT0372); 103rd Avenue to 91st Avenue

Maricopa County, Arizona



Source: lat 33.55127°, lon -112.24950°. Google Earth 09/26/2023 Imagery. Accessed on 8/27/2024.

Figure 6

Site Map Showing Test Locations

MCDOT Northern Parkway (TT0372); 103rd Avenue to 91st Avenue

Maricopa County, Arizona



Source: lat 33.54831°, lon -112.27350°. Google Earth 09/26/2023 Imagery. Accessed on 8/27/2024.

Figure 7

Site Map Showing Test Locations

MCDOT Northern Parkway (TT0372); 103rd Avenue to 91st Avenue

Maricopa County, Arizona

GENERAL LITHOLOGIC PROFILE ALONG NORTHERN PARKWAY FROM WEST TO EAST

GENERAL LITHOLOGIC PROFILE ALONG NORTHERN PARKWAY FROM WEST TO EAST

- = CH, MH, CL/CH, SC/CH
= CL, ML, ML/CL, SM/ML
= SC, SM, SC/SM, SP/SC, SC/CL
= GC, GC/SC, GC/GM,
= SP, SW, SP/SM, SW/SM
= GP, GP/GM, GM, SP/GP, SW/GW

[illegible][illegible]

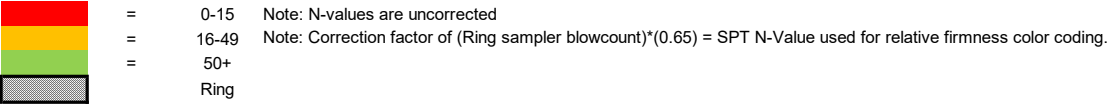
Fill

Native

FIGURE 9 N-VALUE SITE PROFILE

N-VALUE VS. DEPTH PROFILE ALONG NORTHERN PARKWAY FROM WEST TO EAST & ALONG SR 101 RAMP A WALL

LEGEND



LOOKING NORTH ALONG NORTHERN AVENUE

[illegible]

LOOKING WEST ALONG SR 101 RAMP A WALL

[illegible]

Fill
Native

APPENDIX A

Boring and Test Pit 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

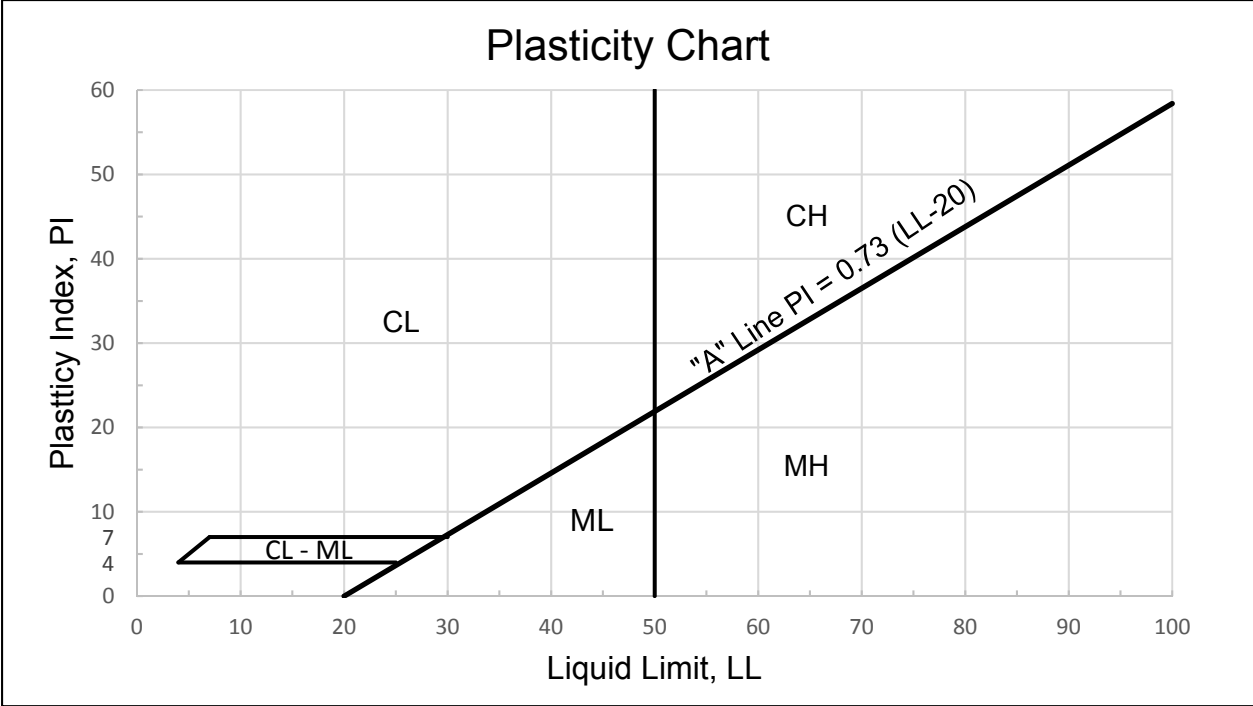
Relative Firmness for cohesive and/or cemented soils including silts, clays and silty to clayey sandy and gravelly soils is described based on the following SPT blowcounts:

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 in.)
Coarse Gravel	75 mm to 19 mm (3 in. to ¾ in.)
Fine Gravel	19 mm (¾ 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
$1 \leq PI \leq 7$	Low
$8 \leq PI \leq 25$	Medium
$PI \geq 25$	High

Moisture
Slightly Moist
Moist
Wet
(Saturated)

ROCK SAMPLING & BORING LOG INFORMATION

Borings are advanced in rock and rock-like materials using one of, or combinations of, various drilling methods, including wireline coring, pneumatic percussion, mud-rotary, or rock-bit. Typically, borings are advanced through unconsolidated overburden materials using hollow-stem auger, pneumatic percussion with casing, or mud-rotary with casing methods until competent rock is reached. The underlying rock is then usually cored using wireline methods with the upper casing sections left in-place to maintain the borehole until completion. Core may be recovered in N- or H-sizes, usually in a triple-tube core barrel with a split inner liner. N-series core has an approximate O.D. of 1.8 inches and H-series core has an approximate O.D. of 2.4 inches. The recovered core is logged and then placed into waxed cardboard boxes for future inspection, shipping, and storage.

The classifications and material descriptions of rocks presented on the boring logs are based on visual observation and classification in general accordance with widely used and accepted systems and formats. The classifications and names of rock types presented on the boring logs are given in general accordance with the field classification system adopted by the United States Bureau of Reclamation (USBR, as modified from R. B. Travis, 1955). The classifications are intended to provide general lithologic classification to the rock materials encountered and are not based on any detailed petrographic or mineralogical analyses. The descriptive rock information presented on the boring logs is in general accordance with the standards given in the Guidelines for Geotechnical Investigation and Geotechnical Report Presentation (ADOT, 1991), and supplemented as warranted by descriptive criteria presented in the Engineering Geology Field Manual (Second Edition, Volume I, USBR, 1998). Abbreviations of full descriptive terms may be shown on the boring logs and are parenthesized within the full descriptions given below. The percent core recovery, Rock Quality Designation (RQD), and percent fluid recovery are continuously logged during drilling. Selected samples from the recovered core may be submitted for laboratory testing, including unconfined compressive strength, triaxial compression, and direct shear, among others. The field logs are modified, where appropriate, based on further inspection of recovered core and/or laboratory testing of selected samples.

Degree of Rock Weathering

The degree of weathering of the rock mass is described based on the following criteria:

Designation	Field Identification
Fresh (F)	Crystals are bright. Discontinuities may show some minor surface staining. No discoloration in rock fabric.
Slightly Weathered (SW)	Rock mass is generally fresh. Discontinuities are stained and may contain clay. Some discoloration in rock fabric. Decomposition extends up to 1 inch into rock.
Moderately Weathered (MW)	Rock mass is decomposed 50% or less. Significant portions of rock show discoloration and weathering effects. Crystals are dull and show visible chemical alteration. Discontinuities are stained and may contain secondary mineral deposits.
Highly Weathered (HW)	Rock mass is more than 50% decomposed. Rock can be excavated with geologist's pick. All discontinuities exhibit secondary mineralization. Complete discoloration of rock fabric. Surface of core is friable and usually pitted due to washing out of highly altered minerals by drilling water.
Decomposed (Dec)	Rock mass is completely decomposed. Original rock "fabric" may be evident. May be reduced to a soil with hand pressure.

Note: The designations and diagnostic characteristics listed above are most applicable to crystalline rocks with feldspars and ferromagnesian minerals. Weathering in some other rock types, particularly young and/or poorly indurated sedimentary units, may not entirely conform to the above designations and criteria.

Scale of Relative Rock Hardness

Relative rock hardness and strength of intact rock is described based on the following criteria:

Designation	Field Identification
Extremely Soft (ES)	Can be indented with difficulty by thumbnail. May be moldable or friable with finger pressure.
Very Soft (VS)	Crumbles under firm blows with point of a geology pick. Can be peeled by a pocketknife. Scratched with fingernail.
Soft (S)	Can be peeled by a pocketknife with difficulty. Cannot be scratched with fingernail. Shallow indentation made by firm blow of geology pick.
Medium Hard (MH)	Can be scratched by knife or pick. Specimen can be fractured with a single firm blow of hammer/geology pick.
Hard (H)	Can be scratched with knife or pick only with difficulty. Several hard hammer blows required to fracture specimen.
Very Hard (VH)	Cannot be scratched by knife or sharp pick. Specimen requires many blows of hammer to fracture or chip. Hammer rebounds after impact.

Discontinuity Spacing Terms

The spacing of natural discontinuities in rock masses, including fractures, joints, bedding and bedding-parallel separations, foliation, and shears, is described based on the following criteria:

Spacing	Joint/Fracture Spacing Terms	Bedding/Foliation Spacing Terms
Less than 2 inches	Very Close (VC)	Very Thin (VTn) – Laminated if bedding less than ½ inch
2 inches – 1 foot	Close (C)	Thin (Tn)
1 foot – 3 feet	Moderately Close (MC)	Medium (M)
.3 feet – 10 feet	Wide (W)	Thick (Tk)
More than 10 feet	Very Wide (VW)	Very Thick (VTk) [massive]

Note: The spacings of discontinuities indicated within the columnar field on the Boring Logs are typically provided as apparent spacing measurements (along core axis) between any and all adjacent observed natural discontinuities, regardless of type or orientation. The apparent spacing measurements may, however, over- or underestimate the true spacings of individual sets of joints or fractures depending upon their orientation and/or intersection. Where possible, the true spacing of individual sets of discontinuities are measured and noted in the Material Description. Additionally, the documentation of close or very close spacings of healed, filled, incipient, or otherwise intact and unbroken discontinuities may appear to conflict with RQD values recorded on the Boring Log, and the presence of such features are noted to the extent practical in the Material Description.



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CLIENT T.Y. Lin International, Inc.PROJECT NAME MCDOT Northern Parkway (TT0372)PROJECT NUMBER 2021015PROJECT LOCATION 103rd Avenue to 91st Avenue, Maricopa County, ArizonaDATE STARTED 2/20/2023COMPLETED 2/21/2023BORING LOCATION West AbutmentDRILLER ResilientDRILLED BY F. EsparzaGPS COORDINATES 33.55102°N, -112.27589°EDRILLING METHOD TubexGROUND ELEVATION 1076 ft BOREHOLE DEPTH 116 ftRIG TYPE / # CME-75 / 113GROUNDWATER DEPTH ---HAMMER TYPE AutoHAMMER EFFICIENCY 87LOGGED BY M. MezaCHECKED BY J. Huston

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (N VALUE)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
								LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
1075			SILTY, CLAYEY SAND (SC-SM), some fine gravel, no to low plasticity, dark brown to brown, slightly moist	AU				21	16	5	30
	5			SPT	7-50/5"						
1070											
	10		Note: moderately firm to firm below 10'	R	10-10	106	6				
1065											
	15			SPT	11-11-11 (22)						
1060			SILTY GRAVEL WITH SAND (GM), considerable medium sand, low plasticity, light brown to brown, slightly moist								
	20										
1055			SILTY, CLAYEY SAND WITH GRAVEL (SC-SM), some fine gravel, low plasticity, light brown, slightly moist	SPT	18-16-35 (51)						
	25										
1050			GRAVEL WITH SAND (GP), trace cobbles, considerable medium sand, poorly graded, nonplastic, light brown to brown, slightly moist	SPT	50/4"						
	30										
1045				SPT	50/4"						
	35										

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CLIENT T.Y. Lin International, Inc.PROJECT NAME MCDOT Northern Parkway (TT0372)PROJECT NUMBER 2021015PROJECT LOCATION 103rd Avenue to 91st Avenue, Maricopa County, ArizonaDATE STARTED 2/20/2023COMPLETED 2/21/2023BORING LOCATION West AbutmentDRILLER ResilientDRILLED BY F. EsparzaGPS COORDINATES 33.55102°N, -112.27589°EDRILLING METHOD TubexGROUND ELEVATION 1076 ftBOREHOLE DEPTH 116 ftRIG TYPE / # CME-75 / 113▼ GROUNDWATER DEPTH ---HAMMER TYPE AutoHAMMER EFFICIENCY 87LOGGED BY M. MezaCHECKED BY J. Huston

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (N VALUE)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
								LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
1040			GRAVEL WITH SAND (GP), trace cobbles, considerable medium sand, poorly graded, nonplastic, light brown to brown, slightly moist(<i>continued</i>)	✱ SPT	38-50/5"						
	40		SILTY SAND (SM), trace fine gravel, low plasticity, brown, moist	✱ R	14-50	96	17	NP	NP	NP	32
1035											
	45		SAND (SP), trace fine gravel, poorly graded, nonplastic, light brown, moist	✱ SPT	6-11-14 (25)						
1030											
	50			✱ SPT	10-10-10 (20)						
1025			CLAYEY SAND (SC), some fine gravel, medium plasticity, brown, moist								
	55			✱ R	50/4"						
1020			SAND (SP), trace fine gravel, poorly graded, nonplastic, light brown to brown, moist								
	60			✱ SPT	10-26-22 (48)						
1015			CLAYEY SAND (SC), trace fine gravel, low plasticity, brown, moist								
	65			✱ R	10-20	100	14				
1010											
	70										

(Continued Next Page)



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CLIENT T.Y. Lin International, Inc.PROJECT NAME MCDOT Northern Parkway (TT0372)PROJECT NUMBER 2021015PROJECT LOCATION 103rd Avenue to 91st Avenue, Maricopa County, ArizonaDATE STARTED 2/20/2023COMPLETED 2/21/2023BORING LOCATION West AbutmentDRILLER ResilientDRILLED BY F. EsparzaGPS COORDINATES 33.55102°N, -112.27589°EDRILLING METHOD TubexGROUND ELEVATION 1076 ftBOREHOLE DEPTH 116 ftRIG TYPE / # CME-75 / 113▼ GROUNDWATER DEPTH ---HAMMER TYPE AutoHAMMER EFFICIENCY 87LOGGED BY M. MezaCHECKED BY J. Huston

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (N VALUE)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
								LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
1005			SILTY GRAVEL WITH SAND (GM), trace cobbles, considerable fine to medium sand, nonplastic, light brown, slightly moist(<i>continued</i>)	SPT	50/1"						
	75		SILTY SAND WITH GRAVEL (SM), some fine gravel, low plasticity, light brown, moist								
1000				SPT	50/1"						
	80		SILT (ML), occasional fine gravel, trace fine sand, medium plasticity, brown, moist								
995				SPT	5-8-13 (21)						
	85										
990			SILTY SAND (SM), occasional fine gravel, nonplastic, light brown to brown, moist	R	19-32	99	8	NP	NP	NP	15
	90		CLAY (CL), occasional fine gravel, trace fine sand, medium plasticity, brown, moist								
985			CLAYEY SAND (SC), trace fine gravel, weak lime cementation, low to medium plasticity, light brown to brown, moist	SPT	9-14-14 (28)						
	95										
980			Note: moderate lime cementation below 95'	R	23-50						
	100										
975			CLAY (CL), occasional fine gravel, trace fine sand, low to medium plasticity, brown, moist	SPT	8-17-20 (37)						
	105		GRAVEL WITH SAND (GP), occasional cobbles, some medium sand, poorly graded, nonplastic, light brown, slightly moist								

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CLIENT T.Y. Lin International, Inc. **PROJECT NAME** MCDOT Northern Parkway (TT0372)
PROJECT NUMBER 2021015 **PROJECT LOCATION** 103rd Avenue to 91st Avenue, Maricopa County, Arizona
DATE STARTED 2/20/2023 **COMPLETED** 2/21/2023 **BORING LOCATION** West Abutment
DRILLER Resilient **DRILLED BY** F. Esparza **GPS COORDINATES** 33.55102°N, -112.27589°E
DRILLING METHOD Tubex **GROUND ELEVATION** 1076 ft **BOREHOLE DEPTH** 116 ft
RIG TYPE / # CME-75 / 113 **GROUNDWATER DEPTH** ---
HAMMER TYPE Auto **HAMMER EFFICIENCY** 87 **LOGGED BY** M. Meza **CHECKED BY** J. Huston

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (N VALUE)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
								LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
970			GRAVEL WITH SAND (GP), occasional cobbles, some medium sand, poorly graded, nonplastic, light brown, slightly moist(continued)	SPT	19-29-35 (64)						
	110										
965			CLAY WITH SAND (CL), occasional fine gravel, some fine sand, low to medium plasticity, brown, moist	SPT	14-7-9 (16)						
	115										
960			GRAVELLY CLAY WITH SAND (CL), considerable gravel, some fine sand, medium plasticity, brown, moist	R	23-50						

Bottom of borehole at 116.0 feet. Backfilled full depth with bentonite-slurry.



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CLIENT T.Y. Lin International, Inc. **PROJECT NAME** MCDOT Northern Parkway (TT0372)
PROJECT NUMBER 2021015 **PROJECT LOCATION** 103rd Avenue to 91st Avenue, Maricopa County, Arizona
DATE STARTED 2/28/2023 **COMPLETED** 3/1/2023 **BORING LOCATION** Pier 1
DRILLER Resilient **DRILLED BY** F. Esparza **GPS COORDINATES** 33.55116°N, -112.27557°E
DRILLING METHOD Tubex **GROUND ELEVATION** 1060 ft **BOREHOLE DEPTH** 106.5 ft
RIG TYPE / # CME-75 / 113 **GROUNDWATER DEPTH** ---
HAMMER TYPE Auto **HAMMER EFFICIENCY** 87 **LOGGED BY** M. Meza **CHECKED BY** J. Huston

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (N VALUE)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)	
								LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX		
1060												
			GRAVEL WITH SAND (GP), considerable medium to coarse sand, poorly graded, no to low plasticity, light brown to light gray, moist									
1055	5											
				Note: slightly Moist, occassional cobbles below 7'	⊗ SPT	16-25-30 (55)			22	17	5	4
1050	10											
				Note: increased cobbles below 11'	⊗ SPT	15-50/4"						
1045	15											
				⊗ SPT	21-50/5"							
1040	20		SAND WITH CLAY (SP-SC), considerable gravel, poorly graded, low plasticity, grayish brown to brown, moist	⊗ SPT	12-19-28 (47)							
1035	25											
			SAND WITH SILT AND GRAVEL (SP-SM), considerable gravel, poorly graded, nonplastic, grayish brown to brown, moist	⊗ SPT	16-29-39 (68)							
1030	30		SANDY CLAY (CL), trace fine gravel, considerable fine sand, low plasticity, brown, moist	⊗ SPT	1-2-8 (10)							
				SAND (SP), trace fine gravel, poorly graded, nonplastic, light brown, moist								
1025	35											

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Ethos Engineering, LLC

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CLIENT T.Y. Lin International, Inc.**PROJECT NAME** MCDOT Northern Parkway (TT0372)**PROJECT NUMBER** 2021015**PROJECT LOCATION** 103rd Avenue to 91st Avenue, Maricopa County, Arizona**DATE STARTED** 2/28/2023**COMPLETED** 3/1/2023**BORING LOCATION** Pier 1**DRILLER** Resilient**DRILLED BY** F. Esparza**GPS COORDINATES** 33.55116°N, -112.27557°E**DRILLING METHOD** Tubex**GROUND ELEVATION** 1060 ft**BOREHOLE DEPTH** 106.5 ft**RIG TYPE / #** CME-75 / 113**GROUNDWATER DEPTH** ---**HAMMER TYPE** Auto**HAMMER EFFICIENCY** 87**LOGGED BY** M. Meza**CHECKED BY** J. Huston

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (N VALUE)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
								LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
1025											
			SILTY GRAVEL WITH SAND (GP-GM), considerable medium to coarse sand, nonplastic, light brown to brown, moist	R	18-42	101	9	NP	NP	NP	10
1020	40										
			SAND (SP), trace fine gravel, poorly graded, nonplastic, brown, moist	SPT	10-27-37 (64)						
1015	45										
			SANDY CLAY (CL), trace fine gravel, considerable fine sand, low plasticity, brown, moist	SPT	5-12-22 (34)						
1010	50										
			SAND WITH GRAVEL (SP), some gravel, poorly graded, nonplastic, brown, moist	R	12-20	104	11				
1005	55										
			SILT (ML), trace fine gravel, trace fine sand, medium plasticity, brown, moist	SPT	50/5"						
1000	60		Note: strong lime cementation, slightly moist, light brown below 58'	SPT	50/4"						
995	65										
			SANDY SILT (ML), trace fine gravel, considerable fine sand, low to medium plasticity, brown, moist	R	5-19						
990	70										
			SAND (SP), trace fine gravel, poorly graded, nonplastic, light brown to brown, moist								

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CLIENT T.Y. Lin International, Inc. **PROJECT NAME** MCDOT Northern Parkway (TT0372)
PROJECT NUMBER 2021015 **PROJECT LOCATION** 103rd Avenue to 91st Avenue, Maricopa County, Arizona
DATE STARTED 2/28/2023 **COMPLETED** 3/1/2023 **BORING LOCATION** Pier 1
DRILLER Resilient **DRILLED BY** F. Esparza **GPS COORDINATES** 33.55116°N, -112.27557°E
DRILLING METHOD Tubex **GROUND ELEVATION** 1060 ft **BOREHOLE DEPTH** 106.5 ft
RIG TYPE / # CME-75 / 113 **GROUNDWATER DEPTH** ---
HAMMER TYPE Auto **HAMMER EFFICIENCY** 87 **LOGGED BY** M. Meza **CHECKED BY** J. Huston

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (N VALUE)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
								LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
990											
			CLAYEY SAND (SC), some fine gravel, strong lime cementation, low plasticity, light brown, moist	⊗ SPT	5-50/5"						
985	75										
			SANDY SILT (ML), trace fine gravel, considerable fine sand, low to medium plasticity, brown, moist	⊗ R	11-50	88	28	34	25	9	55
980	80										
				⊗ SPT	4-9-15 (24)						
975	85										
			SAND WITH GRAVEL (SP), considerable fine to coarse gravel, poorly graded, nonplastic, light brown, slightly moist	⊗ SPT	12-14-21 (35)						
970	90										
			CLAYEY SAND (SC), trace fine gravel, strong lime cementation, low to medium plasticity, light brown, slightly moist	⊗ SPT	12-50/5"						
965	95										
			Note: firm, moist, brown below 95'	⊗ SPT	6-12-11 (23)						
960	100										
			SILTY SAND (SM), trace fine gravel, no to low plasticity, light brown to brown, moist	⊗ R	25-50	87	19	NP	NP	NP	29
955	105										

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CLIENT T.Y. Lin International, Inc. **PROJECT NAME** MCDOT Northern Parkway (TT0372)
PROJECT NUMBER 2021015 **PROJECT LOCATION** 103rd Avenue to 91st Avenue, Maricopa County, Arizona
DATE STARTED 2/28/2023 **COMPLETED** 3/1/2023 **BORING LOCATION** Pier 1
DRILLER Resilient **DRILLED BY** F. Esparza **GPS COORDINATES** 33.55116°N, -112.27557°E
DRILLING METHOD Tubex **GROUND ELEVATION** 1060 ft **BOREHOLE DEPTH** 106.5 ft
RIG TYPE / # CME-75 / 113 **GROUNDWATER DEPTH** ---
HAMMER TYPE Auto **HAMMER EFFICIENCY** 87 **LOGGED BY** M. Meza **CHECKED BY** J. Huston

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (N VALUE)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
								LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
955			SAND WITH GRAVEL (SP), some fine gravel, poorly graded, nonplastic, light brown, moist(continued)	SPT	12-15-28 (43)						

Bottom of borehole at 106.5 feet. Backfilled full depth with bentonite-slurry.



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CLIENT T.Y. Lin International, Inc. **PROJECT NAME** MCDOT Northern Parkway (TT0372)
PROJECT NUMBER 2021015 **PROJECT LOCATION** 103rd Avenue to 91st Avenue, Maricopa County, Arizona
DATE STARTED 3/30/2023 **COMPLETED** 3/31/2023 **BORING LOCATION** Pier 2
DRILLER Resilient **DRILLED BY** F. Esparza **GPS COORDINATES** 33.5511°N, -112.27529°E
DRILLING METHOD Tubex **GROUND ELEVATION** 1062 ft **BOREHOLE DEPTH** 106.5 ft
RIG TYPE / # CME-75 / 113 **GROUNDWATER DEPTH** ---
HAMMER TYPE Auto **HAMMER EFFICIENCY** 87 **LOGGED BY** M. Meza **CHECKED BY** J. Huston

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (N VALUE)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
								LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
1060	5		CLAYEY SAND WITH GRAVEL (SC), considerable fine gravel, medium plasticity, light brown to gray, moist	AU SPT	25-27-50/3"			28	14	14	16
1055	10			SPT	17-23-35 (58)						
1050	15		GRAVELLY CLAY (GC), considerable fine gravel, trace fine sand, medium to high plasticity, moist	SPT	17-12-9 (21)						
1045	20										
1040	25		SAND (SP), some fine gravel, poorly graded, nonplastic, light brown to red, moist	R	22-20	107	12				
1035	30		SILTY SAND (SM), trace fine gravel, low plasticity, brown, moist	SPT	12-15-10 (25)						
1030	35		SAND WITH SILT AND GRAVEL (SP-SM), some fine gravel, poorly graded, no to low plasticity, brown, moist	R	25-20	118	8				
			CLAYEY SAND (SC), trace fine gravel, medium plasticity, brown, moist								

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CLIENT T.Y. Lin International, Inc.PROJECT NAME MCDOT Northern Parkway (TT0372)PROJECT NUMBER 2021015PROJECT LOCATION 103rd Avenue to 91st Avenue, Maricopa County, ArizonaDATE STARTED 3/30/2023COMPLETED 3/31/2023BORING LOCATION Pier 2DRILLER ResilientDRILLED BY F. EsparzaGPS COORDINATES 33.5511°N, -112.27529°EDRILLING METHOD TubexGROUND ELEVATION 1062 ft BOREHOLE DEPTH 106.5 ftRIG TYPE / # CME-75 / 113GROUNDWATER DEPTH ---HAMMER TYPE AutoHAMMER EFFICIENCY 87LOGGED BY M. MezaCHECKED BY J. Huston

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (N VALUE)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
								LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
1025			CLAYEY SAND (SC), trace fine gravel, medium plasticity, brown, moist(<i>continued</i>)	✱ SPT	8-9-15 (24)						
	40										
1020				✱ SPT	9-12-18 (30)						
	45										
1015			Note: hard, weak to moderate cementation below 45'	✱ R	33-50	101	19				
	50		CLAY WITH SAND (CL), occasional fine gravel, some fine sand, low to medium plasticity, light brown, slightly moist	✱ SPT	50/4"						
1010											
	55		SAND (SP), some fine gravel, poorly graded, nonplastic, light brown to gray, slightly moist	✱ SPT	14-17-20 (37)						
1005											
	60		SILTY GRAVEL WITH SAND (GM), occasional cobbles, some medium sand, no to low plasticity, light brown to gray, slightly moist								
1000			SANDY CLAY (CL), trace fine gravel, considerable fine sand, weak lime cementation, medium plasticity, light brown, slightly moist to moist	✱ SPT	24-14-16 (30)			33	16	17	63
	65										
995			Note: hard at 65'	✱ SPT	3-5-50/2"						
	70										

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CLIENT T.Y. Lin International, Inc.PROJECT NAME MCDOT Northern Parkway (TT0372)PROJECT NUMBER 2021015PROJECT LOCATION 103rd Avenue to 91st Avenue, Maricopa County, ArizonaDATE STARTED 3/30/2023COMPLETED 3/31/2023BORING LOCATION Pier 2DRILLER ResilientDRILLED BY F. EsparzaGPS COORDINATES 33.5511°N, -112.27529°EDRILLING METHOD TubexGROUND ELEVATION 1062 ftBOREHOLE DEPTH 106.5 ftRIG TYPE / # CME-75 / 113▼ GROUNDWATER DEPTH ---HAMMER TYPE AutoHAMMER EFFICIENCY 87LOGGED BY M. MezaCHECKED BY J. Huston

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (N VALUE)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
								LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
990			SANDY CLAY (CL), trace fine gravel, considerable fine sand, weak lime cementation, medium plasticity, light brown, slightly moist to moist(<i>continued</i>)	✕ SPT	4-7-15 (22)						
			SAND (SP), trace fine gravel, poorly graded, nonplastic, light brown, slightly moist								
75			CLAYEY GRAVEL WITH SAND (GC), some fine sand, medium plasticity, light brown to brown, moist								
985			SILTY GRAVEL (GM), occasional cobbles, trace fine sand, no to low plasticity, light gray, slightly moist								
80			CLAY WITH SAND (CL), occasional fine gravel, some fine sand, medium plasticity, brown to light brown, slightly moist	✕ SPT	11-50/3"						
980											
85			CLAYEY SAND (SC), trace fine gravel, low to medium plasticity, brown, moist	✕ SPT	5-11-50/2"	100	15				
975			SAND (SP), trace fine gravel, poorly graded, nonplastic, brown to gray, moist								
90				✕ SPT	18-21-32 (53)						
970			CLAYEY SAND (SC), trace fine gravel, moderate lime cementation, low to medium plasticity, light brown to brown, slightly moist	✕ SPT	6-50/2"						
95											
965											
100				✕ SPT	50/5"						
960											
105											

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CLIENT T.Y. Lin International, Inc. **PROJECT NAME** MCDOT Northern Parkway (TT0372)
PROJECT NUMBER 2021015 **PROJECT LOCATION** 103rd Avenue to 91st Avenue, Maricopa County, Arizona
DATE STARTED 3/30/2023 **COMPLETED** 3/31/2023 **BORING LOCATION** Pier 2
DRILLER Resilient **DRILLED BY** F. Esparza **GPS COORDINATES** 33.5511°N, -112.27529°E
DRILLING METHOD Tubex **GROUND ELEVATION** 1062 ft **BOREHOLE DEPTH** 106.5 ft
RIG TYPE / # CME-75 / 113 **GROUNDWATER DEPTH** ---
HAMMER TYPE Auto **HAMMER EFFICIENCY** 87 **LOGGED BY** M. Meza **CHECKED BY** J. Huston

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (N VALUE)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
								LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
-	-		CLAY WITH SAND (CL), occasional fine gravel, some fine sand, weak lime cementation, medium plasticity, brown, moist	 SPT	4-8-27 (35)						

Bottom of borehole at 106.5 feet. Backfilled full depth with bentonite-slurry.



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BORING NUMBER NR-4

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CLIENT T.Y. Lin International, Inc. **PROJECT NAME** MCDOT Northern Parkway (TT0372)
PROJECT NUMBER 2021015 **PROJECT LOCATION** 103rd Avenue to 91st Avenue, Maricopa County, Arizona
DATE STARTED 2/24/2023 **COMPLETED** 2/27/2023 **BORING LOCATION** Pier 3
DRILLER Resilient **DRILLED BY** F. Esparza **GPS COORDINATES** 33.55118°N, -112.27492°E
DRILLING METHOD Tubex **GROUND ELEVATION** 1062 ft **BOREHOLE DEPTH** 106 ft
RIG TYPE / # CME-75 / 113 **GROUNDWATER DEPTH** ---
HAMMER TYPE Auto **HAMMER EFFICIENCY** 87 **LOGGED BY** M. Meza **CHECKED BY** J. Huston

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (N VALUE)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
								LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
1060			SILTY GRAVEL WITH SAND (GP-GM), occasional cobbles, some medium to coarse sand, no to low plasticity, dark brown to brown, moist								
	5			✖ SPT	31-50/1"						
1055			Note: increased cobbles below 7'								
	10			✖ SPT	50/1"						
1050											
	15			✖ SPT	50/2"						
1045											
	20			✖ SPT	24-32-50/5"						
1040											
	25										
			SANDY CLAY (CL), occasional fine gravel, considerable fine sand, low to medium plasticity, brown, moist	✖ SPT	1-4-5 (9)			35	23	12	62
1035											
	30		Note: hard, moderate cementation below 30'	✖ R	31-50	94	18				
1030											
			SILTY SAND (SM), trace fine gravel, nonplastic, brown, moist								
	35										

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BORING NUMBER NR-4

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CLIENT T.Y. Lin International, Inc. **PROJECT NAME** MCDOT Northern Parkway (TT0372)
PROJECT NUMBER 2021015 **PROJECT LOCATION** 103rd Avenue to 91st Avenue, Maricopa County, Arizona
DATE STARTED 2/24/2023 **COMPLETED** 2/27/2023 **BORING LOCATION** Pier 3
DRILLER Resilient **DRILLED BY** F. Esparza **GPS COORDINATES** 33.55118°N, -112.27492°E
DRILLING METHOD Tubex **GROUND ELEVATION** 1062 ft **BOREHOLE DEPTH** 106 ft
RIG TYPE / # CME-75 / 113 **GROUNDWATER DEPTH** ---
HAMMER TYPE Auto **HAMMER EFFICIENCY** 87 **LOGGED BY** M. Meza **CHECKED BY** J. Huston

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (N VALUE)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
								LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
1025			SILTY SAND (SM), trace fine gravel, nonplastic, brown, moist(continued)	✱ SPT	8-11-15 (26)						
	40		SILTY GRAVEL WITH SAND (GM), some medium to coarse sand, low plasticity, light brown to brown, moist	✱ SPT	17-50/3"						
1020											
	45		CLAYEY SAND (SC), trace fine gravel, low plasticity, brown, moist	✱ R	9-31	92	27				
1015											
	50		SANDY CLAY (CL), occasional fine gravel, considerable fine sand, medium plasticity, brown, moist	✱ SPT	7-8-12 (20)						
1010											
	55		SAND WITH GRAVEL (SP), considerable gravel, poorly graded, nonplastic, light brown, slightly moist	✱ SPT	6-18-21 (39)						
1005											
	60		GRAVELLY SILT WITH SAND (ML), considerable fine gravel, some fine to coarse sand, weak to moderate lime cementation, medium plasticity, light brown to brown, slightly moist to moist	✱ SPT	8-11-50 (61)						
1000											
	65			✱ R	21-26	97	26	48	30	18	59
995											
	70										

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Ethos Engineering, LLC

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CLIENT T.Y. Lin International, Inc.	PROJECT NAME MCDOT Northern Parkway (TT0372)
PROJECT NUMBER 2021015	PROJECT LOCATION 103rd Avenue to 91st Avenue, Maricopa County, Arizona
DATE STARTED 2/24/2023	COMPLETED 2/27/2023
DRILLER Resilient	DRILLED BY F. Esparza
DRILLING METHOD Tubex	BORING LOCATION Pier 3
RIG TYPE / # CME-75 / 113	GPS COORDINATES 33.55118°N, -112.27492°E
HAMMER TYPE Auto	HAMMER EFFICIENCY 87
GROUND ELEVATION 1062 ft	BOREHOLE DEPTH 106 ft
GROUNDWATER DEPTH ---	LOGGED BY M. Meza
CHECKED BY J. Huston	

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (N VALUE)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
								LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
990			GRAVELLY SILT WITH SAND (ML), considerable fine gravel, some fine to coarse sand, weak to moderate lime cementation, medium plasticity, light brown to brown, slightly moist to moist(continued) Note: firm, no cementation at 70'	✱ SPT	3-6-13 (19)						
	75		SAND (SP), trace fine gravel, poorly graded, nonplastic, brown, slightly moist								
985			CLAYEY SAND (SC), trace to some fine gravel, low plasticity, light brown to brown, slightly moist	✱ SPT	21-50/4"						
	80		Note: increased gravel below 78'								
980			Note: strong cementation between 80' and 83'	✱ SPT	50/2"						
	85		Note: trace gravel, brown, weak lime cementation below 84'								
975				✱ SPT	4-20-16 (36)						
970			SAND WITH GRAVEL (SP-SM), considerable fine gravel, poorly graded, nonplastic, light brown, slightly moist	✱ R	9-16	104	7	NP	NP	NP	7
	95		CLAYEY SAND WITH GRAVEL (SC), considerable fine gravel, considerable clay, strong lime cementation, light brown, slightly moist	✱ SPT	50/5"						
960			SANDY CLAY (CL), trace fine gravel, considerable fine sand, weak lime cementation, medium plasticity, light brown to brown, moist	✱ SPT	15-15-10 (25)						

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Ethos Engineering, LLC

BORING NUMBER NR-4

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CLIENT T.Y. Lin International, Inc. **PROJECT NAME** MCDOT Northern Parkway (TT0372)
PROJECT NUMBER 2021015 **PROJECT LOCATION** 103rd Avenue to 91st Avenue, Maricopa County, Arizona
DATE STARTED 2/24/2023 **COMPLETED** 2/27/2023 **BORING LOCATION** Pier 3
DRILLER Resilient **DRILLED BY** F. Esparza **GPS COORDINATES** 33.55118°N, -112.27492°E
DRILLING METHOD Tubex **GROUND ELEVATION** 1062 ft **BOREHOLE DEPTH** 106 ft
RIG TYPE / # CME-75 / 113 **GROUNDWATER DEPTH** ---
HAMMER TYPE Auto **HAMMER EFFICIENCY** 87 **LOGGED BY** M. Meza **CHECKED BY** J. Huston

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (N VALUE)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
								LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
			Note: brown, no cementation below 105'	 R	7-12						

Bottom of borehole at 106.0 feet. Backfilled full depth with bentonite-slurry.



Ethos Engineering, LLC

BORING NUMBER NR-5

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CLIENT T.Y. Lin International, Inc. **PROJECT NAME** MCDOT Northern Parkway (TT0372)
PROJECT NUMBER 2021015 **PROJECT LOCATION** 103rd Avenue to 91st Avenue, Maricopa County, Arizona
DATE STARTED 2/22/2023 **COMPLETED** 2/23/2023 **BORING LOCATION** East Abutment
DRILLER Resilient **DRILLED BY** F. Esparza **GPS COORDINATES** 33.55104°N, -112.27461°E
DRILLING METHOD Tubex **GROUND ELEVATION** 1077 ft **BOREHOLE DEPTH** 116.2 ft
RIG TYPE / # CME-75 / 113 **GROUNDWATER DEPTH** ---
HAMMER TYPE Auto **HAMMER EFFICIENCY** 87 **LOGGED BY** M. Meza **CHECKED BY** J. Huston

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (N VALUE)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
								LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
1075	5		SILTY, CLAYEY SAND WITH GRAVEL (SC-SM), considerable fine gravel, low plasticity, dark brown to brown, moist	AU				22	16	6	21
1070	10		SILTY GRAVEL WITH SAND (GP-GM), some fine to medium sand, low plasticity, dark brown to brown, moist	SPT	1-9-11 (20)						
1065	15		Note: occasional cobbles at 14'	SPT	10-8-7 (15)						
1060	20		SILTY SAND (SM), trace to some fine gravel, low plasticity, dark brown to brown, moist	SPT	5-4-3 (7)						
1055	25		SAND WITH GRAVEL (SP), considerable fine to coarse gravel, poorly graded, no to low plasticity, gray to red, slightly moist	SPT	21-50/5"			25	17	8	2
1050	30		CLAYEY GRAVEL WITH SAND (GC), some medium sand, low plasticity, reddish gray to brown, slightly moist	SPT	21-30- 50/5"						
1045	35		GRAVEL WITH SAND (GP), considerable medium to coarse sand, poorly graded, nonplastic, light brown, slightly moist	SPT	31-50/5"						

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CLIENT T.Y. Lin International, Inc. **PROJECT NAME** MCDOT Northern Parkway (TT0372)
PROJECT NUMBER 2021015 **PROJECT LOCATION** 103rd Avenue to 91st Avenue, Maricopa County, Arizona
DATE STARTED 2/22/2023 **COMPLETED** 2/23/2023 **BORING LOCATION** East Abutment
DRILLER Resilient **DRILLED BY** F. Esparza **GPS COORDINATES** 33.55104°N, -112.27461°E
DRILLING METHOD Tubex **GROUND ELEVATION** 1077 ft **BOREHOLE DEPTH** 116.2 ft
RIG TYPE / # CME-75 / 113 **GROUNDWATER DEPTH** ---
HAMMER TYPE Auto **HAMMER EFFICIENCY** 87 **LOGGED BY** M. Meza **CHECKED BY** J. Huston

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (N VALUE)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
								LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
1040			GRAVEL WITH SAND (GP), considerable medium to coarse sand, poorly graded, nonplastic, light brown, slightly moist(continued)	▲ SPT	7-31-29 (60)						
40											
1035				▲ SPT	13-17-34 (51)						
45											
1030			GRAVELLY CLAY (CL), considerable gravel, trace fine sand, medium plasticity, brown, moist	▲ SPT	22-8-6 (14)						
			CLAY WITH SAND (CL), trace fine gravel, some fine sand, medium plasticity, brown, moist								
50				▲ R	9-14	101	21	33	19	14	41
1025			CLAYEY SAND (SC), trace fine gravel, low to medium plasticity, brown, moist								
55				▲ SPT	33-50/1"						
1020			SAND (SP), trace fine gravel, poorly graded, nonplastic, light brown, slightly moist								
60				▲ SPT	10-22-41 (63)						
1015			SANDY CLAY (CL), trace fine gravel, considerable fine sand, low to medium plasticity, brown, moist								
65			Note: firm at 65'	▲ SPT	7-10-15 (25)						
1010											
70											

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CLIENT T.Y. Lin International, Inc.PROJECT NAME MCDOT Northern Parkway (TT0372)PROJECT NUMBER 2021015PROJECT LOCATION 103rd Avenue to 91st Avenue, Maricopa County, ArizonaDATE STARTED 2/22/2023COMPLETED 2/23/2023BORING LOCATION East AbutmentDRILLER ResilientDRILLED BY F. EsparzaGPS COORDINATES 33.55104°N, -112.27461°EDRILLING METHOD TubexGROUND ELEVATION 1077 ftBOREHOLE DEPTH 116.2 ftRIG TYPE / # CME-75 / 113GROUNDWATER DEPTH ---HAMMER TYPE AutoHAMMER EFFICIENCY 87LOGGED BY M. MezaCHECKED BY J. Huston

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (N VALUE)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
								LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
1005			SILTY, CLAYEY SAND WITH GRAVEL (SC-SM), some fine gravel, low plasticity, brown, moist	R	15-40	112	8				
	75										
1000			SANDY CLAY (CL), trace fine gravel, considerable fine sand, subangular, low plasticity, brown, moist	SPT	6-8-25 (33)						
			Note: increased gravel below 78'								
	80										
995				SPT	13-13-26 (39)						
	85										
990			Note: occasional gravel below 85'	R	10-27	106	17				
	90		SAND WITH GRAVEL (SP), considerable gravel, poorly graded, nonplastic, light brown, slightly moist								
985			SILTY SAND (SM), trace fine gravel, low plasticity, brown, moist	SPT	21-50/1"						
	95		SILTY GRAVEL WITH SAND (GM), considerable fine to medium sand, low plasticity, brown, moist	SPT	50/5"						
980											
	100										
975			GRAVELLY CLAY (CL), considerable gravel, trace fine sand, low to medium plasticity, brown, moist	SPT	50/5"						
	105										

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CLIENT T.Y. Lin International, Inc. **PROJECT NAME** MCDOT Northern Parkway (TT0372)
PROJECT NUMBER 2021015 **PROJECT LOCATION** 103rd Avenue to 91st Avenue, Maricopa County, Arizona
DATE STARTED 2/22/2023 **COMPLETED** 2/23/2023 **BORING LOCATION** East Abutment
DRILLER Resilient **DRILLED BY** F. Esparza **GPS COORDINATES** 33.55104°N, -112.27461°E
DRILLING METHOD Tubex **GROUND ELEVATION** 1077 ft **BOREHOLE DEPTH** 116.2 ft
RIG TYPE / # CME-75 / 113 **GROUNDWATER DEPTH** ---
HAMMER TYPE Auto **HAMMER EFFICIENCY** 87 **LOGGED BY** M. Meza **CHECKED BY** J. Huston

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (N VALUE)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
								LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
970			SAND (SP), trace fine gravel, poorly graded, nonplastic, light brown to brown, slightly moist	✕ SPT	13-50/4"						
110											
965			SILTY, CLAYEY SAND WITH GRAVEL (SC-SM), some fine gravel, low plasticity, brown, moist	✕ SPT	50/5"						
115											
			SANDY CLAY (CL), trace fine gravel, considerable fine sand, low plasticity, light brown to brown, moist	✕ SPT	10-31-50/3"						

Bottom of borehole at 116.2 feet. Backfilled full depth with bentonite-slurry.

Project Name:		MCDOT NORTHERN PARKWAY			Boring Number:		NP-1	
Project Location:		Northern Parkway; 99th Ave to 87th Ave			Boring Location:		STA 100+53, 14' R	
Project Number:		2021 015			Coordinates:		N 33.55121°, W 1127328°	
Logger - Firm:		M.Meza - Ethos Engineering, LLC			Surface Elevation (feet):		1,079	
Drill - Drilling Method:		CME -75; HOLLOW STEM AUGER			Groundwater Depth (feet):		N/A	
Driller - Firm:		A.WRIGHT - ACS DRILLING SERVICES			Date(s):		8/3/2021	

Elev (feet)	Depth (feet)	Drill Rate (min/ft)	Sample Interval	Sample Type	Blowcounts	Firmness/ Density	Moisture	Description & USCS
1,074	1			A	2-2-2 (4)		Moist	SILTY CLAYEY SAND (SC-SM) Some Sub-Angular Fine Gravel Fine to Medium Grained Sand Low Plasticity Brown to Dark Brown
	2							
	3		S	Very Soft		Moist	CLAYEY SAND (SC) Trace (Sub-Angular) Fine Gravel Fine to Medium Grained Sand Medium Plasticity Brown Note: Concrete Fragments Encountered at 4'	
	4							
1,069	5							Hollow Stem Auger Stopped at 4' (Due to Concrete) Sampler Stopped at 4'
	6							
	7							
	8							
1,064	9							
	10							
	11							
	12							
1,059	13							
	14							
	15							
	16							
1,054	17							
	18							
	19							
	20							
	21							
	22							
	23							
	24							
	25							

	Sample Type	Notes	
	S - SPT Spoon Sampler	NR - No Recovery	
	R - Ring Sampler	PR - Poor Recovery	
	A - Auger Cuttings		

Project Name:	MCDOT NORTHERN PARKWAY	Boring Number:	NP-2
Project Location:	Northern Parkway; 99th Ave to 87th Ave	Boring Location:	STA 24+14, 4' R ⁽²⁾
Project Number:	2021 015	Coordinates:	N 33.55026° W 112.27246°
Logger - Firm:	M.Meza - Ethos Engineering, LLC	Surface Elevation (feet):	1,079
Drill - Drilling Method:	CME -75; HOLLOW STEM AUGER	Groundwater Depth (feet):	N/A
Driller - Firm:	A.WRIGHT - ACS	Date(s):	8/2/2021

Elev (feet)	Depth (feet)	Drill Rate (min/ft)	Sample Interval	Sample Type	Blowcounts	Firmness/ Density	Moisture	Description & USCS
1,074	1			A			Slightly Moist	SANDY CLAY (CL) Occasional Sub-Rounded Fine Gravel Predominantly Fine to Medium Grained Sand Low to Medium Plasticity Brown
	2							
	3							
	4			S	2-2-2 (4)	Very Soft	Moist	CLAYEY SAND (SC) Occasional Sub-Angular Fine Gravel Predominantly Fine to Medium Grained Gravel Medium Plasticity Dark Brown to Brown
	5							
	6			S	3-2-2 (4)			
1,069	7							Hollow Stem Auger Stopped 5' Sampler Stopped at 6'6" Backfilled with Auger Cuttings
	8							
	9							
	10							
	11							
	12							
1,064	13							
	14							
	15							
	16							
	17							
	18							
1,059	19							
	20							
	21							
	22							
	23							
	24							
1,054	25							

	Sample Type	Notes
	S - SPT Spoon Sampler	NR - No Recovery
	R - Ring Sampler	PR - Poor Recovery
	A - Auger Cuttings	



Project Name:		MCDOT NORTHERN PARKWAY				Boring Number:		NP-3	
Project Location:		Northern Parkway; 99th Ave to 87th Ave				Boring Location:		STA 107+03, 19'R	
Project Number:		2021 015				Coordinates:		N 33.55125°, W 112.27114°	
Logger - Firm:		M.Meza - Ethos Engineering, LLC				Surface Elevation (feet):		1,080	
Drill - Drilling Method:		CME -75; HOLLOW STEM AUGER				Groundwater Depth (feet):		N/A	
Driller - Firm:		A.WRIGHT - ACS				Date(s):		8/2/2021	

Elev (feet)	Depth (feet)	Drill Rate (min/ft)	Sample Interval	Sample Type	Blowcounts	Firmness/Density	Moisture	Description & USCS
1,075	1			A		Soft	Slightly Moist	CLAYEY SAND (SC) Trace Sub-Angular Fine Gravel Fine to Medium Grained Sand Low to Medium Plasticity Brown
	2							
	3							
	4							
	5							
1,070	6			S	5-3-2 (5)	Soft	Dry	SILTY CLAYEY SAND (SC-SM) Some Sub-Rounded Fine Gravel Predominantly Fine to Medium Grained Sand Low Plasticity Light Brown to Brown
	7							
	8							
	9							
	10							
1,065	11							Hollow Stem Auger Stopped at 5' Sampler Stopped at 6'6" Backfilled with Auger Cuttings
	12							
	13							
	14							
	15							
1,060	16							
	17							
	18							
	19							
	20							
1,055	21							
	22							
	23							
	24							
	25							

 Sample Type S - SPT Spoon Sampler  R - Ring Sampler  A - Auger Cuttings		Notes NR - No Recovery PR - Poor Recovery	
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Project Name:		MCDOT NORTHERN PARKWAY			Boring Number:		NP-4	
Project Location:		Northern Parkway; 99th Ave to 87th Ave			Boring Location:		STA 302+68, 3' L ⁽³⁾	
Project Number:		2021 015			Coordinates:		N 33.55126°, W 112.26857°	
Logger - Firm:		M.Meza - Ethos Engineering, LLC			Surface Elevation (feet):		1,084	
Drill - Drilling Method:		CME -75; HOLLOW STEM AUGER			Groundwater Depth (feet):		N/A	
Driller - Firm:		J. KANIA - ACS			Date(s):		7/22/2021	

Elev (feet)	Depth (feet)	Drill Rate (min/ft)	Sample Interval	Sample Type	Blowcounts	Firmness/ Density	Moisture	Description & USCS
1,079	1			A	4 3 3 (6)	Soft	Slightly Moist	CLAYEY SAND (SC) Some Sub-Angular Fine Gravel Fine to Medium Grained Sand Low to Medium Plasticity Brown
	2							CLAYEY SAND (SC) Trace Sub-Angular Fine Gravel Fine to Medium Grained Sand Medium Plasticity Brown
	3							
	4							
	5							
1,074	6			S	3-4-6 (10)	Loose	Slightly Moist	SAND with SILT (SW-SM) Occasional Sub-Rounded Fine Gravel Medium Grained Sand Low Plasticity Brown
	7							
	8							
	9							
	10							
1,069	11							Hollow Stem Auger Stopped at 5' Sampler Stopped at 6'6" Backfilled with Auger Cuttings
	12							
	13							
	14							
	15							
1,064	16							
	17							
	18							
	19							
	20							
1,059	21							
	22							
	23							
	24							
	25							

	Sample Type	Notes	
	S - SPT Spoon Sampler	NR - No Recovery	
	R - Ring Sampler	PR - Poor Recovery	
	A - Auger Cuttings		

Project Name:		MCDOT NORTHERN PARKWAY			Boring Number:		NP-5	
Project Location:		Northern Parkway; 99th Ave to 87th Ave			Boring Location:		STA 14+00, 135' R ⁽⁴⁾	
Project Number:		2021 015			Coordinates:		N 33.54952°, W 112.26901°	
Logger - Firm:		M.Meza - Ethos Engineering, LLC			Surface Elevation (feet):		1,094	
Drill - Drilling Method:		CME -75; HOLLOW STEM AUGER			Groundwater Depth (feet):		N/A	
Driller - Firm:		A. Wright - ACS Services			Date(s):		8/22/2021	
Elev (feet)	Depth (feet)	Drill Rate (min/ft)	Sample Interval	Sample Type	Blowcounts	Firmness/ Density	Moisture	Description & USCS
1,089	1							1 1/4" ARFC, 10" PCCP. 4.5" AC
	2						Moist	Embankment Fill GRAVEL with SAND and CLAY (GP-GC) Fine Sub-Angular Gravel Some Fine to Medium Grained Sand Low to Medium Plasticity Brown
	3							
	4							
	5							
1,084	6			R	13-6 (19)	Firm	Moist	Embankment Fill CLAYEY TO SILTY SAND (SC-SM) Some Sub-Angular Fine Gravel Fine to Medium Grained Sand Low Plasticity Light Brown to Brown
	7							
	8			A		to		
	9							
	10			S	50/6"	Hard		Note: Probable native below 10' embankment Fill
1,079	11							
	12							
	13							Note: Occasional Cobbles at 13'
	14						Slightly Moist	GRAVEL with SAND and SILT (GP-GM) Occasional Cobbles Coarse Sub-Angular Gravel Some Medium Grained Sand Non Plastic Light Brown to Grey
	15			R	50/5"	Hard		
1,074	16			NR				
	17							
	18						Slightly Moist	GRAVEL with SAND (GP) Some (Sub-Angular) Cobbles Coarse (Sub-Angular) Gravel Some Medium Grained Sand No Plasticity Light Brown to Grey
	19			R	50/2"	Hard		
	20			NR				
1,069	21							Hollow Stem Auger Refusal at 19'
	22							Sampler Refused at 19' 2"
	23							Backfilled with Auger Cuttings
	24							ARFC, PCCP and AC Depth Grouted with Non Shrink High Strength Grout
	25							
		 Sample Type S - SPT Spoon Sampler R - Ring Sampler A - Auger Cuttings		Notes NR - No Recovery PR - Poor Recovery				

Project Name:		MCDOT NORTHERN PARKWAY			Boring Number:		NP-6	
Project Location:		Northern Parkway; 99th Ave to 87th Ave			Boring Location:		STA 15+00, 102' R ⁽⁴⁾	
Project Number:		2021 015			Coordinates:		N 33.54984°, W 112.26867°	
Logger - Firm:		M.Meza - Ethos Engineering, LLC			Surface Elevation (feet):		1,097	
Drill - Drilling Method:		CME -75; HOLLOW STEM AUGER			Groundwater Depth (feet):		N/A	
Driller - Firm:		A. Wright - ACS Services			Date(s):		8/22/2021	

Elev (feet)	Depth (feet)	Drill Rate (min/ft)	Sample Interval	Sample Type	Blowcounts	Firmness/ Density	Moisture	Description & USCS
1,092	1							1" ARFC; 10" PCCP; 4.5" AC
	2						Moist	Embankment Fill GRAVEL with SAND and SILT (GP-GM) Fine Sub-Angular Gravel Some Fine to Medium Grained Sand Low Plasticity Brown
	3						to	
	4							
	5							
1,087	6		X	S	13-34-45 (79)	Hard	Slightly Moist	Note: Trace sub-angular cobbles, light brown to gray below 5'
	7							
	8							
	9							Embankment Fill CLAYEY SAND (SC) Trace Sub-Angular Fine Gravel Fine to Medium Grained Sand Medium Plasticity Brown
	10			R	10-18 (28)	Firm	Moist	
1,082	11						Moist	Embankment Fill GRAVEL with SAND and CLAY (GP-GC) Coarse Sub-Angular Gravel Some Fine to Medium Grained Sand Medium Plasticity Brown Note: Probable native contact below 15'
	12						to	
	13			A				
	14							
	15				R	50/5"	Hard	Slightly Moist
1,077	16			NR				
	17							
	18							
	19							
	20				R	50/3"	Hard	CLAYEY SAND (SC) Some Sub-Angular Fine Gravel Predominate Fine Grained Sand Low to Medium Plasticity Light Brown
1,072	21			NR				
	22							
	23							
	24							
	25							

 Sample Type S - SPT Spoon Sampler R - Ring Sampler A - Auger Cuttings		Notes NR - No Recovery PR - Poor Recovery			
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Project Name:		MCDOT NORTHERN PARKWAY			Boring Number:		NP-6	
Project Location:		Northern Parkway; 99th Ave to 87th Ave			Boring Location:		STA 25+00, 75' R ⁽⁴⁾	
Project Number:		2021 015			Coordinates:		N 33.54984°, W 112.26867°	
Logger - Firm:		M.Meza - Ethos Engineering, LLC			Surface Elevation (feet):		1,097	
Drill - Drilling Method:		CME -75; HOLLOW STEM AUGER			Groundwater Depth (feet):		N/A	
Driller - Firm:		A. Wright - ACS Services			Date(s):		8/22/2021	

Elev (feet)	Depth (feet)	Drill Rate (min/ft)	Sample Interval	Sample Type	Blowcounts	Firmness/ Density	Moisture	Description & USCS
1,067	26			R PR	50/4" Bagged	Hard	Moist	CLAYEY SAND (SC) Cont.d
	27							
	28							
	29							
	30							
1,062	31			R PR	50/5" Bagged	Hard	Slightly Moist	GRAVEL with SAND and CLAY (GP-GC) Coarse Sub-Angular Gravel Some Fine to Medium Grained Sand Medium Plasticity Brown
	32							
	33							
	34							
	35							
1,057	36			R NR	50/3"			Note: Light Brown Note: Low to Medium Plasticity
	37							Hollow Stem Auger Stopped at 35 Feet Sampler Refused at 35' 3" Backfilled with Auger Cuttings ARFC, PCCP and AC Depth Grouted with Non Shrink High Strength Grout
	38							
	39							
	40							
1,052	41							
	42							
	43							
	44							
	45							
1,047	46							
	47							
	48							
	49							
	50							

	Sample Type	Notes	
	S - SPT Spoon Sampler	NR - No Recovery	
	R - Ring Sampler	PR - Poor Recovery	
	A - Auger Cuttings		

Project Name:		MCDOT NORTHERN PARKWAY			Boring Number:		NP-7	
Project Location:		Northern Parkway; 99th Ave to 87th Ave			Boring Location:		STA 17+00, 95'R ⁽⁴⁾	
Project Number:		2021 015			Coordinates:		N 33.55025°, W 112.26823°	
Logger - Firm:		M.Meza - Ethos Engineering, LLC			Surface Elevation (feet):		1,101	
Drill - Drilling Method:		CME -75; HOLLOW STEM AUGER			Groundwater Depth (feet):		N/A	
Driller - Firm:		NOEL - ACS Services			Date(s):		8/19/2021	

Elev (feet)	Depth (feet)	Drill Rate (min/ft)	Sample Interval	Sample Type	Blowcounts	Firmness/ Density	Moisture	Description & USCS
1,096	1							1" ARFC, 9" PCCP. 3.5" AC
	2						Moist	Embankment Fill GRAVEL with SAND and SILT (GP-GM) Fine Sub-Angular Gravel Some Medium to Coarse Grained Sand Low Plasticity Brown
	3							
	4							
	5							
1,091	6		X	S	17-28-18 (46)	Very Firm	Slightly Moist	Note: Trace Sub-Angular Cobbles at 5'6"
	7							
	8							
	9							Embankment Fill CLAYEY SAND (SC) Some Sub-Angular Fine Gravel Fine to Medium Grained Sand Medium Plasticity Brown Note: Trace cobbles from 11 to 12'
	10		X	S	19-35-34 (69)	Hard	Moist	
1,086	11							
	12							
	13							
	14							GRAVEL with SAND and SILTY CLAY (GP-GC) Coarse Sub-Angular Gravel Some Fine to Medium Grained Sand Low to Medium Plasticity Light Brown to Gray Note: Some sub-angular cobbles below 15.5'
	15			R	15-50/6" (65)	Hard	Slightly Moist	
1,081	16			NR				
	17							
	18							
	19							
	20						Slightly Moist	CLAYEY SAND (SC) Predominate (Sub-Angular) Fine Gravel Predominate Fine Grained Sand Medium Plasticity Brown Note: Some Sub-Angular Cobbles below 23'
21		X	S	10-24-26 (50)	Very Firm			
22								
23								
1,076	24							
	25							

 Sample Type S - SPT Spoon Sampler  R - Ring Sampler  A - Auger Cuttings		Notes NR - No Recovery PR - Poor Recovery	
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Project Name:		MCDOT NORTHERN PARKWAY			Boring Number:		NP-7	
Project Location:		Northern Parkway; 99th Ave to 87th Ave			Boring Location:		STA 17+00, 87°R ⁽⁴⁾	
Project Number:		2021 015			Coordinates:		N 33.55025°, W 112.26823°	
Logger - Firm:		M.Meza - Ethos Engineering, LLC			Surface Elevation (feet):		1,101	
Drill - Drilling Method:		CME -75; HOLLOW STEM AUGER			Groundwater Depth (feet):		N/A	
Driller - Firm:		NOEL - ACS Services			Date(s):		8/19/2021	

Elev (feet)	Depth (feet)	Drill Rate (min/ft)	Sample Interval	Sample Type	Blowcounts	Firmness/ Density	Moisture	Description & USCS
1,071	26			S	21-27-22 (49)	Very Firm	Moist	GRAVEL with SAND and CLAY (GP-GC) Some Sub-Angular Cobbles Coarse Gravel Some Fine Grained Sand Medium Plasticity Light Brown to Gray
	27							
	28							
	29							
	30							
1,066	31			R PR	13-50/3"	Hard		
	32							
	33							
1,061	34			S NR	50/0"			Hollow Stem Auger Refusal on Cobbles at 32' Sampler Refused at 32' 0" Backfilled with Auger Cuttings ARFC, PCCP and AC Depth Grouted with Non Shrink High Strength Grout
	35							
	36							
	37							
	38							
	39							
	40							
	41							
	42							
	43							
1,056	44							
	45							
	46							
	47							
	48							
	49							
1,051	50							

	Sample Type	Notes	
	S - SPT Spoon Sampler	NR - No Recovery	
	R - Ring Sampler	PR - Poor Recovery	
	A - Auger Cuttings		

Project Name:		MCDOT NORTHERN PARKWAY			Boring Number:		NP-8	
Project Location:		Northern Parkway; 99th Ave to 87th Ave			Boring Location:		STA 18+50, 90' R ⁽⁴⁾	
Project Number:		2021 015			Coordinates:		N 33.55056°, W 112.26793°	
Logger - Firm:		M.Meza - Ethos Engineering, LLC			Surface Elevation (feet):		1,090	
Drill - Drilling Method:		CME -75; HOLLOW STEM AUGER			Groundwater Depth (feet):		N/A	
Driller - Firm:		NOEL - ACS Services			Date(s):		8/19/2021	

Elev (feet)	Depth (feet)	Drill Rate (min/ft)	Sample Interval	Sample Type	Blowcounts	Firmness/ Density	Moisture	Description & USCS
1,085	1							1" ARFC, 9" PCCP. 4.5" AC
	2						Moist	Embankment Fill GRAVEL with SAND and SILT (GP-GM) Fine Sub-Angular Gravel Some Fine to Medium Grained Sand Low Plasticity Brown
	3						to	
	4							
	5							
1,080	6			R PR	39-50/5" Bagged	Hard	Slightly Moist	Note: Predominantly medium grained sand and light brown below 5' Note: Trace (sub-angular) cobbles below 7'
	7							
	8							
	9							
	10							
1,075	11			S	22-38-28 (66)	Hard	Moist	Embankment Fill: CLAYEY SAND (SC) Some Sub-Angular Fine Gravel Fine to Medium Grained Sand Medium Plasticity Brown
	12						Slightly Moist	SILTY CLAYEY SAND (SC-SM) Some Sub-Angular Fine Gravel Fine to Medium Grained Sand Low to Medium Plasticity Light Brown to Gray
	13							
	14							
	15			S	20-24-20 (44)	Very Firm	Moist	CLAY with GRAVEL (GC/CL) Fine (Sub-Angular) Gravel Some Fine to Medium Grained Sand Medium Plasticity Light Brown to Brown
1,070	16							
	17							
	18							
	19						Moist	CLAYEY SAND (SC) Some Fine (Sub-Angular) Gravel Predominantly Fine to Medium Grained Sand Medium Plasticity Brown
	20			S	15-26-31 (57)	Hard		
1,065	21							
	22							
	23							
	24			A				
	25							

 Sample Type S - SPT Spoon Sampler  R - Ring Sampler  A - Auger Cuttings		Notes NR - No Recovery PR - Poor Recovery	
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Project Name:		MCDOT NORTHERN PARKWAY			Boring Number:		NP-8	
Project Location:		Northern Parkway; 99th Ave to 87th Ave			Boring Location:		STA 18+50, 90' R ⁽⁴⁾	
Project Number:		2021 015			Coordinates:		N 33.55056°, W 112.26793°	
Logger - Firm:		M.Meza - Ethos Engineering, LLC			Surface Elevation (feet):		1,090	
Drill - Drilling Method:		CME -75; HOLLOW STEM AUGER			Groundwater Depth (feet):		N/A	
Driller - Firm:		NOEL - ACS Services			Date(s):		8/19/2021	

Elev (feet)	Depth (feet)	Drill Rate (min/ft)	Sample Interval	Sample Type	Blowcounts	Firmness/ Density	Moisture	Description & USCS
1,060	26			S	18-15-10 (25)	Firm	Moist	CLAYEY SAND (SC) Cont.d Note: Some sub-angular coarse gravel below 26' Note: Some sub-angular Cobbles below 27'
	27							
	28			S NR	50/1"	Hard	Moist	
	29							
	30							
1,055	31							Hollow stem auger refusal on Cobbles at 29 Feet Sampler Stopped at 29'1" Feet Backfilled with Auger Cuttings ARFC, PCCP and AC Depth Grouted with Non Shrink High Strength Grout
	32							
	33							
	34							
	35							
	36							
	37							
	38							
	39							
	40							
1,050	41							
	42							
	43							
	44							
	45							
	46							
	47							
	48							
	49							
	50							
1,045	45							
	46							
	47							
	48							
	49							
	50							
	51							
	52							
	53							
	54							
1,040	50							
	51							
	52							
	53							
	54							
	55							
	56							
	57							
	58							
	59							

	Sample Type	Notes	
	S - SPT Spoon Sampler	NR - No Recovery	
	R - Ring Sampler	PR - Poor Recovery	
	A - Auger Cuttings		

Project Name:		MCDOT NORTHERN PARKWAY				Boring Number:		NP-9	
Project Location:		Northern Parkway; 99th Ave to 87th Ave				Boring Location:		STA 35+20, 32' R ⁽⁵⁾	
Project Number:		2021 015				Coordinates:		N 33.55272°, W 112.26677°	
Logger - Firm:		M.Meza - Ethos Engineering, LLC				Surface Elevation (feet):		1,087	
Drill - Drilling Method:		CME -75; HOLLOW STEM AUGER				Groundwater Depth (feet):		N/A	
Driller - Firm:		J. KANIA - ACS				Date(s):		7/22/2021	

Elev (feet)	Depth (feet)	Drill Rate (min/ft)	Sample Interval	Sample Type	Blowcounts	Firmness/ Density	Moisture	Description & USCS
1,082	1			A	4-4-2 (6)		Dry to Slightly Moist	CLAYEY SAND (SC) Trace (Sub-Angular) Fine Gravel Low to Medium Plasticity Brown
	2							
	3							
	4			S		Soft	Slightly Moist	CLAYEY SAND (SC) Trace Sub-Angular Fine Gravel Fine to Medium Grained Sand Medium Plasticity Light Brown to Brown
	5							
	6							
1,077	7			R	4-6 (10)	Moderately Firm		Note: Some (Sub-Angular) Fine Gravel at 5.5' Hollow Stem Auger Stopped at 5' Sampler Stopped at 6' Backfilled with Auger Cuttings
	8							
	9							
	10							
	11							
	12							
	13							
	14							
	15							
	16							
	17							
	18							
1,072	19							
	20							
	21							
	22							
	23							
	24							
1,067	25							
1,062								

 S - SPT Spoon Sampler  R - Ring Sampler  A - Auger Cuttings	Notes NR - No Recovery PR - Poor Recovery	
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Project Name:		MCDOT NORTHERN PARKWAY			Boring Number:		NP-10	
Project Location:		Northern Parkway; 99th Ave to 87th Ave			Boring Location:		STA 207+80, 55' R ⁽⁶⁾	
Project Number:		2021 015			Coordinates:		N 33.55122°, W 112.26695°	
Logger - Firm:		M.Meza - Ethos Engineering, LLC			Surface Elevation (feet):		1,108	
Drill - Drilling Method:		CME -75; HOLLOW STEM AUGER (75°)			Groundwater Depth (feet):		N/A	
Driller - Firm:		R.Quezada - Resilient			Date(s):		8/17/2021	

Elev (feet)	Depth (feet)	Drill Rate (min/ft)	Sample Interval	Sample Type	Blowcounts	Firmness/ Density	Moisture	Description & USCS
	1							1" AR ACFC, 12" PCCP
	2						Slightly Moist	Embankment Fill GRAVEL with SAND and SILT (GP-GM) Fine Sub-Angular Gravel Some Fine to Medium Grained Sand Low Plasticity Brown
	3							
	4			A				
1,103	5							
	6							
	7							
	8						Moist	Embankment Fill GRAVEL with SAND (GP) Some Sub-Angular Cobbles Coarse Sub-Angular Gravel Some Fine to Medium Grained Sand Non Plastic Brown
1,098	9							
	10			S	8-11-15 (26)	Firm		Embankment Fill CLAYEY SAND (SC) Some Sub-Angular Fine Gravel Fine to Medium Grained Sand Low to Medium Plasticity Brown
	11						Moist	
	12							
	13							
	14							
1,093	15							
	16			R NR	15-26 (41)	Very Firm	Moist	Embankment Fill SANDY CLAY TO CLAYEY SAND (SC/CL) Trace Sub-Angular Gravel Fine Grained Sand Medium Plasticity Brown
	17							
	18							
	19							
1,088	20							
	21			R	15-21 (36)			
	22							
	23			A				
	24							
1,083	25							

 Sample Type S - SPT Spoon Sampler  R - Ring Sampler  A - Auger Cuttings		Notes NR - No Recovery PR - Poor Recovery			
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Project Name:		MCDOT NORTHERN PARKWAY			Boring Number:		NP-10	
Project Location:		Northern Parkway; 99th Ave to 87th Ave			Boring Location:		STA 207+80, 55' R ⁽⁶⁾	
Project Number:		2021 015			Coordinates:		N 33.55122°, W 112.26695°	
Logger - Firm:		M.Meza - Ethos Engineering, LLC			Surface Elevation (feet):		1,108	
Drill - Drilling Method:		CME -75; HOLLOW STEM AUGER (75°)			Groundwater Depth (feet):		N/A	
Driller - Firm:		R.Quezada - Resilient			Date(s):		8/17/2021	

Elev (feet)	Depth (feet)	Drill Rate (min/ft)	Sample Interval	Sample Type	Blowcounts	Firmness/ Density	Moisture	Description & USCS
1,078	26			S	12-12-18 (30)	Firm	Moist	CLAY (CL) Trace (Sub-Angular) Fine Gravel Some Fine Grained Sand High Plasticity Brown
	27							
	28							
	29							
	30							
1,073	31			S	7-12-16 (28)	Firm	Moist	SANDY CLAY (SC/CL) Occassional Sub-Angular Fine Gravel Predominantly Fine to Medium Grained Sand Medium Plasticity Brown
	32							
	33							
	34							
	35							
1,068	36			R	10-50/6" (60)	Very Dense	Moist	CLAYEY SAND (SC) Some Sub-Angular Fine Gravel Fine to Medium Grained Sand Medium Plasticity Brown
	37							
	38							
	39							
	40							
1,063	41			S	10-50/6" (60)	Slightly Moist	Moist	GRAVELS with SAND (GP) Trace Cobbles Predominantly Medium to Coarse Grained Sand Non Plastic Light Brown
	42							
	43							
	44							
	45							
1,058	46			S	10-19-36 (55)	Hard	Moist	SANDY CLAY (SC/CL) Trace (Sub-Angular) Fine Gravel Predominantly Fine Grained Sand Medium Plasticity Brown
	47							
	48							
	49							
	50							
				S	10-50/3"	Very Dense	Slightly Moist	SAND with SILT (SP-SM) Some Sub-Angular Fine Gravel Fine to Medium Grained Sand Low Plasticity Brown

	Sample Type S - SPT Spoon Sampler R - Ring Sampler A - Auger Cuttings	Notes NR - No Recovery PR - Poor Recovery	Hollow Stem Auger Stopped at 50 Feet Sampler Stopped at 50'9" Backfilled with Auger Cuttings ARFC, PCCP and AC Depth Grouted with Non Shrink High Strength Grout	
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Project Name:		MCDOT NORTHERN PARKWAY			Boring Number:		NP-11	
Project Location:		Northern Parkway; 99th Ave to 87th Ave			Boring Location:		STA 309+87, 66'L ⁽³⁾	
Project Number:		2021 015			Coordinates:		N 33.55181°, W 112.26628°	
Logger - Firm:		M.Meza - Ethos Engineering, LLC			Surface Elevation (feet):		1,108	
Drill - Drilling Method:		CME -75; HOLLOW STEM AUGER (75°)			Groundwater Depth (feet):		N/A	
Driller - Firm:		R.Quezada - Resilient			Date(s):		8/17/2021	

Elev (feet)	Depth (feet)	Drill Rate (min/ft)	Sample Interval	Sample Type	Blowcounts	Firmness/ Density	Moisture	Description & USCS
	1							1" ARFC, 13 1/2" PCCP
	2						Slightly Moist	EMBANKMENT FILL: GRAVEL with SAND and SILT (GP-GM) Fine Sub-Angular Gravel Some Fine to Medium Grained Sand Low Plasticity Brown
	3							
	4							
1,103	5							
	6							
	7						Slightly Moist	EMBANKMENT FILL: GRAVEL with SAND (GP) Some Sub-Angular Cobbles Coarse Sub-Angular Gravel Some Fine to Medium Grained Sand Non Plastic Brown
	8							
	9							
1,098	10			S	50/4"	Hard		
	11							
	12							
	13							
	14							
1,093	15			S	21-50/5"	Very Firm	Moist	EMBANKMENT FILL: GRAVEL with SAND and SILT (GP-GM) Fine Sub-Angular Gravel Some Medium to Coarse Grained Sand Low Plasticity Brown
	16							
	17							
	18							EMBANKMENT FILL: CLAYEY SAND (SC) Some Sub-Angular Fine Gravel Medium Grained Sand Medium Plasticity Brown
	19							
1,088	20			R NR	33-13 (46)	Very Firm	Moist	
	21							
	22							
	23			A				
	24							
1,083	25							

 S - SPT Spoon Sampler  R - Ring Sampler  A - Auger Cuttings	Notes NR - No Recovery PR - Poor Recovery	
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Project Name:		MCDOT NORTHERN PARKWAY			Boring Number:		NP-11	
Project Location:		Northern Parkway; 99th Ave to 87th Ave			Boring Location:		STA 309+87, 66'L ⁽³⁾	
Project Number:		2021 015			Coordinates:		N 33.55181°, W 112.26628°	
Logger - Firm:		M.Meza - Ethos Engineering, LLC			Surface Elevation (feet):		1,108	
Drill - Drilling Method:		CME -75; HOLLOW STEM AUGER (75°)			Groundwater Depth (feet):		N/A	
Driller - Firm:		R.Quezada - Resilient			Date(s):		8/17/2021	

Elev (feet)	Depth (feet)	Drill Rate (min/ft)	Sample Interval	Sample Type	Blowcounts	Firmness/ Density	Moisture	Description & USCS	
1,078	26			R	17-25 (42)	Very Firm	Moist	CLAYEY SAND (SC) Some Sub-Angular Fine Gravel Medium Grained Sand Medium Plasticity Brown	
	27								
	28								
	29								
	30								
1,073	31		X	S	15-17-22 (39)	Very Firm		SANDY CLAY (SC/CL) Some Sub-Angular Fine Gravel Predominantly Fine to Medium Grained Sand Medium Plasticity Brown	
	32								
	33								
	34								
	35								
1,068	36		X	S	10-50/4"	Hard	Moist	SILTY CLAYEY SAND (SC-SM) Some Sub-Angular Fine Gravel Fine to Medium Grained Sand Low to Medium Plasticity Brown	
	37								
	38								
	39								
	40								
1,063	41		X	S	10-28-50/4"	Hard	Slightly Moist	CLAYEY SAND (SC) Some Sub-Rounded Fine Gravel Fine to Medium Grained Sand Medium Plasticity Brown	
	42								
	43								
	44								
	45								
1,058	46		X	S	11-50/4"	Hard	Moist	GRAVEL with SAND and CLAY (GP-GC) Coarse Sub-Angular Gravel Some Fine to Medium Grained Sand Medium Plasticity Brown	
	47								
	48								
	49								
	50								
			50-50'1"	S	50/1"	Hard			

  	Sample Type S - SPT Spoon Sampler R - Ring Sampler A - Auger Cuttings	Notes NR - No Recovery PR - Poor Recovery	Hollow Stem Auger Stopped at 50' Sampler Stopped at 50'1" Backfilled with Auger Cuttings ARFC, PCCP and AC Depth Grouted with Non Shrink High Strength Grout	
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Project Name:		MCDOT NORTHERN PARKWAY			Boring Number:		NP-12	
Project Location:		Northern Parkway; 99th Ave to 87th Ave			Boring Location:		STA 26+10, 5' L ⁽⁷⁾	
Project Number:		2021 015			Coordinates:		N 33.55030°, W 112.26620°	
Logger - Firm:		M.Meza - Ethos Engineering, LLC			Surface Elevation (feet):		1,085	
Drill - Drilling Method:		CME -75; HOLLOW STEM AUGER			Groundwater Depth (feet):		N/A	
Driller - Firm:		J. KANIA - ACS			Date(s):		7/22/2021	

Elev (feet)	Depth (feet)	Drill Rate (min/ft)	Sample Interval	Sample Type	Blowcounts	Firmness/ Density	Moisture	Description & USCS
1,080	1			A	4-4-4 (8)	Soft to Firm	Slightly Moist	CLAYEY TO SILTY SAND (SC-SM) Occasional Sub-Angular Fine Gravel Fine to Medium Grained Sand Low to Medium Plasticity Brown
	2							
	3							
	4							
	5							
	6							
1,075	7			S			Moist	
	8							
	9							
	10							
	11							
	12							
	13							
	14							
	15							
	16							
1,070	17							
	18							
	19							
	20							
	21							
	22							
	23							
	24							
	25							
	26							
1,065	27							
	28							
	29							
	30							
	31							
	32							
	33							
	34							
	35							
	36							
1,060	37							
	38							
	39							
	40							
	41							
	42							
	43							
	44							
	45							
	46							

	Sample Type	Notes	
	S - SPT Spoon Sampler	NR - No Recovery	
	R - Ring Sampler	PR - Poor Recovery	
	A - Auger Cuttings		

Project Name:		MCDOT NORTHERN PARKWAY			Boring Number:		NP-13	
Project Location:		Northern Parkway; 99th Ave to 87th Ave			Boring Location:		STA 314+40, 29' R ⁽⁶⁾	
Project Number:		2021 015			Coordinates:		N 33.55137°, W 112.26484°	
Logger - Firm:		M.Meza - Ethos Engineering, LLC			Surface Elevation (feet):		1,088	
Drill - Drilling Method:		CME -75; HOLLOW STEM AUGER			Groundwater Depth (feet):		N/A	
Driller - Firm:		J. KANIA - ACS			Date(s):		7/22/2021	

Elev (feet)	Depth (feet)	Drill Rate (min/ft)	Sample Interval	Sample Type	Blowcounts	Firmness/ Density	Moisture	Description & USCS
1,083	1			A	7-10 (17)	Firm	Slightly Moist	CLAYEY SAND (SC) Some Sub-Angular Fine Gravel Fine to Medium Grained Sand Medium to Low Plasticity Brown
	2							
	3		R	Moist				
	4							
	5		S					
	6							
1,078	7							Hollow Stem Auger Stopped at 5' Sampler Stopped at 6'6" Backfilled with Auger Cuttings
	8							
	9							
	10							
	11							
	12							
	13							
	14							
	15							
	16							
1,073	17							
	18							
	19							
	20							
	21							
	22							
	23							
	24							
1,068	25							
1,063								

 	Sample Type S - SPT Spoon Sampler R - Ring Sampler A - Auger Cuttings	Notes NR - No Recovery PR - Poor Recovery	
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Project Name:		MCDOT NORTHERN PARKWAY			Boring Number:		NP-14	
Project Location:		Northern Parkway; 99th Ave to 87th Ave			Boring Location:		STA 45+72, 26' L ⁽⁸⁾	
Project Number:		2021 015			Coordinates:		N 33.55248°, W 112.26447°	
Logger - Firm:		M.Meza - Ethos Engineering, LLC			Surface Elevation (feet):		1,093	
Drill - Drilling Method:		CME -75; HOLLOW STEM AUGER			Groundwater Depth (feet):		N/A	
Driller - Firm:		J. KANIA - ACS			Date(s):		7/22/2021	

Elev (feet)	Depth (feet)	Drill Rate (min/ft)	Sample Interval	Sample Type	Blowcounts	Firmness/ Density	Moisture	Description & USCS
1,088	1			A	6-6-7 (13)	Moderately Firm	Slightly Moist	CLAYEY SAND (SC)
	2							Trace Sub-Angular Fine Gravel
	3							Fine to Medium Grained Sand
	4							Medium to Low Plasticity
	5							Light Brown to Brown
1,083	6			S	7-8-10 (18)	Firm	Slightly Moist	CLAYEY SAND (SC)
	7							Occasional Angular Fine Gravel
	8							Fine Grained Sand
	9							Weakly Lime Cemented
	10							Medium Plasticity
1,078	11							SANDY CLAY (SC/CL)
	12							Occasional Sub-Angular Fine Gravel
	13							Fine Grained Sand
	14							Weakly Lime Cemented
	15							Medium Plasticity
1,073	16							Light Brown to Brown
	17							
	18							
	19							
	20							
1,068	21							
	22							
	23							
	24							
	25							

	Sample Type	Notes	
	S - SPT Spoon Sampler	NR - No Recovery	
	R - Ring Sampler	PR - Poor Recovery	
	A - Auger Cuttings		

Project Name:		MCDOT NORTHERN PARKWAY			Boring Number:		NP-15	
Project Location:		Northern Parkway; 99th Ave to 87th Ave			Boring Location:		STA 133+72, 44' R	
Project Number:		2021 015			Coordinates:		N 33.55147°, W 112.26235°	
Logger - Firm:		M.Meza - Ethos Engineering, LLC			Surface Elevation (feet):		1,091	
Drill - Drilling Method:		CME -75; HOLLOW STEM AUGER			Groundwater Depth (feet):		N/A	
Driller - Firm:		A. WRIGHT- ACS			Date(s):		8/2/2021	

Elev (feet)	Depth (feet)	Drill Rate (min/ft)	Sample Interval	Sample Type	Blowcounts	Firmness/ Density	Moisture	Description & USCS
1,086	1			A	5-8-9 (17)	Firm	Slightly Moist	SILTY CLAY TO CLAYEY SILT (CL-ML) Occasional Sub-Angular Fine Gravel Fine Grained Sand Weakly Lime Cemented Low to Medium Plasticity Brown
	2							
	3							
	4							
	5							
1,081	6			S	8-9-9 (18)	Firm	Slightly Moist	SANDY CLAY (SC/CL) Trace Sub-Angular Fine Gravel Predominantly Fine to Medium Grained Sand Weakly Lime Cemented Low to Medium Plasticity Light Brown to Brown
	7							
	8							
	9							
	10							
1,076	11							Hollow Stem Auger Stopped at 5' Sampler Stopped at 6'6" Backfilled with Auger Cuttings
	12							
	13							
	14							
	15							
1,071	16							
	17							
	18							
	19							
	20							
	21							
	22							
	23							
	24							
	25							
1,066								

	Sample Type	Notes	
	S - SPT Spoon Sampler	NR - No Recovery	
	R - Ring Sampler	PR - Poor Recovery	
	A - Auger Cuttings		

Project Name:		MCDOT NORTHERN PARKWAY			Boring Number:		NP-16	
Project Location:		Northern Parkway; 99th Ave to 87th Ave			Boring Location:		STA 140+60, 68' R	
Project Number:		2021 015			Coordinates:		N 33.55143°, W 112.26010°	
Logger - Firm:		M.Meza - Ethos Engineering, LLC			Surface Elevation (feet):		1,092	
Drill - Drilling Method:		CME -75; HOLLOW STEM AUGER			Groundwater Depth (feet):		N/A	
Driller - Firm:		A.WRIGHT - ACS DRILLING SERVICES			Date(s):		8/3/2021	

Elev (feet)	Depth (feet)	Drill Rate (min/ft)	Sample Interval	Sample Type	Blowcounts	Firmness/ Density	Moisture	Description & USCS
	1			A	7-8-9 (17)	Firm	Moist	CLAYEY SAND (SC) Trace Sub-Angular Fine Gravel Fine to Medium Grained Sand Medium Plasticity Brown to Dark Brown
	2							
	3							
	4							
1,087	5							Hollow Stem Auger Stopped at 3'6" Sampler Stopped at 4' Backfilled with Auger Cuttings
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
1,077	20							
21								
22								
23								
24								
1,072	25							
1,067	25							

	Sample Type	Notes	
	S - SPT Spoon Sampler	NR - No Recovery	
	R - Ring Sampler	PR - Poor Recovery	
	A - Auger Cuttings		

Project Name:		MCDOT NORTHERN PARKWAY				Boring Number:		NP-17	
Project Location:		Northern Parkway; 99th Ave to 87th Ave				Boring Location:		STA 149+55, 41' R	
Project Number:		2021 015				Coordinates:		N 33.55157°, W 112.25715°	
Logger - Firm:		M.Meza - Ethos Engineering, LLC				Surface Elevation (feet):		1,095	
Drill - Drilling Method:		CME -75; HOLLOW STEM AUGER				Groundwater Depth (feet):		N/A	
Driller - Firm:		A. WRIGHT- ACS				Date(s):		8/2/2021	

Elev (feet)	Depth (feet)	Drill Rate (min/ft)	Sample Interval	Sample Type	Blowcounts	Firmness/ Density	Moisture	Description & USCS
1,090	1			A			Slightly Moist to Moist	CLAYEY SAND (SC) Trace Sub-Angular Fine Gravel Fine to Medium Grained Sand Weakly Lime Cemented Low to Medium Plasticity Brown Note: Some (Sub-Angular) Fine Gravel at 5'
	2							
	3							
	4							
	5							
	6							
1,085	7							Hollow Stem Auger Stopped at 5' Sampler Stopped at 6' Backfilled with Auger Cuttings
	8							
	9							
	10							
	11							
	12							
	13							
	14							
	15							
	16							
	17							
	18							
1,080	15							
	16							
	17							
	18							
	19							
	20							
1,075	20							
	21							
	22							
	23							
	24							
	25							
1,070	25							

 S - SPT Spoon Sampler  R - Ring Sampler  A - Auger Cuttings	Notes NR - No Recovery PR - Poor Recovery	
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Project Name:		MCDOT NORTHERN PARKWAY			Boring Number:		NP-18	
Project Location:		Northern Parkway; 99th Ave to 87th Ave			Boring Location:		STA 155+25, 42' R	
Project Number:		2021 015			Coordinates:		N 33.55160°, W 112.25529°	
Logger - Firm:		M.Meza - Ethos Engineering, LLC			Surface Elevation (feet):		1,097	
Drill - Drilling Method:		CME -75; HOLLOW STEM AUGER			Groundwater Depth (feet):		N/A	
Driller - Firm:		A. WRIGHT- ACS			Date(s):		8/2/2021	

Elev (feet)	Depth (feet)	Drill Rate (min/ft)	Sample Interval	Sample Type	Blowcounts	Firmness/ Density	Moisture	Description & USCS
1,092	1			A	5-5 (10)	Moderately Firm	Slightly Moist	CLAYEY SAND (SC) Trace Sub-Angular Fine Gravel Fine to Medium Grained Sand Weakly Lime Cemented Medium Plasticity Light Brown Note: Brown at 5'
	2						to	
	3			R			Moist	
	4							
	5		S	5-6-8 (14)				
	6							
1,087	7							Hollow Stem Auger Stopped at 5' Sampler Stopped at 6'6" Backfilled with Auger Cuttings
	8							
	9							
	10							
	11							
	12							
	13							
	14							
	15							
	16							
	17							
1,077	20							
	21							
	22							
	23							
	24							
	25							
	25							

	Sample Type	Notes	
	S - SPT Spoon Sampler	NR - No Recovery	
	R - Ring Sampler	PR - Poor Recovery	
	A - Auger Cuttings		

Project Name:		MCDOT NORTHERN PARKWAY			Boring Number:		NP-19	
Project Location:		Northern Parkway; 99th Ave to 87th Ave			Boring Location:		STA 19+75, 5' R ⁽⁹⁾	
Project Number:		2021 015			Coordinates:		N 33.55254°, W 112.25500°	
Logger - Firm:		M.Meza - Ethos Engineering, LLC			Surface Elevation (feet):		1,097	
Drill - Drilling Method:		Hollow Stem Hand Auger			Groundwater Depth (feet):		N/A	
Driller - Firm:		M. Meza - Ethos Engineering			Date(s):		8/27/2021	

Elev (feet)	Depth (feet)	Drill Rate (min/ft)	Sample Interval	Sample Type	Blowcounts	Firmness/ Density	Moisture	Description & USCS
1,092	1			A			Slightly Moist	6" Landscape Gravel
	2							CLAYEY SAND (SC)
	3							Trace Sub-Angular Fine Gravel
	4							Fine to Medium Grained Sand
	5							Low Plasticity Light Brown to Brown
1,087	6							Hollow Stem Auger Stopped at 5'
	7							Backfilled with Auger Cuttings
	8							Topped with Landscaping Gravel
	9							
	10							
	11							
	12							
	13							
	14							
	15							
1,077	16							
	17							
	18							
	19							
	20							
	21							
	22							
	23							
	24							
	25							

	Sample Type	Notes	
	S - SPT Spoon Sampler	NR - No Recovery	
	R - Ring Sampler	PR - Poor Recovery	
	A - Auger Cuttings		

Project Name:		MCDOT NORTHERN PARKWAY			Boring Number:		NP-20	
Project Location:		Northern Parkway; 99th Ave to 87th Ave			Boring Location:		STA 13+30, 19' L ⁽⁹⁾	
Project Number:		2021 015			Coordinates:		N 33.55076°, W 112.25507°	
Logger - Firm:		M.Meza - Ethos Engineering, LLC			Surface Elevation (feet):		1,095	
Drill - Drilling Method:		CME-75 - Hollow Stem Auger			Groundwater Depth (feet):		N/A	
Driller - Firm:		Noel - ACS Services			Date(s):		8/26/2021	

Elev (feet)	Depth (feet)	Drill Rate (min/ft)	Sample Interval	Sample Type	Blowcounts	Firmness/ Density	Moisture	Description & USCS
1,090	1			A	6-8 (14)	Moderately Firm	Moist	3" ASPHALT ; 5" AGGREGATE BASE
	2							CLAYEY SAND (SC) Trace Sub-Angular Fine Gravel Predominantly Fine Grained Sand Low to Medium Plasticity Brown
	3		R					
	4							
	5		R					
1,085	6			R	4-7 (11)	Moderately Firm	Moist	CLAYEY SAND (SC) Trace Sub-Rounded Fine Gravel Fine Grained Sand Medium Plasticity Brown
	7							Hollow Stem Auger Stopped at 5' Sampler Stopped at 6' Backfilled with Auger Cuttings Patched with Cold Patch Asphalt
	8							
	9							
	10							
	11							
	12							
	13							
	14							
	15							
16								
1,075	17							
	18							
	19							
	20							
	21							
	22							
	23							
	24							
1,070	25							

	Sample Type	Notes	
	S - SPT Spoon Sampler	NR - No Recovery	
	R - Ring Sampler	PR - Poor Recovery	
	A - Auger Cuttings		

Project Name:		MCDOT NORTHERN PARKWAY			Boring Number:		NP-21	
Project Location:		Northern Parkway; 99th Ave to 87th Ave			Boring Location:		STA 162+54, 28' R	
Project Number:		2021 015			Coordinates:		N 33.55170°, W 112.25289°	
Logger - Firm:		M.Meza - Ethos Engineering, LLC			Surface Elevation (feet):		1,097	
Drill - Drilling Method:		CME-75 - Hollow Stem Auger			Groundwater Depth (feet):		N/A	
Driller - Firm:		Noel - ACS Services			Date(s):		8/26/2021	

Elev (feet)	Depth (feet)	Drill Rate (min/ft)	Sample Interval	Sample Type	Blowcounts	Firmness/ Density	Moisture	Description & USCS
1,092	1			A	4-8 (12)	Moderately Firm to	Moist	4" ASPHALT ; 6" AGGREGATE BASE
	2							CLAYEY SAND (SC) Occasional Sub-Rounded Fine Gravel Fine to Medium Grained Sand Medium Plasticity Light Brown to Brown
	3		R					
	4							
	5			R	12-13 (25)	Firm		Note: Some (Sub-Rounded) Fine Gravel at 5' Note: Weakly Lime Cemented at 5'
	6							
1,087	7							Hollow Stem Auger Stopped at 5' Sampler Stopped at 6' Backfilled with Auger Cuttings Patched with Cold Patch Asphalt
	8							
	9							
	10							
	11							
	12							
	13							
	14							
	15							
	16							
1,077	17							
	18							
	19							
	20							
	21							
	22							
	23							
	24							
1,072	25							

	Sample Type	Notes	
	S - SPT Spoon Sampler	NR - No Recovery	
	R - Ring Sampler	PR - Poor Recovery	
	A - Auger Cuttings		

Project Name:		MCDOT NORTHERN PARKWAY			Boring Number:		NP-22	
Project Location:		Northern Parkway; 99th Ave to 87th Ave			Boring Location:		STA 169+15, 72' R	
Project Number:		2021 015			Coordinates:		N 33.55162°, W 112.25073°	
Logger - Firm:		M.Meza - Ethos Engineering, LLC			Surface Elevation (feet):		1,100	
Drill - Drilling Method:		CME -75; HOLLOW STEM AUGER			Groundwater Depth (feet):		N/A	
Driller - Firm:		A. WRIGHT- ACS			Date(s):		8/2/2021	

Elev (feet)	Depth (feet)	Drill Rate (min/ft)	Sample Interval	Sample Type	Blowcounts	Firmness/ Density	Moisture	Description & USCS
1,095	1			A	10-18-19 (37)	Very Firm	Moist	SANDY CLAY (SC/CL) Occasional Sub-Angular Fine Gravel Fine to Medium Grained Sand Weakly Lime Cemented Medium Plasticity Brown
	2							
	3							
	4							
	5							
1,090	6			S	10-15-16 (31)	Very Firm	Moist	CLAYEY SAND (SC) Trace Sub-Rounded Gravel Fine to Medium Grained Sand Weakly Lime Cemented Highly Plasticity Light Brown
	7							
	8							
	9							
	10							
1,085	11							Hollow Stem Auger Stopped at 5' Sampler Stopped at 6'6" Backfilled with Auger Cuttings
	12							
	13							
	14							
	15							
1,080	16							
	17							
	18							
	19							
	20							
1,075	21							
	22							
	23							
	24							
	25							

	Sample Type	Notes	
	S - SPT Spoon Sampler	NR - No Recovery	
	R - Ring Sampler	PR - Poor Recovery	
	A - Auger Cuttings		

Project Name:		MCDOT NORTHERN PARKWAY			Boring Number:		NP-23	
Project Location:		Northern Parkway; 99th Ave to 87th Ave			Boring Location:		STA 181+02, 46'R	
Project Number:		2021 015			Coordinates:		N 33.55177°, W 112.24683°	
Logger - Firm:		M.Meza - Ethos Engineering, LLC			Surface Elevation (feet):		1,099	
Drill - Drilling Method:		Hollow Stem Hand Auger			Groundwater Depth (feet):		N/A	
Driller - Firm:		M. Meza - Ethos Engineering			Date(s):		8/27/2021	

Elev (feet)	Depth (feet)	Drill Rate (min/ft)	Sample Interval	Sample Type	Blowcounts	Firmness/Density	Moisture	Description & USCS
1,094	1			A			Slightly Moisture	6" Landscape Gravel
	2							SILTY SAND (SM) Some Sub-Angular Fine Gravel Fine to Medium Grained Sand Low Plasticity Light Brown
	3							
	4							
	5							
1,089	6							Hollow Stem Auger Stopped at 5' Backfilled with Auger Cuttings Topped with Landscaping Gravel
	7							
	8							
	9							
	10							
	11							
	12							
	13							
	14							
	15							
1,084	16							
	17							
	18							
	19							
	20							
	21							
	22							
	23							
	24							
	25							
1,079	20							
1,074	25							

		Sample Type S - SPT Spoon Sampler R - Ring Sampler A - Auger Cuttings	Notes NR - No Recovery PR - Poor Recovery	
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Project Name:		MCDOT NORTHERN PARKWAY			Boring Number:		NP-24	
Project Location:		Northern Parkway; 99th Ave to 87th Ave			Boring Location:		STA 16+05, 2' L ⁽¹⁰⁾	
Project Number:		2021 015			Coordinates:		N 33.55040°, W 112.25069°	
Logger - Firm:		M.Meza - Ethos Engineering, LLC			Surface Elevation (feet):		1,096	
Drill - Drilling Method:		CME -75; HOLLOW STEM AUGER			Groundwater Depth (feet):		N/A	
Driller - Firm:		A. WRIGHT- ACS			Date(s):		8/3/2021	

Elev (feet)	Depth (feet)	Drill Rate (min/ft)	Sample Interval	Sample Type	Blowcounts	Firmness/ Density	Moisture	Description & USCS
1,091	1			A	3-5-7 (12)	Moderately Firm	Moist	SANDY CLAY (SC/CL) Occasional Sub-Angular Fine Gravel Fine Grained Sand Weakly Lime Cemented Medium Plasticity Brown
	2			S			Slightly Moist	CLAYEY SAND (SC) Trace Sub-Rounded Fine Gravel Fine to Medium Grained Sand Weakly Lime Cemented
	3							
	4							
	5			S			to Firm	to Moist
1,086	6				11-11-17 (28)			Hollow Stem Auger Stopped at 5' Sampler Stopped at 6'6" Backfilled with Auger Cuttings
	7							
	8							
	9							
	10							
1,081	11							
	12							
	13							
	14							
	15							
1,076	16							
	17							
	18							
	19							
	20							
1,071	21							
	22							
	23							
	24							
	25							

	Sample Type	Notes	
	S - SPT Spoon Sampler	NR - No Recovery	
	R - Ring Sampler	PR - Poor Recovery	
	A - Auger Cuttings		

Project Name:		MCDOT NORTHERN PARKWAY			Boring Number:		P-1	
Project Location:		Northern Parkway; 99th Ave to 87th Ave			Boring Location:		STA 16+00, 350' L ⁽²⁾	
Project Number:		2021 015			Coordinates:		N 33.54803°, W 112.27405°	
Logger - Firm:		M.Meza - Ethos Engineering, LLC			Surface Elevation (feet):		1,077	
Drill - Drilling Method:		John Deere JD 310 - Test Pits			Groundwater Depth (feet):		N/A	
Driller - Firm:		A. Wright - ACS DRILLING SERVICES			Date(s):		7/29/2021	

Elev (feet)	Depth (feet)	Drill Rate (min/ft)	Sample Interval	Sample Type	Blowcounts	Firmness/ Density	Moisture	Description & USCS
1,072	1			A			Moist	SILTY SAND WITH GRAVEL (SM) Poorly Graded Sub-Angular Gravel Predominantly Medium Grained Sand Non Plastic Light Brown Note: Occasional (Sub-Angular) Cobbles at 2.5'
	2							
	3							
	4							
	5		A	Moist			SILTY SAND with GRAVEL (SM) Some Sub-Angular Cobbles Some Coarse Sub-Angular Gravel Fine to Medium Grained Sand Non Plastic Light Brown to brown Note: Considerable cobbles below 7.5'	
	6							
	7							
	8							
1,067	9							Backhoe Resusal at 8 Feet Backfilled with Excavated Material
	10							
	11							
	12							
	13							
	14							
	15							
	16							
	17							
	18							
	19							
	20							
1,057	21							
	22							
	23							
	24							
	25							
1,052								

 Sample Type S - SPT Spoon Sampler R - Ring Sampler A - Auger Cuttings		Notes NR - No Recovery PR - Poor Recovery			
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Project Name:		MCDOT NORTHERN PARKWAY			Boring Number:		P-2	
Project Location:		Northern Parkway; 99th Ave to 87th Ave			Boring Location:		STA 16+00, 485' L ⁽²⁾	
Project Number:		2021 015			Coordinates:		N 33.54803°, W 112.27360°	
Logger - Firm:		M.Meza - Ethos Engineering, LLC			Surface Elevation (feet):		1,076	
Drill - Drilling Method:		John Deere JD 310 - Test Pits			Groundwater Depth (feet):		N/A	
Driller - Firm:		A. Wright - ACS DRILLING SERVICES			Date(s):		7/29/2021	

Elev (feet)	Depth (feet)	Drill Rate (min/ft)	Sample Interval	Sample Type	Blowcounts	Firmness/ Density	Moisture	Description & USCS
1,071	1			A			Moist	SILTY SAND (SM) Occasional Sub-Rounded Cobbles Some Poorly Graded Sub-Rounded Gravel Medium to Fine Grained Sand Non Plastic Brown
	2							
	3							
	4							
	5			A			Moist	SANDY CLAY (CL) Trace Sub-Rounded Cobbles Trace Poorly Graded Sub-Rounded Gravel Medium to Low Plasticity Brown
	6							
	7							
	8							
	9							
1,066	10							Note: Considerable cobbles at 10' Stopped Digging at 10' Backfilled with Excavated Material
	11							
	12							
	13							
	14							
	15							
	16							
	17							
	18							
	19							
	20							
1,056	21							
	22							
	23							
	24							
	25							
1,051								

	Sample Type	Notes	
	S - SPT Spoon Sampler	NR - No Recovery	
	R - Ring Sampler	PR - Poor Recovery	
	A - Auger Cuttings		

Project Name:		MCDOT NORTHERN PARKWAY			Boring Number:		ADD-1	
Project Location:		Northern Parkway; 99th Ave to 87th Ave			Boring Location:		308+90, 65' L ⁽³⁾	
Project Number:		2021 015			Coordinates:		N 33.55177°, W 112.26666°	
Logger - Firm:		M.Meza - Ethos Engineering, LLC			Surface Elevation (feet):		1,108	
Drill - Drilling Method:		CME-75; Hollow Stem Auger			Groundwater Depth (feet):		N/A	
Driller - Firm:		O. Mariscal - Resilient			Date(s):		11/8/2022	

Elev (feet)	Depth (feet)	Drill Rate (min/ft)	Sample Interval	Sample Type	Blowcounts	Firmness/ Density	Moisture	Description & USCS
1,103	1							1.75" AR ACFC, 11.25" PCCP
	2						Slightly Moist	Embankment Fill GRAVEL with SAND and SILT (GP-GM) Poorly Graded Sub-Angular Gravel Some Well Graded Sand Non Plastic Brown to Dark Brown Note: Increased Sand, Color Change of Light Brown to Brown Below 5'
	3							
	4			R	12-22 (34)	Medium Dense		
	5					to	to	
1,098	6			S	9-17-23 (40)	Dense	Moist	
	7							
	8							
	9							
	10			S	13-23-25 (48)		Moist	Embankment Fill Gravel with Sand (GP) Poorly Graded Subangular Gravel Some to Considerable Medium to Coarse Grained Sand Non Plastic Light Brown to Brown
1,093	11							
	12							
	13							
	14					Firm	Moist	Embankment Fill Silty, Clayey Sand (SC-SM) Some Poorly Graded Subangular Gravel Predominantly Fine to Medium Grained Sand Low Plasticity Brown
	15			S	6-12-14 (26)			
1,088	16							
	17							
	18							
	19							
	20			R	16-23 (39)	Firm	Moist	Clayey Sand (SC) Some Subangular Gravel Fine to Medium Grained Sand Medium Plasticity Brown
1,083	21							
	22							
	23							
	24							
	25							

Sample Type  S - SPT Spoon Sampler  R - Ring Sampler  A - Auger Cuttings		Notes NR - No Recovery PR - Poor Recovery			
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Project Name:		MCDOT NORTHERN PARKWAY			Boring Number:		ADD-1	
Project Location:		Northern Parkway; 99th Ave to 87th Ave			Boring Location:		STA 303+90, 65' L	
Project Number:		2021 015			Coordinates:		N 33.55177°, W 112.26666°	
Logger - Firm:		M.Meza - Ethos Engineering, LLC			Surface Elevation (feet):		1,108	
Drill - Drilling Method:		CME-75; Hollow Stem Auger			Groundwater Depth (feet):		N/A	
Driller - Firm:		O. Mariscal - Resilient			Date(s):		11/8/2022	

Elev (feet)	Depth (feet)	Drill Rate (min/ft)	Sample Interval	Sample Type	Blowcounts	Firmness/ Density	Moisture	Description & USCS
1,078	26		X	S	11-17-29 (46)	Very Firm	Moist	CLAYEY SAND (SC) Occasional (Sub-Angular) Fine Gravel Fine Grained Sand Medium Plasticity Light Brown to Orangish-Brown Weak Lime Cementation
	27							
	28							
	29							
	30							
1,073	31		X	S PR	7-14-20 (34)	Very Firm	Moist	Gravel with Clay and Sand (GP-GC) Poorly Graded Subangular Gravel Predominately Medium to Coarse Grained Sand Low to Medium Plasticity Brown
	32							
	33							
	34							
	35							
1,068	36		X	S PR	28-50/5"	Hard	Slightly Moist	
	37							
	38							
	39							
	40							
1,063	41		X	S	11-31-21 (52)	Hard	Moist	Clayey Sand (SC) Some Fine Subrounded Gravel Fine to Medium Grained Sand Low to Medium Plasticity Light Brown to Brown Weak to Moderate Lime Cementation
	42							
	43							
	44							
	45							
1,058	46		X	S	20-20-50/3"	Hard	Moist	Sand with Clay (SP-SC) Some Fine Subangular Gravel Predominantly Medium to Coarse Grained Sand Low to Medium Plasticity Orangish Brown to Brown Clayey Sand (SC) Trace to Some Fine Subangular Gravel Fine to Medium Grained Sand Low to Medium Plasticity Brown
	47							
	48							
	49							
	50							
			X	S	20-50/2"	Very Dense	Slightly Moist	Hollow Stem Auger Stopped at 50 Feet Sampler Stopped at 50'8" Backfilled with Auger Cuttings ARFC, PCCP and AC Depth Grouted with Non Shrink High Strength Grout

 S - SPT Spoon Sampler  R - Ring Sampler  A - Auger Cuttings	Notes NR - No Recovery PR - Poor Recovery	
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Project Name:		MCDOT NORTHERN PARKWAY			Boring Number:		ADD-2	
Project Location:		Northern Parkway; 99th Ave to 87th Ave			Boring Location:		22+00, 50' R	
Project Number:		2021 015			Coordinates:		N 33.55121°, W 112.26727°	
Logger - Firm:		M.Meza - Ethos Engineering, LLC			Surface Elevation (feet):		1,108	
Drill - Drilling Method:		CME-75; Hollow Stem Auger			Groundwater Depth (feet):		N/A	
Driller - Firm:		O. Mariscal - Resilient			Date(s):		11/8/2022	

Elev (feet)	Depth (feet)	Drill Rate (min/ft)	Sample Interval	Sample Type	Blowcounts	Firmness/ Density	Moisture	Description & USCS
1,103	1							1.25" AR-ACFC Over 9.5" PCCP
	2						Moist	Embankment Fill Clayey Sand with Gravel (SC) Some to Considerable Fine Subangular Gravel Predominantly Fine to Medium Grained Sand Medium Plasticity Brown
	3							
	4		X	S PR	11-13-25 (38)	Very Firm		
	5							
1,098	6							Embankment Fill Clayey Gravel with Sand (GP-GC) Predominantly Coarse Subangular Gravel Some Well Graded Sand Medium Plasticity Light Brown to Grayish-Brown
	7			R	13-28 (41)	Very Firm	Slightly Moist	
	8							Embankment Fill Clayey Sand (SC) Trace Fine Subangular Gravel Fine to Medium Grained Sand Low to Medium Plasticity Brown Weak to Moderate Lime Cementation
	9							
	10							
1,093	11							Embankment Fill Sand with Silty Clay (SP-SC) Trace to Some Fine Subangular Gravel Predominate Medium to Coarse Grained Sand Low to Medium Plasticity Orangish Brown to Light Brown
	12							
	13							
	14							
	15							
1,088	16							Sandy Clay (CL) Trace Fine Subangular Gravel Considerable Fine to Medium Grained Sand Medium Plasticity Brown to Dark Brown Weak Lime Cementation
	17							
	18							
	19							
	20							
1,083	21							
	22							
	23							
	24							
	25							

 S - SPT Spoon Sampler  R - Ring Sampler  A - Auger Cuttings		Sample Type Notes NR - No Recovery PR - Poor Recovery	
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Project Name:		MCDOT NORTHERN PARKWAY			Boring Number:		ADD-2	
Project Location:		Northern Parkway; 99th Ave to 87th Ave			Boring Location:		22+00, 50' R	
Project Number:		2021 015			Coordinates:		N 33.55121°, W 112.26727°	
Logger - Firm:		M.Meza - Ethos Engineering, LLC			Surface Elevation (feet):		1,108	
Drill - Drilling Method:		CME-75; Hollow Stem Auger			Groundwater Depth (feet):		N/A	
Driller - Firm:		O. Mariscal - Resilient			Date(s):		11/8/2022	

Elev (feet)	Depth (feet)	Drill Rate (min/ft)	Sample Interval	Sample Type	Blowcounts	Firmness/ Density	Moisture	Description & USCS
1,078	26			R	7-6 (13)	Soft	Moist	Clayey Sand with Gravel(SC) Considerable Subangular Gravel Fine to Medium Grained Sand Medium Plasticity Brown to Dark Brown
	27							
	28							
	29							
	30							
1,073	31			S PR	20-50/4"	Very Dense	Slightly Moist	Gravel with Silt and Sand (GP-GM) Poorly Graded Subangular Gravel Considerable Medium to Coarse Grained Sand Non-Plastic Light Brown to Light Gray
	32							
	33							
	34							
	35							
1,068	36			S PR	45-50/4"			Note: Color Change of Pinkish-Gray to Light Gray Below 35'
	37							
	38							
	39							
	40							
1,063	41			S	9-13-28 (41)	Hard	Moist	Clay with Sand (CL) Trace Fine Subangular Gravel Some Fine Grained Sand Medium Plastic Brown
	42							
	43							
	44							
	45							
1,058	46			S PR	50/5"		Slightly Moist	Note: Moderate Lime Cementation Below 45'
	47							
	48							
	49							
	50							
				S	11-50/5"	Very Dense		Clayey Gravel with Sand (GC) Subangular Gravel Some Fine Grained Sand Low to Medium Plasticity Brown to Light Grey Moderate Lime Cementation Hollow Stem Auger Stopped at 50 Feet Sampler Stopped at 50'11" Backfilled with Auger Cuttings ARFC, PCCP and AC Depth Grouted with Non Shrink High Strength Grout

		Sample Type S - SPT Spoon Sampler R - Ring Sampler A - Auger Cuttings	Notes NR - No Recovery PR - Poor Recovery	
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Project Name:	MCDOT NORTHERN PARKWAY	Boring Number:	ADD-3
Project Location:	Northern Parkway; 99th Ave to 87th Ave	Boring Location:	20+00, 78' R
Project Number:	2021 015	Coordinates:	N 33.55088°, W 112.26761°
Logger - Firm:	M.Meza - Ethos Engineering, LLC	Surface Elevation (feet):	1,099
Drill - Drilling Method:	CME -75; HOLLOW STEM AUGER	Groundwater Depth (feet):	N/A
Driller - Firm:	NOEL - ACS Services	Date(s):	11/7/2022

Elev (feet)	Depth (feet)	Drill Rate (min/ft)	Sample Interval	Sample Type	Blowcounts	Firmness/ Density	Moisture	Description & USCS
1,094	1			S	8-13-22 (35)	Very Firm	Moist	1.5" AR-ACFC Over 9.5" PCCP
	2							Embankment Fill Silty Gravel with Sand (GP-GM)
	3							Angular Gravel
	4							Considerable Medium Grained Sand
	5							Non-Plastic Brown
1,089	6			S NR	31-50/5"	Hard	Moist	Embankment Fill Silty, Clayey Sand (SC-SM)
	7							Trace to Some Subangular Gravel
	8							Predominantly Fine to Medium Grained Sand
	9							Low Plasticity
	10							Brown
1,084	11			S PR	50/3"	Hard	Moist	Embankment Fill Silty, Clayey Gravel (GC)
	12							Subrounded Gravel
	13							Predominantly Fine to Medium Grained Sand
	14							Low Plasticity
	15							Brown
1,079	16			S	16-22-20 (42)	Very Firm	Moist	Embankment Fill Clayey Gravel with Sand (GC)
	17							Subrounded Gravel
	18							Considerable Medium Grained Sand
	19							Low to Medium Plasticity
	20							Light Brown to Brown
1,074	21			S PR	42-43-32 (75)	Hard	Slightly Moist	
	22							
	23							Sandy Clay (CL)
	24							Trace Fine Subangular Gravel
	25							Considerable Fine to Medium Grained Sand


S - SPT Spoon Sampler
R - Ring Sampler
A - Auger Cuttings

Notes
NR - No Recovery
PR - Poor Recovery



Project Name:		MCDOT NORTHERN PARKWAY			Boring Number:		ADD-3	
Project Location:		Northern Parkway; 99th Ave to 87th Ave			Boring Location:		20+00, 78' R	
Project Number:		2021 015			Coordinates:		N 33.55088°, W 112.26761°	
Logger - Firm:		M.Meza - Ethos Engineering, LLC			Surface Elevation (feet):		1,099	
Drill - Drilling Method:		CME -75; HOLLOW STEM AUGER			Groundwater Depth (feet):		N/A	
Driller - Firm:		NOEL - ACS Services			Date(s):		11/7/2022	

Elev (feet)	Depth (feet)	Drill Rate (min/ft)	Sample Interval	Sample Type	Blowcounts	Firmness/ Density	Moisture	Description & USCS
1,069	26			R	12-24 (36)	Medium Dense	Slightly Moist	Silty Sand (SM) Some to Considerable Subangular Gravel Predominantly Medium to Coarse Grained Sand Non Plastic Light Brown
	27							
	28							
	29							
	30							
1,064	31		X	S	5-6-5 (11)	Medium Dense	Slightly Moist	Clayey Sand (SC) Trace Fine Subangular Gravel Predominantly Fine to Medium Grained Sand Low Plasticity Brown Weak Lime Cementation
	32							
	33							
	34							
	35		X	S PR				50/5"
36								
37								
38								
39								
1,059	40		X	S PR	22-50/4"	Hard	Moist	Clayey Sand with Gravel (SC) Some to Considerable Poorly Graded Subrounded Gravel Fine to Medium Grained Sand Low to Medium Plasticity Brown Weak to Moderate Lime Cementation
	41							
1,054	42							Hollow stem auger Stopped at 40' Sampler Stopped at 40' 10" Backfilled with Auger Cuttings ARFC, PCCP and AC Depth Grouted with Non-Shrink High Strength Grout
	43							
	44							
	45							
	46							
	47							
	48							
	49							
	50							

 Sample Type S - SPT Spoon Sampler R - Ring Sampler A - Auger Cuttings		Notes NR - No Recovery PR - Poor Recovery			
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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)	In Place Dry Density (pcf) ¹ (ASTM D2937)	Optimum Moisture Content (%) (by ASTM D698A)	Maximum Dry Density (pcf) ¹ (by ASTM D698A)	Expansion % (ASTM D4546)	Consolidation% (ASTM D2435)	Direct Shear (ASTM D3080)	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																
P-17	0.0	5.0	SM	21	NV	NP												
P-18	0.0	5.0	SM	34	20	3												
NR-1	0.0	5.0	SC-SM	30	21	5									8.2	1,150	5.0	28.0
NR-1	10.0	11.0					5.5	106.2					X					
NR-1	40.0	41.0	SM	32	NV	NP	16.8	96.3										
NR-1	65.0	66.0					14.3	99.7										
NR-1	85.0	86.0	SM	15	NV	NP	7.9	98.6										
NR-2	5.0	6.0	GP	4	22	5												
NR-2	30.0	31.0															4.0	5.0
NR-2	35.0	36.0	GP-GM	10	NV	NP	8.8	101.4										
NR-2	50.0	51.0					11	104.1					X					
NR-2	75.0	76.0	ML	55	34	9	28.4	88.2										
NR-2	100.0	101.0	SM	29	NV	NP	18.9	87.2										
NR-3	0.0	10.0	SC	16	28	14									8.4	2,170	9.0	8.0
NR-3	20.0	21.0					11.7	106.6										
NR-3	30.0	31.0					7.8	118										
NR-3	45.0	46.0					19.4	101.3										
NR-3	60.0	61.5	CL	63	33	17												
NR-3	85.0	86.0					15.4	99.7										
NR-4	25.0	26.5	CL	62	35	12											7.0	29.0
NR-4	30.0	31.0					18.4	93.9					X					
NR-4	45.0	46.0					26.5	91.5										
NR-4	60.0	61.5															<3	9.0
NR-4	65.0	66.0	ML	59	48	18	26.1	96.5										
NR-4	90.0	91.0	SP-SM	7	NV	NP	6.5	104										
NR-5	0.0	5.0	SC-SM	21	22	6									8.2	1,150	3.0	26.0
NR-5	20.0	20.9	SP	2	25	8												
NR-5	50.0	51.0	SC	41	33	14	21.1	101.2										
NR-5	70.0	71.0					8.4	112.4										
NR-5	85.0	86.0					17.3	106.1										
P-1	0.0	3.0	SM	19	NV	NP	8											
P-1	3.0	8.0	SM	25	NV	NP	5.4											
P-2	0.0	3.0	SM	34	NV	NP	9.9											
P-2	3.0	8.0	CL	57	26	8	7.4											

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)	In Place Dry Density (pcf) ¹ (ASTM D2937)	Optimum Moisture Content (%) (by ASTM D698A)	Maximum Dry Density (pcf) ¹ (by ASTM D698A)	Expansion % (ASTM D4546)	Consolidation% (ASTM D2435)	Direct Shear (ASTM D3080)	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																
NP-1	0.0	2.5	SC-SM	44	25	6	8.1											
NP-2	0.0	2.5	CL	65	28	11	9.7		13.3	119.3	1.2			22	8.3	450	3	193
NP-3	0.0	2.5	SC	33	24	8	4.3											
NP-4	0.0	2.5	SC	33	26	9	4.4											
NP-5	5.0	6.0										15						
NP-5	5.0	10.0	SC-SM	30	22	7	6.7										<3	16
NP-6	10.0	11.0	SC	31	24	10	3.1					4.5						
NP-6	10.0	15.0													8.8	2,000	5	15
NP-7	15.0	20.0	SC	26	26	13	4.1								8.6	1,900	3	28
NP-8	20.0	21.5																
NP-8	20.0	25.0	SC	30	26.0	12	4.4								8.6	2,000	7	25
NP-9	0.0	2.5	SC	34	25.0	9	5.8		10.8	124.7	0.4				8.0	3,114	5	<3
NP-9	5.0	6.0					8.3	99.6										
NP-10	1.0	5.0																
NP-10	20.0	21.0																
NP-10	20.0	25.0	CL	54	35.0	18	12.6											
NP-10	35.0	36.0																
NP-11	20.0	25.0	SC	40	36	19	13.9											
NP-11	25.0	26.0	SC	38	40	21	13.7											
NP-11	30.0	31.5	SC	39	29	10	12.2											
NP-12	0.0	2.5	SC-SM	40	23	7	3.9		10.9	122.9	1.6				8.2	1,760	22	<3
NP-12	5.0	6.0																
NP-13	0.0	2.5	SC	26	29	12	3.4							35				
NP-13	2.5	3.5					2.6	109.3										
NP-14	0.0	2.5	SC	43	29	13	2.5		10.3	122.9	0.9				8.0	745	6	123
NP-15	0.0	2.5	CL-ML	58	29	7	6.7		14.2	113.1	1.2						6	72

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)	In Place Dry Density (pcf) ¹ (ASTM D2937)	Optimum Moisture Content (%) (by ASTM D698A)	Maximum Dry Density (pcf) ¹ (by ASTM D698A)	Expansion % (ASTM D4546)	Consolidation % (ASTM D2435)	Direct Shear (ASTM D3080)	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																
NP-16	2.5	3.5	CL	57	46	21	14.6											
NP-17	0.0	2.5	SC	45	29	9	11.1		12.1	119.3	1.2				8.0	1,100	6	<3
NP-17	5.0	6.0					8	118.2										
NP-18	0.0	2.5																
NP-18	2.5	3.0		55			5.2	114.2										
NP-19	0.5	2.5	SC-SM	47	26	7	1.5											
NP-20	1.0	2.5	SC	28	25	10	9.8		7.6	137.9	0.2						3	<3
NP-20	2.5	3.5					12.1	111.1										
NP-20	5.0	6.0		68			11.8	104.0										
NP-21	1.0	2.5	GC	25	33	17	10.5							26				
NP-21	2.5	3.5					12	111.5										
NP-21	5.0	6.0					9.9	122.9										
NP-22	0.0	2.5	SC	34	31	14	7.5		8.4	132.3	1.8						29	464
NP-23	0.5	2.5	SM	45	23	3	1.7		11.3	122.2	0.1						5	13
NP-24	0.0	2.5	CL	52	25	9	6.7							32			20	279
ADD-1/ ADD-2*	0.0	21.5													8.6	1,855	4	62
ADD-1	3.0	4.0	GP-GM	7.7	NV	NP	2.9						X					
ADD-1	20.0	21.0	SC	38	34	18	10.2											
ADD-1	25.0	26.5					17.2											
ADD-1	45.0	46.3					8.8											
ADD-2	5.0	6.0	GP-GC	8	32	13	1.9						X					
ADD-2	25.0	26.0	SC	30	30	11	7.4						X					
ADD-2	40.0	41.5					20.8											
ADD-3	15.0	16.5	GC	15	27	11	8.3											
ADD-3	25.0	26.0	SM	13	NV	NP	3.5						X					
ADD-3	30.0	31.5					4.6											
Average				36.9	---	---	8.1	110.9	11.0	123.8	1.0	9.8	---	28.8	8.3	1,658	9	89
Standard Deviation				15.0	---	---	4.4	6.8	2.1	7.3	0.6	7.4	---	5.9	0.3	796	8	143
Maximum				68	46	21	20.8	122.9	14.2	137.9	1.8	15.0	---	35	8.8	3,114	29	464
Minimum				7.7	NV	NP	1.5	99.6	7.6	113.1	0.1	4.5	---	22	8.0	450	3	<3
Count				37	35	35	49	10	9	9	9	2	4	4	9	9	15	15

*Combined ADD-1 @ 5-6.5, 10-11.5 and 15-16.5 with ADD-2 @ 10-11', 15-16.5 and 20-21.5'

(1) pcf = pounds per cubic foot

(2) ppm = parts per million

ACS Services LLC

Material Type:	Soil
Extraction Date:	3/2/2023
Extracted By:	Client
Laboratory Test Date	3/7/2023
Laboratory Tested By:	-
Reviewed By:	-

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

[illegible]



PROJECT: ACS Project #2301257

LOCATION: Mesa, AZ

MATERIAL: Native

JOB NO: 19-2012-2017

WORK ORDER NO: N/A

DATE ASSIGNED: 3/9/23

DENSITY OF SOIL IN PLACE BY THE DRIVE-CYLINDER METHOD(ASTM D2937)

LAB #	BORING	MOISTURE			NUMBER OF RINGS	WET WEIGHT & RINGS (g)	WEIGHT OF RINGS (g)	DRY DENSITY (pcf)
		WET WT. (g)	DRY WT. (g)	MOISTURE CONTENT				
23-1135-01	NR-1 (10.0-11.0')	432.3	409.8	5.5%	6	1,080.9	269.2	106.2
23-1135-02	NR-2 (50.0-51.0')	418.7	377.3	11.0%	6	1,098.3	261.3	104.1
23-1135-03	NR-4 (30.0-31.0')	454.0	383.3	18.4%	5	889.9	218.1	93.9

ACS Services LLC

Job #	2301257	Material Type:	Soil
Lab #	23-2447	Extraction Date:	4/18/2023
Client:	Ethos Engineering	Extracted By:	Client
Project Name:	Northern Parkway, Agua Fria to 99th Ave	Laboratory Test Date	4/24/2023
Project Address:	Maricopa County	Laboratory Tested By:	Fernando Montero
Project City:	Maricopa County	Reviewed By:	Dylan Ward
Material Source:	-		

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

[illegible]

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2301257
ACS Lab # 23-2129-2
Client: Ethos Engineering, LLC
Project Name: Northern Parkway, Agua Fria to 99th Avenue
Project Address: Northern Parkway, Agua Fria to 99th Avenue
Project City: Maricopa County
Sample Location: P-17 @ 0.0 - 5.0

Material Type: Soil
Supplier: -
Sample Date: 3/22/2023
Sampled By: Client
Test Date: 3/29/2023
Tested By: Fernando Montero
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"	5	95	
1"	1	94	
3/4"	3	91	
1/2"	8	83	
3/8"	6	77	
1/4"	8	70	
#4	5	65	
#8	9	56	
#10	2	54	
#16	6	48	
#30	8	40	
#40	5	36	
#50	4	32	
#100	6	25	
#200	4	21	

Liquid Limit
(ASTM D4318)

Plastic Limit
(ASTM D4318)

Plasticity Index
(ASTM D4318)

NP

Moisture Content
(ASTM D2216)

6.0

USCS Soil
Classification

SM

Group Name (ASTM D2487)

Silty SAND with gravel

Dylan Ward

Laboratory Manager

Dylan Ward

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2301257
ACS Lab # 23-2129-3
Client: Ethos Engineering, LLC
Project Name: Northern Parkway, Agua Fria to 99th Avenue
Project Address: Northern Parkway, Agua Fria to 99th Avenue
Project City: Maricopa County
Sample Location: P-18 @ 0.0 - 5.0

Material Type: Soil
Supplier: -
Sample Date: 3/22/2023
Sampled By: Client
Test Date: 3/29/2023
Tested By: Fernando Montero
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"	4	96	
3/8"	3	93	
1/4"	3	89	
#4	3	87	
#8	5	81	
#10	2	80	
#16	6	74	
#30	11	63	
#40	6	57	
#50	5	52	
#100	9	43	
#200	9	34	

Liquid Limit
(ASTM D4318)

20

Plastic Limit
(ASTM D4318)

17

Plasticity Index
(ASTM D4318)

3

Moisture Content
(ASTM D2216)

6.6

USCS Soil
Classification

SM

Group Name (ASTM D2487)

Silty SAND

Dylan Ward

Laboratory Manager

Dylan Ward

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2301257
ACS Lab # 23-1858-1
Client: Ethos Engineering, LLC
Project Name: Northern Parkway, Agua Fria to 99th Avenue
Project Address: Northern Parkway, Agua Fria to 99th Avenue
Project City: Maricopa County
Sample Location: NR-1 @ 0.0 - 5.0

Material Type: Soil
Supplier: -
Sample Date: 3/2/2023
Sampled By: Client
Test Date: 3/8/2023
Tested By: Mahalia Davis
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"	0	99	
1/2"	1	98	
3/8"	2	96	
1/4"	5	91	
#4	4	87	
#8	8	79	
#10	2	77	
#16	6	71	
#30	10	60	
#40	6	54	
#50	6	49	
#100	10	39	
#200	9	30	

Liquid Limit
(ASTM D4318)

21

Plastic Limit
(ASTM D4318)

16

Plasticity Index
(ASTM D4318)

5

Moisture Content
(ASTM D2216)

4.7

USCS Soil
Classification

SC-SM

Group Name (ASTM D2487)

Silty, clayey SAND

Dylan Ward

Laboratory Manager

Dylan Ward

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2301257
ACS Lab # 23-1858-3
Client: Ethos Engineering, LLC
Project Name: Northern Parkway, Agua Fria to 99th Avenue
Project Address: Northern Parkway, Agua Fria to 99th Avenue
Project City: Maricopa County
Sample Location: NR-1 @ 40.0 - 41.0

Material Type: Soil
Supplier: -
Sample Date: 3/2/2023
Sampled By: Client
Test Date: 3/10/2023
Tested By: Fernando Montero
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"	0	100	
1/2"	0	100	
3/8"	0	100	
1/4"	0	100	
#4	0	100	
#8	1	99	
#10	1	98	
#16	4	94	
#30	18	76	
#40	11	65	
#50	8	57	
#100	15	43	
#200	10	32	

Liquid Limit
(ASTM D4318)

Plastic Limit
(ASTM D4318)

Plasticity Index
(ASTM D4318)

NP

Moisture Content
(ASTM D2216)

16.8

USCS Soil
Classification

SM

Group Name (ASTM D2487)

Silty SAND

Dylan Ward

Laboratory Manager

Dylan Ward

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2301257
ACS Lab # 23-1858-5
Client: Ethos Engineering, LLC
Project Name: Northern Parkway, Agua Fria to 99th Avenue
Project Address: Northern Parkway, Agua Fria to 99th Avenue
Project City: Maricopa County
Sample Location: NR-1 @ 85 - 86.0

Material Type: Soil
Supplier: -
Sample Date: 3/2/2023
Sampled By: Client
Test Date: 3/10/2023
Tested By: Fernando Montero
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"	0	100	
1/2"	0	100	
3/8"	0	100	
1/4"	0	100	
#4	0	100	
#8	0	99	
#10	0	99	
#16	1	98	
#30	5	93	
#40	9	83	
#50	17	67	
#100	38	29	
#200	13	15	

Liquid Limit
(ASTM D4318)

Plastic Limit
(ASTM D4318)

Plasticity Index
(ASTM D4318)

NP

Moisture Content
(ASTM D2216)

7.9

USCS Soil
Classification

SM

Group Name (ASTM D2487)

Silty SAND

Dylan Ward

Laboratory Manager

Dylan Ward

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2301257
ACS Lab # 23-1858-6
Client: Ethos Engineering, LLC
Project Name: Northern Parkway, Agua Fria to 99th Avenue
Project Address: Northern Parkway, Agua Fria to 99th Avenue
Project City: Maricopa County
Sample Location: NR-2 @ 5.0 - 6.0

Material Type: Soil
Supplier: -
Sample Date: 3/2/2023
Sampled By: Client
Test Date: 3/10/2023
Tested By: Fernando Montero
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"	13	87	
3/4"	4	83	
1/2"	13	70	
3/8"	7	64	
1/4"	10	54	
#4	5	49	
#8	11	38	
#10	3	35	
#16	11	24	
#30	10	14	
#40	3	11	
#50	2	9	
#100	3	6	
#200	2	3.6	

Liquid Limit
(ASTM D4318)

22

Plastic Limit
(ASTM D4318)

17

Plasticity Index
(ASTM D4318)

5

Moisture Content
(ASTM D2216)

6.9

USCS Soil
Classification

GP

Group Name (ASTM D2487)

Poorly graded GRAVEL with sand

Testing sizes reduced from standard minimums due to lack of material

Dylan Ward

Laboratory Manager

Dylan Ward

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2301257
ACS Lab # 23-1858-7
Client: Ethos Engineering, LLC
Project Name: Northern Parkway, Agua Fria to 99th Avenue
Project Address: Northern Parkway, Agua Fria to 99th Avenue
Project City: Maricopa County
Sample Location: NR-2 @ 35.0 - 36.0

Material Type: Soil
Supplier: -
Sample Date: 3/2/2023
Sampled By: Client
Test Date: 3/8/2023
Tested By: Fernando Montero
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"	11	89	
3/4"	0	89	
1/2"	14	74	
3/8"	8	66	
1/4"	9	57	
#4	6	52	
#8	11	40	
#10	3	37	
#16	8	29	
#30	7	22	
#40	3	19	
#50	2	17	
#100	4	13	
#200	3	10	

Liquid Limit
(ASTM D4318)

Plastic Limit
(ASTM D4318)

Plasticity Index
(ASTM D4318)

NP

Moisture Content
(ASTM D2216)

8.8

USCS Soil
Classification

GP-GM

Group Name (ASTM D2487)

Poorly graded GRAVEL with silt and sand

Testing sizes reduced from standard minimums due to lack of material

Dylan Ward

Laboratory Manager

Dylan Ward

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2301257
ACS Lab # 23-1858-9
Client: Ethos Engineering, LLC
Project Name: Northern Parkway, Agua Fria to 99th Avenue
Project Address: Northern Parkway, Agua Fria to 99th Avenue
Project City: Maricopa County
Sample Location: NR-2 @ 75.0 - 76.0

Material Type: Soil
Supplier: -
Sample Date: 3/2/2023
Sampled By: Client
Test Date: 3/10/2023
Tested By: Fernando Montero
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"	0	100	
1/2"	0	100	
3/8"	0	100	
1/4"	0	100	
#4	0	100	
#8	0	99	
#10	0	99	
#16	0	98	
#30	4	95	
#40	4	91	
#50	7	85	
#100	14	71	
#200	16	55	

Liquid Limit
(ASTM D4318)

34

Plastic Limit
(ASTM D4318)

25

Plasticity Index
(ASTM D4318)

9

Moisture Content
(ASTM D2216)

28.4

USCS Soil
Classification

ML

Group Name (ASTM D2487)

Sandy SILT

Dylan Ward

Laboratory Manager

Dylan Ward

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2301257
ACS Lab # 23-1858-10
Client: Ethos Engineering, LLC
Project Name: Northern Parkway, Agua Fria to 99th Avenue
Project Address: Northern Parkway, Agua Fria to 99th Avenue
Project City: Maricopa County
Sample Location: NR-2 @ 100.0 - 101.0

Material Type: Soil
Supplier: -
Sample Date: 3/2/2023
Sampled By: Client
Test Date: 3/14/2023
Tested By: Fernando Montero
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"	0	100	
1/2"	0	100	
3/8"	0	100	
1/4"	0	100	
#4	0	100	
#8	0	100	
#10	0	99	
#16	1	99	
#30	2	97	
#40	3	93	
#50	11	82	
#100	34	48	
#200	19	29	

Liquid Limit
(ASTM D4318)

Plastic Limit
(ASTM D4318)

Plasticity Index
(ASTM D4318)

NP

Moisture Content
(ASTM D2216)

18.9

USCS Soil
Classification

SM

Group Name (ASTM D2487)

Silty SAND

Dylan Ward

Laboratory Manager

Dylan Ward

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2301257
ACS Lab # 23-2447-1
Client: Ethos Engineering, LLC
Project Name: Northern Parkway, Agua Fria to 99th Avenue
Project Address: Northern Parkway, Agua Fria to 99th Avenue
Project City: Maricopa County
Sample Location: NR-3 @ 0.0 - 10.0

Material Type: Soil
Supplier: -
Sample Date: 4/18/2023
Sampled By: Client
Test Date: 4/24/2023
Tested By: Mahalia Davis
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"	3	97	
3/4"	0	97	
1/2"	2	95	
3/8"	5	91	
1/4"	11	79	
#4	8	71	
#8	13	58	
#10	3	56	
#16	11	45	
#30	13	32	
#40	4	28	
#50	4	24	
#100	5	19	
#200	3	16	

Liquid Limit
(ASTM D4318)

28

Plastic Limit
(ASTM D4318)

14

Plasticity Index
(ASTM D4318)

14

Moisture Content
(ASTM D2216)

10.0

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 # 2301257
ACS Lab # 23-2447-5
Client: Ethos Engineering, LLC
Project Name: Northern Parkway, Agua Fria to 99th Avenue
Project Address: Northern Parkway, Agua Fria to 99th Avenue
Project City: Maricopa County
Sample Location: NR-3 @ 60.0 - 61.5

Material Type: Soil
Supplier: -
Sample Date: 4/18/2023
Sampled By: Client
Test Date: 4/24/2023
Tested By: Mahalia Davis
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"	2	98	
1/2"	2	96	
3/8"	2	93	
1/4"	3	90	
#4	1	89	
#8	2	87	
#10	1	86	
#16	1	85	
#30	3	82	
#40	3	79	
#50	3	76	
#100	6	70	
#200	7	63	

Liquid Limit
(ASTM D4318)

33

Plastic Limit
(ASTM D4318)

16

Plasticity Index
(ASTM D4318)

17

Moisture Content
(ASTM D2216)

15.7

USCS Soil
Classification

CL

Group Name (ASTM D2487)

Sandy lean CLAY

Testing sizes reduced from standard minimums due to lack of material

Dylan Ward

Laboratory Manager

Dylan Ward

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2301257
ACS Lab # 23-1858-11
Client: Ethos Engineering, LLC
Project Name: Northern Parkway, Agua Fria to 99th Avenue
Project Address: Northern Parkway, Agua Fria to 99th Avenue
Project City: Maricopa County
Sample Location: NR-4 @ 25.0 - 26.5

Material Type: Soil
Supplier: -
Sample Date: 3/2/2023
Sampled By: Client
Test Date: 3/8/2023
Tested By: Mahalia Davis
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"	0	100	
1/2"	0	100	
3/8"	0	100	
1/4"	0	100	
#4	0	100	
#8	0	100	
#10	0	100	
#16	1	99	
#30	1	98	
#40	3	95	
#50	6	90	
#100	14	75	
#200	13	62	

Liquid Limit
(ASTM D4318)

35

Plastic Limit
(ASTM D4318)

23

Plasticity Index
(ASTM D4318)

12

Moisture Content
(ASTM D2216)

30.4

USCS Soil
Classification

CL

Group Name (ASTM D2487)

Sandy lean CLAY

Testing sizes reduced from standard minimums due to lack of material

Dylan Ward

Laboratory Manager

Dylan Ward

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2301257
ACS Lab # 23-1858-14
Client: Ethos Engineering, LLC
Project Name: Northern Parkway, Agua Fria to 99th Avenue
Project Address: Northern Parkway, Agua Fria to 99th Avenue
Project City: Maricopa County
Sample Location: NR-4 @ 65.0 - 66.0

Material Type: Soil
Supplier: -
Sample Date: 3/2/2023
Sampled By: Client
Test Date: 3/10/2023
Tested By: Fernando Montero
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"	15	85	
3/4"	4	80	
1/2"	0	80	
3/8"	1	79	
1/4"	2	77	
#4	1	76	
#8	3	73	
#10	1	72	
#16	1	71	
#30	1	70	
#40	1	69	
#50	1	69	
#100	3	66	
#200	7	59	

Liquid Limit
(ASTM D4318)

48

Plastic Limit
(ASTM D4318)

30

Plasticity Index
(ASTM D4318)

18

Moisture Content
(ASTM D2216)

26.1

USCS Soil
Classification

ML

Group Name (ASTM D2487)

Gravelly SILT with sand

Dylan Ward

Laboratory Manager

Dylan Ward

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2301257
ACS Lab # 23-1858-15
Client: Ethos Engineering, LLC
Project Name: Northern Parkway, Agua Fria to 99th Avenue
Project Address: Northern Parkway, Agua Fria to 99th Avenue
Project City: Maricopa County
Sample Location: NR-4 @ 90.0 - 91.0

Material Type: Soil
Supplier: -
Sample Date: 3/2/2023
Sampled By: Client
Test Date: 3/10/2023
Tested By: Fernando Montero
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"	5	95	
1/2"	3	92	
3/8"	0	92	
1/4"	4	89	
#4	4	85	
#8	6	79	
#10	2	78	
#16	9	69	
#30	23	45	
#40	14	32	
#50	13	19	
#100	9	10	
#200	3	7.0	

Liquid Limit
(ASTM D4318)

Plastic Limit
(ASTM D4318)

Plasticity Index
(ASTM D4318)

NP

Moisture Content
(ASTM D2216)

6.5

USCS Soil
Classification

SP-SM

Group Name (ASTM D2487)

Poorly graded SAND with silt

Dylan Ward

Laboratory Manager

Dylan Ward

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2301257
ACS Lab # 23-1858-16
Client: Ethos Engineering, LLC
Project Name: Northern Parkway, Agua Fria to 99th Avenue
Project Address: Northern Parkway, Agua Fria to 99th Avenue
Project City: Maricopa County
Sample Location: NR-5 @ 0.0 - 5.0

Material Type: Soil
Supplier: -
Sample Date: 3/2/2023
Sampled By: Client
Test Date: 3/8/2023
Tested By: Mahalia Davis
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"	1	98	
1/2"	3	94	
3/8"	6	89	
1/4"	10	79	
#4	7	72	
#8	9	63	
#10	2	61	
#16	8	53	
#30	12	41	
#40	6	35	
#50	4	31	
#100	5	25	
#200	4	21	

Liquid Limit
(ASTM D4318)

22

Plastic Limit
(ASTM D4318)

16

Plasticity Index
(ASTM D4318)

6

Moisture Content
(ASTM D2216)

8.5

USCS Soil
Classification

SC-SM

Group Name (ASTM D2487)

Silty, clayey SAND with gravel

Dylan Ward

Laboratory Manager

Dylan Ward

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2301257
ACS Lab # 23-1858-17
Client: Ethos Engineering, LLC
Project Name: Northern Parkway, Agua Fria to 99th Avenue
Project Address: Northern Parkway, Agua Fria to 99th Avenue
Project City: Maricopa County
Sample Location: NR-5 @ 20.0 - 20.9

Material Type: Soil
Supplier: -
Sample Date: 3/2/2023
Sampled By: Client
Test Date: 3/15/2023
Tested By: Fernando Montero
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"	7	93	
3/4"	6	88	
1/2"	9	78	
3/8"	5	73	
1/4"	6	67	
#4	3	64	
#8	13	51	
#10	4	47	
#16	15	32	
#30	14	17	
#40	6	12	
#50	4	8	
#100	4	4	
#200	2	2.2	

Liquid Limit
(ASTM D4318)

25

Plastic Limit
(ASTM D4318)

17

Plasticity Index
(ASTM D4318)

8

Moisture Content
(ASTM D2216)

11.6

USCS Soil
Classification

SP

Group Name (ASTM D2487)

Poorly graded SAND with gravel

Dylan Ward

Laboratory Manager

Dylan Ward

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2301257
ACS Lab # 23-1858-18
Client: Ethos Engineering, LLC
Project Name: Northern Parkway, Agua Fria to 99th Avenue
Project Address: Northern Parkway, Agua Fria to 99th Avenue
Project City: Maricopa County
Sample Location: NR-5 @ 50.0 - 51.0

Material Type: Soil
Supplier: -
Sample Date: 3/2/2023
Sampled By: Client
Test Date: 3/15/2023
Tested By: Fernando Montero
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"	0	100	
1/2"	0	100	
3/8"	0	100	
1/4"	0	100	
#4	0	100	
#8	0	100	
#10	0	100	
#16	0	99	
#30	2	97	
#40	2	95	
#50	8	87	
#100	29	58	
#200	17	41	

Liquid Limit
(ASTM D4318)

33

Plastic Limit
(ASTM D4318)

19

Plasticity Index
(ASTM D4318)

14

Moisture Content
(ASTM D2216)

21.1

USCS Soil
Classification

SC

Group Name (ASTM D2487)

Clayey SAND

Dylan Ward

Laboratory Manager

Dylan Ward

Signature



MATERIAL: Native

JOB NO: 19-2012-2017

WORK ORDER NO: N/A

DATE ASSIGNED: 11/16/22

MECHANICAL SIEVE ANALYSIS (ASTM C136/C117) PLASTICITY INDEX (ASTM D4318)
GROUP SYMBOL, USCS (ASTM D2487)

PERCENT PASSING BY WEIGHT

[illegible]

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2101595
ACS Lab # 21-3632-15
Client: Ethos Engineering
Project Name: Northern Parkway
Project Address: Northern Parkway, 99th Ave to 87th Ave
Project City: Glendale, AZ
Sample Location: NP - 1 @ 0.0'-2.5'

Material Type: Native
Supplier: -
Sample Date: 8/16/2021
Sampled By: Client
Test Date: 9/10/2021
Tested By: Jose Botello
Reviewed By: Andrew Jamrogiewicz, P.E.

Sieve Analysis (ASTM C-139 / AASHTO T-27)

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"	3	97	
3/4"	0	97	
1/2"	3	94	
3/8"	3	90	
1/4"	6	84	
#4	3	81	
#8	2	80	
#10	1	79	
#16	3	76	
#30	8	68	
#40	4	64	
#50	4	60	
#100	7	53	
#200	8	44.4	

Liquid Limit (AASHTO T-89)	25
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Plastic Limit (AASHTO T-90)	19
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Plasticity Index (AASHTO T-90)	6
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Moisture Content (AASHTO T-255)	8.1
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Fractured Faces (ARIZ 212)	
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Soluble Salts (ARIZ 237)	
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USCS Soil Classification	SC-SM
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Andrew Jamrogiewicz

Project Manager

Andrew Jamrogiewicz

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2101595
ACS Lab # 22-4879-10
Client: Ethos Engineering, LLC
Project Name: Northern Parkway - 99th Avenue and 87th Avenue
Project Address: Northern Parkway
Project City: Peoria
Sample Location: ADD-3 @ 15 - 16.5

Material Type: Soil
Supplier: -
Sample Date: 11/14/2022
Sampled By: Client
Test Date: 11/21/2022
Tested By: Fernando Montero
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"	14	86	
1/2"	9	77	
3/8"	7	69	
1/4"	9	61	
#4	3	57	
#8	7	50	
#10	2	49	
#16	7	42	
#30	10	32	
#40	5	27	
#50	4	24	
#100	5	19	
#200	4	15.1	

Liquid Limit
(AASHTO T-89)

27

Plastic Limit
(AASHTO T-90)

16

Plasticity Index
(AASHTO T-90)

11

Moisture Content
(AASHTO T-265)

8.3

USCS Soil
Classification

GC

Group Name (ASTM D2487)

Clayey GRAVEL with sand

Dylan Ward

Laboratory Manager

Dylan Ward

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2101595
ACS Lab # 22-4879-3
Client: Ethos Engineering, LLC
Project Name: Northern Parkway - 99th Avenue and 87th Avenue
Project Address: Northern Parkway
Project City: Peoria
Sample Location: ADD-1 @ 20 - 21

Material Type: Soil
Supplier: -
Sample Date: 11/14/2022
Sampled By: Client
Test Date: 11/21/2022
Tested By: Fernando Montero
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"	4	96	
3/4"	2	94	
1/2"	2	92	
3/8"	2	90	
1/4"	4	87	
#4	3	83	
#8	7	76	
#10	2	74	
#16	6	69	
#30	9	59	
#40	5	54	
#50	4	50	
#100	6	44	
#200	6	37.9	

Liquid Limit
(AASHTO T-89) 34

Plastic Limit
(AASHTO T-90) 16

Plasticity Index
(AASHTO T-90) 18

Moisture Content
(AASHTO T-265) 10.2

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 # 2101595 Material Type: Native
ACS Lab # 21-3632-16 Supplier: -
Client: Ethos Engineering Sample Date: 8/16/2021
Project Name: Northern Parkway Sampled By: Client
Project Address: Northern Parkway, 99th Ave to 87th Ave Test Date: 9/14/2021
Project City: Glendale, AZ Tested By: Jose Botello
Sample Location: NP - 2 @ 0.0'-2.5' Reviewed By: Andrew Jamrogiewicz, P.E.

Sieve Analysis (ASTM C-139 / AASHTO T-27)

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"	2	98	
3/8"	1	96	
1/4"	3	94	
#4	1	92	
#8	2	91	
#10	0	90	
#16	2	88	
#30	5	83	
#40	3	80	
#50	2	78	
#100	5	73	
#200	8	64.9	

Liquid Limit (AASHTO T-89)	28
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Plastic Limit (AASHTO T-90)	17
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Plasticity Index (AASHTO T-90)	11
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Moisture Content (AASHTO T-255)	9.7
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Fractured Faces (ARIZ 212)	
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Soluble Salts (ARIZ 237)	
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USCS Soil Classification	CL
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Andrew Jamrogiewicz

Project Manager

Andrew Jamrogiewicz

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2101595 Material Type: Native
ACS Lab # 21-3632-17 Supplier: -
Client: Ethos Engineering Sample Date: 8/16/2021
Project Name: Northern Parkway Sampled By: Client
Project Address: Northern Parkway, 99th Ave to 87th Ave Test Date: 9/13/2021
Project City: Glendale, AZ Tested By: Jose Botello
Sample Location: NP - 3 @ 0.0'-2.5' Reviewed By: Andrew Jamrogiewicz, P.E.

Sieve Analysis (ASTM C-139 / AASHTO T-27)

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"	4	95	
1/2"	8	87	
3/8"	4	82	
1/4"	6	76	
#4	3	73	
#8	5	68	
#10	2	66	
#16	4	62	
#30	9	53	
#40	5	48	
#50	4	44	
#100	6	37	
#200	5	32.6	

Liquid Limit (AASHTO T-89)	24
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Plastic Limit (AASHTO T-90)	16
--------------------------------	----

Plasticity Index (AASHTO T-90)	8
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Moisture Content (AASHTO T-255)	4.3
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Fractured Faces (ARIZ 212)	
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Soluble Salts (ARIZ 237)	
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USCS Soil Classification	SC
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Andrew Jamrogiewicz

Project Manager

Andrew Jamrogiewicz

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2101595
ACS Lab # 21-3632-5
Client: Ethos Engineering
Project Name: Northern Parkway
Project Address: Northern Parkway, 99th Ave to 87th Ave
Project City: Glendale, AZ
Sample Location: NP - 4 @ 0.0'-2.5'

Material Type: Native
Supplier: -
Sample Date: 7/30/2021
Sampled By: Client
Test Date: 8/13/2021
Tested By: Ryan Richardson
Reviewed By: Andrew Jamrogiewicz, PE

Sieve Analysis (ASTM C-139 / AASHTO T-27)

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"	6	94	
3/4"	5	89	
1/2"	4	85	
3/8"	3	82	
1/4"	3	79	
#4	2	78	
#8	4	74	
#10	1	73	
#16	4	68	
#30	10	58	
#40	5	53	
#50	5	48	
#100	8	40	
#200	7	33.4	

Liquid Limit (AASHTO T-89)	26
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Plastic Limit (AASHTO T-90)	17
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Plasticity Index (AASHTO T-90)	9
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Moisture Content (AASHTO T-255)	4.4
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Fractured Faces (ARIZ 212)	
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Soluble Salts (ARIZ 237)	
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USCS Soil Classification	SC
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Andrew Jamrogiewicz

Project Manager

Andrew Jamrogiewicz

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2101595
ACS Lab # 21-3632-23
Client: Ethos Engineering
Project Name: Northern Parkway
Project Address: Northern Parkway, 99th Ave to 87th Ave
Project City: Glendale, AZ
Sample Location: NP - 5 @ 5.0'-10.0'

Material Type: Native
Supplier: -
Sample Date: 8/31/2021
Sampled By: Client
Test Date: 9/13/2021
Tested By: Jose Botello
Reviewed By: Andrew Jamrogiewicz, P.E.

Sieve Analysis (ASTM C-139 / AASHTO T-27)

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"	0	100	
1/2"	1	98	
3/8"	3	95	
1/4"	5	90	
#4	3	87	
#8	5	82	
#10	2	80	
#16	6	73	
#30	13	61	
#40	6	55	
#50	5	50	
#100	14	36	
#200	6	29.7	

Liquid Limit (AASHTO T-89)	22
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Plastic Limit (AASHTO T-90)	15
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Plasticity Index (AASHTO T-90)	7
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Moisture Content (AASHTO T-255)	6.7
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Fractured Faces (ARIZ 212)	
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Soluble Salts (ARIZ 237)	
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USCS Soil Classification	SC-SM
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Andrew Jamrogiewicz

Project Manager

Andrew Jamrogiewicz

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2101595 Material Type: Native
ACS Lab # 21-3632-25 Supplier: -
Client: Ethos Engineering Sample Date: 8/31/2021
Project Name: Northern Parkway Sampled By: Client
Project Address: Northern Parkway, 99th Ave to 87th Ave Test Date: 9/17/2021
Project City: Glendale, AZ Tested By: Jose Botello
Sample Location: NP - 6 @ 10.0'-15.0' Reviewed By: Andrew Jamrogiewicz, P.E.

Sieve Analysis (ASTM C-139 / AASHTO T-27)

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"	0	100	
1/2"	1	99	
3/8"	3	95	
1/4"	7	88	
#4	6	83	
#8	8	74	
#10	3	71	
#16	8	63	
#30	11	52	
#40	5	47	
#50	4	43	
#100	7	37	
#200	6	30.9	

Liquid Limit (AASHTO T-89)	24
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Plastic Limit (AASHTO T-90)	14
--------------------------------	----

Plasticity Index (AASHTO T-90)	10
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Moisture Content (AASHTO T-255)	3.1
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Fractured Faces (ARIZ 212)	
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Soluble Salts (ARIZ 237)	
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USCS Soil Classification	SC
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Andrew Jamrogiewicz

Project Manager

Andrew Jamrogiewicz

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2101595
ACS Lab # 21-3632-26
Client: Ethos Engineering
Project Name: Northern Parkway
Project Address: Northern Parkway, 99th Ave to 87th Ave
Project City: Glendale, AZ
Sample Location: NP - 7 @ 15.0'-20.0'

Material Type: Native
Supplier: -
Sample Date: 8/31/2021
Sampled By: Client
Test Date: 9/17/2021
Tested By: Jose Botello
Reviewed By: Andrew Jamrogiewicz, P.E.

Sieve Analysis (ASTM C-139 / AASHTO T-27)

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"	5	92	
1/4"	9	82	
#4	6	76	
#8	11	66	
#10	3	63	
#16	7	56	
#30	11	45	
#40	5	40	
#50	4	36	
#100	6	30	
#200	4	25.9	

Liquid Limit (AASHTO T-89)	26
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Plastic Limit (AASHTO T-90)	13
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Plasticity Index (AASHTO T-90)	13
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Moisture Content (AASHTO T-255)	4.1
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Fractured Faces (ARIZ 212)	
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Soluble Salts (ARIZ 237)	
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USCS Soil Classification	SC
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Andrew Jamrogiewicz

Project Manager

Andrew Jamrogiewicz

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2101595
ACS Lab # 21-3632-27
Client: Ethos Engineering
Project Name: Northern Parkway
Project Address: Northern Parkway, 99th Ave to 87th Ave
Project City: Glendale, AZ
Sample Location: NP - 8 @ 20.0'-25.0'

Material Type: Native
Supplier: -
Sample Date: 8/31/2021
Sampled By: Client
Test Date: 9/17/2021
Tested By: Jose Botello
Reviewed By: Andrew Jamrogiewicz, P.E.

Sieve Analysis (ASTM C-139 / AASHTO T-27)

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"	2	96	
3/8"	3	94	
1/4"	7	87	
#4	5	81	
#8	8	74	
#10	2	72	
#16	7	65	
#30	12	52	
#40	5	47	
#50	4	43	
#100	7	36	
#200	6	30.2	

Liquid Limit (AASHTO T-89)	26
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Plastic Limit (AASHTO T-90)	14
--------------------------------	----

Plasticity Index (AASHTO T-90)	12
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Moisture Content (AASHTO T-255)	4.4
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Fractured Faces (ARIZ 212)	
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Soluble Salts (ARIZ 237)	
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USCS Soil Classification	SC
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Andrew Jamrogiewicz

Project Manager

Andrew Jamrogiewicz

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2101595
ACS Lab # 21-3632-6
Client: Ethos Engineering
Project Name: Northern Parkway
Project Address: Northrn Parkway, 99th Ave to 87th Ave
Project City: Glendale
Sample Location: NP - 9 @ 0.0'-2.5'

Material Type: Native
Supplier: -
Sample Date: 7/30/2021
Sampled By: Client
Test Date: 8/13/2021
Tested By: Ryan Richardson
Reviewed By: Andrew Jamrogiewicz, PE

Sieve Analysis (ASTM C-139 / AASHTO T-27)

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"	0	99	
1/2"	1	99	
3/8"	0	98	
1/4"	1	98	
#4	0	97	
#8	3	94	
#10	2	93	
#16	8	84	
#30	18	66	
#40	8	58	
#50	7	51	
#100	10	42	
#200	8	33.8	

Liquid Limit (AASHTO T-89)	25
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Plastic Limit (AASHTO T-90)	16
--------------------------------	----

Plasticity Index (AASHTO T-90)	9
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Moisture Content (AASHTO T-255)	5.8
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Fractured Faces (ARIZ 212)	
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Soluble Salts (ARIZ 237)	
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USCS Soil Classification	SC
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Andrew Jamrogiewicz

Project Manager

Andrew Jamrogiewicz

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2101595 Material Type: Native
ACS Lab # 21-3632-31 Supplier: -
Client: Ethos Engineering Sample Date: 8/31/2021
Project Name: Northern Parkway Sampled By: Client
Project Address: Northern Parkway, 99th Ave to 87th Ave Test Date: 9/10/2021
Project City: Glendale, AZ Tested By: Jose Botello
Sample Location: NP - 10 @ 20.0'-25.0' Reviewed By: Andrew Jamrogiewicz, P.E.

Sieve Analysis (ASTM C-139 / AASHTO T-27)

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"	0	100	
1/2"	0	100	
3/8"	1	99	
1/4"	1	99	
#4	2	97	
#8	2	95	
#10	1	94	
#16	4	90	
#30	11	79	
#40	6	73	
#50	5	68	
#100	6	61	
#200	7	54.4	

Liquid Limit (AASHTO T-89)	35
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Plastic Limit (AASHTO T-90)	17
--------------------------------	----

Plasticity Index (AASHTO T-90)	18
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Moisture Content (AASHTO T-255)	12.6
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Fractured Faces (ARIZ 212)	
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Soluble Salts (ARIZ 237)	
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USCS Soil Classification	CL
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Andrew Jamrogiewicz

Project Manager

Andrew Jamrogiewicz

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2101595 Material Type: Native
ACS Lab # 21-3632-32 Supplier: -
Client: Ethos Engineering Sample Date: 8/31/2021
Project Name: Northern Parkway Sampled By: Client
Project Address: Northern Parkway, 99th Ave to 87th Ave Test Date: 9/10/2021
Project City: Glendale, AZ Tested By: Jose Botello
Sample Location: NP - 11 @ 20.0'-25.0' Reviewed By: Andrew Jamrogiewicz, P.E.

Sieve Analysis (ASTM C-139 / AASHTO T-27)

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"	5	94	
1/2"	3	91	
3/8"	3	89	
1/4"	8	81	
#4	6	76	
#8	4	71	
#10	1	70	
#16	4	66	
#30	8	58	
#40	4	54	
#50	4	50	
#100	5	45	
#200	5	39.9	

Liquid Limit (AASHTO T-89)	36
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Plastic Limit (AASHTO T-90)	17
--------------------------------	----

Plasticity Index (AASHTO T-90)	19
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Moisture Content (AASHTO T-255)	13.9
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Fractured Faces (ARIZ 212)	
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Soluble Salts (ARIZ 237)	
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USCS Soil Classification	SC
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Andrew Jamrogiewicz

Project Manager

Andrew Jamrogiewicz

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2101595
ACS Lab # 21-3632-30
Client: Ethos Engineering
Project Name: Northern Parkway
Project Address: Northern Parkway, 99th Ave to 87th Ave
Project City: Glendale, AZ
Sample Location: NP - 11 @ 25.0'-26.0'

Material Type: Native
Supplier: -
Sample Date: 8/31/2021
Sampled By: Client
Test Date: 9/17/2021
Tested By: Jose Botello
Reviewed By: Andrew Jamrogiewicz, P.E.

Sieve Analysis (ASTM C-139 / AASHTO T-27)

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"	3	97	
1/2"	1	95	
3/8"	2	93	
1/4"	3	90	
#4	2	88	
#8	7	80	
#10	2	78	
#16	7	72	
#30	12	60	
#40	5	54	
#50	5	50	
#100	6	44	
#200	5	38.2	

Liquid Limit (AASHTO T-89)	40
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Plastic Limit (AASHTO T-90)	19
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Plasticity Index (AASHTO T-90)	21
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Moisture Content (AASHTO T-255)	13.7
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Fractured Faces (ARIZ 212)	
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Soluble Salts (ARIZ 237)	
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USCS Soil Classification	SC
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Andrew Jamrogiewicz

Project Manager

Andrew Jamrogiewicz

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2101595
ACS Lab # 21-3632-34
Client: Ethos Engineering
Project Name: Northern Parkway
Project Address: Northern Parkway, 99th Ave to 87th Ave
Project City: Glendale, AZ
Sample Location: NP - 11 @ 30.0'-31.5'

Material Type: Native
Supplier: -
Sample Date: 8/31/2021
Sampled By: Client
Test Date: 9/23/2021
Tested By: Jose Botello
Reviewed By: Andrew Jamrogiewicz, P.E.

Sieve Analysis (ASTM C-139 / AASHTO T-27)

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"	2	98	
1/2"	9	89	
3/8"	4	85	
1/4"	5	79	
#4	3	76	
#8	6	71	
#10	2	69	
#16	4	65	
#30	7	57	
#40	4	54	
#50	3	50	
#100	6	45	
#200	5	39.2	

Liquid Limit (AASHTO T-89)	29
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Plastic Limit (AASHTO T-90)	19
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Plasticity Index (AASHTO T-90)	10
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Moisture Content (AASHTO T-255)	12.2
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Fractured Faces (ARIZ 212)	
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Soluble Salts (ARIZ 237)	
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USCS Soil Classification	SC
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Andrew Jamrogiewicz

Project Manager

Andrew Jamrogiewicz

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2101595
ACS Lab # 21-3632-8
Client: Ethos Engineering
Project Name: Northern Parkway
Project Address: Northern Parkway, 99th Ave to 87th Ave
Project City: Glendale, AZ
Sample Location: NP - 12 @ 0.0'-2.5'

Material Type: Native
Supplier: -
Sample Date: 7/30/2021
Sampled By: Client
Test Date: 8/13/2021
Tested By: Ryan Richardson
Reviewed By: Andrew Jamrogiewicz, PE

Sieve Analysis (ASTM C-139 / AASHTO T-27)

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"	0	99	
1/2"	1	98	
3/8"	0	98	
1/4"	1	97	
#4	1	96	
#8	2	94	
#10	1	93	
#16	6	86	
#30	14	73	
#40	7	66	
#50	6	60	
#100	10	51	
#200	11	40.1	

Liquid Limit (AASHTO T-89)	23
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Plastic Limit (AASHTO T-90)	16
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Plasticity Index (AASHTO T-90)	7
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Moisture Content (AASHTO T-255)	3.9
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Fractured Faces (ARIZ 212)	
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Soluble Salts (ARIZ 237)	
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USCS Soil Classification	SC-SM
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Andrew Jamrogiewicz

Project Manager

Andrew Jamrogiewicz

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2101595
ACS Lab # 21-3632-10
Client: Ethos Engineering
Project Name: Northern Parkway
Project Address: Northern Parkway, 99th Ave to 87th Ave
Project City: Glendale, AZ
Sample Location: NP - 13 @ 0.0'-2.5'

Material Type: Native
Supplier: -
Sample Date: 7/30/2021
Sampled By: Client
Test Date: 8/13/2021
Tested By: Ryan Richardson
Reviewed By: Andrew Jamrogiewicz, PE

Sieve Analysis (ASTM C-139 / AASHTO T-27)

Sieve Size	% Retained	% Passed	Specs
6"	0	100	
3"	0	100	
2 1/2"	0	100	
2"	0	100	
1 1/2"	4	96	
1"	2	93	
3/4"	3	90	
1/2"	4	86	
3/8"	2	85	
1/4"	2	82	
#4	1	81	
#8	8	73	
#10	2	70	
#16	8	62	
#30	13	50	
#40	5	44	
#50	4	40	
#100	7	33	
#200	7	26.2	

Liquid Limit (AASHTO T-89)	29
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Plastic Limit (AASHTO T-90)	17
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Plasticity Index (AASHTO T-90)	12
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Moisture Content (AASHTO T-255)	3.4
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Fractured Faces (ARIZ 212)	
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Soluble Salts (ARIZ 237)	
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USCS Soil Classification	SC
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Andrew Jamrogiewicz

Project Manager

Andrew Jamrogiewicz

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2101595
ACS Lab # 21-3632-12
Client: Ethos Engineering
Project Name: Northern Parkway
Project Address: Northern Parkway, 99th Ave to 87th Ave
Project City: Glendale, AZ
Sample Location: NP - 14 @ 0.0'-2.5'

Material Type: Native
Supplier: -
Sample Date: 7/30/2021
Sampled By: Client
Test Date: 8/13/2021
Tested By: Ryan Richardson
Reviewed By: Andrew Jamrogiewicz, PE

Sieve Analysis (ASTM C-139 / AASHTO T-27)

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"	0	99	
1/2"	2	97	
3/8"	1	96	
1/4"	2	94	
#4	1	93	
#8	3	90	
#10	1	89	
#16	5	85	
#30	11	73	
#40	6	68	
#50	5	63	
#100	9	54	
#200	11	42.5	

Liquid Limit (AASHTO T-89)	29
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Plastic Limit (AASHTO T-90)	16
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Plasticity Index (AASHTO T-90)	13
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Moisture Content (AASHTO T-255)	2.5
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Fractured Faces (ARIZ 212)	
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Soluble Salts (ARIZ 237)	
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USCS Soil Classification	SC
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Andrew Jamrogiewicz

Project Manager

Andrew Jamrogiewicz

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2101595 Material Type: Native
ACS Lab # 21-3632-18 Supplier: -
Client: Ethos Engineering Sample Date: 8/16/2021
Project Name: Northern Parkway Sampled By: Client
Project Address: Northern Parkway, 99th Ave to 87th Ave Test Date: 9/15/2021
Project City: Glendale, AZ Tested By: Jose Botello
Sample Location: NP - 15 @ 0.0'-2.5' Reviewed By: Andrew Jamrogiewicz, P.E.

Sieve Analysis (ASTM C-139 / AASHTO T-27)

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"	0	100	
1/2"	1	99	
3/8"	1	98	
1/4"	2	96	
#4	1	95	
#8	2	93	
#10	1	92	
#16	3	90	
#30	7	83	
#40	4	79	
#50	4	74	
#100	9	65	
#200	8	57.6	

Liquid Limit (AASHTO T-89)	29
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Plastic Limit (AASHTO T-90)	22
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Plasticity Index (AASHTO T-90)	7
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Moisture Content (AASHTO T-255)	6.7
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Fractured Faces (ARIZ 212)	
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Soluble Salts (ARIZ 237)	
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USCS Soil Classification	CL-ML
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Andrew Jamrogiewicz

Project Manager

Andrew Jamrogiewicz

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2101595
ACS Lab # 21-3632-41
Client: Ethos Engineering
Project Name: Northern Parkway
Project Address: Northern Parkway, 99th Ave to 87th Ave
Project City: Glendale, AZ
Sample Location: NP - 16 @ 2.5'-3.5'

Material Type: Native
Supplier: -
Sample Date: 8/31/2021
Sampled By: Client
Test Date: 9/24/2021
Tested By: Jose Botello
Reviewed By: Andrew Jamrogiewicz, P.E.

Sieve Analysis (ASTM C-139 / AASHTO T-27)

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"	0	100	
1/2"	0	100	
3/8"	0	100	
1/4"	2	98	
#4	1	97	
#8	3	94	
#10	1	93	
#16	2	91	
#30	6	85	
#40	4	81	
#50	5	76	
#100	9	67	
#200	10	57.2	

Liquid Limit (AASHTO T-89)	46
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Plastic Limit (AASHTO T-90)	25
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Plasticity Index (AASHTO T-90)	21
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Moisture Content (AASHTO T-255)	14.6
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Fractured Faces (ARIZ 212)	
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Soluble Salts (ARIZ 237)	
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USCS Soil Classification	CL
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Andrew Jamrogiewicz

Project Manager

Andrew Jamrogiewicz

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2101595
ACS Lab # 21-3632-19
Client: Ethos Engineering
Project Name: Northern Parkway
Project Address: Northern Parkway, 99th Ave to 87th Ave
Project City: Glendale, AZ
Sample Location: NP - 17 @ 0.0'-2.5'

Material Type: Native
Supplier: -
Sample Date: 8/16/2021
Sampled By: Client
Test Date: 9/14/2021
Tested By: Jose Botello
Reviewed By: Andrew Jamrogiewicz, P.E.

Sieve Analysis (ASTM C-139 / AASHTO T-27)

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"	2	98	
1/2"	5	93	
3/8"	3	91	
1/4"	4	86	
#4	2	84	
#8	4	80	
#10	1	79	
#16	4	75	
#30	8	67	
#40	4	63	
#50	4	59	
#100	7	52	
#200	7	44.8	

Liquid Limit (AASHTO T-89)	29
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Plastic Limit (AASHTO T-90)	20
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Plasticity Index (AASHTO T-90)	9
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Moisture Content (AASHTO T-255)	11.1
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Fractured Faces (ARIZ 212)	
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Soluble Salts (ARIZ 237)	
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USCS Soil Classification	SC
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Andrew Jamrogiewicz

Project Manager

Andrew Jamrogiewicz

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2101595
ACS Lab # 21-3632-14
Client: Ethos Engineering
Project Name: Northern Parkway
Project Address: Northern Parkway, 99th Ave to 87th Ave
Project City: Glendale, AZ
Sample Location: NP - 18 @ 2.5'-3.0'

Material Type: Native
Supplier: -
Sample Date: 8/16/2021
Sampled By: Client
Test Date: 9/23/2021
Tested By: Jose Botello
Reviewed By: Andrew Jamrogiewicz, P.E.

Sieve Analysis (ASTM C-139 / AASHTO T-27)

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"	0	100	
1/2"	0	100	
3/8"	0	100	
1/4"	0	100	
#4	1	99	
#8	1	98	
#10	1	97	
#16	3	94	
#30	8	86	
#40	5	81	
#50	5	76	
#100	10	66	
#200	12	54.6	

Liquid Limit
(AASHTO T-89)

Plastic Limit
(AASHTO T-90)

Plasticity Index
(AASHTO T-90)

Moisture Content
(AASHTO T-255)

5.2

Fractured Faces
(ARIZ 212)

Soluble Salts
(ARIZ 237)

USCS Soil
Classification

Andrew Jamrogiewicz

Project Manager

Andrew Jamrogiewicz

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2101595
ACS Lab # 21-3632-35
Client: Ethos Engineering
Project Name: Northern Parkway
Project Address: Northern Parkway, 99th Ave to 87th Ave
Project City: Glendale, AZ
Sample Location: NP - 19 @ 0.5'-2.5'

Material Type: Native
Supplier: -
Sample Date: 8/31/2021
Sampled By: Client
Test Date: 9/17/2021
Tested By: Jose Botello
Reviewed By: Andrew Jamrogiewicz, P.E.

Sieve Analysis (ASTM C-139 / AASHTO T-27)

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"	0	100	
1/2"	1	99	
3/8"	0	99	
1/4"	2	97	
#4	1	96	
#8	4	92	
#10	1	91	
#16	4	87	
#30	8	79	
#40	4	75	
#50	5	70	
#100	11	59	
#200	12	47.1	

Liquid Limit (AASHTO T-89)	26
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Plastic Limit (AASHTO T-90)	19
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Plasticity Index (AASHTO T-90)	7
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Moisture Content (AASHTO T-255)	1.5
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Fractured Faces (ARIZ 212)	
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Soluble Salts (ARIZ 237)	
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USCS Soil Classification	SC-SM
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Andrew Jamrogiewicz

Project Manager

Andrew Jamrogiewicz

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2101595
ACS Lab # 21-3632-36
Client: Ethos Engineering
Project Name: Northern Parkway
Project Address: Northern Parkway, 99th Ave to 87th Ave
Project City: Glendale, AZ
Sample Location: NP - 20 @ 1.0'-2.5'

Material Type: Native
Supplier: -
Sample Date: 8/31/2021
Sampled By: Client
Test Date: 9/14/2021
Tested By: Jose Botello
Reviewed By: Andrew Jamrogiewicz, P.E.

Sieve Analysis (ASTM C-139 / AASHTO T-27)

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"	3	96	
1/2"	9	87	
3/8"	6	81	
1/4"	8	73	
#4	4	68	
#8	4	64	
#10	1	63	
#16	4	58	
#30	11	47	
#40	5	42	
#50	4	38	
#100	6	32	
#200	4	27.6	

Liquid Limit (AASHTO T-89)	25
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Plastic Limit (AASHTO T-90)	15
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Plasticity Index (AASHTO T-90)	10
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Moisture Content (AASHTO T-255)	9.8
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Fractured Faces (ARIZ 212)	
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Soluble Salts (ARIZ 237)	
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USCS Soil Classification	SC
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Andrew Jamrogiewicz

Project Manager

Andrew Jamrogiewicz

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2101595 Material Type: Native
ACS Lab # 21-3632-38 Supplier: -
Client: Ethos Engineering Sample Date: 8/31/2021
Project Name: Northern Parkway Sampled By: Client
Project Address: Northern Parkway, 99th Ave to 87th Ave Test Date: 9/23/2021
Project City: Glendale, AZ Tested By: Jose Botello
Sample Location: NP - 20 @ 5.0'-6.0' Reviewed By: Andrew Jamrogiewicz, P.E.

Sieve Analysis (ASTM C-139 / AASHTO T-27)

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"	0	100	
1/2"	0	100	
3/8"	0	100	
1/4"	0	100	
#4	1	99	
#8	1	98	
#10	0	97	
#16	2	95	
#30	5	90	
#40	3	87	
#50	3	84	
#100	7	77	
#200	9	68.2	

Liquid Limit
(AASHTO T-89)

Plastic Limit
(AASHTO T-90)

Plasticity Index
(AASHTO T-90)

Moisture Content
(AASHTO T-255)

11.8

Fractured Faces
(ARIZ 212)

Soluble Salts
(ARIZ 237)

USCS Soil
Classification

Andrew Jamrogiewicz

Project Manager

Andrew Jamrogiewicz

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2101595 Material Type: Native
ACS Lab # 21-3632-39 Supplier: -
Client: Ethos Engineering Sample Date: 8/31/2021
Project Name: Northern Parkway Sampled By: Client
Project Address: Northern Parkway, 99th Ave to 87th Ave Test Date: 9/17/2021
Project City: Glendale, AZ Tested By: Jose Botello
Sample Location: NP - 21 @ 1.0'-2.5' Reviewed By: Andrew Jamrogiewicz, P.E.

Sieve Analysis (ASTM C-139 / AASHTO T-27)

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"	2	98	
1/2"	10	88	
3/8"	8	80	
1/4"	12	68	
#4	6	61	
#8	5	57	
#10	1	55	
#16	4	51	
#30	8	44	
#40	4	39	
#50	4	36	
#100	6	30	
#200	5	25.3	

Liquid Limit (AASHTO T-89)	33
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Plastic Limit (AASHTO T-90)	16
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Plasticity Index (AASHTO T-90)	17
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Moisture Content (AASHTO T-255)	10.5
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Fractured Faces (ARIZ 212)	
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Soluble Salts (ARIZ 237)	
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USCS Soil Classification	GC
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Andrew Jamrogiewicz

Project Manager

Andrew Jamrogiewicz

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2101595 Material Type: Native
ACS Lab # 21-3632-20 Supplier: -
Client: Ethos Engineering Sample Date: 8/16/2021
Project Name: Northern Parkway Sampled By: Client
Project Address: Northern Parkway, 99th Ave to 87th Ave Test Date: 9/14/2021
Project City: Glendale, AZ Tested By: Jose Botello
Sample Location: NP - 22 @ 0.0'-2.5' Reviewed By: Andrew Jamrogiewicz, P.E.

Sieve Analysis (ASTM C-139 / AASHTO T-27)

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"	3	96	
1/2"	13	83	
3/8"	6	77	
1/4"	7	71	
#4	4	67	
#8	5	62	
#10	2	60	
#16	4	56	
#30	7	49	
#40	3	46	
#50	3	43	
#100	5	38	
#200	4	34.0	

Liquid Limit (AASHTO T-89)	31
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Plastic Limit (AASHTO T-90)	17
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Plasticity Index (AASHTO T-90)	14
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Moisture Content (AASHTO T-255)	7.5
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Fractured Faces (ARIZ 212)	
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Soluble Salts (ARIZ 237)	
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USCS Soil Classification	SC
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Andrew Jamrogiewicz

Project Manager

Andrew Jamrogiewicz

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2101595
ACS Lab # 21-3632-40
Client: Ethos Engineering
Project Name: Northern Parkway
Project Address: Northern Parkway, 99th Ave to 87th Ave
Project City: Glendale, AZ
Sample Location: NP - 23 @ 0.5'-2.5'

Material Type: Native
Supplier: -
Sample Date: 8/16/2021
Sampled By: Client
Test Date: 9/14/2021
Tested By: Jose Botello
Reviewed By: Andrew Jamrogiewicz, P.E.

Sieve Analysis (ASTM C-139 / AASHTO T-27)

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"	2	98	
3/4"	1	98	
1/2"	1	96	
3/8"	1	95	
1/4"	3	93	
#4	2	91	
#8	3	88	
#10	1	87	
#16	4	83	
#30	8	74	
#40	4	70	
#50	5	65	
#100	10	55	
#200	10	44.5	

Liquid Limit (AASHTO T-89)	23
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Plastic Limit (AASHTO T-90)	20
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Plasticity Index (AASHTO T-90)	3
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Moisture Content (AASHTO T-255)	1.7
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Fractured Faces (ARIZ 212)	
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Soluble Salts (ARIZ 237)	
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USCS Soil Classification	SM
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Andrew Jamrogiewicz

Project Manager

Andrew Jamrogiewicz

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2101595
ACS Lab # 21-3632-21
Client: Ethos Engineering
Project Name: Northern Parkway
Project Address: Northern Parkway, 99th Ave to 87th Ave
Project City: Glendale, AZ
Sample Location: NP - 24 @ 0.0'-2.5'

Material Type: Native
Supplier: -
Sample Date: 8/16/2021
Sampled By: Client
Test Date: 9/13/2021
Tested By: Jose Botello
Reviewed By: Andrew Jamrogiewicz, P.E.

Sieve Analysis (ASTM C-139 / AASHTO T-27)

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"	0	100	
1/2"	1	98	
3/8"	1	97	
1/4"	2	95	
#4	1	94	
#8	2	92	
#10	1	91	
#16	2	89	
#30	6	83	
#40	3	80	
#50	4	76	
#100	11	65	
#200	14	51.5	

Liquid Limit (AASHTO T-89)	25
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Plastic Limit (AASHTO T-90)	16
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Plasticity Index (AASHTO T-90)	9
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Moisture Content (AASHTO T-255)	6.7
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Fractured Faces (ARIZ 212)	
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Soluble Salts (ARIZ 237)	
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USCS Soil Classification	CL
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Andrew Jamrogiewicz

Project Manager

Andrew Jamrogiewicz

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2101595 Material Type: Native
ACS Lab # 21-3632-1 Supplier: -
Client: Ethos Engineering Sample Date: 7/30/2021
Project Name: Northern Parkway Sampled By: Client
Project Address: Northern Parkway, 99th Ave to 87th Ave Test Date: 8/13/2021
Project City: Glendale, AZ Tested By: Ryan Richardson
Sample Location: P - 1 @ 0.0'-3.0' Reviewed By: Andrew Jamrogiewicz, PE

Sieve Analysis (ASTM C-139 / AASHTO T-27)

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"	6	94	
3/4"	3	91	
1/2"	6	85	
3/8"	2	83	
1/4"	3	80	
#4	1	79	
#8	5	74	
#10	2	72	
#16	7	65	
#30	18	47	
#40	9	38	
#50	7	32	
#100	8	24	
#200	5	19.2	

Liquid Limit
(AASHTO T-89)

Plastic Limit
(AASHTO T-90)

Plasticity Index
(AASHTO T-90)

NP

Moisture Content
(AASHTO T-255)

8.0

Fractured Faces
(ARIZ 212)

Soluble Salts
(ARIZ 237)

USCS Soil
Classification

SM

Andrew Jamrogiewicz

Project Manager

Andrew Jamrogiewicz

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2101595 Material Type: Native
ACS Lab # 21-3632-2 Supplier: -
Client: Ethos Engineering Sample Date: 7/30/2021
Project Name: Northern Parkway Sampled By: Client
Project Address: Northern Parkway, 99th Ave to 87th Ave Test Date: 8/13/2021
Project City: Glendale, AZ Tested By: Ryan Richardson
Sample Location: P - 1 @ 3.0'-8.0' Reviewed By: Andrew Jamrogiewicz, PE

Sieve Analysis (ASTM C-139 / AASHTO T-27)

Sieve Size	% Retained	% Passed	Specs
6"	0	100	
3"	0	100	
2 1/2"	0	100	
2"	0	100	
1 1/2"	3	97	
1"	14	83	
3/4"	4	78	
1/2"	2	76	
3/8"	2	74	
1/4"	2	72	
#4	1	71	
#8	3	68	
#10	1	67	
#16	5	62	
#30	13	49	
#40	7	42	
#50	5	37	
#100	7	30	
#200	5	24.5	

Liquid Limit
(AASHTO T-89)

Plastic Limit
(AASHTO T-90)

Plasticity Index
(AASHTO T-90)

NP

Moisture Content
(AASHTO T-255)

5.4

Fractured Faces
(ARIZ 212)

Soluble Salts
(ARIZ 237)

USCS Soil
Classification

SM

Andrew Jamrogiewicz

Project Manager

Andrew Jamrogiewicz

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2101595
ACS Lab # 21-3632-3
Client: Ethos Engineering
Project Name: Northern Parkway
Project Address: Northern Parkway, 99th Ave to 87th Ave
Project City: Glendale, AZ
Sample Location: P - 2 @ 0.0'-3.0'

Material Type: Native
Supplier: -
Sample Date: 7/30/2021
Sampled By: Client
Test Date: 8/13/2021
Tested By: Ryan Richardson
Reviewed By: Andrew Jamrogiewicz, PE

Sieve Analysis (ASTM C-139 / AASHTO T-27)

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"	1	98	
1/2"	2	96	
3/8"	1	94	
1/4"	2	92	
#4	1	91	
#8	3	88	
#10	1	87	
#16	6	82	
#30	15	66	
#40	8	58	
#50	7	51	
#100	10	41	
#200	7	33.7	

Liquid Limit
(AASHTO T-89)

Plastic Limit
(AASHTO T-90)

Plasticity Index
(AASHTO T-90)

NP

Moisture Content
(AASHTO T-255)

9.9

Fractured Faces
(ARIZ 212)

Soluble Salts
(ARIZ 237)

USCS Soil
Classification

SM

Andrew Jamrogiewicz

Project Manager

Andrew Jamrogiewicz

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2101595
ACS Lab # 21-3632-4
Client: Ethos Engineering
Project Name: Northern Parkway
Project Address: Northern Parkway, 99th Ave to 87th Ave
Project City: Glendale, AZ
Sample Location: P - 2 @ 3.0' - 8.0'

Material Type: Native
Supplier: -
Sample Date: 7/30/2021
Sampled By: Client
Test Date: 8/13/2021
Tested By: Ryan Richardson
Reviewed By: Andrew Jamrogiewicz, PE

Sieve Analysis (ASTM C-139 / AASHTO T-27)

Sieve Size	% Retained	% Passed	Specs
6"	0	100	
3"	0	100	
2 1/2"	0	100	
2"	0	100	
1 1/2"	3	97	
1"	0	97	
3/4"	2	95	
1/2"	1	94	
3/8"	1	93	
1/4"	2	91	
#4	1	90	
#8	1	89	
#10	0	89	
#16	2	87	
#30	6	81	
#40	3	78	
#50	3	75	
#100	7	67	
#200	10	57.4	

Liquid Limit (AASHTO T-89)	26
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Plastic Limit (AASHTO T-90)	18
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Plasticity Index (AASHTO T-90)	8
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Moisture Content (AASHTO T-255)	7.4
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Fractured Faces (ARIZ 212)	
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Soluble Salts (ARIZ 237)	
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USCS Soil Classification	CL
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Andrew Jamrogiewicz

Project Manager

Andrew Jamrogiewicz

Signature



PROJECT: ACS Project #2101595
LOCATION: Mesa, AZ
MATERIAL: Native

JOB NO: 19-2012-2017
WORK ORDER NO: N/A
DATE ASSIGNED: 11/16/22

MOISTURE CONTENT OF SOIL (ASTM D2216)

LAB #	BORING & DEPTH	WET WT. (gram)	DRY WT. (gram)	MOISTURE CONTENT
22-1779-01	ADD-1 (3-4')	507.9	493.8	2.9%
22-1779-02	ADD-2 (5-6')	528.3	518.4	1.9%
22-1779-03	ADD-2 (25-26')	413.5	384.9	7.4%
22-1779-04	ADD-3 (25-26')	463.6	447.9	3.5%

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2101595
ACS Lab # 22-4879-4
Client: Ethos Engineering, LLC
Project Name: Northern Parkway - 99th Avenue and 87th Avenue
Project Address: Northern Parkway
Project City: Peoria
Sample Location: ADD-1 @ 25 - 26.5

Material Type: Soil
Supplier: -
Sample Date: 11/14/2022
Sampled By: Client
Test Date: 11/21/2022
Tested By: Fernando Montero
Reviewed By: Dylan Ward

Sieve Analysis (ASTM C-136 / AASHTO T 27 / ARIZ 201)

Sieve Size	% Retained	% Passed	Specs
6"			
3"			
2 1/2"			
2"			
1 1/2"			
1"			
3/4"			
1/2"			
3/8"			
1/4"			
#4			
#8			
#10			
#16			
#30			
#40			
#50			
#100			
#200			

Liquid Limit
(AASHTO T-89)

Plastic Limit
(AASHTO T-90)

Plasticity Index
(AASHTO T-90)

Moisture Content
(AASHTO T-265)

17.2

USCS Soil
Classification

Group Name (ASTM D2487)

Dylan Ward

Laboratory Manager

Dylan Ward

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2101595
ACS Lab # 22-4879-5
Client: Ethos Engineering, LLC
Project Name: Northern Parkway - 99th Avenue and 87th Avenue
Project Address: Northern Parkway
Project City: Peoria
Sample Location: ADD-1 @ 45 - 46.25

Material Type: Soil
Supplier: -
Sample Date: 11/14/2022
Sampled By: Client
Test Date: 11/21/2022
Tested By: Fernando Montero
Reviewed By: Dylan Ward

Sieve Analysis (ASTM C-136 / AASHTO T 27 / ARIZ 201)

Sieve Size	% Retained	% Passed	Specs
6"			
3"			
2 1/2"			
2"			
1 1/2"			
1"			
3/4"			
1/2"			
3/8"			
1/4"			
#4			
#8			
#10			
#16			
#30			
#40			
#50			
#100			
#200			

Liquid Limit
(AASHTO T-89)

Plastic Limit
(AASHTO T-90)

Plasticity Index
(AASHTO T-90)

Moisture Content
(AASHTO T-265)

8.8

USCS Soil
Classification

Group Name (ASTM D2487)

Dylan Ward

Laboratory Manager

Dylan Ward

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2101595
ACS Lab # 22-4879-9
Client: Ethos Engineering, LLC
Project Name: Northern Parkway - 99th Avenue and 87th Avenue
Project Address: Northern Parkway
Project City: Peoria
Sample Location: ADD-2 @ 40 - 41.5

Material Type: Soil
Supplier: -
Sample Date: 11/14/2022
Sampled By: Client
Test Date: 11/21/2022
Tested By: Fernando Montero
Reviewed By: Dylan Ward

Sieve Analysis (ASTM C-136 / AASHTO T 27 / ARIZ 201)

Sieve Size	% Retained	% Passed	Specs
6"			
3"			
2 1/2"			
2"			
1 1/2"			
1"			
3/4"			
1/2"			
3/8"			
1/4"			
#4			
#8			
#10			
#16			
#30			
#40			
#50			
#100			
#200			

Liquid Limit
(AASHTO T-89)

Plastic Limit
(AASHTO T-90)

Plasticity Index
(AASHTO T-90)

Moisture Content
(AASHTO T-265)

20.8

USCS Soil
Classification

Group Name (ASTM D2487)

Dylan Ward

Laboratory Manager

Dylan Ward

Signature

ACS SERVICES LLC

Laboratory Soil Test Results

ACS PROJECT # 2101595
ACS Lab # 22-4879-12
Client: Ethos Engineering, LLC
Project Name: Northern Parkway - 99th Avenue and 87th Avenue
Project Address: Northern Parkway
Project City: Peoria
Sample Location: ADD-3 @ 30 - 31.5

Material Type: Soil
Supplier: -
Sample Date: 11/14/2022
Sampled By: Client
Test Date: 11/21/2022
Tested By: Fernando Montero
Reviewed By: Dylan Ward

Sieve Analysis (ASTM C-136 / AASHTO T 27 / ARIZ 201)

Sieve Size	% Retained	% Passed	Specs
6"			
3"			
2 1/2"			
2"			
1 1/2"			
1"			
3/4"			
1/2"			
3/8"			
1/4"			
#4			
#8			
#10			
#16			
#30			
#40			
#50			
#100			
#200			

Liquid Limit
(AASHTO T-89)

Plastic Limit
(AASHTO T-90)

Plasticity Index
(AASHTO T-90)

Moisture Content
(AASHTO T-265)

4.6

USCS Soil
Classification

Group Name (ASTM D2487)

Dylan Ward

Laboratory Manager

Dylan Ward

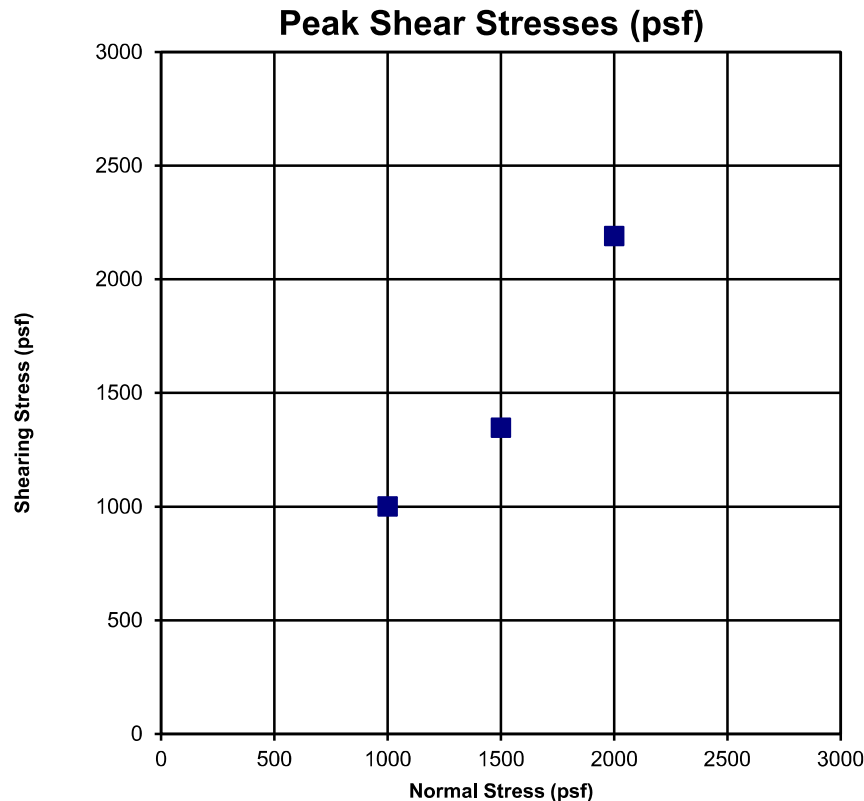
Signature

PROJECT: ACS Project #2301257
LOCATION: Mesa, AZ
MATERIAL: Native
SAMPLE SOURCE: NR-1 (10.0-11.0')
SAMPLE PREPARATION: Saturated - 1, 1.5, and 2ksf

JOB NO: 19-2012-2017
WORK ORDER NO: N/A
LAB NO: 23-1135-01
DATE ASSIGNED: 12/9/2022

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (ASTM D3080)

Initial thickness of specimen (in.):	1.00	1.00	1.00
Initial diameter of specimen (in.):	2.42	2.42	2.42
Final thickness before shear (in.):	0.917	0.938	0.957
Shearing device used: Humboldt Automated Shear Test System by Trautwein Soil Testing Equipment			
Rate of deformation (in/min):	0.01	0.01	0.01
Direct shear point:	1	2	3
Dry mass of specimen (g):	116.4	121.8	129.5
Initial Moisture Content:	7.5%	7.1%	6.3%
Initial Wet Density (pcf):	103.6	108.1	114.0
Initial Dry Density (pcf):	96.4	100.9	107.3
Final Moisture Content:	16.5%	16.3%	15.6%
Final Wet Density (pcf):	122.5	125.0	129.5
Final Dry Density (pcf):	105.1	107.6	112.1
Normal Stress (psf):	1000	1500	2000
Maximum Shearing Stress (psf):	1001	1347	2191
Vertical Deformation @ Max Shear (in):	0.151	0.165	0.176
Horizontal Deformation @ Max Shear (in):	0.384	0.380	0.331



PROJECT: ACS Project #2301257

LOCATION: Mesa, AZ

MATERIAL: Native

SAMPLE SOURCE: NR-1 (10.0-11.0')

SAMPLE PREPARATION: Saturated - 1, 1.5, and 2ksf

JOB NO: 19-2012-2017

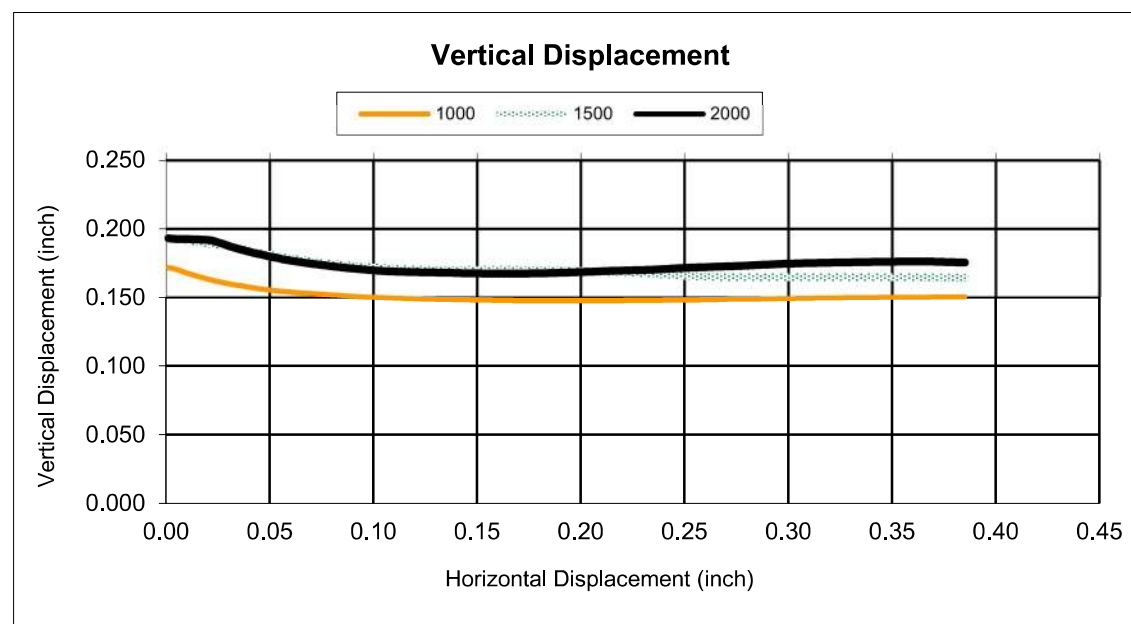
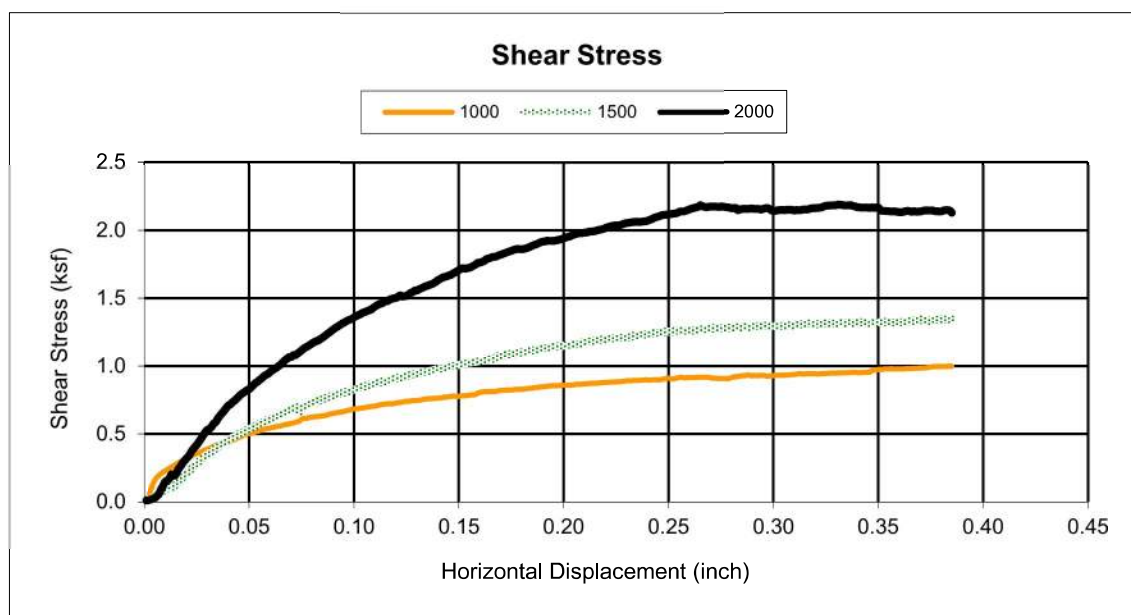
WORK ORDER NO: N/A

LAB NO: 23-1135-01

DATE ASSIGNED: 12/9/2022

NORMAL LOADS (psf): 1000 1500 2000

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (ASTM D3080)

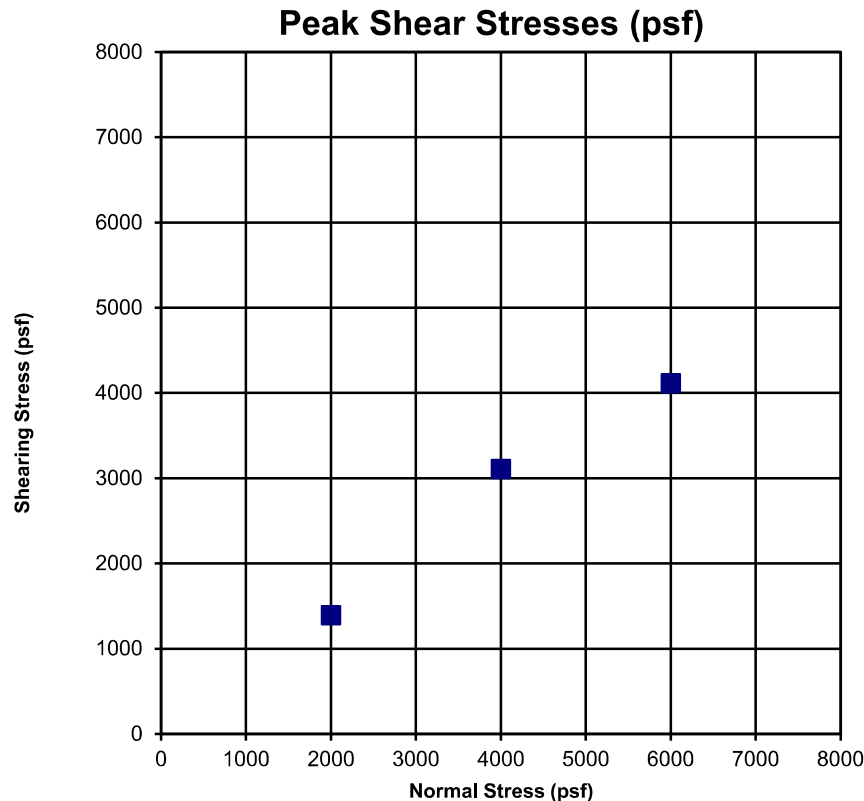


PROJECT: ACS Project #2301257
LOCATION: Mesa, AZ
MATERIAL: Native
SAMPLE SOURCE: NR-2 (50.0-51.0')
SAMPLE PREPARATION: Saturated - 2, 4, and 6ksf

JOB NO: 19-2012-2017
WORK ORDER NO: N/A
LAB NO: 23-1135-02
DATE ASSIGNED: 3/9/2023

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (ASTM D3080)

Initial thickness of specimen (in.):	1.00	1.00	1.00
Initial diameter of specimen (in.):	2.42	2.42	2.42
Final thickness before shear (in.):	0.992	0.995	0.993
Shearing device used: Humboldt Automated Shear Test System by Trautwein Soil Testing Equipment			
Rate of deformation (in/min):	0.01	0.01	0.01
Direct shear point:	1	2	3
Dry mass of specimen (g):	122.1	127.4	128.5
Initial Moisture Content:	11.8%	10.3%	10.4%
Initial Wet Density (pcf):	113.1	116.4	117.5
Initial Dry Density (pcf):	101.1	105.5	106.4
Final Moisture Content:	18.8%	16.2%	17.7%
Final Wet Density (pcf):	121.1	123.2	126.1
Final Dry Density (pcf):	102.0	106.0	107.1
Normal Stress (psf):	2000	4000	6000
Maximum Shearing Stress (psf):	1391	3107	4116
Vertical Deformation @ Max Shear (in):	0.214	0.198	0.211
Horizontal Deformation @ Max Shear (in):	0.471	0.489	0.163





PROJECT: ACS Project #2301257

LOCATION: Mesa, AZ

MATERIAL: Native

SAMPLE SOURCE: NR-2 (50.0-51.0')

SAMPLE PREPARATION: Saturated - 2, 4, and 6ksf

JOB NO: 19-2012-2017

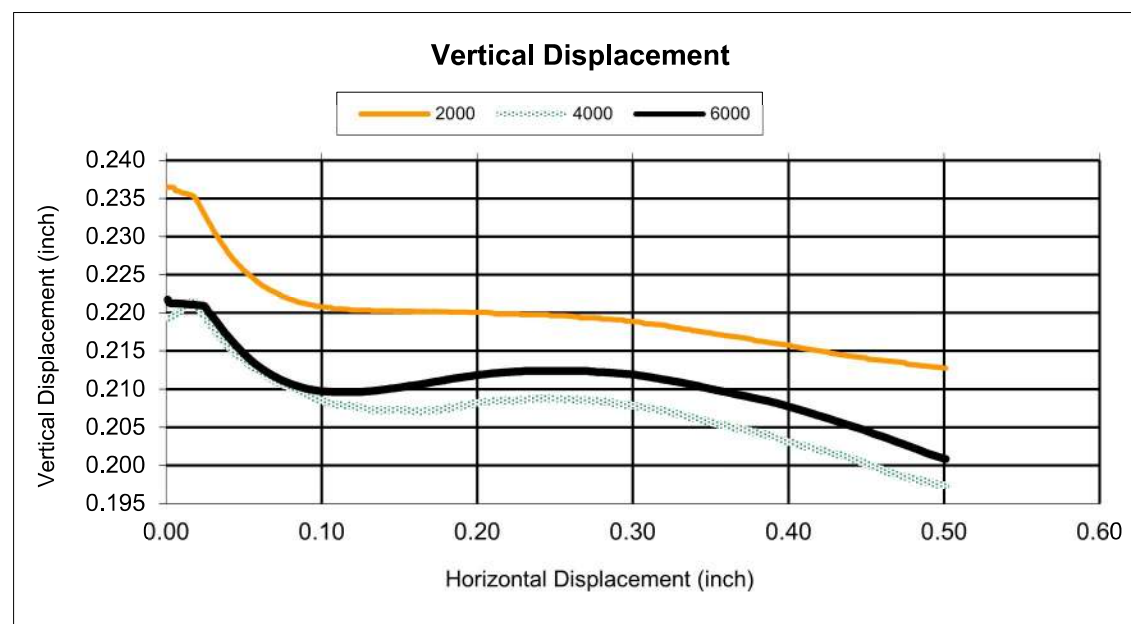
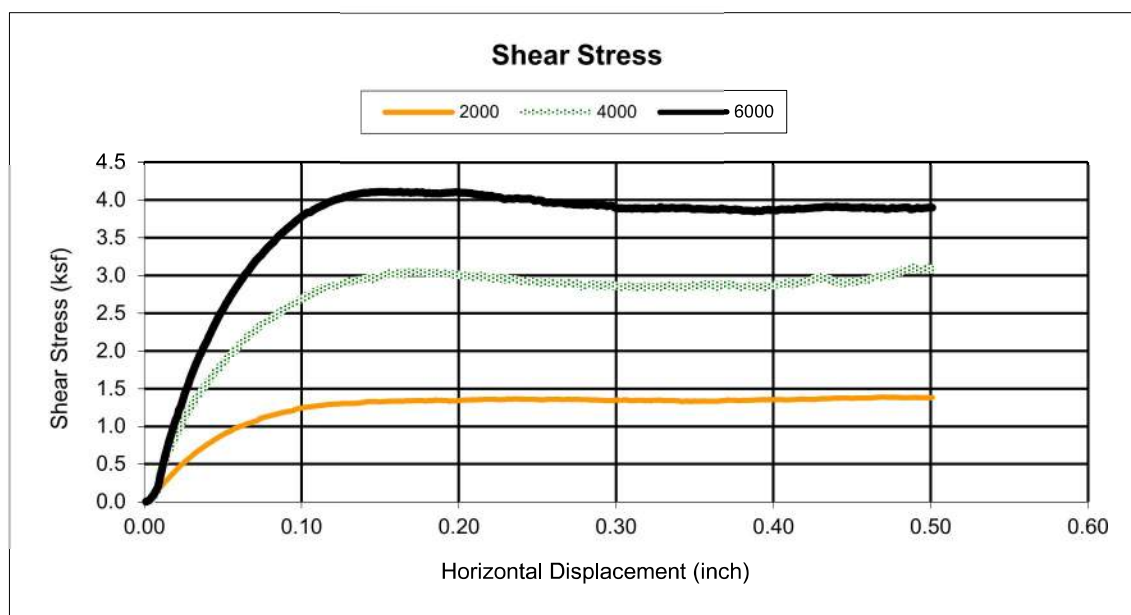
WORK ORDER NO: N/A

LAB NO: 23-1135-02

DATE ASSIGNED: 3/9/2023

NORMAL LOADS (psf): 2000 4000 6000

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (ASTM D3080)

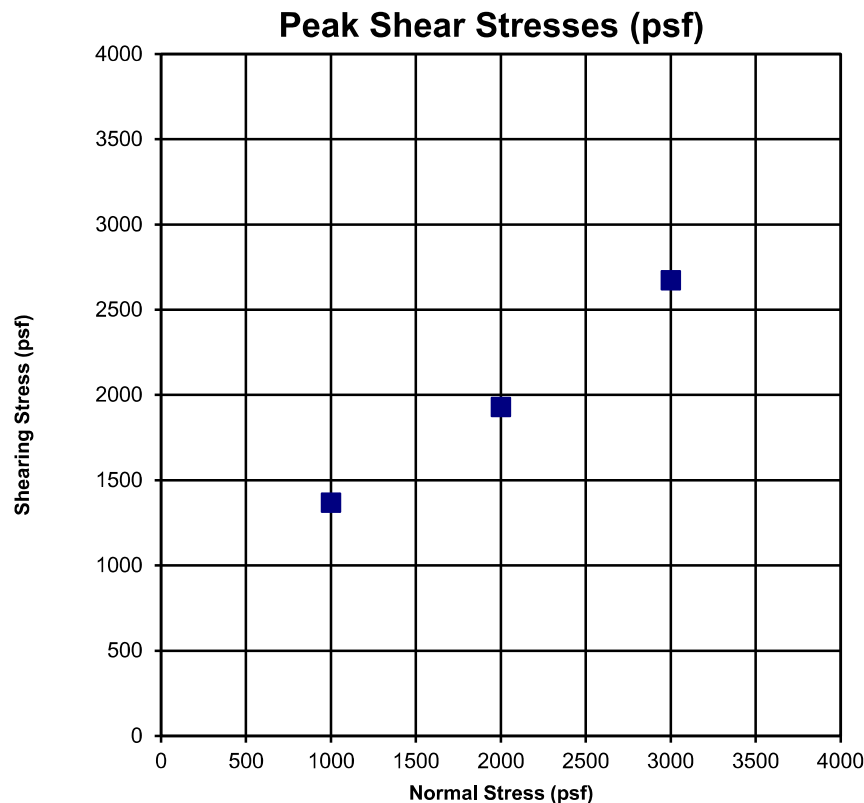


PROJECT: ACS Project #2301257
LOCATION: Mesa, AZ
MATERIAL: Native
SAMPLE SOURCE: NR-4 (30.0-31.0')
SAMPLE PREPARATION: Saturated - 1, 2, and 3ksf

JOB NO: 19-2012-2017
WORK ORDER NO: N/A
LAB NO: 23-1135-03
DATE ASSIGNED: 3/16/2023

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (ASTM D3080)

Initial thickness of specimen (in.):	1.00	1.00	1.00
Initial diameter of specimen (in.):	2.42	2.42	2.42
Final thickness before shear (in.):	0.998	0.996	0.997
Shearing device used: Humboldt Automated Shear Test System by Trautwein Soil Testing Equipment			
Rate of deformation (in/min):	0.01	0.01	0.01
Direct shear point:	1	2	3
Dry mass of specimen (g):	99.6	103.2	119.7
Initial Moisture Content:	27.4%	29.1%	19.9%
Initial Wet Density (pcf):	105.1	110.3	118.9
Initial Dry Density (pcf):	82.5	85.5	99.1
Final Moisture Content:	38.9%	39.4%	29.3%
Final Wet Density (pcf):	114.8	119.6	128.7
Final Dry Density (pcf):	82.7	85.8	99.5
Normal Stress (psf):	1000	2000	3000
Maximum Shearing Stress (psf):	1369	1930	2672
Vertical Deformation @ Max Shear (in):	0.287	0.272	0.275
Horizontal Deformation @ Max Shear (in):	0.381	0.173	0.262



PROJECT: ACS Project #2301257

LOCATION: Mesa, AZ

MATERIAL: Native

SAMPLE SOURCE: NR-4 (30.0-31.0')

SAMPLE PREPARATION: Saturated - 1, 2, and 3ksf

JOB NO: 19-2012-2017

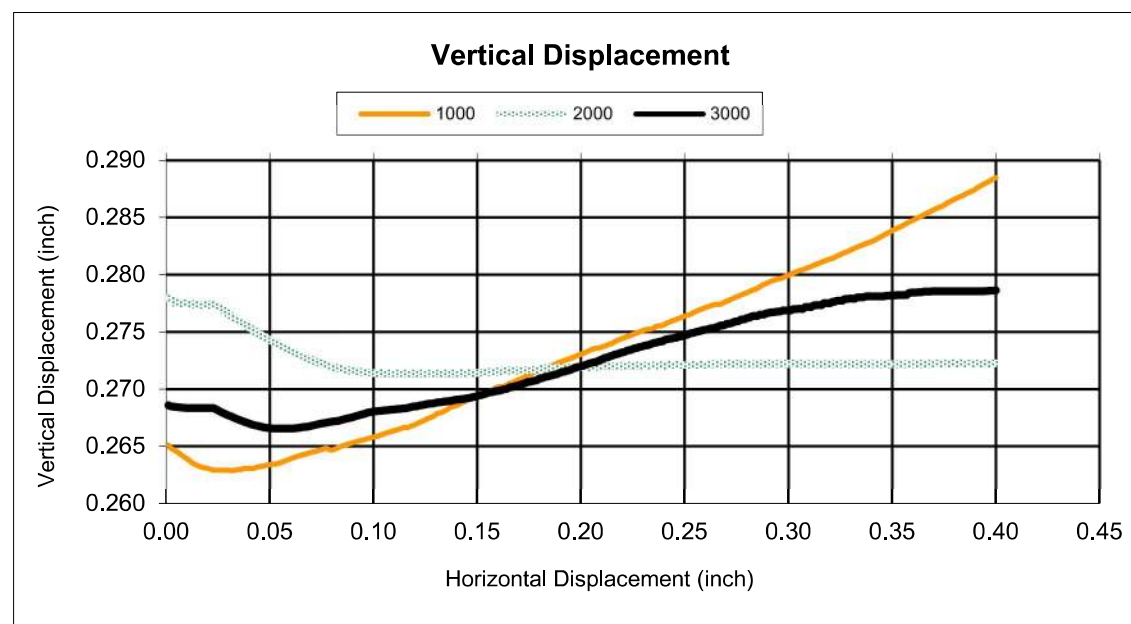
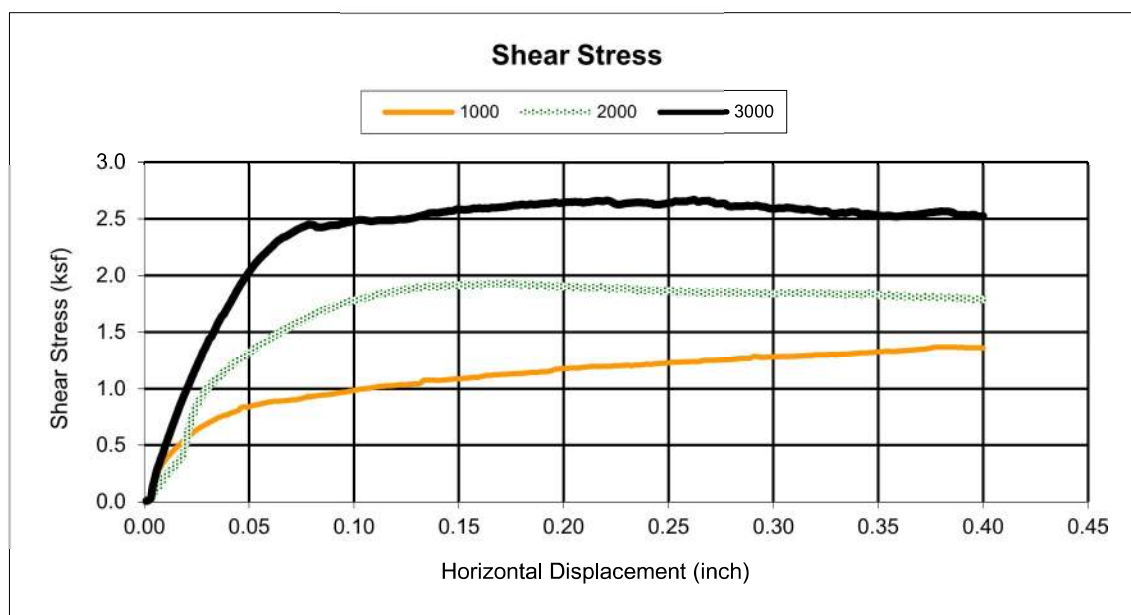
WORK ORDER NO: N/A

LAB NO: 23-1135-03

DATE ASSIGNED: 3/16/2023

NORMAL LOADS (psf): 1000 2000 3000

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (ASTM D3080)





PROJECT: ACS Project #2101595

LOCATION: Mesa, AZ

MATERIAL: Native

SAMPLE SOURCE: ADD-1 (3.0-4.0')

SAMPLE PREPARATION: Saturated - 1, 2, and 4ksf

JOB NO: 19-2012-2017

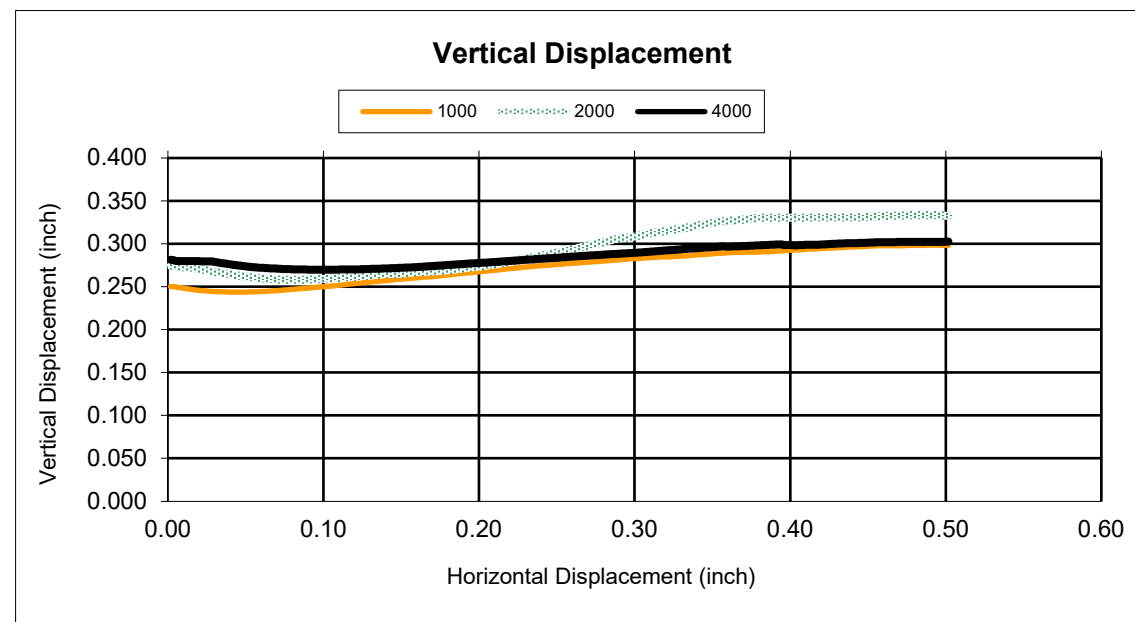
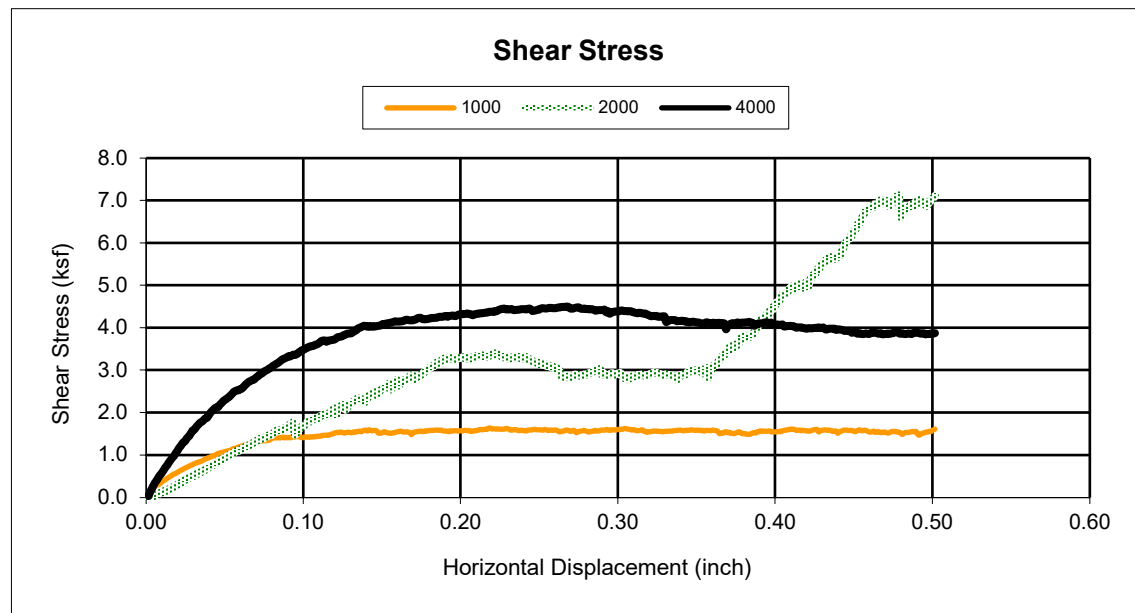
WORK ORDER NO: N/A

LAB NO: 22-1779-01

DATE ASSIGNED: 11/16/2022

NORMAL LOADS (psf): 1000 2000 4000

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (ASTM D3080)





PROJECT: ACS Project #2101595

LOCATION: Mesa, AZ

MATERIAL: Native

SAMPLE SOURCE: ADD-1 (3.0-4.0')

SAMPLE PREPARATION: Saturated - 1, 2, and 4ksf

JOB NO: 19-2012-2017

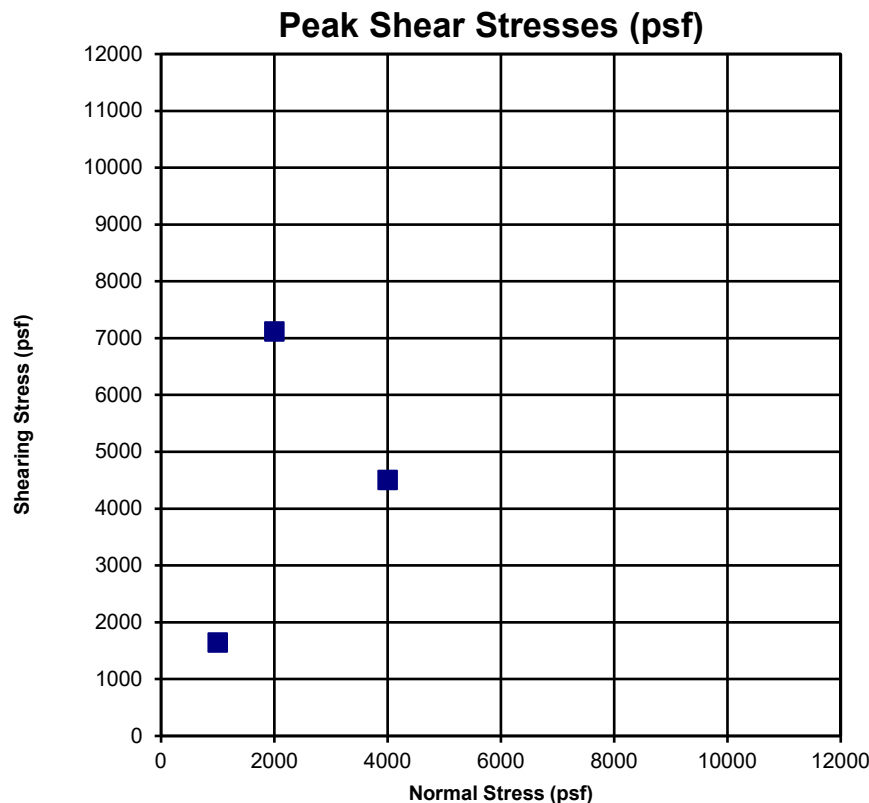
WORK ORDER NO: N/A

LAB NO: 22-1779-01

DATE ASSIGNED: 11/16/2022

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (ASTM D3080)

Initial thickness of specimen (in.):	1.00	1.00	1.00
Initial diameter of specimen (in.):	2.42	2.42	2.42
Final thickness before shear (in.):	0.995	0.994	0.994
Shearing device used: Humboldt Automated Shear Test System by Trautwein Soil Testing Equipment			
Rate of deformation (in/min):	0.016	0.016	0.016
Direct shear point:	1	2	3
Dry mass of specimen (g):	135.2	138.4	139.7
Initial Moisture Content:	4.5%	3.8%	4.6%
Initial Wet Density (pcf):	117.0	119.0	121.0
Initial Dry Density (pcf):	112.0	114.6	115.7
Final Moisture Content:	14.6%	13.2%	13.8%
Final Wet Density (pcf):	129.1	130.5	132.5
Final Dry Density (pcf):	112.6	115.3	116.4
Normal Stress (psf):	1000	2000	4000
Maximum Shearing Stress (psf):	1643	7115	4503
Vertical Deformation @ Max Shear (in):	0.271	0.333	0.286
Horizontal Deformation @ Max Shear (in):	0.219	0.479	0.268





PROJECT: ACS Project #2101595

LOCATION: Mesa, AZ

MATERIAL: Native

SAMPLE SOURCE: ADD-2 (5.0-6.0')

SAMPLE PREPARATION: Saturated - 1, 2, and 4ksf

JOB NO: 19-2012-2017

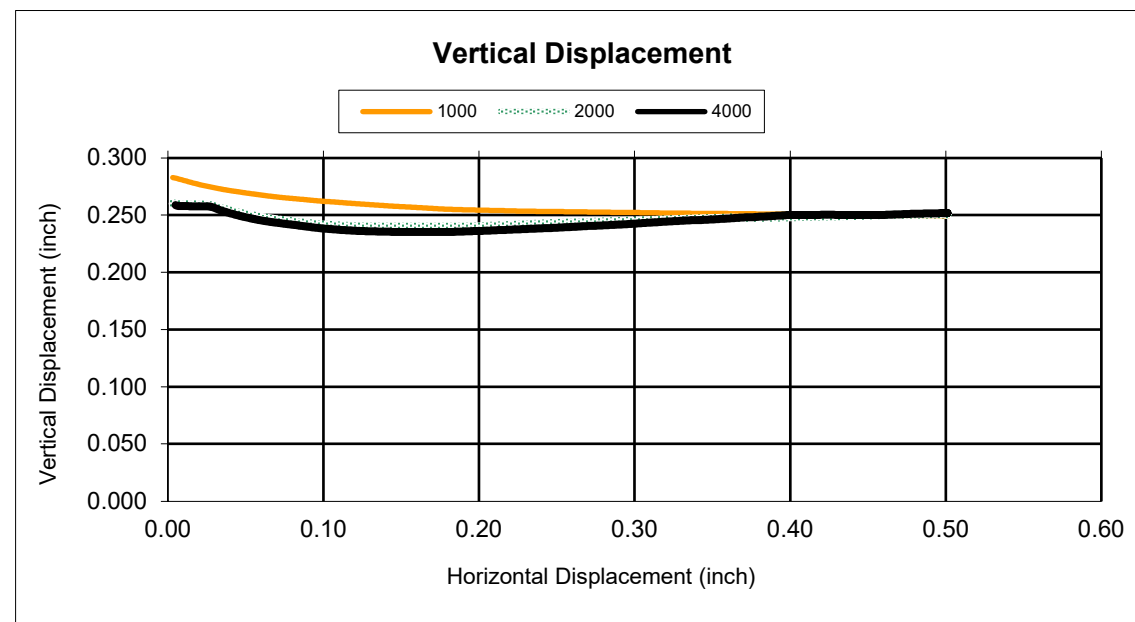
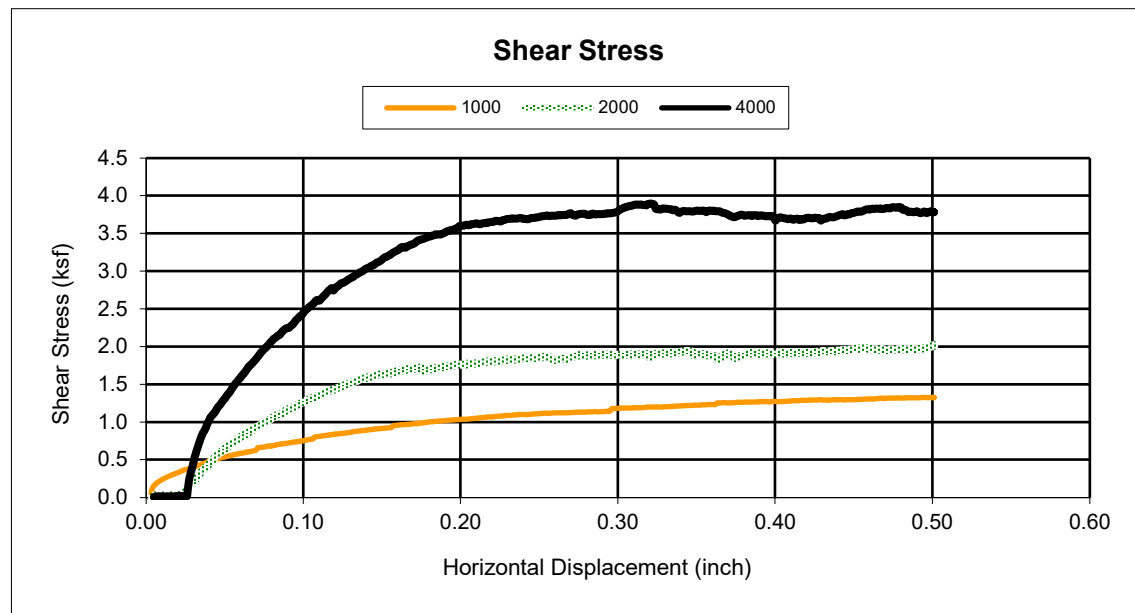
WORK ORDER NO: N/A

LAB NO: 22-1779-02

DATE ASSIGNED: 11/16/2022

NORMAL LOADS (psf): 1000 2000 4000

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (ASTM D3080)

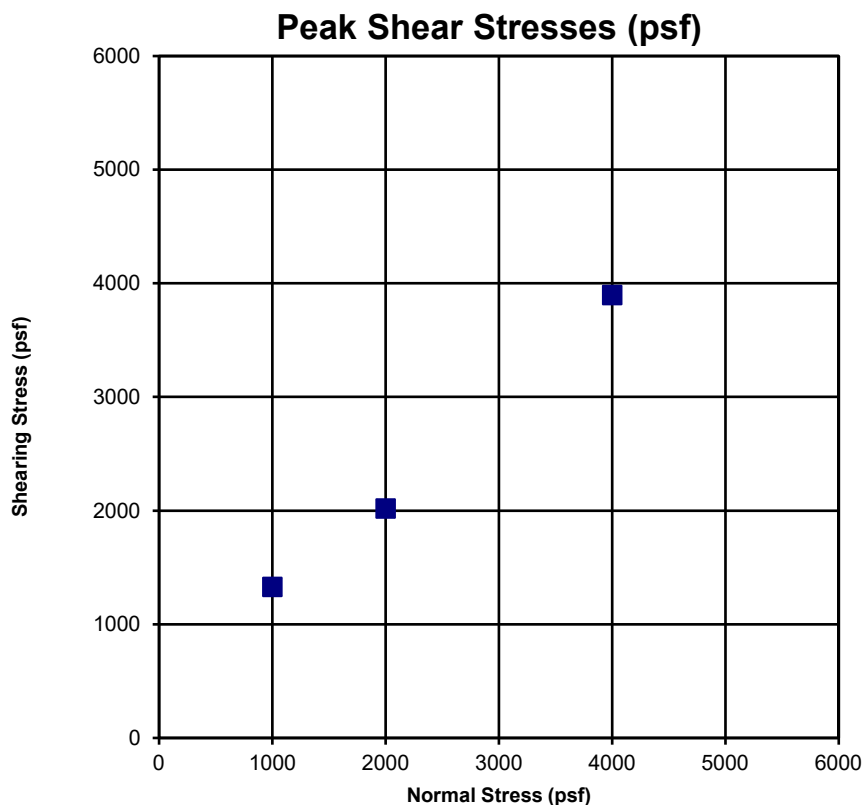


PROJECT: ACS Project #2101595
LOCATION: Mesa, AZ
MATERIAL: Native
SAMPLE SOURCE: ADD-2 (5.0-6.0')
SAMPLE PREPARATION: Saturated - 1, 2, and 4ksf

JOB NO: 19-2012-2017
WORK ORDER NO: N/A
LAB NO: 22-1779-02
DATE ASSIGNED: 11/16/2022

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (ASTM D3080)

Initial thickness of specimen (in.):	1.00	1.00	1.00
Initial diameter of specimen (in.):	2.42	2.42	2.42
Final thickness before shear (in.):	0.972	0.990	0.990
Shearing device used: Humboldt Automated Shear Test System by Trautwein Soil Testing Equipment			
Rate of deformation (in/min):	0.002	0.002	0.002
Direct shear point:	1	2	3
Dry mass of specimen (g):	123.9	130.7	132.2
Initial Moisture Content:	8.6%	7.2%	7.6%
Initial Wet Density (pcf):	111.5	116.0	117.9
Initial Dry Density (pcf):	102.6	108.3	109.5
Final Moisture Content:	18.6%	16.4%	16.1%
Final Wet Density (pcf):	125.2	127.3	128.5
Final Dry Density (pcf):	105.6	109.4	110.7
Normal Stress (psf):	1000	2000	4000
Maximum Shearing Stress (psf):	1329	2018	3897
Vertical Deformation @ Max Shear (in):	0.249	0.251	0.244
Horizontal Deformation @ Max Shear (in):	0.501	0.501	0.321





PROJECT: ACS Project #2101595

LOCATION: Mesa, AZ

MATERIAL: Native

SAMPLE SOURCE: ADD-2 (25.0-26.0')

SAMPLE PREPARATION: Saturated - 2, 4, and 6ksf

JOB NO: 19-2012-2017

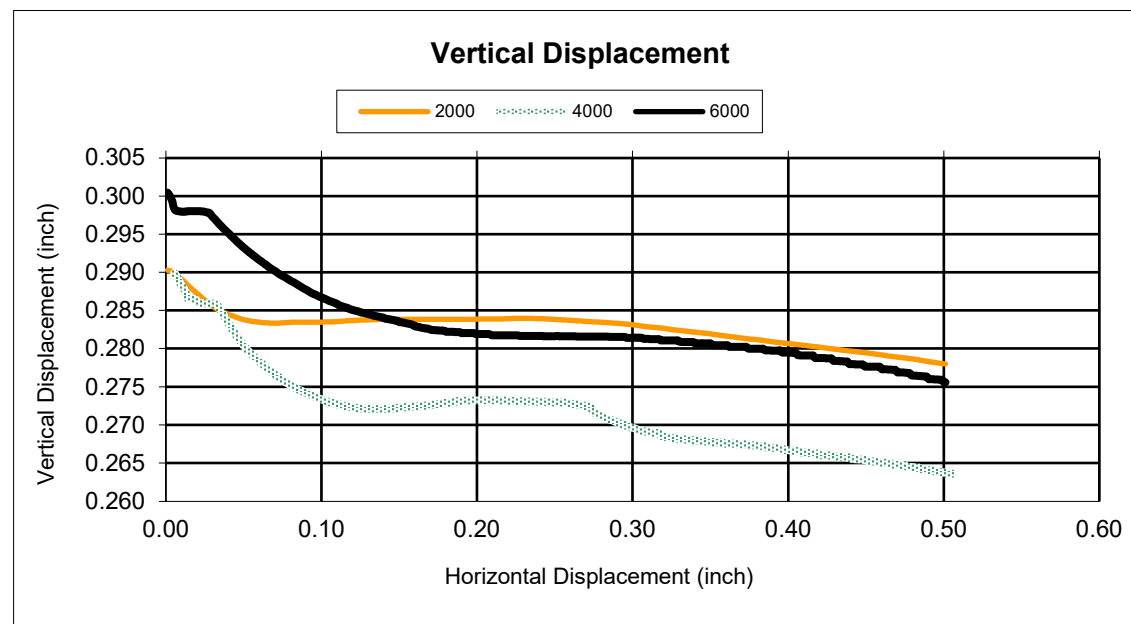
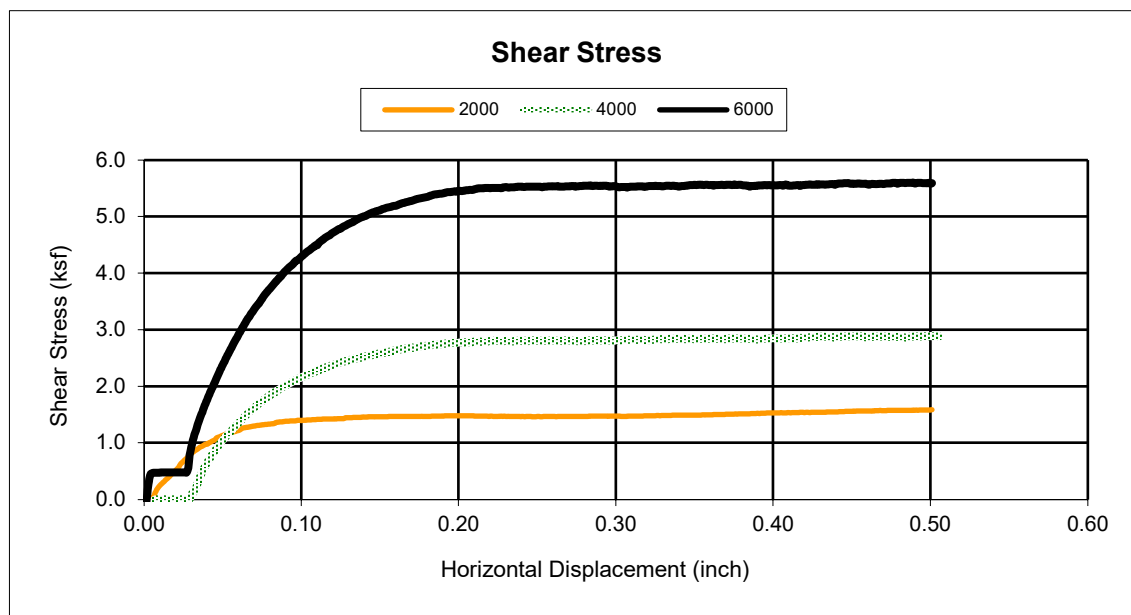
WORK ORDER NO: N/A

LAB NO: 22-1779-03

DATE ASSIGNED: 11/16/2022

NORMAL LOADS (psf): 2000 4000 6000

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (ASTM D3080)

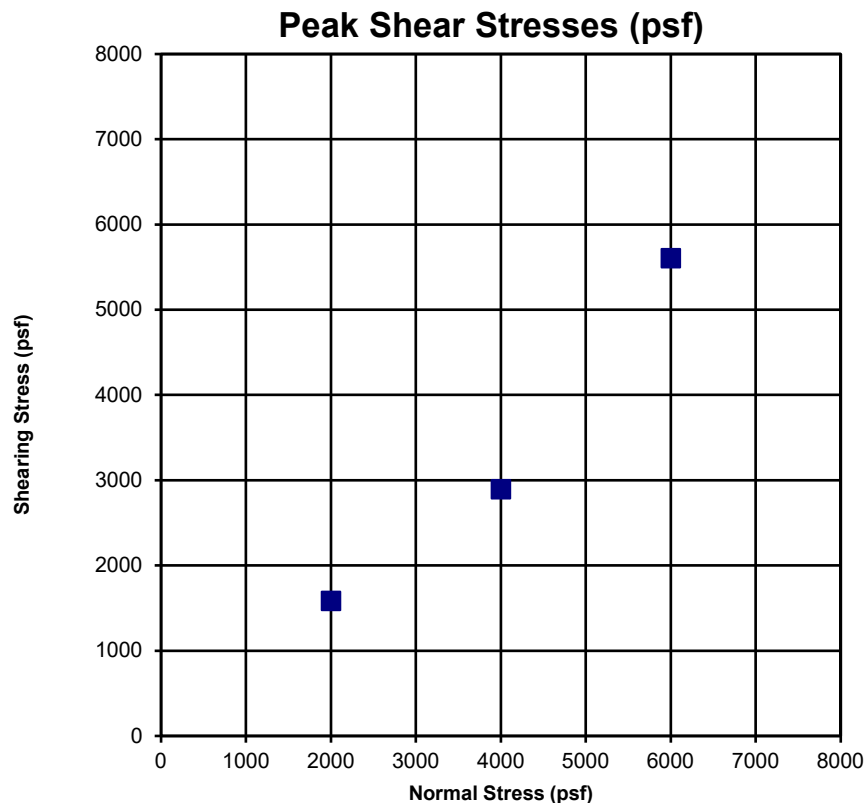


PROJECT: ACS Project #2101595
LOCATION: Mesa, AZ
MATERIAL: Native
SAMPLE SOURCE: ADD-2 (25.0-26.0')
SAMPLE PREPARATION: Saturated - 2, 4, and 6ksf

JOB NO: 19-2012-2017
WORK ORDER NO: N/A
LAB NO: 22-1779-03
DATE ASSIGNED: 11/16/2022

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (ASTM D3080)

Initial thickness of specimen (in.):	1.00	1.00	1.00
Initial diameter of specimen (in.):	2.42	2.42	2.42
Final thickness before shear (in.):	0.994	0.992	0.991
Shearing device used: Humboldt Automated Shear Test System by Trautwein Soil Testing Equipment			
Rate of deformation (in/min):	0.002	0.002	0.002
Direct shear point:	1	2	3
Dry mass of specimen (g):	133.0	136.2	137.3
Initial Moisture Content:	13.3%	13.0%	12.5%
Initial Wet Density (pcf):	124.8	127.5	127.9
Initial Dry Density (pcf):	110.2	112.8	113.7
Final Moisture Content:	24.6%	16.7%	19.4%
Final Wet Density (pcf):	138.1	132.6	137.1
Final Dry Density (pcf):	110.8	113.7	114.8
Normal Stress (psf):	2000	4000	6000
Maximum Shearing Stress (psf):	1585	2895	5604
Vertical Deformation @ Max Shear (in):	0.278	0.264	0.276
Horizontal Deformation @ Max Shear (in):	0.501	0.502	0.489



PROJECT: ACS Project #2101595

LOCATION: Mesa, AZ

MATERIAL: Native

SAMPLE SOURCE: ADD-3 (25.0-26.0')

SAMPLE PREPARATION: Saturated - 2, 4, and 6ksf

JOB NO: 19-2012-2017

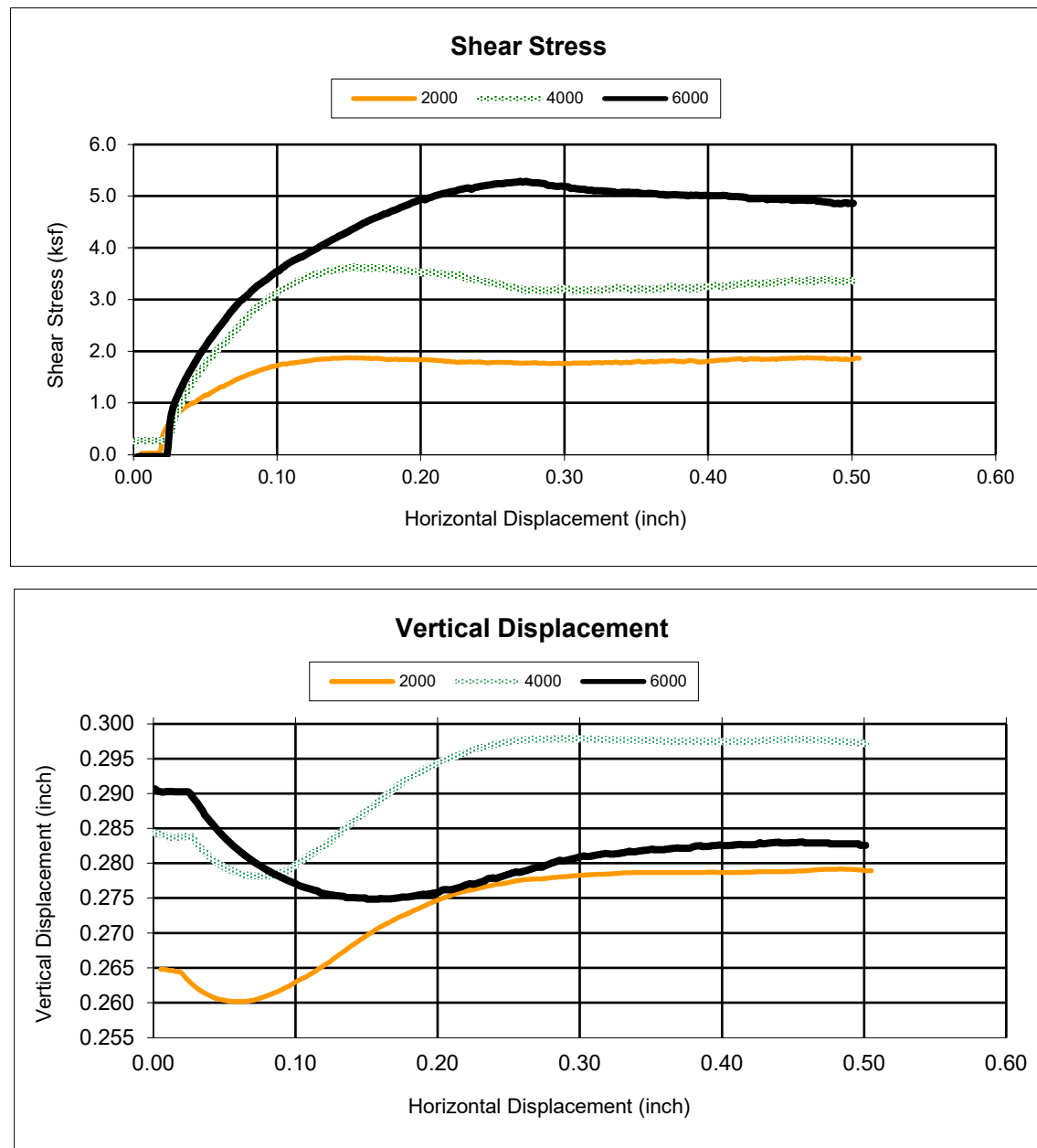
WORK ORDER NO: N/A

LAB NO: 22-1779-04

DATE ASSIGNED: 11/16/2022

NORMAL LOADS (psf): 2000 4000 6000

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (ASTM D3080)

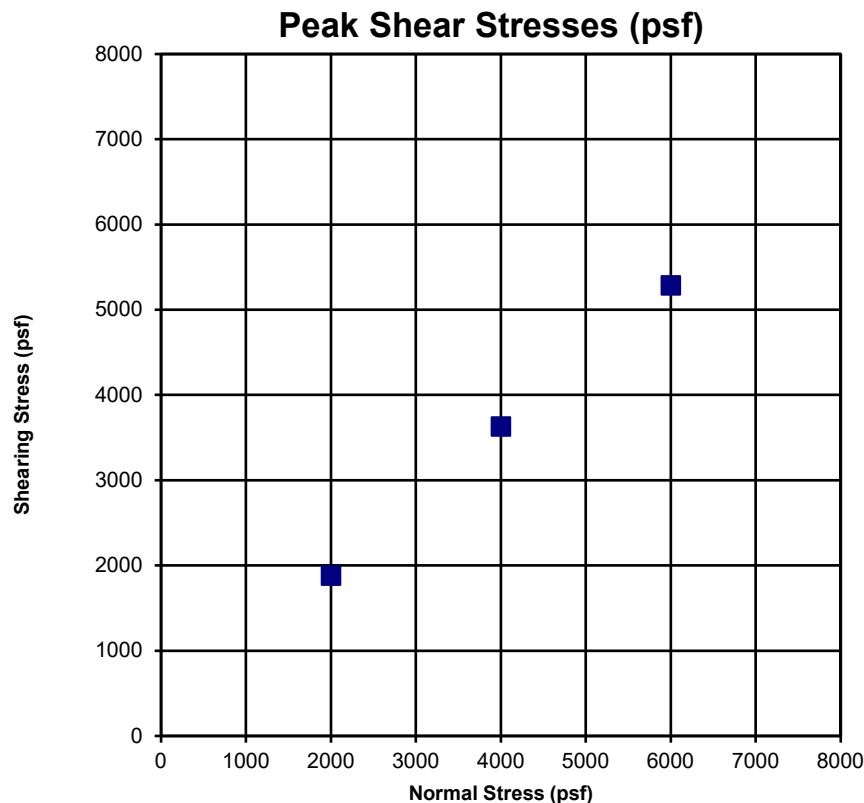


PROJECT: ACS Project #2101595
LOCATION: Mesa, AZ
MATERIAL: Native
SAMPLE SOURCE: ADD-3 (25.0-26.0')
SAMPLE PREPARATION: Saturated - 2, 4, and 6ksf

JOB NO: 19-2012-2017
WORK ORDER NO: N/A
LAB NO: 22-1779-04
DATE ASSIGNED: 11/16/2022

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (ASTM D3080)

Initial thickness of specimen (in.):	1.00	1.00	1.00
Initial diameter of specimen (in.):	2.42	2.42	2.42
Final thickness before shear (in.):	0.997	0.996	0.989
Shearing device used: Humboldt Automated Shear Test System by Trautwein Soil Testing Equipment			
Rate of deformation (in/min):	0.016	0.016	0.016
Direct shear point:	1	2	3
Dry mass of specimen (g):	133.7	135.1	133.2
Initial Moisture Content:	5.6%	5.4%	8.3%
Initial Wet Density (pcf):	116.9	117.9	119.5
Initial Dry Density (pcf):	110.7	111.9	110.3
Final Moisture Content:	17.7%	16.5%	19.0%
Final Wet Density (pcf):	130.7	130.9	132.7
Final Dry Density (pcf):	111.1	112.3	111.5
Normal Stress (psf):	2000	4000	6000
Maximum Shearing Stress (psf):	1879	3631	5286
Vertical Deformation @ Max Shear (in):	0.279	0.288	0.279
Horizontal Deformation @ Max Shear (in):	0.469	0.154	0.269



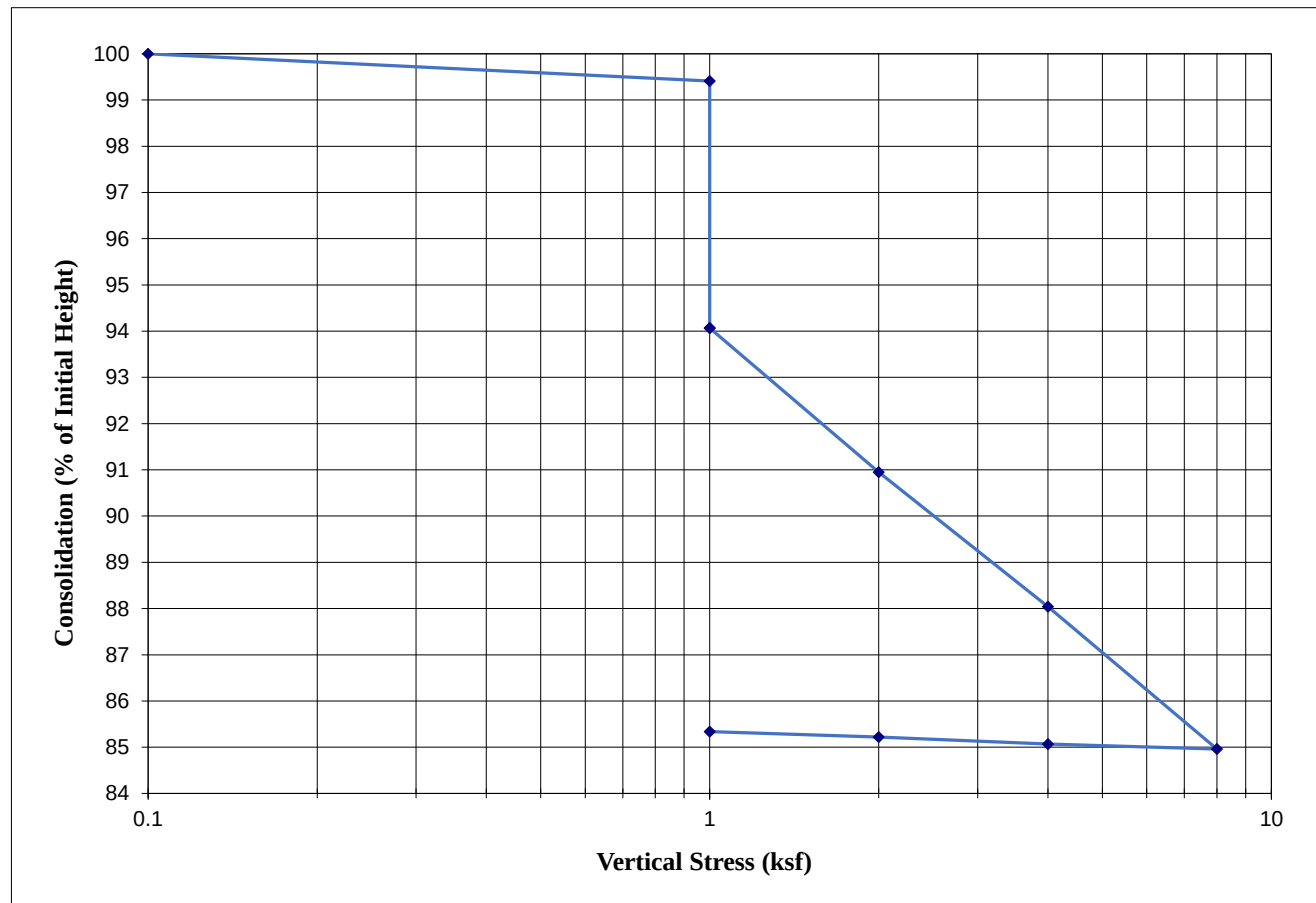
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ENGINEERING DESIGN • MATERIAL TESTING • CONSTRUCTION INSPECTION

* ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (ASTM D2435)

ACS Project No.:	2101595		
Lab No.:	21-3632-22	Material Type:	Native
Client:	Ethos Engineering	Date of Extraction:	8/16/2021
Project Name:	Northern Parkway	Extracted By:	Ethos Engineering
Project Address:	Northern Parkway 99th Ave	Date of Lab Test:	9/16/2021
Project City:	Glendale, AZ	Lab Tested By:	Jose Botello
Sample Location:	NP - 5 @ 5.0' - 6.0'	Reviewed By:	Andrew Jamrogiewicz, P.E.

INITIAL VOLUME (cu.in)	4.60	FINAL VOLUME (cu.in)	4.05
INITIAL MOISTURE CONTENT	4.5%	FINAL MOISTURE CONTENT	12.5%
INITIAL DRY DENSITY(pcf)	104.2	FINAL DRY DENSITY(pcf)	118.4
INITIAL DEGREE OF SATURATION	20%	FINAL DEGREE OF SATURATION	84%
INITIAL VOID RATIO	0.6	FINAL VOID RATIO	0.4
ESTIMATED SPECIFIC GRAVITY	2.65	SATURATED AT	1 ksf



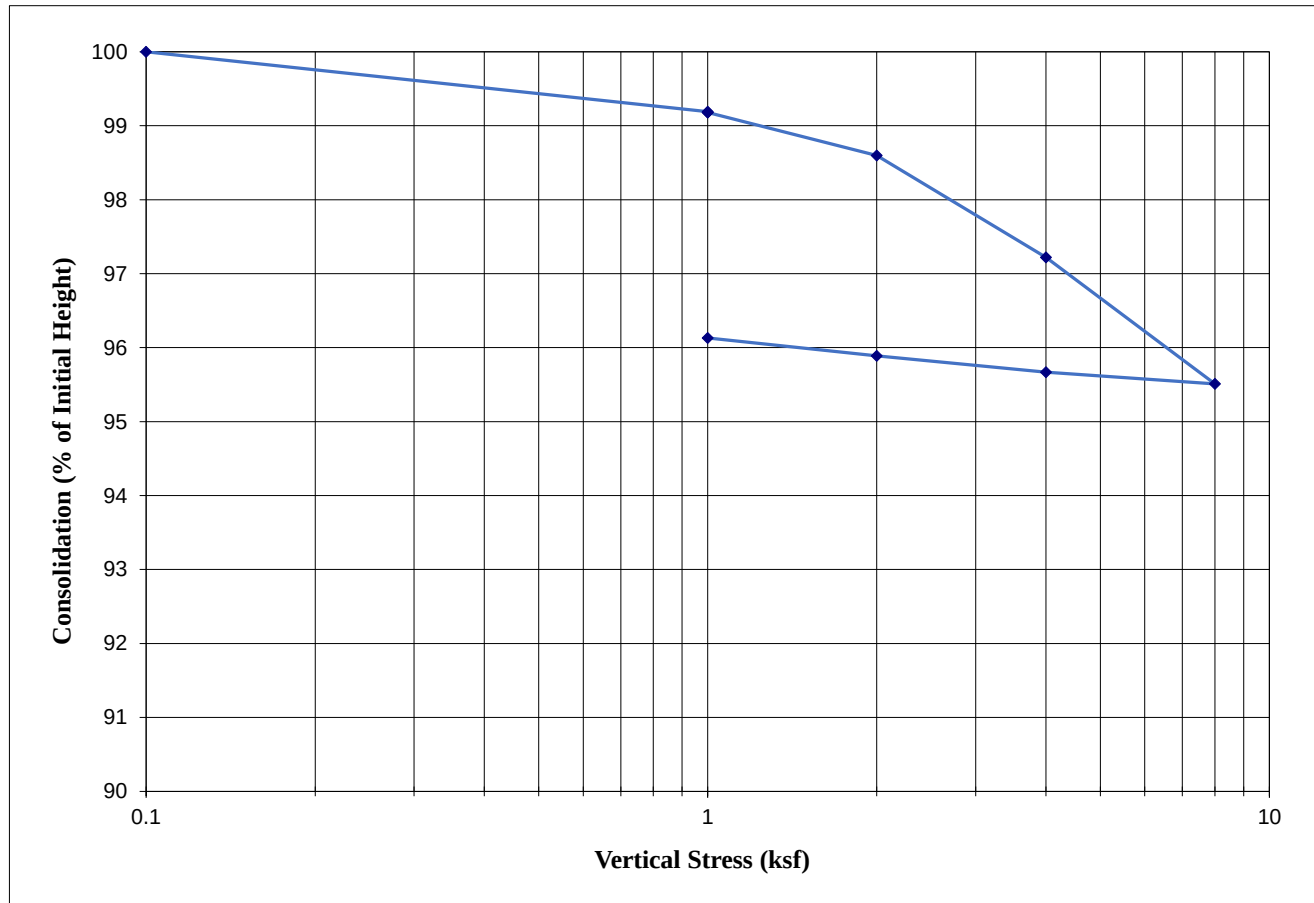
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ENGINEERING DESIGN • MATERIAL TESTING • CONSTRUCTION INSPECTION

* ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (ASTM D2435)

ACS Project No.:	2101595		
Lab No.:	21-3632-24	Material Type:	Native
Client:	Ethos Engineering	Date of Extraction:	8/31/2021
Project Name:	Northern Parkway	Extracted By:	Ethos Engineering
Project Address:	Northern Parkway 99th Ave	Date of Lab Test:	9/16/2021
Project City:	Glendale, AZ	Lab Tested By:	Jose Botello
Sample Location:	NP - 6 @ 10.0' - 11.0'	Reviewed By:	Andrew Jamrogiewicz, P.E.

INITIAL VOLUME (cu.in)	4.60	FINAL VOLUME (cu.in)	4.48
INITIAL MOISTURE CONTENT	12.8%	FINAL MOISTURE CONTENT	13.6%
INITIAL DRY DENSITY(pcf)	116.0	FINAL DRY DENSITY(pcf)	119.3
INITIAL DEGREE OF SATURATION	80%	FINAL DEGREE OF SATURATION	93%
INITIAL VOID RATIO	0.4	FINAL VOID RATIO	0.4
ESTIMATED SPECIFIC GRAVITY	2.65	SATURATED AT	1 ksf



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ENGINEERING DESIGN • MATERIAL TESTING • CONSTRUCTION INSPECTION

* One Dimensional Swell Test @ 144 psf

ACS Project No.:	2101595		
Lab No.:	21-3632-16	Material Type:	Native
Client:	Ethos Engineering	Extraction Date:	8/16/2021
Project Name:	Northern Parkway	Extracted By:	Client
Project Address:	Northern Parkway, 99th Ave to 87th Ave	Laboratory Test Date:	9/16/2021
Project City:	Glendale, AZ	Laboratory Tested By:	Jose Botello
Material Source:	NP - 2 @ 0.0 to 2.5'	Reviewed By:	Andrew Jamrogiewicz, P.E.

Standard Proctor Information

Maximum Dry Density	119.3 pcf
Optimum Moisture Content	13.3 %

Ring Mold Information

Diameter of Ring (D)	2.421 inches
Height of Ring (h)	1 inches
Volume of Ring = $(\pi)(r^2)(h) = 3.142 (1.2165)^2 (0.998)$	
Volume of Ring = $4.604 \text{ in}^3 = 0.002664 \text{ ft}^3$	

Initial Moisture Content of Soil Sample

Weight of Wet Soil Sample	109.9 grams
Weight of Dry Soil Sample	101.4 grams
Moisture % of Soil Sample (w)	8.4 %

Soil Sample's Remolded Density Information

Weight of Ring Mold	45.9 grams
Weight of Soil+Ring Mold	194.2 grams
Weight of Soil+Water+Ring Mold	198.2 grams
Wet Density of Soil Sample = $\frac{\text{Weight of Soil+Water}}{\text{Volume of Ring Mold}}$	
Wet Density of Soil Sample (γ)	126.0 pcf
Dry Density of Soil Sample = $\frac{\gamma}{1 + w}$	
Dry Density of Soil Sample (γ_d)	113.2 pcf
Compaction of Sample	95%
Moisture Content of Sample	11.3%

Dial Readings During Test

Time	Dial Reading
hours	inches
0 (with seating pressure)	0.000
0 (with load applied)	0.000
30 seconds	0.001
1 minute	0.002
2 minutes	0.003
4 minutes	0.004
8 minutes	0.006
15 minutes	0.008
30 minutes	-
1 hour	0.011
2 hours	0.012
4 hours	0.012
8 hours	-
15 hours	0.012
24 hours	0.012
Swell =	1.20%

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ENGINEERING DESIGN • MATERIAL TESTING • CONSTRUCTION INSPECTION

* One Dimensional Swell Test @ 144 psf

ACS Project No.:	2101595		
Lab No.:	21-3632-6	Material Type:	Native
Client:	Ethos Engineering	Extraction Date:	8/4/2021
Project Name:	Northern Parkway	Extracted By:	Client
Project Address:	Northern Parkway, 99th Ave to 87th Ave	Laboratory Test Date:	9/16/2021
Project City:	Glendale, AZ	Laboratory Tested By:	Jose Botello
Material Source:	NP - 9 @ 0.0 to 2.5'	Reviewed By:	Andrew Jamrogiewicz, P.E.

Standard Proctor Information

Maximum Dry Density	124.7 pcf
Optimum Moisture Content	10.8 %

Ring Mold Information

Diameter of Ring (D)	2.421 inches
Height of Ring (h)	1 inches
Volume of Ring = $(\pi)(r^2)(h) = 3.142 (1.2165)^2 (0.998)$	
Volume of Ring = $4.604 \text{ in}^3 = 0.002664 \text{ ft}^3$	

Initial Moisture Content of Soil Sample

Weight of Wet Soil Sample	128.1 grams
Weight of Dry Soil Sample	121.4 grams
Moisture % of Soil Sample (w)	5.5 %

Soil Sample's Remolded Density Information

Weight of Ring Mold	46.0 grams
Weight of Soil+Ring Mold	196.9 grams
Weight of Soil+Water+Ring Mold	201.6 grams
Wet Density of Soil Sample = $\frac{\text{Weight of Soil+Water}}{\text{Volume of Ring Mold}}$	
Wet Density of Soil Sample (γ)	128.8 pcf
Dry Density of Soil Sample = $\frac{\gamma}{1 + w}$	
Dry Density of Soil Sample (γ_d)	118.4 pcf
Compaction of Sample	95%
Moisture Content of Sample	8.8%

Dial Readings During Test

Time	Dial Reading
hours	inches
0 (with seating pressure)	0.000
0 (with load applied)	0.000
30 seconds	0.001
1 minute	0.002
2 minutes	0.002
4 minutes	0.003
8 minutes	0.004
15 minutes	0.004
30 minutes	0.004
1 hour	0.004
2 hours	0.004
4 hours	-
8 hours	-
15 hours	-
24 hours	0.004
Swell =	0.40%

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ENGINEERING DESIGN • MATERIAL TESTING • CONSTRUCTION INSPECTION

* One Dimensional Swell Test @ 144 psf

ACS Project No.:	2101595		
Lab No.:	21-3632-8	Material Type:	Native
Client:	Ethos Engineering	Extraction Date:	8/4/2021
Project Name:	Northern Parkway	Extracted By:	Client
Project Address:	Northern Parkway, 99th Ave to 87th Ave	Laboratory Test Date:	9/16/2021
Project City:	Glendale, AZ	Laboratory Tested By:	Jose Botello
Material Source:	NP - 12 @ 0.0 to 2.5'	Reviewed By:	Andrew Jamrogiewicz, P.E.

Standard Proctor Information

Maximum Dry Density	122.8 pcf
Optimum Moisture Content	10.9 %

Ring Mold Information

Diameter of Ring (D)	2.421 inches
Height of Ring (h)	1 inches
Volume of Ring = $(\pi)(r^2)(h) = 3.142 (1.2165)^2 (0.998)$	
Volume of Ring = $4.604 \text{ in}^3 = 0.002664 \text{ ft}^3$	

Initial Moisture Content of Soil Sample

Weight of Wet Soil Sample	133.9 grams
Weight of Dry Soil Sample	128.4 grams
Moisture % of Soil Sample (w)	4.3 %

Soil Sample's Remolded Density Information

Weight of Ring Mold	46.3 grams
Weight of Soil+Ring Mold	193.2 grams
Weight of Soil+Water+Ring Mold	199.7 grams
Wet Density of Soil Sample = $\frac{\text{Weight of Soil+Water}}{\text{Volume of Ring Mold}}$	
Wet Density of Soil Sample (γ)	126.9 pcf
Dry Density of Soil Sample = $\frac{\gamma}{1 + w}$	
Dry Density of Soil Sample (γ_d)	116.6 pcf
Compaction of Sample	95%
Moisture Content of Sample	8.9%

Dial Readings During Test

Time	Dial Reading
hours	inches
0 (with seating pressure)	0.000
0 (with load applied)	0.000
30 seconds	0.003
1 minute	0.005
2 minutes	0.008
4 minutes	0.012
8 minutes	0.014
15 minutes	0.014
30 minutes	0.015
1 hour	-
2 hours	0.016
4 hours	0.016
8 hours	0.016
15 hours	-
24 hours	0.016
Swell =	1.60%

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ENGINEERING DESIGN • MATERIAL TESTING • CONSTRUCTION INSPECTION

* One Dimensional Swell Test @ 144 psf

ACS Project No.:	2101595		
Lab No.:	21-3632-12	Material Type:	Native
Client:	Ethos Engineering	Extraction Date:	8/4/2021
Project Name:	Northern Parkway	Extracted By:	Client
Project Address:	Northern Parkway, 99th Ave to 87th Ave	Laboratory Test Date:	9/16/2021
Project City:	Glendale, AZ	Laboratory Tested By:	Jose Botello
Material Source:	NP - 14 @ 0.0 to 2.5'	Reviewed By:	Andrew Jamrogiewicz, P.E.

Standard Proctor Information

Maximum Dry Density	122.9 pcf
Optimum Moisture Content	10.3 %

Ring Mold Information

Diameter of Ring (D)	2.421 inches
Height of Ring (h)	1 inches
Volume of Ring = $(\pi)(r^2)(h) = 3.142 (1.2165)^2 (0.998)$	
Volume of Ring = $4.604 \text{ in}^3 = 0.002664 \text{ ft}^3$	

Initial Moisture Content of Soil Sample

Weight of Wet Soil Sample	106.8 grams
Weight of Dry Soil Sample	104.4 grams
Moisture % of Soil Sample (w)	2.3 %

Soil Sample's Remolded Density Information

Weight of Ring Mold	46.2 grams
Weight of Soil+Ring Mold	190.4 grams
Weight of Soil+Water+Ring Mold	198.9 grams
Wet Density of Soil Sample = $\frac{\text{Weight of Soil+Water}}{\text{Volume of Ring Mold}}$	
Wet Density of Soil Sample (γ)	126.4 pcf
Dry Density of Soil Sample = $\frac{\gamma}{1 + w}$	
Dry Density of Soil Sample (γ_d)	116.7 pcf
Compaction of Sample	95%
Moisture Content of Sample	8.3%

Dial Readings During Test

Time	Dial Reading
hours	inches
0 (with seating pressure)	0.000
0 (with load applied)	0.000
30 seconds	0.001
1 minute	0.002
2 minutes	0.004
4 minutes	0.005
8 minutes	0.007
15 minutes	0.007
30 minutes	0.008
1 hour	0.008
2 hours	0.008
4 hours	-
8 hours	-
15 hours	-
24 hours	0.009
Swell =	0.90%

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ENGINEERING DESIGN • MATERIAL TESTING • CONSTRUCTION INSPECTION

* One Dimensional Swell Test @ 144 psf

ACS Project No.:	2101595		
Lab No.:	21-3632-18	Material Type:	Native
Client:	Ethos Engineering	Extraction Date:	8/16/2021
Project Name:	Northern Parkway	Extracted By:	Client
Project Address:	Northern Parkway, 99th Ave to 87th Ave	Laboratory Test Date:	9/16/2021
Project City:	Glendale, AZ	Laboratory Tested By:	Jose Botello
Material Source:	NP - 15 @ 0.0 to 2.5'	Reviewed By:	Andrew Jamrogiewicz, P.E.

Standard Proctor Information

Maximum Dry Density	113.1 pcf
Optimum Moisture Content	14.2 %

Ring Mold Information

Diameter of Ring (D)	2.421 inches
Height of Ring (h)	1 inches
Volume of Ring = $(\pi)(r^2)(h) = 3.142 (1.2165)^2 (0.998)$	
Volume of Ring = $4.604 \text{ in}^3 = 0.002664 \text{ ft}^3$	

Initial Moisture Content of Soil Sample

Weight of Wet Soil Sample	120.1 grams
Weight of Dry Soil Sample	112.7 grams
Moisture % of Soil Sample (w)	6.6 %

Soil Sample's Remolded Density Information

Weight of Ring Mold	46.0 grams
Weight of Soil+Ring Mold	184.3 grams
Weight of Soil+Water+Ring Mold	191.6 grams
Wet Density of Soil Sample = $\frac{\text{Weight of Soil+Water}}{\text{Volume of Ring Mold}}$	
Wet Density of Soil Sample (γ)	120.5 pcf
Dry Density of Soil Sample = $\frac{\gamma}{1 + w}$	
Dry Density of Soil Sample (γ_d)	107.4 pcf
Compaction of Sample	95%
Moisture Content of Sample	12.2%

Dial Readings During Test

Time	Dial Reading
hours	inches
0 (with seating pressure)	0.000
0 (with load applied)	0.000
30 seconds	0.000
1 minute	0.001
2 minutes	0.002
4 minutes	0.004
8 minutes	0.007
15 minutes	-
30 minutes	0.011
1 hour	0.012
2 hours	0.012
4 hours	0.012
8 hours	-
15 hours	-
24 hours	0.012
Swell =	1.20%

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ENGINEERING DESIGN • MATERIAL TESTING • CONSTRUCTION INSPECTION

* One Dimensional Swell Test @ 144 psf

ACS Project No.:	2101595		
Lab No.:	21-3632-19	Material Type:	Native
Client:	Ethos Engineering	Extraction Date:	8/16/2021
Project Name:	Northern Parkway	Extracted By:	Client
Project Address:	Northern Parkway, 99th Ave to 87th Ave	Laboratory Test Date:	9/16/2021
Project City:	Glendale, AZ	Laboratory Tested By:	Jose Botello
Material Source:	NP - 17 @ 0.0 to 2.5'	Reviewed By:	Andrew Jamrogiewicz, P.E.

Standard Proctor Information

Maximum Dry Density	112.8 pcf
Optimum Moisture Content	14.2 %

Ring Mold Information

Diameter of Ring (D)	2.421 inches
Height of Ring (h)	1 inches
Volume of Ring = $(\pi)(r^2)(h) = 3.142 (1.2165)^2 (0.998)$	
Volume of Ring = $4.604 \text{ in}^3 = 0.002664 \text{ ft}^3$	

Initial Moisture Content of Soil Sample

Weight of Wet Soil Sample	104.0 grams
Weight of Dry Soil Sample	94.0 grams
Moisture % of Soil Sample (w)	10.6 %

Soil Sample's Remolded Density Information

Weight of Ring Mold	46.0 grams
Weight of Soil+Ring Mold	189.1 grams
Weight of Soil+Water+Ring Mold	191.2 grams
Wet Density of Soil Sample = $\frac{\text{Weight of Soil+Water}}{\text{Volume of Ring Mold}}$	
Wet Density of Soil Sample (γ)	120.2 pcf
Dry Density of Soil Sample = $\frac{\gamma}{1 + w}$	
Dry Density of Soil Sample (γ_d)	107.1 pcf
Compaction of Sample	95%
Moisture Content of Sample	12.2%

Dial Readings During Test

Time	Dial Reading
hours	inches
0 (with seating pressure)	0.000
0 (with load applied)	0.000
30 seconds	0.001
1 minute	0.002
2 minutes	0.004
4 minutes	0.007
8 minutes	0.010
15 minutes	0.011
30 minutes	0.012
1 hour	0.012
2 hours	0.012
4 hours	0.012
8 hours	0.012
15 hours	0.012
24 hours	0.012
Swell =	1.20%

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ENGINEERING DESIGN • MATERIAL TESTING • CONSTRUCTION INSPECTION

* One Dimensional Swell Test @ 144 psf

ACS Project No.:	2101595		
Lab No.:	21-3632-36	Material Type:	Native
Client:	Ethos Engineering	Extraction Date:	8/31/2021
Project Name:	Northern Parkway	Extracted By:	Client
Project Address:	Northern Parkway, 99th Ave to 87th Ave	Laboratory Test Date:	9/16/2021
Project City:	Glendale, AZ	Laboratory Tested By:	Jose Botello
Material Source:	NP - 20 @ 1.0 to 2.5'	Reviewed By:	Andrew Jamrogiewicz, P.E.

Standard Proctor Information

Maximum Dry Density	125.1 pcf
Optimum Moisture Content	10.9 %

Ring Mold Information

Diameter of Ring (D)	2.421 inches
Height of Ring (h)	1 inches
Volume of Ring = $(\pi)(r^2)(h) = 3.142 (1.2165)^2 (0.998)$	
Volume of Ring = $4.604 \text{ in}^3 = 0.002664 \text{ ft}^3$	

Initial Moisture Content of Soil Sample

Weight of Wet Soil Sample	120.0 grams
Weight of Dry Soil Sample	110.7 grams
Moisture % of Soil Sample (w)	8.4 %

Soil Sample's Remolded Density Information

Weight of Ring Mold	46.2 grams
Weight of Soil+Ring Mold	201.8 grams
Weight of Soil+Water+Ring Mold	202.5 grams
Wet Density of Soil Sample = $\frac{\text{Weight of Soil+Water}}{\text{Volume of Ring Mold}}$	
Wet Density of Soil Sample (γ)	129.3 pcf
Dry Density of Soil Sample = $\frac{\gamma}{1 + w}$	
Dry Density of Soil Sample (γ_d)	118.8 pcf
Compaction of Sample	95%
Moisture Content of Sample	8.9%

Dial Readings During Test

Time	Dial Reading
hours	inches
0 (with seating pressure)	0.000
0 (with load applied)	0.000
30 seconds	.001.001
1 minute	0.002
2 minutes	0.002
4 minutes	0.002
8 minutes	0.002
15 minutes	0.002
30 minutes	0.002
1 hour	0.002
2 hours	0.002
4 hours	-
8 hours	-
15 hours	-
24 hours	0.002
Swell =	0.20%

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ENGINEERING DESIGN • MATERIAL TESTING • CONSTRUCTION INSPECTION

* One Dimensional Swell Test @ 144 psf

ACS Project No.:	2101595		
Lab No.:	21-3632-20	Material Type:	Native
Client:	Ethos Engineering	Extraction Date:	8/16/2021
Project Name:	Northern Parkway	Extracted By:	Client
Project Address:	Northern Parkway, 99th Ave to 87th Ave	Laboratory Test Date:	9/16/2021
Project City:	Glendale, AZ	Laboratory Tested By:	Jose Botello
Material Source:	NP - 22 @ 0.0 to 2.5'	Reviewed By:	Andrew Jamrogiewicz, P.E.

Standard Proctor Information

Maximum Dry Density	119.5 pcf
Optimum Moisture Content	11.9 %

Ring Mold Information

Diameter of Ring (D)	2.421 inches
Height of Ring (h)	1 inches
Volume of Ring = $(\pi)(r^2)(h) = 3.142 (1.2165)^2 (0.998)$	
Volume of Ring = $4.604 \text{ in}^3 = 0.002664 \text{ ft}^3$	

Initial Moisture Content of Soil Sample

Weight of Wet Soil Sample	112.7 grams
Weight of Dry Soil Sample	106.5 grams
Moisture % of Soil Sample (w)	5.8 %

Soil Sample's Remolded Density Information

Weight of Ring Mold	45.8 grams
Weight of Soil+Ring Mold	190.9 grams
Weight of Soil+Water+Ring Mold	196.5 grams
Wet Density of Soil Sample = $\frac{\text{Weight of Soil+Water}}{\text{Volume of Ring Mold}}$	
Wet Density of Soil Sample (γ)	124.7 pcf
Dry Density of Soil Sample = $\frac{\gamma}{1 + w}$	
Dry Density of Soil Sample (γ_d)	113.5 pcf
Compaction of Sample	95%
Moisture Content of Sample	9.9%

Dial Readings During Test

Time	Dial Reading
hours	inches
0 (with seating pressure)	0.000
0 (with load applied)	0.000
30 seconds	0.004
1 minute	0.007
2 minutes	0.009
4 minutes	0.014
8 minutes	0.015
15 minutes	-
30 minutes	-
1 hour	-
2 hours	-
4 hours	-
8 hours	-
15 hours	0.017
24 hours	0.018
Swell =	1.80%

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ENGINEERING DESIGN • MATERIAL TESTING • CONSTRUCTION INSPECTION

* One Dimensional Swell Test @ 144 psf

ACS Project No.:	2101595		
Lab No.:	21-3632-40	Material Type:	Native
Client:	Ethos Engineering	Extraction Date:	8/16/2021
Project Name:	Northern Parkway	Extracted By:	Client
Project Address:	Northern Parkway, 99th Ave to 87th Ave	Laboratory Test Date:	9/16/2021
Project City:	Glendale, AZ	Laboratory Tested By:	Jose Botello
Material Source:	NP - 23 @ 0.5 to 2.5'	Reviewed By:	Andrew Jamrogiewicz, P.E.

Standard Proctor Information

Maximum Dry Density	118.8 pcf
Optimum Moisture Content	12.3 %

Ring Mold Information

Diameter of Ring (D)	2.421 inches
Height of Ring (h)	1 inches
Volume of Ring = $(\pi)(r^2)(h) = 3.142 (1.2165)^2 (0.998)$	
Volume of Ring = $4.604 \text{ in}^3 = 0.002664 \text{ ft}^3$	

Initial Moisture Content of Soil Sample

Weight of Wet Soil Sample	127.6 grams
Weight of Dry Soil Sample	126.6 grams
Moisture % of Soil Sample (w)	0.8 %

Soil Sample's Remolded Density Information

Weight of Ring Mold	46.3 grams
Weight of Soil+Ring Mold	183.7 grams
Weight of Soil+Water+Ring Mold	196.6 grams
Wet Density of Soil Sample = $\frac{\text{Weight of Soil+Water}}{\text{Volume of Ring Mold}}$	
Wet Density of Soil Sample (γ)	124.4 pcf
Dry Density of Soil Sample = $\frac{\gamma}{1 + w}$	
Dry Density of Soil Sample (γ_d)	112.8 pcf
Compaction of Sample	95%
Moisture Content of Sample	10.3%

Dial Readings During Test

Time	Dial Reading
hours	inches
0 (with seating pressure)	0.000
0 (with load applied)	0.000
30 seconds	0.000
1 minute	0.000
2 minutes	0.000
4 minutes	0.000
8 minutes	0.001
15 minutes	0.001
30 minutes	0.001
1 hour	0.001
2 hours	0.001
4 hours	0.001
8 hours	-
15 hours	-
24 hours	0.001
Swell =	0.10%

ACS Services LLC

Maximum Dry Density & Optimum Moisture

☐ AASHTO T-99 | ☐ AASHTO T-180 | ☒ ASTM D-698 | ☐ ASTM D-1557

ACS Project # 2101595
 ACS Lab # 21-3632-16
 Client Name: Ethos Engineering
 Project Name: Northern Parkway
 Project Address: Northern Pkwy, 99th Ave to 87th
 Project City: Glendale, AZ

Material Type: Native
 Material Supplier: -
 Sample Date: 8/16/2021
 Sampled By: Client
 Date Tested: 9/14/2021
 Tested By: Fernando Montero
 Reviewed By: Andrew Jamrogiewicz, P.E.

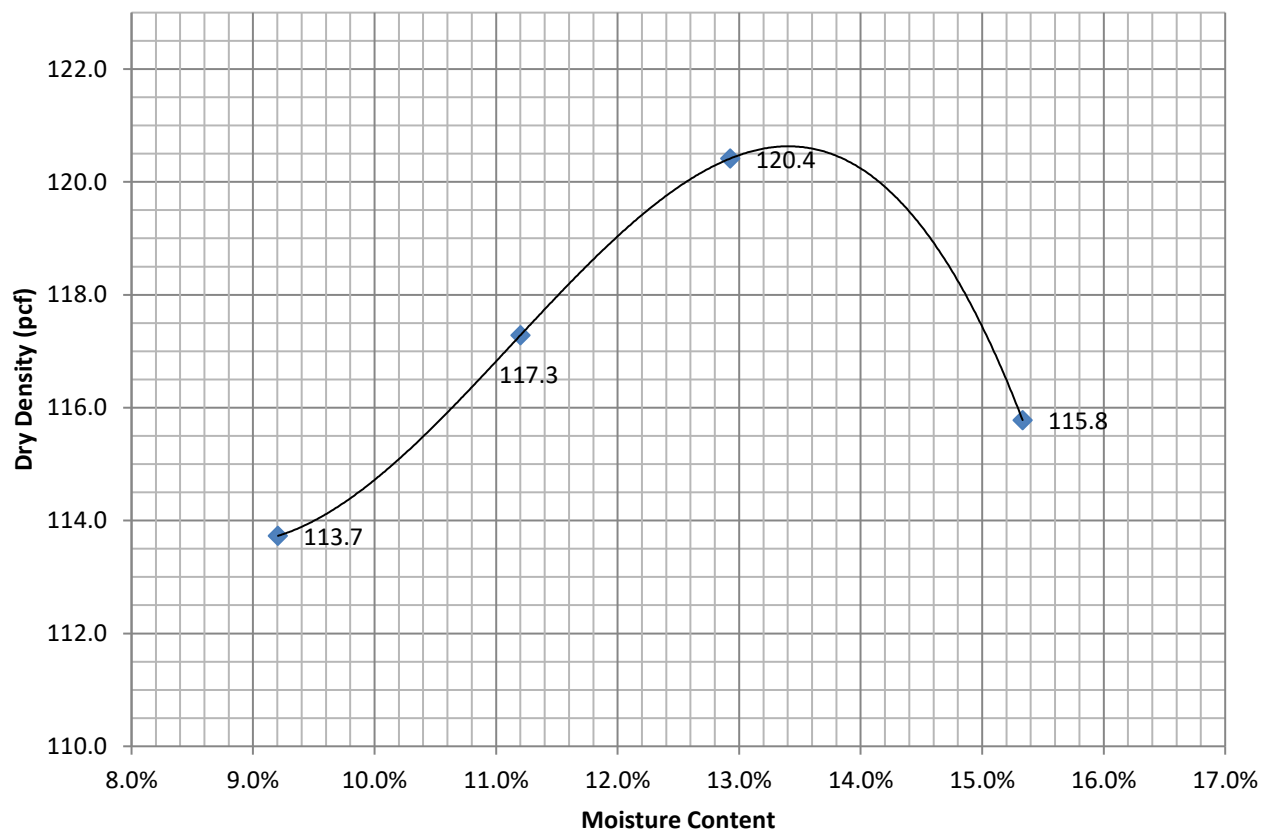
Sample Location: NP-2 @ 0.0'-2.5'

Method:

☒ A ☐ B
☐ C ☐ D

Dry Density	113.7	117.3	120.4	115.8
Moisture Content	9.2%	11.2%	12.9%	15.3%

Uncorrected Dry Density	119.3	Uncorrected Moisture Content	13.3
% Rock	9	% Passing	91
Rock Corrected Dry Density	119.3	Rock Corrected Moisture Content	13.3
Specific Gravity of Oversize Aggregate	2.650		



Andrew Jamrogiewicz

Project Manager

ACS Services LLC

Maximum Dry Density & Optimum Moisture

☒ AASHTO T-99 | ☐ AASHTO T-180 | ☐ ASTM D-698 | ☐ ASTM D-1557

ACS Project # 2101595
 ACS Lab # 21-3632-6
 Client Name: Ethos Engineering
 Project Name: Northern Parkway
 Project Address: Northern Pkwy, 99th Ave to 87th
 Project City: Glendale, AZ

Material Type: Native
 Material Supplier: -
 Sample Date: 8/4/2021
 Sampled By: Client
 Date Tested: 8/13/2021
 Tested By: Fernando Montero
 Reviewed By: Andrew Jamrogiewicz, P.E.

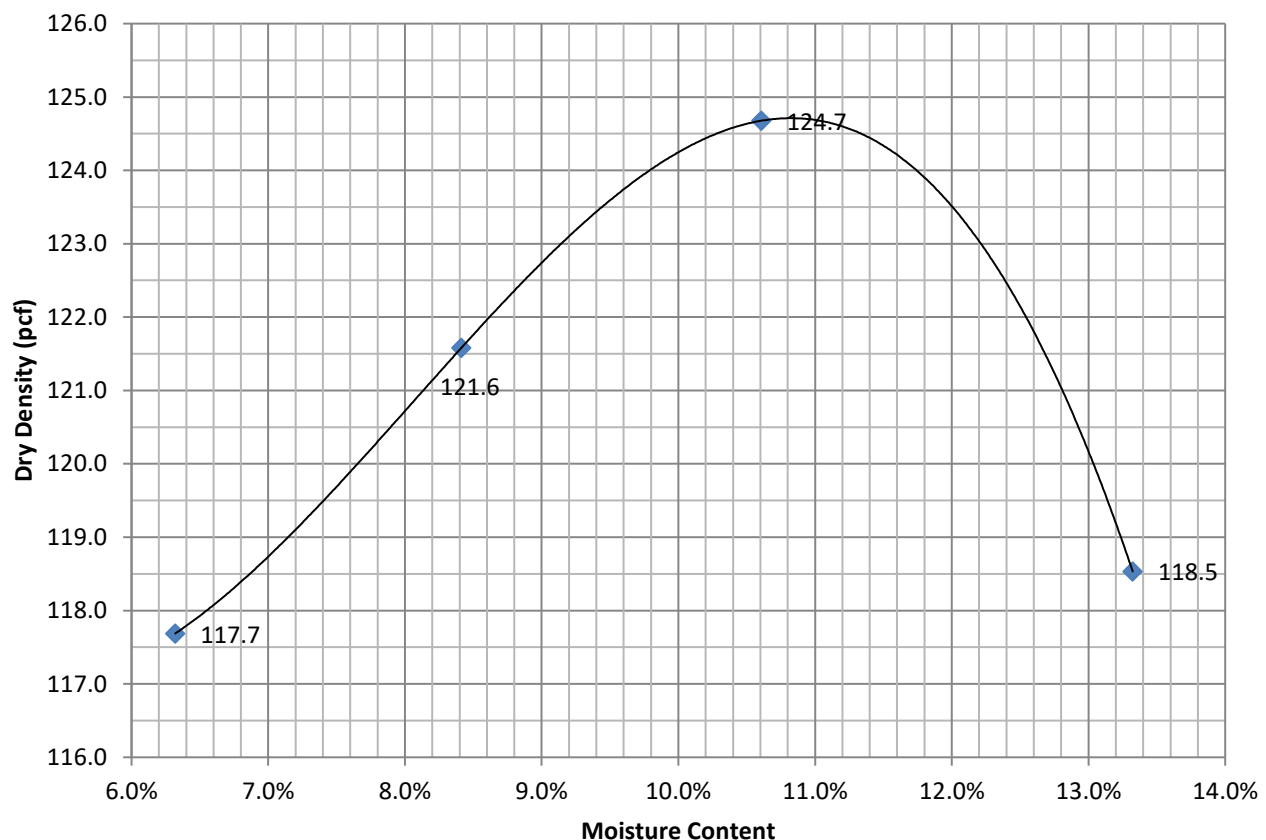
Sample Location: NP- 9 @ 0.0'-2.5'

Method:

☒ A ☐ B
☐ C ☐ D

Dry Density	117.7	121.6	124.7	118.5
Moisture Content	6.3%	8.4%	10.6%	13.3%

Uncorrected Dry Density	124.7	Uncorrected Moisture Content	10.8
% Rock	4	% Passing	96
Rock Corrected Dry Density	124.7	Rock Corrected Moisture Content	10.8
Specific Gravity of Oversize Aggregate	2.650		



Andrew Jamrogiewicz

Project Manager

ACS Services LLC

Maximum Dry Density & Optimum Moisture

☒ AASHTO T-99 | ☐ AASHTO T-180 | ☐ ASTM D-698 | ☐ ASTM D-1557

ACS Project # 2101595
 ACS Lab # 21-3632-8
 Client Name: Ethos Engineering
 Project Name: Northern Parkway
 Project Address: Northern Pkwy, 99th Ave to 87th
 Project City: Glendale, AZ

Material Type: Native
 Material Supplier: -
 Sample Date: 8/4/2021
 Sampled By: Client
 Date Tested: 8/13/2021
 Tested By: Fernando Montero
 Reviewed By: Jose Botello

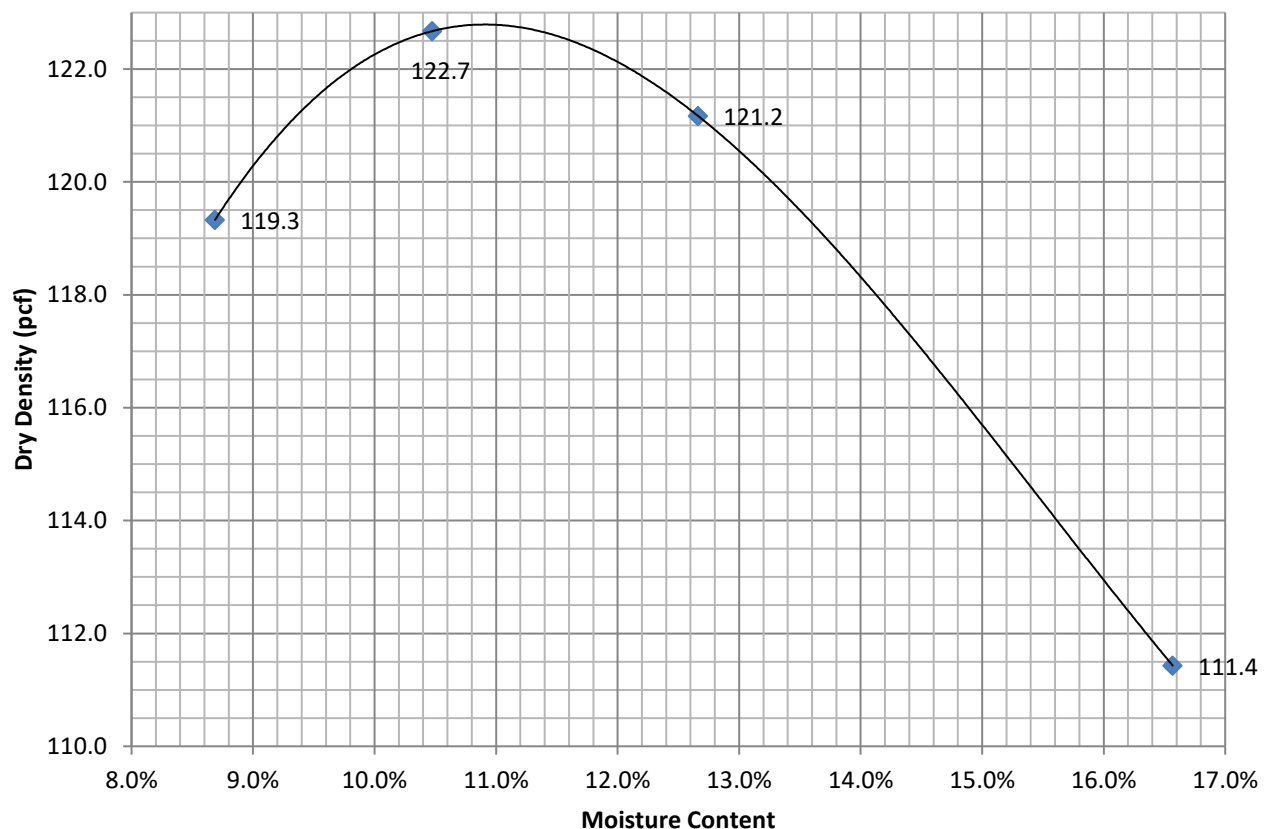
Sample Location: NP- 12 @ 0.0'-2.5'

Method:

☒ A ☐ B
☐ C ☐ D

Dry Density	119.3	122.7	121.2	111.4
Moisture Content	8.7%	10.5%	12.7%	16.6%

Uncorrected Dry Density	122.8	Uncorrected Moisture Content	10.9
% Rock	5	% Passing	95
Rock Corrected Dry Density	122.8	Rock Corrected Moisture Content	10.9
Specific Gravity of Oversize Aggregate	2.650		



Andrew Jamrojiewicz

Project Manager

ACS Services LLC

Maximum Dry Density & Optimum Moisture

☒ AASHTO T-99 | ☐ AASHTO T-180 | ☐ ASTM D-698 | ☐ ASTM D-1557

ACS Project # 2101595
 ACS Lab # 21-3632-12
 Client Name: Ethos Engineering
 Project Name: Northern Parkway
 Project Address: Northern Pkwy, 99th Ave to 87th
 Project City: Glendale, AZ

Material Type: Native
 Material Supplier: -
 Sample Date: 8/4/2021
 Sampled By: Client
 Date Tested: 8/13/2021
 Tested By: Fernando Montero
 Reviewed By: Andrew Jamrogiewicz, PE

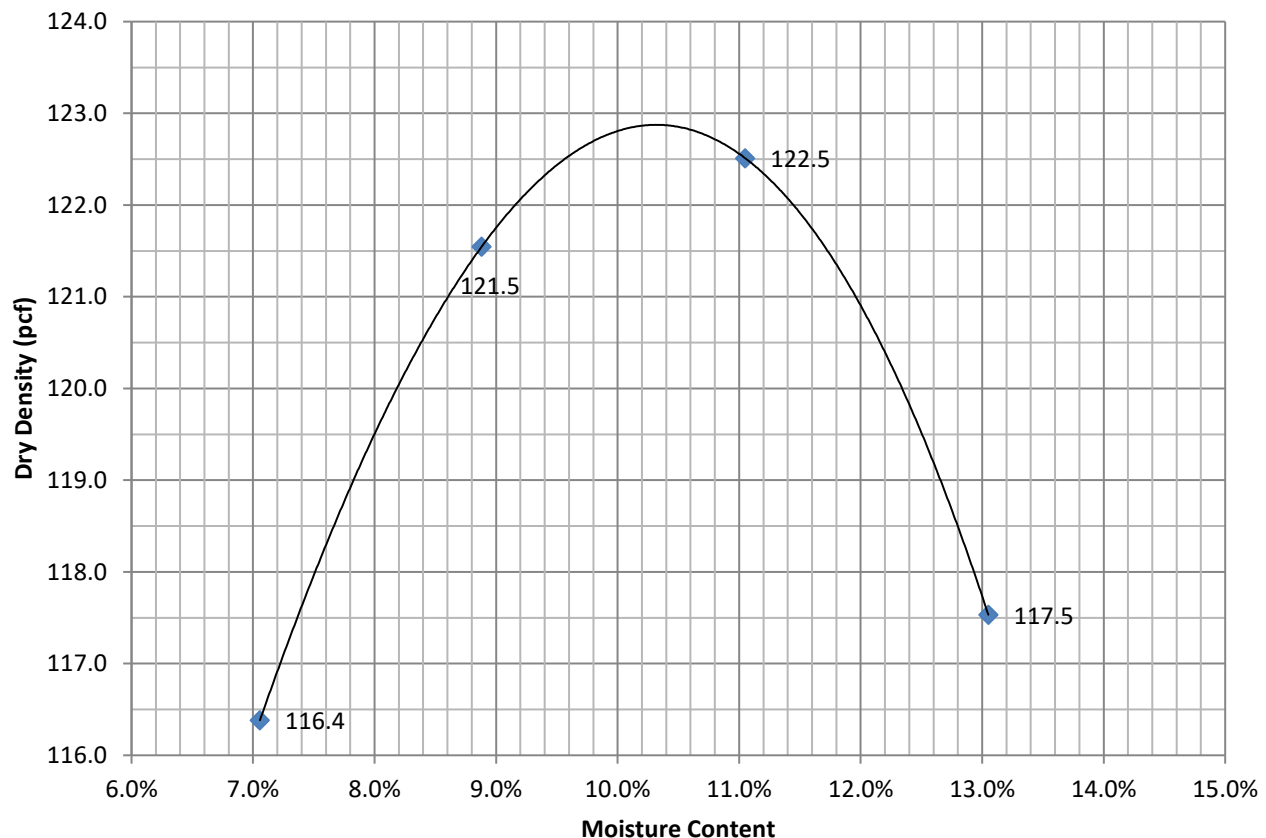
Sample Location: NP- 14 @ 0.0'-2.5'

Method:

☒ A ☐ B
☐ C ☐ D

Dry Density	116.4	121.5	122.5	117.5
Moisture Content	7.1%	8.9%	11.1%	13.1%

Uncorrected Dry Density	122.9	Uncorrected Moisture Content	10.3
% Rock	8	% Passing	92
Rock Corrected Dry Density	122.9	Rock Corrected Moisture Content	10.3
Specific Gravity of Oversize Aggregate	2.650		



Andrew Jamrogiewicz

Project Manager

ACS Services LLC

Maximum Dry Density & Optimum Moisture

☐ AASHTO T-99 | ☐ AASHTO T-180 | ☒ ASTM D-698 | ☐ ASTM D-1557

ACS Project # 2101595
 ACS Lab # 21-3632-18
 Client Name: Ethos Engineering
 Project Name: Northern Parkway
 Project Address: Northern Pkwy, 99th Ave to 87th
 Project City: Glendale, AZ

Material Type: Native
 Material Supplier: -
 Sample Date: 8/16/2021
 Sampled By: Client
 Date Tested: 9/15/2021
 Tested By: Fernando Montero
 Reviewed By: Andrew Jamrogiewicz, P.E.

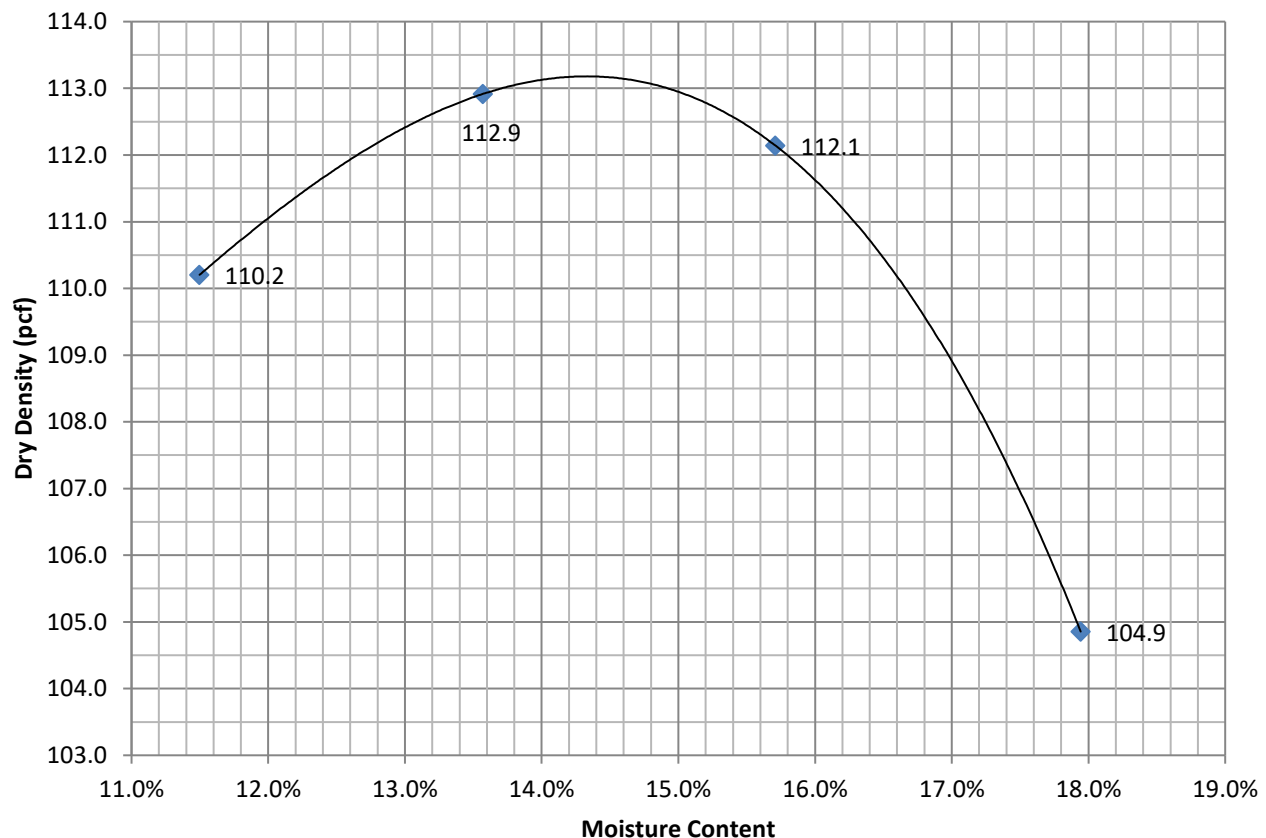
Sample Location: NP-15 @ 0.0'-2.5'

Method:

☒ A ☐ B
☐ C ☐ D

Dry Density	110.2	112.9	112.1	104.9
Moisture Content	11.5%	13.6%	15.7%	17.9%

Uncorrected Dry Density	113.1	Uncorrected Moisture Content	14.2
% Rock	6	% Passing	94
Rock Corrected Dry Density	113.1	Rock Corrected Moisture Content	14.2
Specific Gravity of Oversize Aggregate	2.650		



Andrew Jamrogiewicz

Project Manager

ACS Services LLC

Maximum Dry Density & Optimum Moisture

☒ AASHTO T-99 / ☐ AASHTO T-180

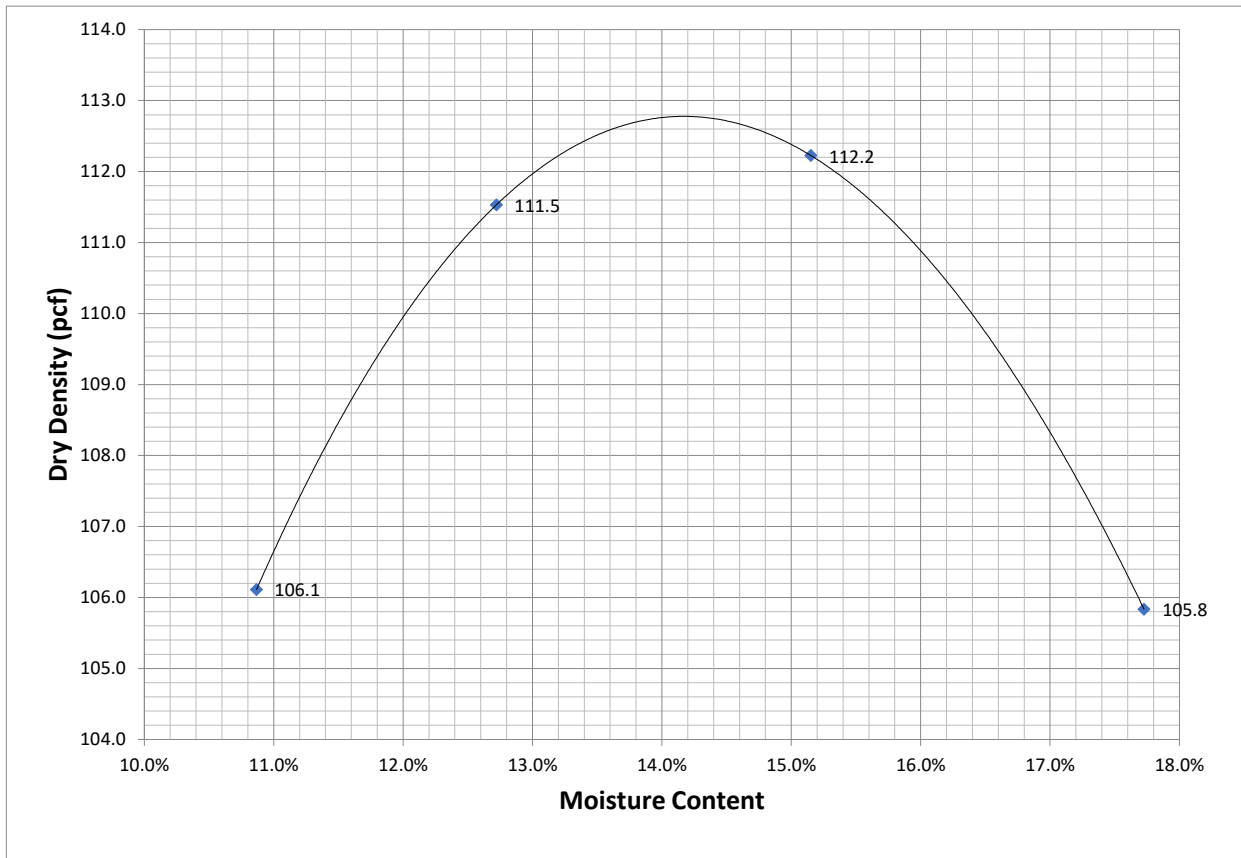
ACS Project # 2101595
 ACS Lab # 21-3632-19
 Client Name: Ethos Engineering
 Project Name: Northern Parkway
 Project Address: Northern Parkway 99th Ave
 Project City: Glendale, AZ

Material Type: Native
 Material Supplier: -
 Sample Date: 8/16/2021
 Sampled By: Ethos Engineering
 Date Tested: 9/14/2021
 Tested By: Fernando Montero
 Reviewed By: Jose Botello

Sample Location: NP - 17 @ 0.0' - 2.5'

Dry Density	106.1	111.5	112.2	105.8
Moisture Content	10.9%	12.7%	15.2%	17.7%

Uncorrected Dry Density	112.8	Uncorrected Moisture Content	14.2
% Rock	17	% Passing	83
Rock Corrected Dry Density	119.3	Rock Corrected Moisture Content	12.1



Andrew Jamrogiewicz
 Project Manager

ACS Services LLC

Maximum Dry Density & Optimum Moisture

☐ AASHTO T-99 | ☐ AASHTO T-180 | ☒ ASTM D-698 | ☐ ASTM D-1557

ACS Project # 2101595
 ACS Lab # 21-3632-36
 Client Name: Ethos Engineering
 Project Name: Northern Parkway
 Project Address: Northern Pkwy, 99th Ave to 87th
 Project City: Glendale, AZ

Material Type: Native
 Material Supplier: -
 Sample Date: 8/31/2021
 Sampled By: Client
 Date Tested: 9/14/2021
 Tested By: Fernando Montero
 Reviewed By: Andrew Jamrogiewicz, P.E.

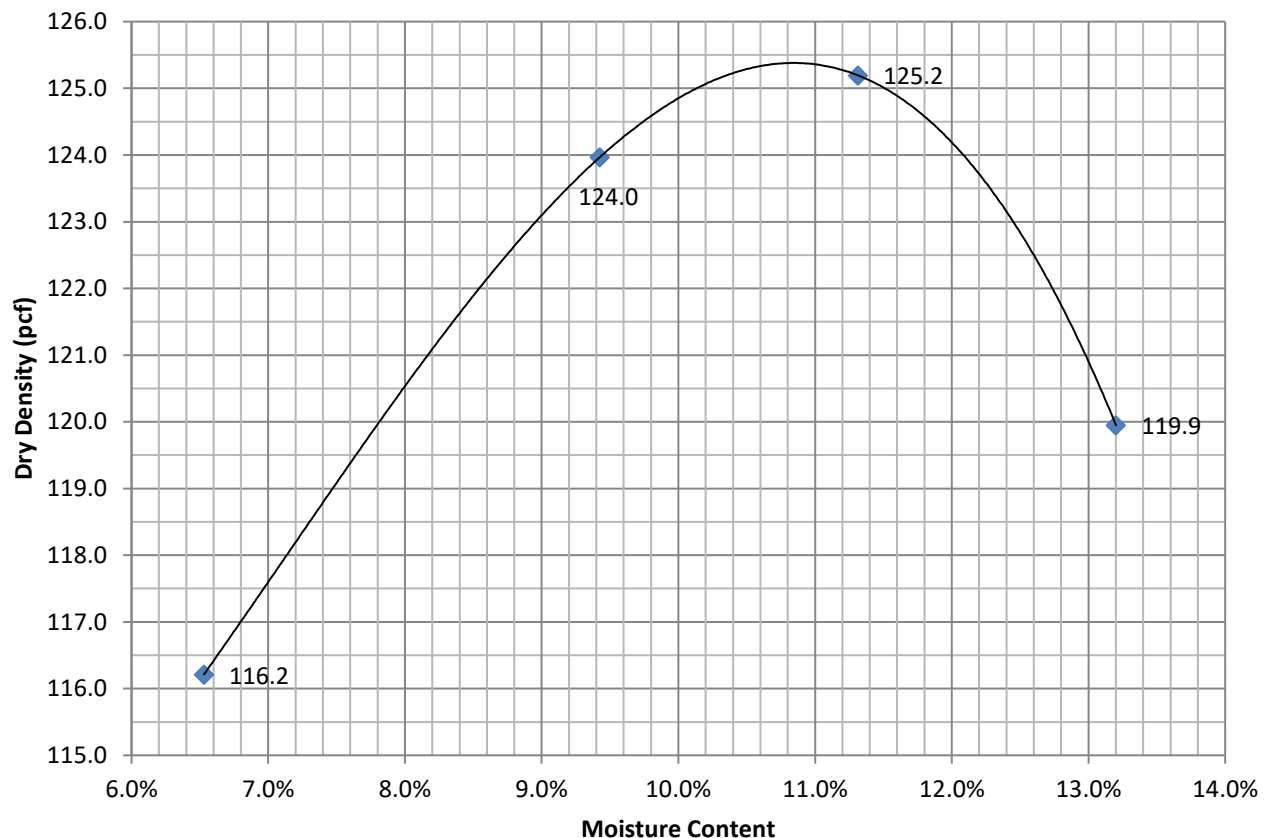
Sample Location: NP-20 @ 1.0'-2.5'

Method:

☒ A ☐ B
☐ C ☐ D

Dry Density	116.2	124.0	125.2	119.9
Moisture Content	6.5%	9.4%	11.3%	13.2%

Uncorrected Dry Density	125.7	Uncorrected Moisture Content	10.9
% Rock	37	% Passing	63
Rock Corrected Dry Density	137.9	Rock Corrected Moisture Content	7.6
Specific Gravity of Oversize Aggregate	2.650		



Andrew Jamrogiewicz

Project Manager

ACS Services LLC

Maximum Dry Density & Optimum Moisture

☐ AASHTO T-99 | ☐ AASHTO T-180 | ☒ ASTM D-698 | ☐ ASTM D-1557

ACS Project # 2101595
 ACS Lab # 21-3632-20
 Client Name: Ethos Engineering
 Project Name: Northern Parkway
 Project Address: Northern Pkwy, 99th Ave to 87th
 Project City: Glendale, AZ

Material Type: Native
 Material Supplier: -
 Sample Date: 8/16/2021
 Sampled By: Client
 Date Tested: 9/14/2021
 Tested By: Brett Rottenberger
 Reviewed By: Andrew Jamrogiewicz, P.E.

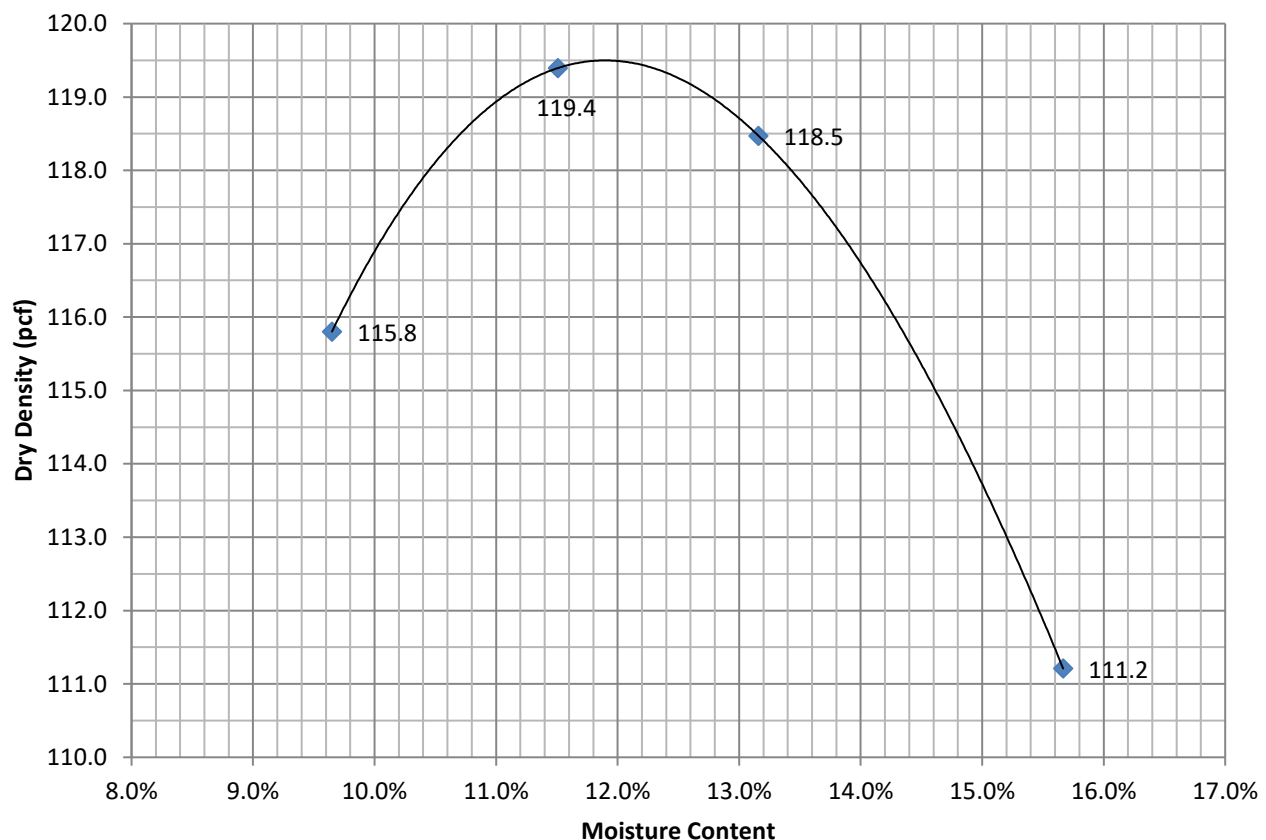
Sample Location: NP-22 @ 0.0'-2.5'

Method:

☒ A ☐ B
☐ C ☐ D

Dry Density	115.8	119.4	118.5	111.2
Moisture Content	9.6%	11.5%	13.2%	15.7%

Uncorrected Dry Density	119.5	Uncorrected Moisture Content	11.9
% Rock	35	% Passing	65
Rock Corrected Dry Density	132.3	Rock Corrected Moisture Content	8.4
Specific Gravity of Oversize Aggregate	2.650		



Andrew Jamrogiewicz

Project Manager

ACS Services LLC

Maximum Dry Density & Optimum Moisture

☐ AASHTO T-99 | ☐ AASHTO T-180 | ☒ ASTM D-698 | ☐ ASTM D-1557

ACS Project # 2101595
 ACS Lab # 21-3632-40
 Client Name: Ethos Engineering
 Project Name: Northern Parkway
 Project Address: Northern Pkwy, 99th Ave to 87th
 Project City: Glendale, AZ

Material Type: Native
 Material Supplier: -
 Sample Date: 8/31/2021
 Sampled By: Client
 Date Tested: 9/14/2021
 Tested By: Fernando Montero
 Reviewed By: Andrew Jamrogiewicz, P.E.

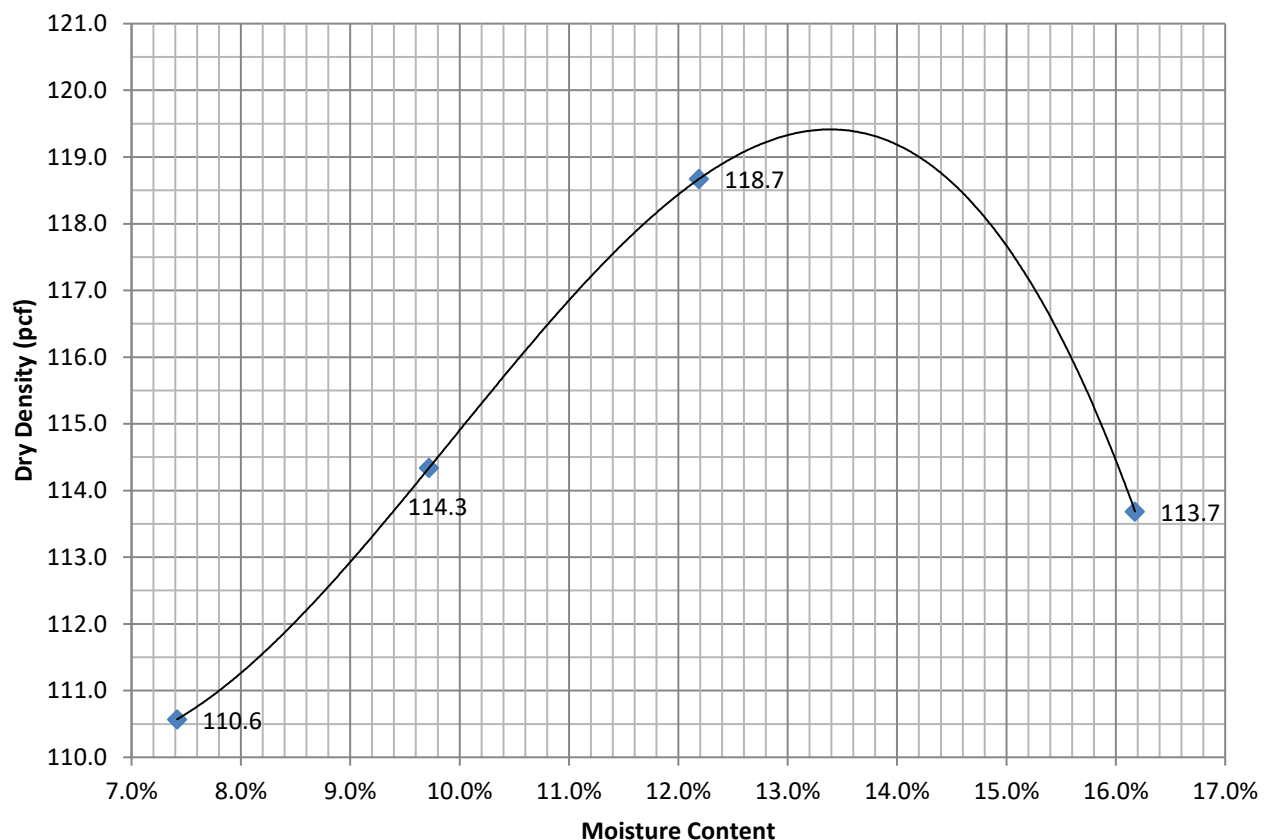
Sample Location: NP-23 @ 0.5'-2.5'

Method:

☒ A ☐ B
☐ C ☐ D

Dry Density	110.6	114.3	118.7	113.7
Moisture Content	7.4%	9.7%	12.2%	16.2%

Uncorrected Dry Density	118.8	Uncorrected Moisture Content	12.3
% Rock	10	% Passing	90
Rock Corrected Dry Density	122.2	Rock Corrected Moisture Content	11.3
Specific Gravity of Oversize Aggregate	2.650		



Andrew Jamrogiewicz

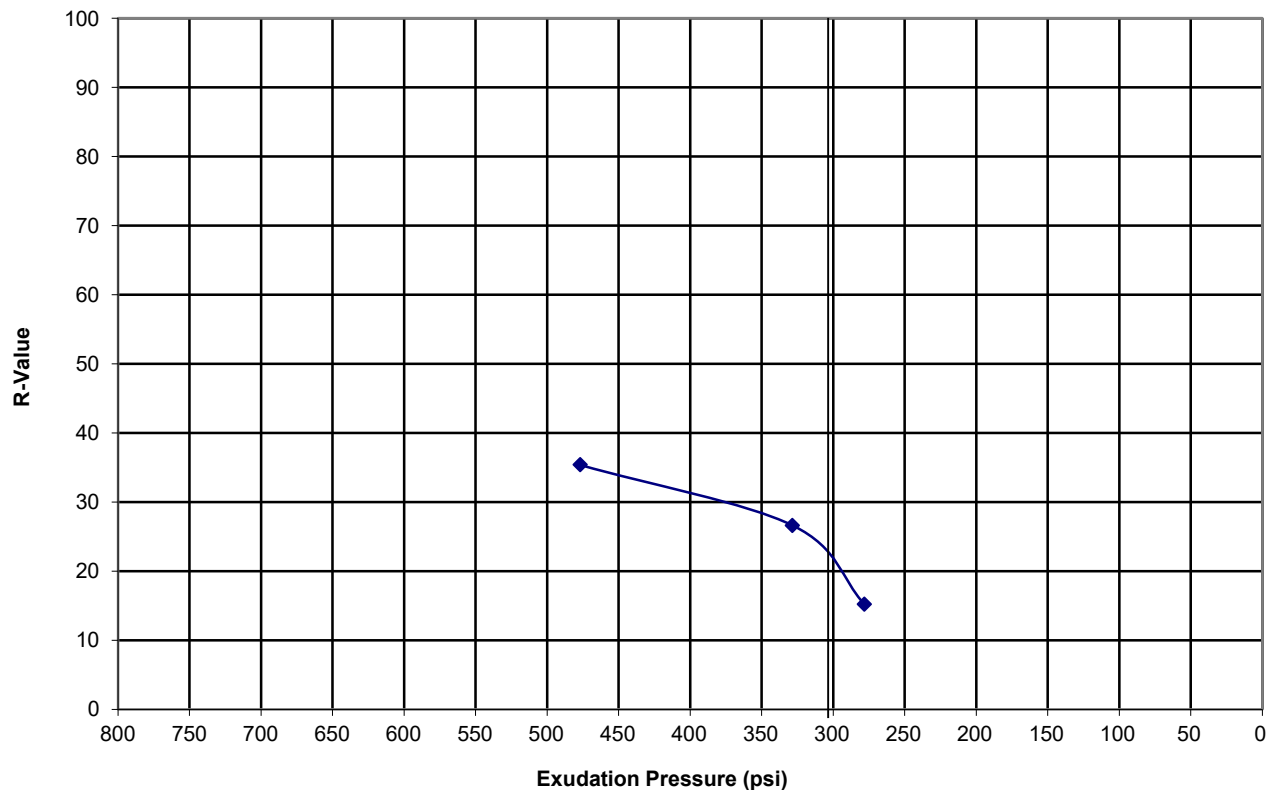
Project Manager

PROJECT: ACS - Lab Testing Services
LOCATION: Mesa, AZ
MATERIAL: Native Soil
SAMPLE SOURCE: NP (0-2.5') ACS Lab #21-3632.16
 NP-2 @ 0' - 2.5'

JOB NO: 19-2012-2017
WORK ORDER NO: N/A
LAB NO: 21-1781-03
DATE SAMPLED: 09/17/21

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

SPECIMEN ID	A	B	C
Moisture Content	15.6%	14.7%	13.8%
Compaction Pressure (psi)	150	175	200
Specimen Height (inches)	2.50	2.48	2.50
Dry Density (pcf)	117.6	118.4	120.2
Horiz. Pres. @ 1000lbs (psi)	48.0	36.0	32.0
Horiz. Pres. @ 2000lbs (psi)	124.0	104.0	91.0
Displacement	4.04	3.71	3.46
Expansion Pressure (psi)	0.0	0.0	2.2
Exudation Pressure (psi)	278	328	477
R Value	15	27	35



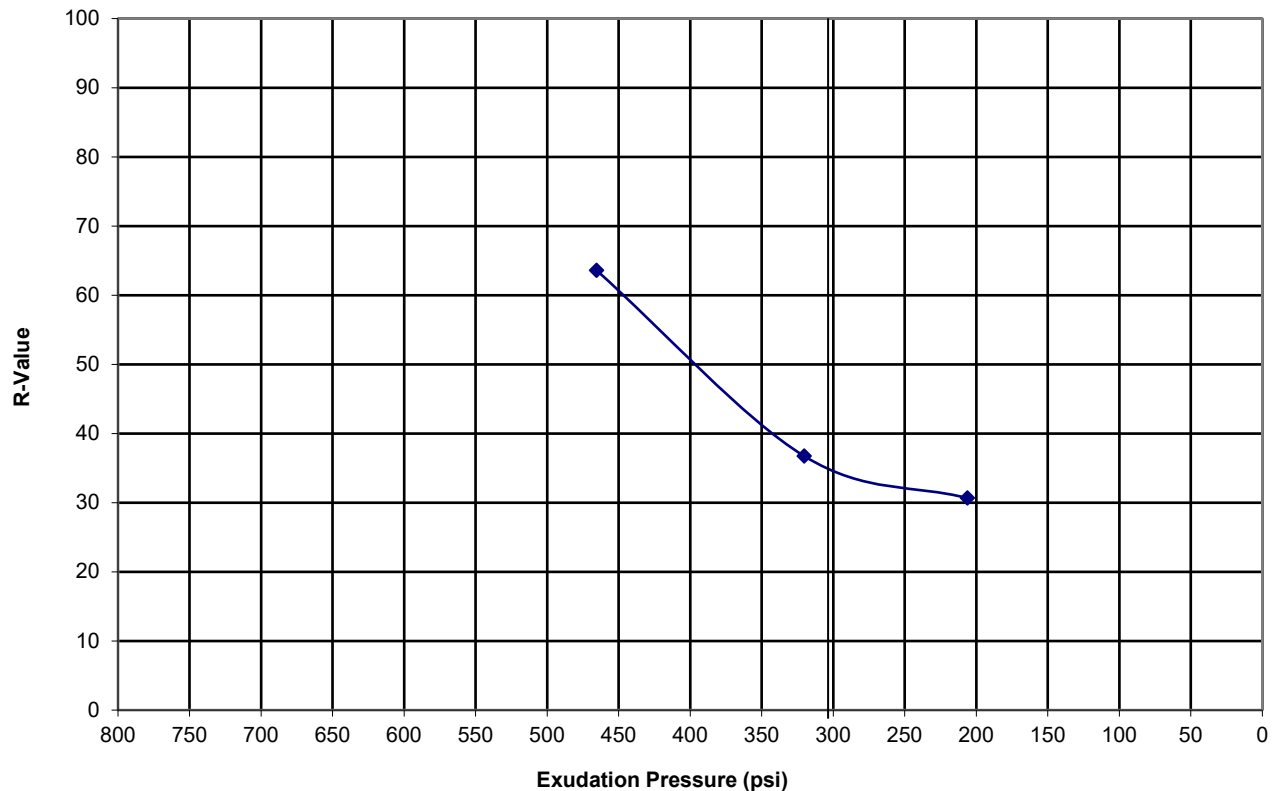
R Value at 300 PSI = 22

PROJECT: Northern Parkway (Project #92101595)
LOCATION: Glendale, AZ
MATERIAL: Soil
SAMPLE SOURCE: ACS Lab #21-3632
 NP-13 @ 0' - 2.5'

JOB NO: 19-2012-2017
WORK ORDER NO: N/A
LAB NO: 21-1685
DATE SAMPLED: 08/13/21

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

SPECIMEN ID	A	B	C
Moisture Content	10.5%	10.1%	9.2%
Compaction Pressure (psi)	150	200	200
Specimen Height (inches)	2.45	2.40	2.48
Dry Density (pcf)	127.5	128.0	129.5
Horiz. Pres. @ 1000lbs (psi)	33.0	28.0	18.0
Horiz. Pres. @ 2000lbs (psi)	94.0	83.0	44.0
Displacement	3.97	3.61	3.77
Expansion Pressure (psi)	0.0	0.3	1.7
Exudation Pressure (psi)	206	320	466
R Value	31	37	64



R Value at 300 PSI = 35

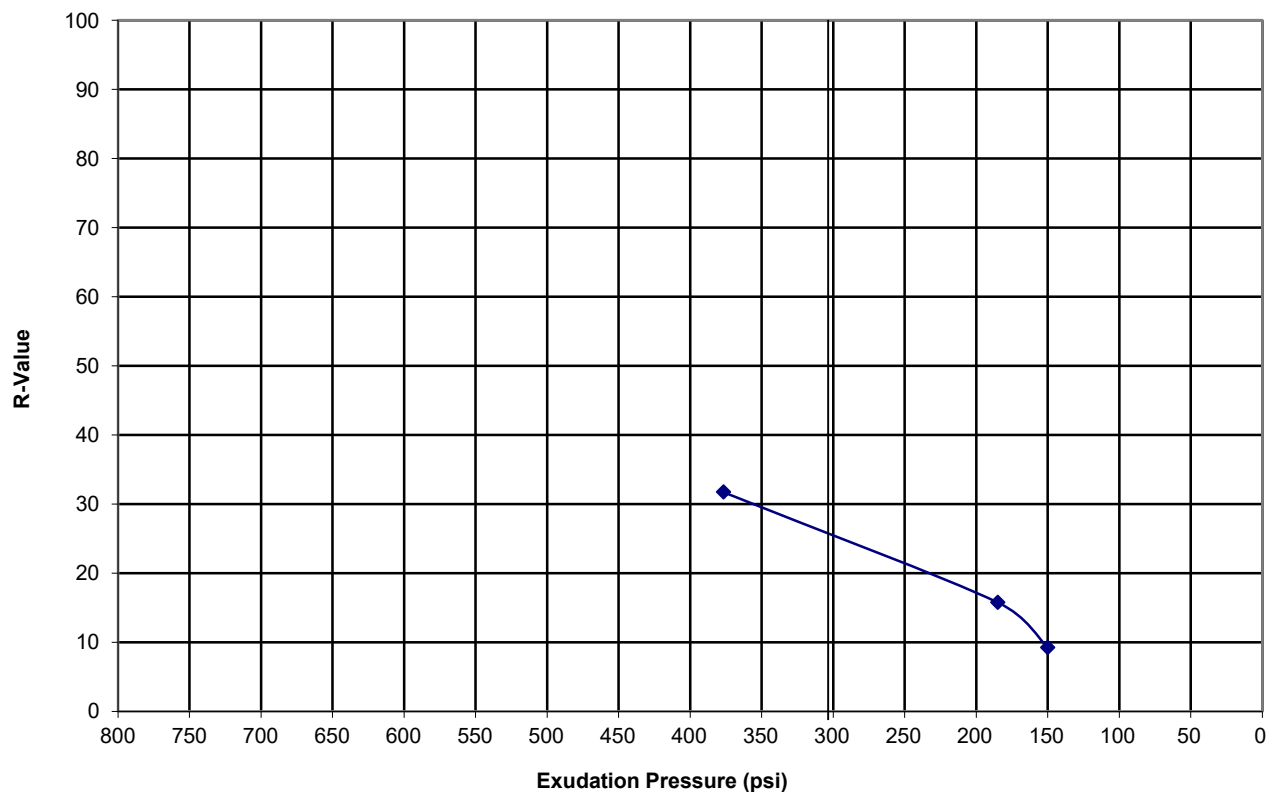
PROJECT: ACS - Lab Testing Services
LOCATION: Mesa, AZ
MATERIAL: Native Soil
SAMPLE SOURCE: NP-21 (1-2.5') ACS Lab #21-3632.39

JOB NO: 19-2012-2017
WORK ORDER NO: N/A
LAB NO: 21-1781-01
DATE SAMPLED: 09/17/21

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

SPECIMEN ID	A	B	C
Moisture Content	46.4%	35.4%	24.3%
Compaction Pressure (psi)	*	125	175
Specimen Height (inches)	2.55	2.50	2.43
Dry Density (pcf)	90.8	99.9	110.8
Horiz. Pres. @ 1000lbs (psi)	54.0	43.0	34.0
Horiz. Pres. @ 2000lbs (psi)	133.0	120.0	93.0
Displacement	4.98	4.45	3.61
Expansion Pressure (psi)	0.0	0.0	1.4
Exudation Pressure (psi)	150	185	377
R Value	9	16	32

* HAND TAMPED



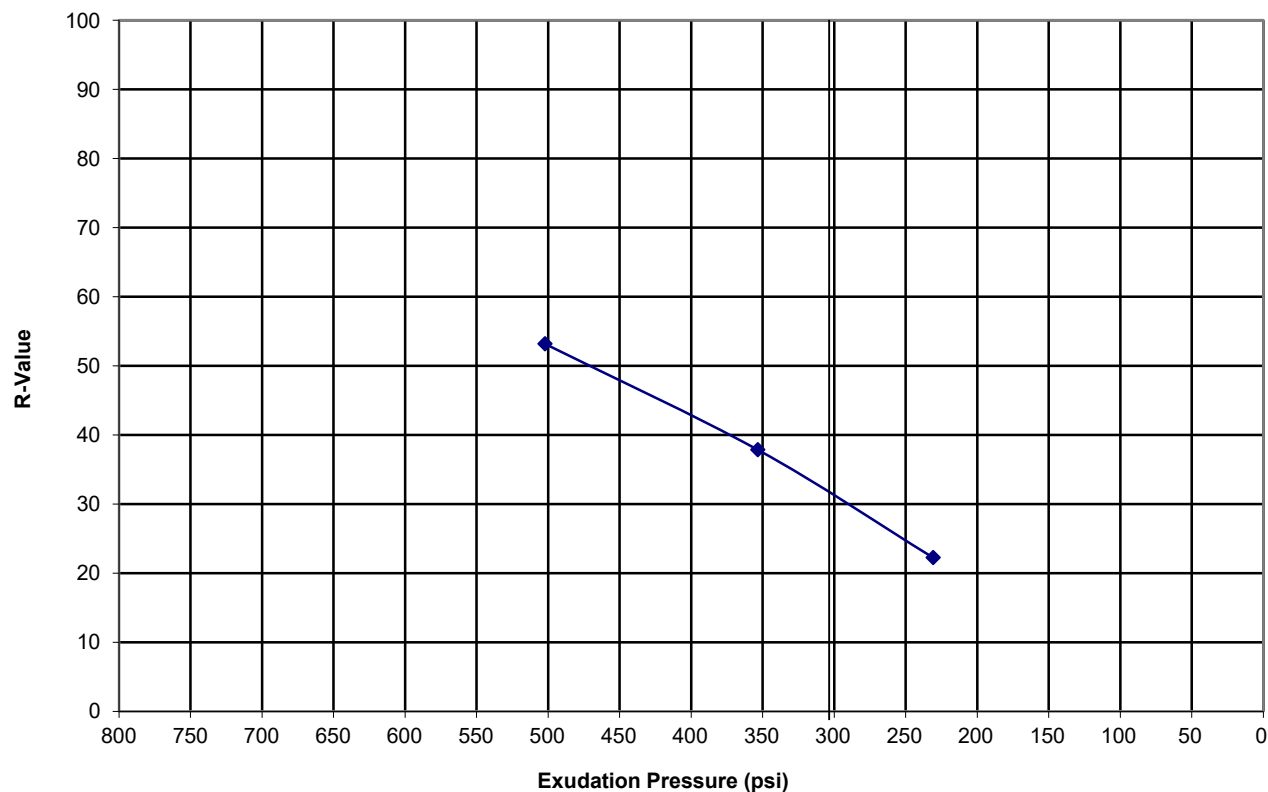
R Value at 300 PSI = 26

PROJECT: ACS - Lab Testing Services
LOCATION: Mesa, AZ
MATERIAL: Native Soil
SAMPLE SOURCE: NP-24 (0-2.5') ACS Lab #21-3632.21

JOB NO: 19-2012-2017
WORK ORDER NO: N/A
LAB NO: 21-1781-02
DATE SAMPLED: 09/17/21

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

SPECIMEN ID	A	B	C
Moisture Content	13.5%	12.6%	11.7%
Compaction Pressure (psi)	150	200	225
Specimen Height (inches)	2.50	2.45	2.47
Dry Density (pcf)	121.3	123.7	124.7
Horiz. Pres. @ 1000lbs (psi)	40.0	28.0	23.0
Horiz. Pres. @ 2000lbs (psi)	108.0	83.0	59.0
Displacement	4.21	3.81	3.77
Expansion Pressure (psi)	0.0	0.0	1.8
Exudation Pressure (psi)	231	353	502
R Value	22	38	53



R Value at 300 PSI = 32

ACS Services LLC**Soil pH and Resistivity Determination**

AASHTO T-289 AASHTO T-288 / ARIZ 236

Project # 2301257
Lab # 23-1858-1
Client: Ethos Engineering, LLC
Project Name: Northern Parkway, Agua Fria to 99th Avenue
Project Address: Northern Parkway, Agua Fria to 99th Avenue
Project City: Maricopa County
Sample Source: NR-1 @ 0.0 - 5.0

Material Type: Soil
Supplier: -
Sample Date: 3/2/2023
Sampled By: Client
Test Date: Wednesday, March 15, 2023
Tested By: Fernando Montero
Resistivity Box: -
Reviewed By: Dylan Ward

pH Reading = 8.2

$$P = (SBF) \times R \times M$$

Where:

SBF = Soil Box Factor, cm

R = Dial Reading, OHMS

M = Multiplier

Water Added	SBF (cm)	Dial Reading (OHMS)	Multiplier	P (OHM-cm)
200	6.77	1.9	100	1290
50	6.77	1.7	100	1150
50	6.77	1.7	100	1150
50	6.77	1.7	100	1150
50	6.77	1.8	100	1220

Fernando Montero

Lab Supervisor

Dylan Ward

Laboratory Manager

ACS Services LLC

Soil pH and Resistivity Determination

AASHTO T-289 AASHTO T-288 / ARIZ 236

Project # 2301257
 Lab # 23-2447-1
 Client: Ethos Engineering, LLC
 Project Name: Northern Parkway, Agua Fria to 99th Avenue
 Project Address: Northern Parkway, Agua Fria to 99th Avenue
 Project City: Maricopa County
 Sample Source: NR-3 @ 0.0 - 10.0

Material Type: Soil
 Supplier: -
 Sample Date: 4/18/2023
 Sampled By: Client
 Test Date: Friday, April 21, 2023
 Tested By: Fernando Montero
 Resistivity Box: -
 Reviewed By: Dylan Ward

pH Reading = 8.4

$$P = (SBF) \times R \times M$$

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	3.8	100	2570
50	6.77	3.2	100	2170
50	6.77	3.3	100	2230

Fernando Montero
 Lab Supervisor

Dylan Ward
 Laboratory Manager

ACS Services LLC**Soil pH and Resistivity Determination**

AASHTO T-289 AASHTO T-288 / ARIZ 236

Project # 2301257
Lab # 23-1858-16
Client: Ethos Engineering, LLC
Project Name: Northern Parkway, Agua Fria to 99th Avenue
Project Address: Northern Parkway, Agua Fria to 99th Avenue
Project City: Maricopa County
Sample Source: NR-5 @ 0.0 - 5.0

Material Type: Soil
Supplier: -
Sample Date: 3/2/2023
Sampled By: Client
Test Date: Wednesday, March 15, 2023
Tested By: Fernando Montero
Resistivity Box: -
Reviewed By: Dylan Ward

pH Reading = 8.2

$$P = (SBF) \times R \times M$$

Where:

SBF = Soil Box Factor, cm

R = Dial Reading, OHMS

M = Multiplier

Water Added	SBF (cm)	Dial Reading (OHMS)	Multiplier	P (OHM-cm)
200	6.77	2.0	100	1350
50	6.77	1.7	100	1150
50	6.77	1.7	100	1150
50	6.77	1.9	100	1290

Fernando Montero

Lab Supervisor

Dylan Ward

Laboratory Manager

ACS Services LLC

Soil pH and Resistivity Determination

AASHTO T-289 AASHTO T-288

Project # 2101595
 Lab # 21-3632-16
 Client: Ethos Engineering
 Project Name: Northern Parkway
 Project Address: Northern Parkway, 99th Ave to 87th Ave
 Project City: Glendale, AZ
 Sample Source: NP - 2 @ 0.0'-2.5'

Material Type: Native
 Supplier: -
 Sample Date: Thursday, September 16, 2021
 Sampled By: Client
 Test Date: Tuesday, September 14, 2021
 Tested By: Jose Botello
 Resistivity Box:
 Reviewed By: Andrew Jamrogiewicz, P.E.

pH Reading = 8.3

$$P = (SBF) \times R \times M$$

Where:

SBF = Soil Box Factor, cm

R = Dial Reading, OHMS

M = Multiplier

Water Added	SBF (cm)	Dial Reading (OHMS)	Multiplier	P (OHM-cm)
100	1.00	0.11	10000	1100
25	1.00	0.74	1000	740
25	1.00	0.45	1000	450
25	1.00	0.45	1000	450
25	1.00	0.45	1000	450
25	1.00	0.45	1000	450

Geoff Matthew, EIT

Lab Supervisor

Sean Mayfield

Operations Manager

ACS Services LLC

Soil pH and Resistivity Determination

AASHTO T-289 AASHTO T-288

Project # 2101595
 Lab # 21-3632-25
 Client: Ethos Engineering
 Project Name: Northern Parkway
 Project Address: Northern Parkway, 99th Ave to 87th Ave
 Project City: Glendale, AZ
 Sample Source: NP - 6 @ 10.0'-15.0'

Material Type: Native
 Supplier: -
 Sample Date:
 Sampled By: Client
 Test Date: Tuesday, September 21, 2021
 Tested By: Jose Botello
 Resistivity Box:
 Reviewed By: Andrew Jamrogiewicz, P.E.

pH Reading = 8.8

$$P = (SBF) \times R \times M$$

Where:

SBF = Soil Box Factor, cm

R = Dial Reading, OHMS

M = Multiplier

Water Added	SBF (cm)	Dial Reading (OHMS)	Multiplier	P (OHM-cm)
100	1.00	0.22	10000	2200
25	1.00	0.20	10000	2000
25	1.00	0.21	10000	2100

Jose Botello
 Lab Supervisor

Sean Mayfield
 Operations Manager

ACS Services LLC

Soil pH and Resistivity Determination

AASHTO T-289 AASHTO T-288

Project # 2101595
 Lab # 21-3632-26
 Client: Ethos Engineering
 Project Name: Northern Parkway
 Project Address: Northern Parkway, 99th Ave to 87th Ave
 Project City: Glendale, AZ
 Sample Source: NP - 7 @ 15.0'-20.0'

Material Type: Native
 Supplier: -
 Sample Date:
 Sampled By: Client
 Test Date: Tuesday, September 21, 2021
 Tested By: Jose Botello
 Resistivity Box:
 Reviewed By: Andrew Jamrogiewicz, P.E.

pH Reading = 8.6

$$P = (SBF) \times R \times M$$

Where:

SBF = Soil Box Factor, cm

R = Dial Reading, OHMS

M = Multiplier

Water Added	SBF (cm)	Dial Reading (OHMS)	Multiplier	P (OHM-cm)
100	1.00	0.19	10000	1900
25	1.00	0.19	10000	1900
25	1.00	0.2	10000	2000

Jose Botello
 Lab Supervisor

Sean Mayfield
 Operations Manager

ACS Services LLC

Soil pH and Resistivity Determination

AASHTO T-289 AASHTO T-288

Project # 2101595
 Lab # 21-3632-27
 Client: Ethos Engineering
 Project Name: Northern Parkway
 Project Address: Northern Parkway, 99th Ave to 87th Ave
 Project City: Glendale, AZ
 Sample Source: NP - 8 @ 20.0'-25.0'

Material Type: Native
 Supplier: -
 Sample Date:
 Sampled By: Client
 Test Date: Tuesday, September 21, 2021
 Tested By: Jose Botello
 Resistivity Box:
 Reviewed By: Andrew Jamrogiewicz, P.E.

pH Reading = 8.6

$$P = (SBF) \times R \times M$$

Where:

SBF = Soil Box Factor, cm

R = Dial Reading, OHMS

M = Multiplier

Water Added	SBF (cm)	Dial Reading (OHMS)	Multiplier	P (OHM-cm)
100	1.00	0.20	10000	2000
25	1.00	0.20	10000	2000
25	1.00	0.21	10000	2100

Jose Botello
 Lab Supervisor

Sean Mayfield
 Operations Manager

ACS Services LLC

Soil pH and Resistivity Determination

AASHTO T-289 AASHTO T-288

Project # 2101595
 Lab # 21-3632-6
 Client: Ethos Engineering
 Project Name: Northern Parkway
 Project Address: Northern Parkway, 99th Ave to 87th Ave
 Project City: Glendale, AZ
 Sample Source: NP - 9 @ 0.0'-2.5'

Material Type: Native
 Supplier: -
 Sample Date: Friday, July 30, 2021
 Sampled By: Client
 Test Date: Monday, August 16, 2021
 Tested By: Ryan Richardson
 Resistivity Box:
 Reviewed By: Andrew Jamrogiewicz, PE

pH Reading = 8.0

$$P = (SBF) \times R \times M$$

Where:

SBF = Soil Box Factor, cm

R = Dial Reading, OHMS

M = Multiplier

Water Added	SBF (cm)	Dial Reading (OHMS)	Multiplier	P (OHM-cm)
200	6.77	4.6	100	3114
50	6.77	4.7	100	3182
50	6.77	4.8	100	3250

Jill Bryant
 Lab Supervisor

Sean Mayfield
 Operations Manager

ACS Services LLC

Soil pH and Resistivity Determination

AASHTO T-289 AASHTO T-288

Project # 2101595
 Lab # 21-3632-8
 Client: Ethos Engineering
 Project Name: Northern Parkway
 Project Address: Northern Parkway, 99th Ave to 87th Ave
 Project City: Glendale, AZ
 Sample Source: NP - 12 @ 0.0'-2.5'

Material Type: Native
 Supplier: -
 Sample Date: Friday, July 30, 2021
 Sampled By: Client
 Test Date: Monday, August 16, 2021
 Tested By: Ryan Richardson
 Resistivity Box:
 Reviewed By: Andrew Jamrogiewicz, PE

pH Reading = 8.2

$$P = (SBF) \times R \times M$$

Where:

SBF = Soil Box Factor, cm

R = Dial Reading, OHMS

M = Multiplier

Water Added	SBF (cm)	Dial Reading (OHMS)	Multiplier	P (OHM-cm)
200	6.77	3.1	100	2099
50	6.77	2.6	100	1760
50	6.77	2.8	100	1896

Jill Bryant
 Lab Supervisor

Sean Mayfield
 Operations Manager

ACS Services LLC

Soil pH and Resistivity Determination

AASHTO T-289 AASHTO T-288

Project # 2101595
 Lab # 21-3632-12
 Client: Ethos Engineering
 Project Name: Northern Parkway
 Project Address: Northern Parkway, 99th Ave to 87th Ave
 Project City: Glendale, AZ
 Sample Source: NP - 14 @ 0.0'-2.5'

Material Type: Native
 Supplier: -
 Sample Date: Friday, July 30, 2021
 Sampled By: Client
 Test Date: Monday, August 16, 2021
 Tested By: Ryan Richardson
 Resistivity Box:
 Reviewed By: Andrew Jamrogiewicz, PE

pH Reading = 8.0

$$P = (SBF) \times R \times M$$

Where:

SBF = Soil Box Factor, cm

R = Dial Reading, OHMS

M = Multiplier

Water Added	SBF (cm)	Dial Reading (OHMS)	Multiplier	P (OHM-cm)
200	6.77	1.4	100	948
50	6.77	1.1	100	745
50	6.77	1.1	100	745
50	6.77	1.1	100	745

Jill Bryant
 Lab Supervisor

Sean Mayfield
 Operations Manager

ACS Services LLC

Soil pH and Resistivity Determination

AASHTO T-289 AASHTO T-288

Project # 2101595
 Lab # 21-3632-19
 Client: Ethos Engineering
 Project Name: Northern Parkway
 Project Address: Northern Parkway, 99th Ave to 87th Ave
 Project City: Glendale, AZ
 Sample Source: NP - 17 @ 0.0'-2.5'

Material Type: Native
 Supplier: -
 Sample Date:
 Sampled By: Client
 Test Date: Tuesday, September 14, 2021
 Tested By: Jose Botello
 Resistivity Box:
 Reviewed By: Andrew Jamrogiewicz, P.E.

pH Reading = 8.0

$$P = (SBF) \times R \times M$$

Where:

SBF = Soil Box Factor, cm

R = Dial Reading, OHMS

M = Multiplier

Water Added	SBF (cm)	Dial Reading (OHMS)	Multiplier	P (OHM-cm)
100	1.00	0.31	10000	3100
25	1.00	0.17	10000	1700
25	1.00	0.11	10000	1100
25	1.00	0.11	10000	1100

Jill Bryant
 Lab Supervisor

Sean Mayfield
 Operations Manager

Project # 2101595
Lab # 22-4879-2
Client: Ethos Engineering, LLC
Project Name: Northern Parkway - 99th Avenue and 87th Avenue
Project Address: Northern Parkway
Project City: Peoria
Sample Source: ADD-1 @ (Combined) 5-6.5, 10-11.5, and 15-16.5 and
ADD-2 @ (Combined) 10-11, 15-16.5, and 20-21.5

Material Type: Soil
Supplier: -
Sample Date: 11/14/2022
Sampled By: Client
Test Date: Friday, November 18, 2022
Tested By: Fernando Montero
Resistivity Box: -
Reviewed By: Dylan Ward

pH Reading = 8.57

$$P = (SBF) \times R \times M$$

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	455	1	3080
50	6.77	294	1	1990
50	6.77	274	1	1855
50	6.77	278	1	1882

Fernando Montero
Lab Supervisor

Dylan Ward
Laboratory Manager



ACS Services LLC
Dylan Ward
2235 W Broadway Road
Mesa, AZ 85202

Report: 945720
Reported: 3/13/2023
Received: 3/9/2023
PO: 2301257

Laboratory Analysis Report

Project: 2301257

Lab Number	Sample ID
945720-1	23-1558-1 NR-1 (0-5')

Test Parameter

Test	Method	Result	Units
Sulfate	ARIZ 733b	5	ppm
Chloride	ARIZ 736b	28	ppm

Lab Number	Sample ID
945720-2	23-1858-11 NR-4 (25-26')

Test Parameter

Test	Method	Result	Units
Sulfate	ARIZ 733b	7	ppm
Chloride	ARIZ 736b	29	ppm

Lab Number	Sample ID
945720-3	23-1858-16 NR-5 (0-5')

Test Parameter

Test	Method	Result	Units
Sulfate	ARIZ 733b	3	ppm
Chloride	ARIZ 736b	26	ppm

Lab Number	Sample ID
945720-4	23-1858-21 NR-4 (60-61.6')

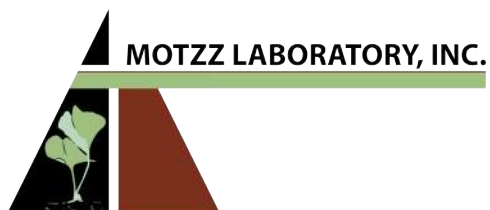
Test Parameter

Test	Method	Result	Units
Sulfate	ARIZ 733b	< 3	ppm
Chloride	ARIZ 736b	9	ppm

Lab Number	Sample ID
945720-5	23-1858-22 NR-2 (30-31')

Test Parameter

Test	Method	Result	Units
Sulfate	ARIZ 733b	4	ppm
Chloride	ARIZ 736b	5	ppm



Report: 946262
Reported: 4/25/2023
Received: 4/21/2023
PO: 2301257

Laboratory Analysis Report

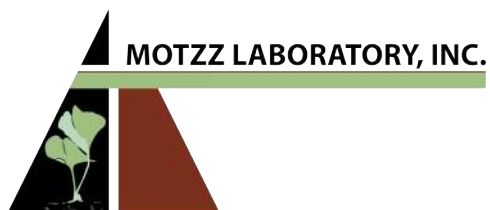
ACS Services LLC
Dylan Ward
2235 W Broadway Road
Mesa, AZ 85202

Project: 2301257

Lab Number	Sample ID
946262-1	23-2447-1 (NR-3, 0-10')

Test Parameter

<i>Test</i>	<i>Method</i>	<i>Result</i>	<i>Units</i>
Sulfate	ARIZ 733b	9	ppm
Chloride	ARIZ 736b	8	ppm



MOTZZ LABORATORY, INC.

Report: 944596
Reported: 11/30/2022
Received: 11/28/2022
PO: 2101595

Laboratory Analysis Report

ACS Services LLC
Dylan Ward
2235 W Broadway Road
Mesa, AZ 85202

Project: 2101595

Lab Number	Sample ID
944596-1	22-4879-2 ADD-1 & 2 @ 0' - 21.5'

Test Parameter

<i>Test</i>	<i>Method</i>	<i>Result</i>	<i>Units</i>
Organic Content	AASHTO T267	0.81	%
Sulfate	ARIZ 733b	4	ppm
Chloride	ARIZ 736b	62	ppm



Laboratory Analysis Report

ACS Services LLC
Andy Jamrogiewicz
2235 W Broadway Road
Mesa, AZ 85202

Project: 2101595
Date Received: 9/16/2021
Date Reported: 9/18/2021
PO Number: 2101595

Lab Number: 938712-1	NP2 21-3632-16 (0-2.5')
-----------------------------	--------------------------------

<i>Test Parameter</i>	Method	Result	Units	Levels
Sulfate	ARIZ 733b	3	ppm	
Chloride	ARIZ 736b	193	ppm	

Lab Number: 938712-2	NP15 21-3632-18 (0-2.5')
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<i>Test Parameter</i>	Method	Result	Units	Levels
Sulfate	ARIZ 733b	6	ppm	
Chloride	ARIZ 736b	72	ppm	

Lab Number: 938712-3	NP17 21-3632-19 (0-2.5')
-----------------------------	---------------------------------

<i>Test Parameter</i>	Method	Result	Units	Levels
Sulfate	ARIZ 733b	6	ppm	
Chloride	ARIZ 736b	< 3	ppm	

Lab Number: 938712-4	NP22 21-3632-20 (0-2.5')
-----------------------------	---------------------------------

<i>Test Parameter</i>	Method	Result	Units	Levels
Sulfate	ARIZ 733b	29	ppm	
Chloride	ARIZ 736b	464	ppm	

Lab Number: 938712-5	NP24 21-3632-21 (0-2.5')
-----------------------------	---------------------------------

<i>Test Parameter</i>	Method	Result	Units	Levels
Sulfate	ARIZ 733b	20	ppm	
Chloride	ARIZ 736b	279	ppm	

Lab Number: 938712-6	NP5 21-3632-23 (5-10')
-----------------------------	-------------------------------

<i>Test Parameter</i>	Method	Result	Units	Levels
Sulfate	ARIZ 733b	< 3	ppm	
Chloride	ARIZ 736b	16	ppm	



Laboratory Analysis Report

ACS Services LLC
Andy Jamrogiewicz
2235 W Broadway Road
Mesa, AZ 85202

Project: 2101595
Date Received: 9/16/2021
Date Reported: 9/18/2021
PO Number: 2101595

Lab Number: 938712-7	NP20 21-3632-36 (1-2.5')
-----------------------------	---------------------------------

<i>Test Parameter</i>	Method	Result	Units	Levels
Sulfate	ARIZ 733b	3	ppm	
Chloride	ARIZ 736b	< 3	ppm	

Lab Number: 938712-8	NP23 21-3632-40 (0.5-2.5')
-----------------------------	-----------------------------------

<i>Test Parameter</i>	Method	Result	Units	Levels
Sulfate	ARIZ 733b	5	ppm	
Chloride	ARIZ 736b	13	ppm	



Laboratory Analysis Report

ACS Services LLC
Andy Jamrogiewicz
2235 W Broadway Road
Mesa, AZ 85202

Project: 21-3632
Date Received: 9/17/2021
Date Reported: 9/22/2021
PO Number: 21-3632

Lab Number: 938717-1	21-3632-25	NP-6 @ 10' - 15'
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<i>Test Parameter</i>	Method	Result	Units	Levels
Sulfate	ARIZ 733b	5	ppm	
Chloride	ARIZ 736b	15	ppm	

Lab Number: 938717-2	21-3632-26	NP-7 @ 15' - 20'
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<i>Test Parameter</i>	Method	Result	Units	Levels
Sulfate	ARIZ 733b	3	ppm	
Chloride	ARIZ 736b	28	ppm	

Lab Number: 938717-3	21-3632-27	NP-8 @ 20' - 25'
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<i>Test Parameter</i>	Method	Result	Units	Levels
Sulfate	ARIZ 733b	7	ppm	
Chloride	ARIZ 736b	25	ppm	



Laboratory Analysis Report

ACS Services LLC
Andy Jamrogiewicz
2235 W Broadway Road
Mesa, AZ 85202

Project: 2101595
Date Received: 8/20/2021
Date Reported: 8/24/2021
PO Number: 2101595

Lab Number: 938375-1	21-3632-6 NP-9 (0.0-2.5')
-----------------------------	----------------------------------

<i>Test Parameter</i>	Method	Result	Units	Levels
Sulfate	ARIZ 733b	5	ppm	
Chloride	ARIZ 736b	< 3	ppm	

Lab Number: 938375-2	21-3632-8 NP-12 (0.0-2.5')
-----------------------------	-----------------------------------

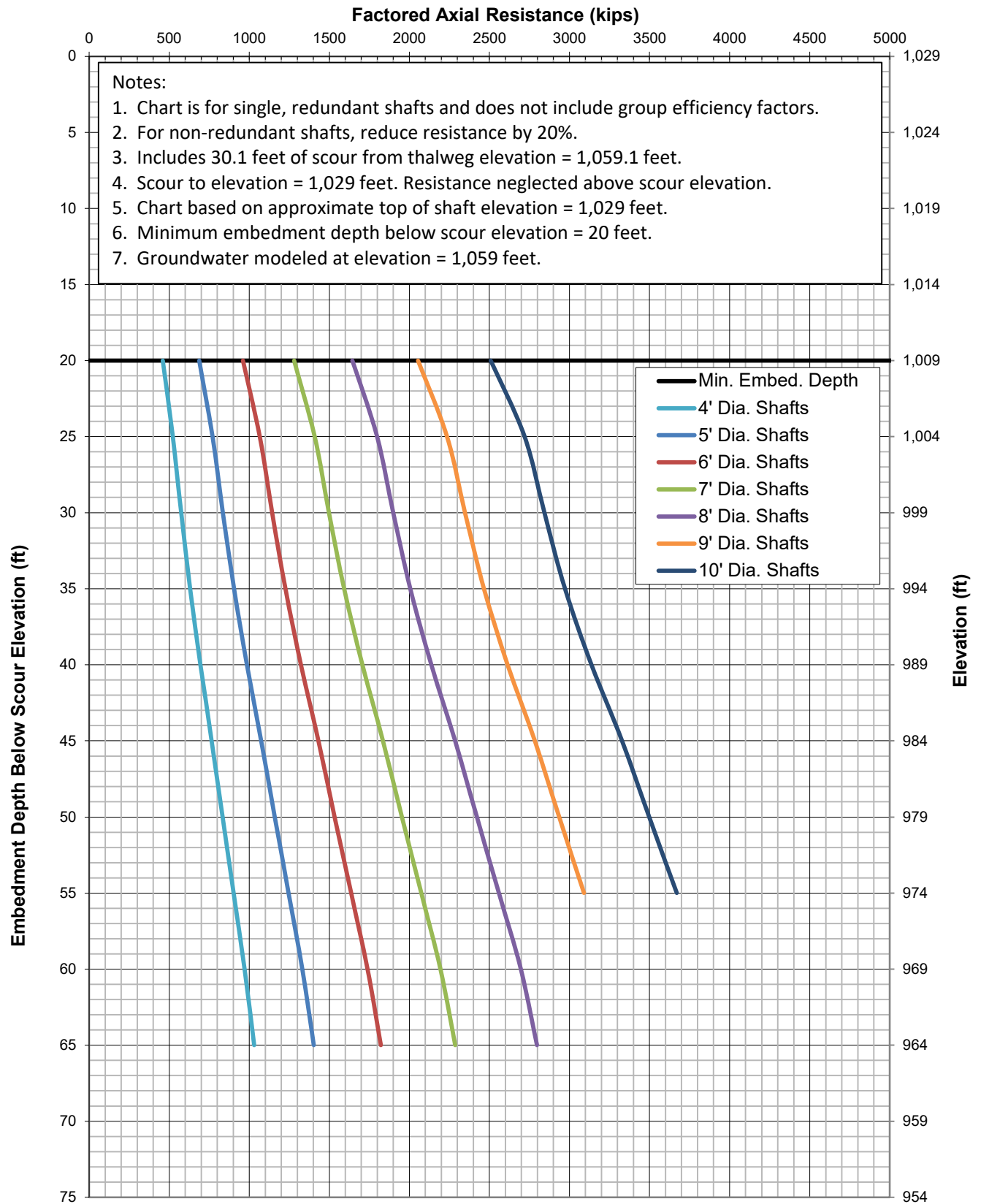
<i>Test Parameter</i>	Method	Result	Units	Levels
Sulfate	ARIZ 733b	22	ppm	
Chloride	ARIZ 736b	< 3	ppm	

Lab Number: 938375-3	21-3632-12 NP-14 (0.0-2.5')
-----------------------------	------------------------------------

<i>Test Parameter</i>	Method	Result	Units	Levels
Sulfate	ARIZ 733b	6	ppm	
Chloride	ARIZ 736b	123	ppm	

APPENDIX C

Drilled Shaft Axial Resistance Charts



DRILLED SHAFT FOUNDATION DESIGN CHART
Strength Limit Axial Resistance in Kips

Northern Avenue, 103rd Avenue to 91st Avenue
New River Bridge Piers
Based on Borings NR-1 to NR-5

Figure

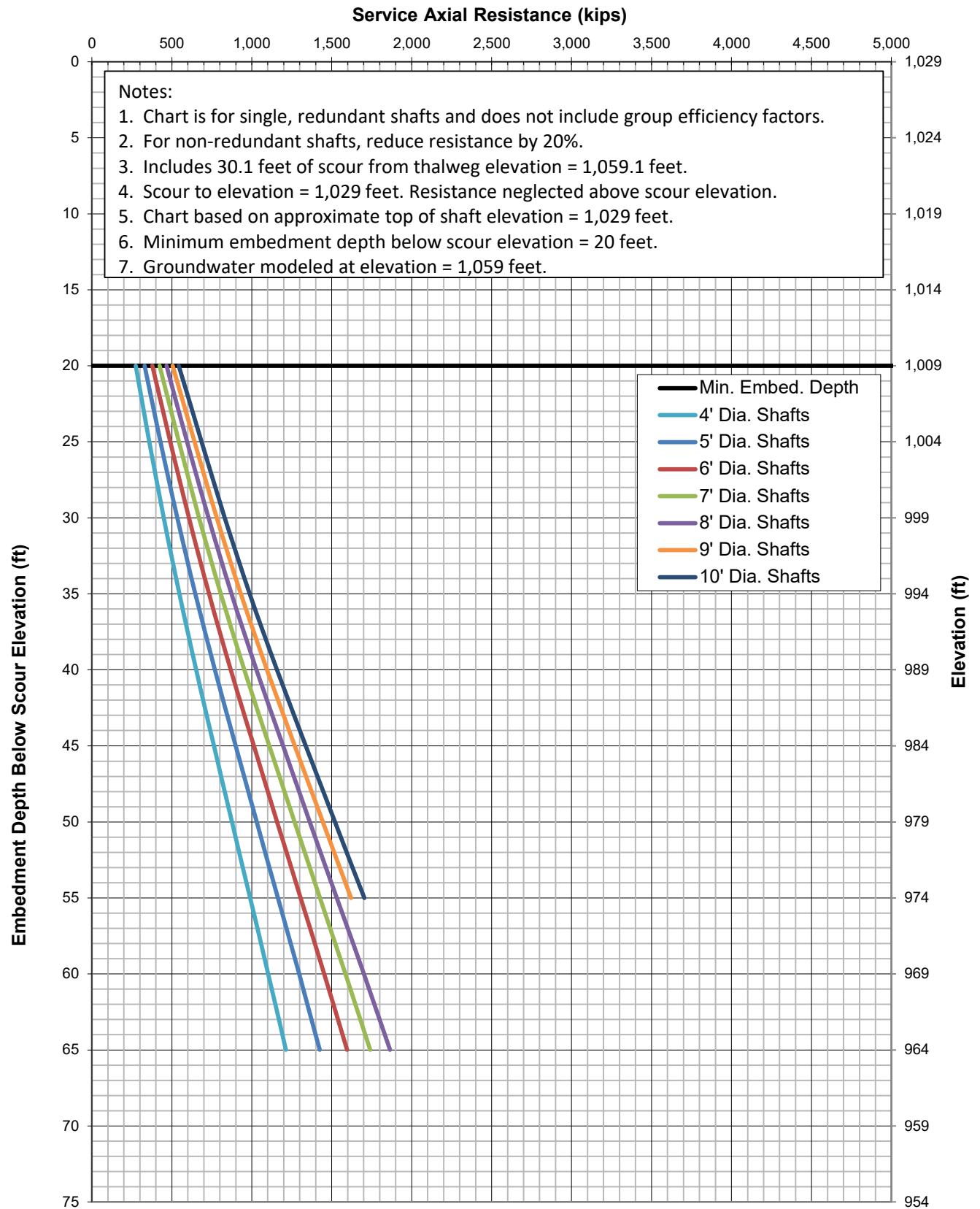
C1

Designer:

Date:

J. Huston

10/24/2024



DRILLED SHAFT FOUNDATION DESIGN CHART
Service Limit (0.25-Inch Settlement) - Axial Resistance in Kips

Northern Avenue, 103rd Avenue to 91st Avenue
New River Bridge Piers
Based on Borings NR-1 to NR-5

Figure

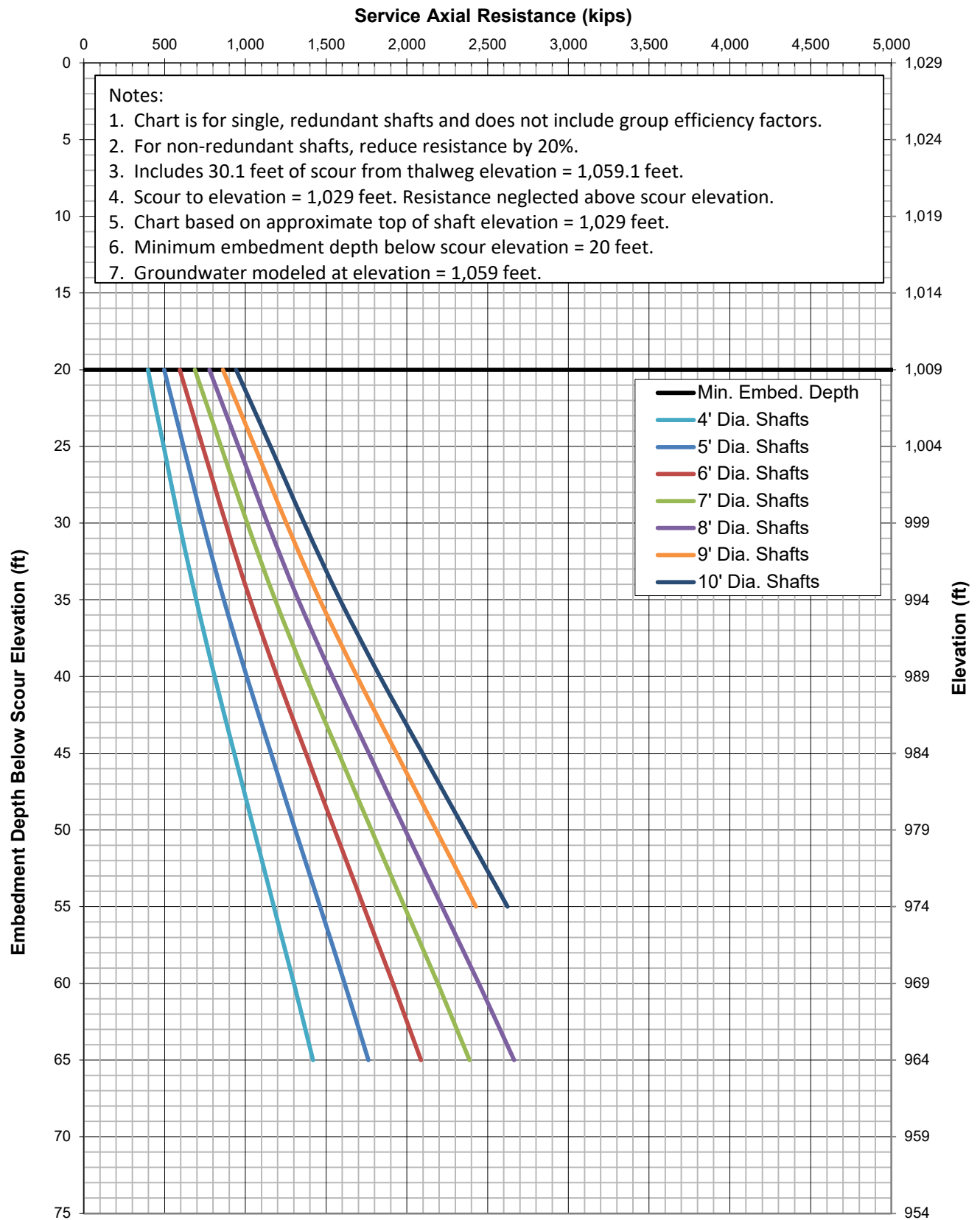
C2

Designer:

Date:

J. Huston

10/24/2024



DRILLED SHAFT FOUNDATION DESIGN CHART
Service Limit (0.5-Inch Settlement) - Axial Resistance in Kips

Northern Avenue, 103rd Avenue to 91st Avenue
New River Bridge Piers
Based on Borings NR-1 to NR-5

Figure

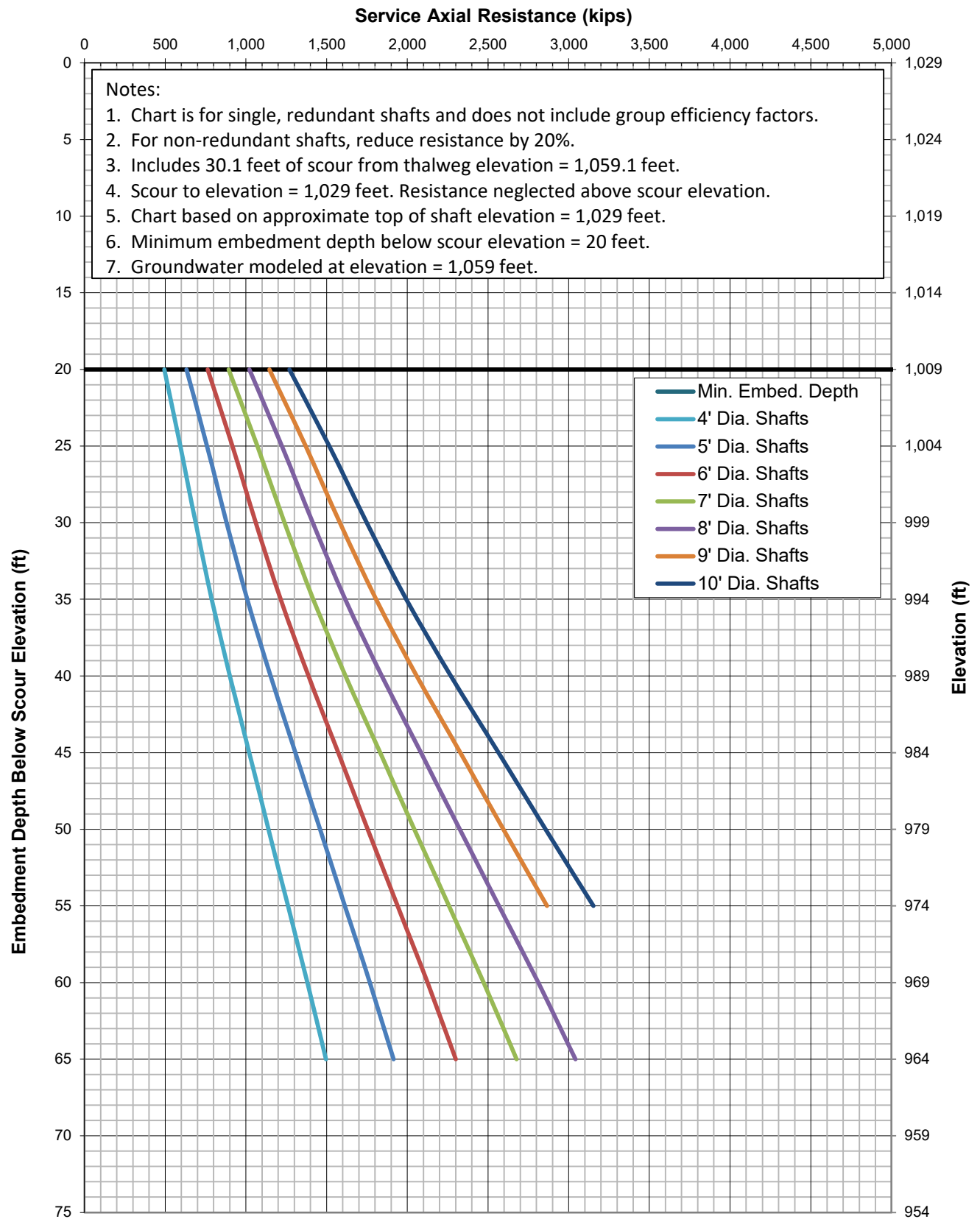
C3

Designer:

Date:

J. Huston

10/24/2024



DRILLED SHAFT FOUNDATION DESIGN CHART
Service Limit (0.75-Inch Settlement) - Axial Resistance in Kips

Northern Avenue, 103rd Avenue to 91st Avenue
New River Bridge Piers
Based on Borings NR-1 to NR-5

Figure

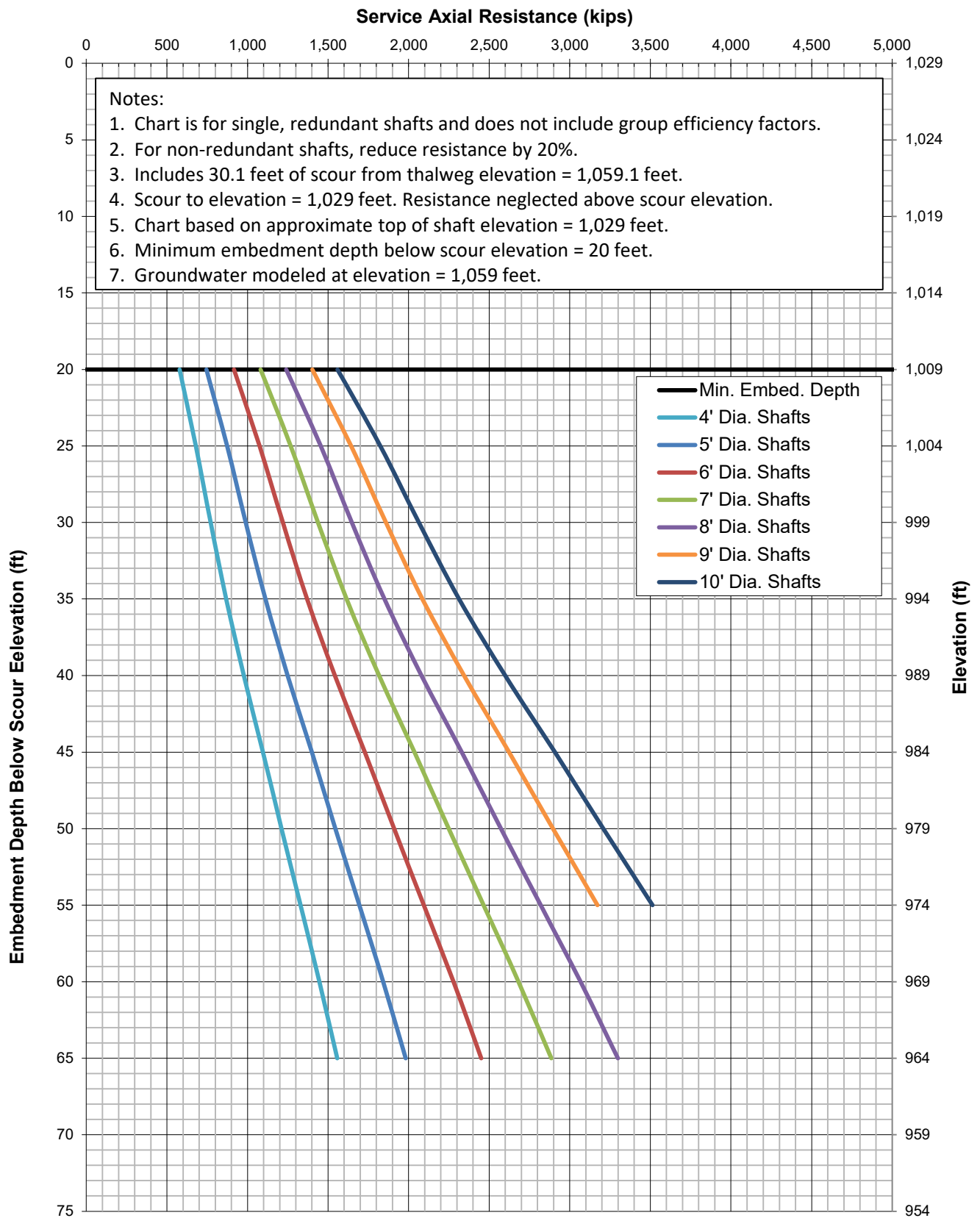
C4

Designer:

Date:

J. Huston

10/24/2024



DRILLED SHAFT FOUNDATION DESIGN CHART
Service Limit (1 Inch Settlement) - Axial Resistance in Kips

Northern Avenue, 103rd Avenue to 91st Avenue
New River Bridge Piers
Based on Borings NR-1 to NR-5

Figure

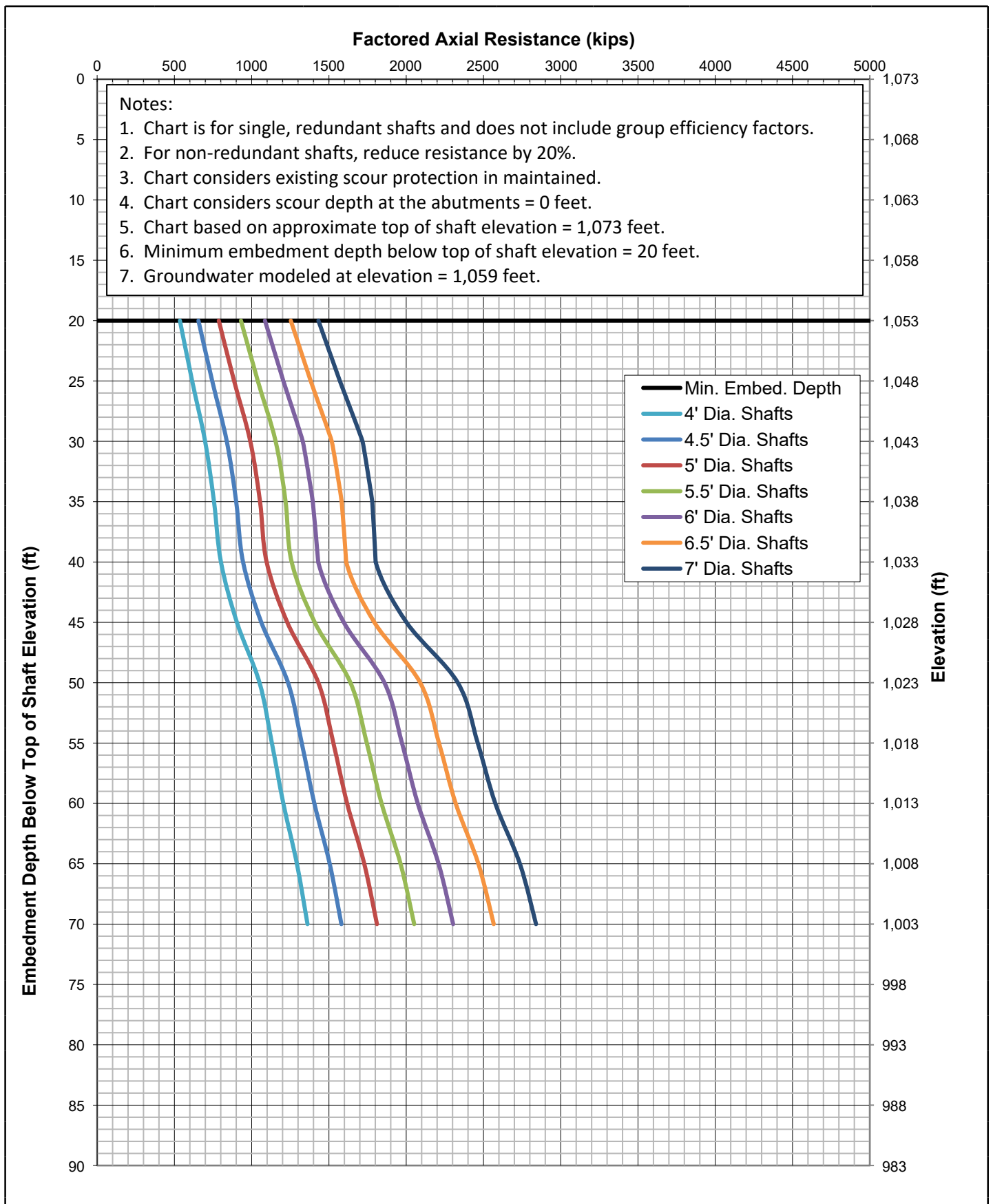
C5

Designer:

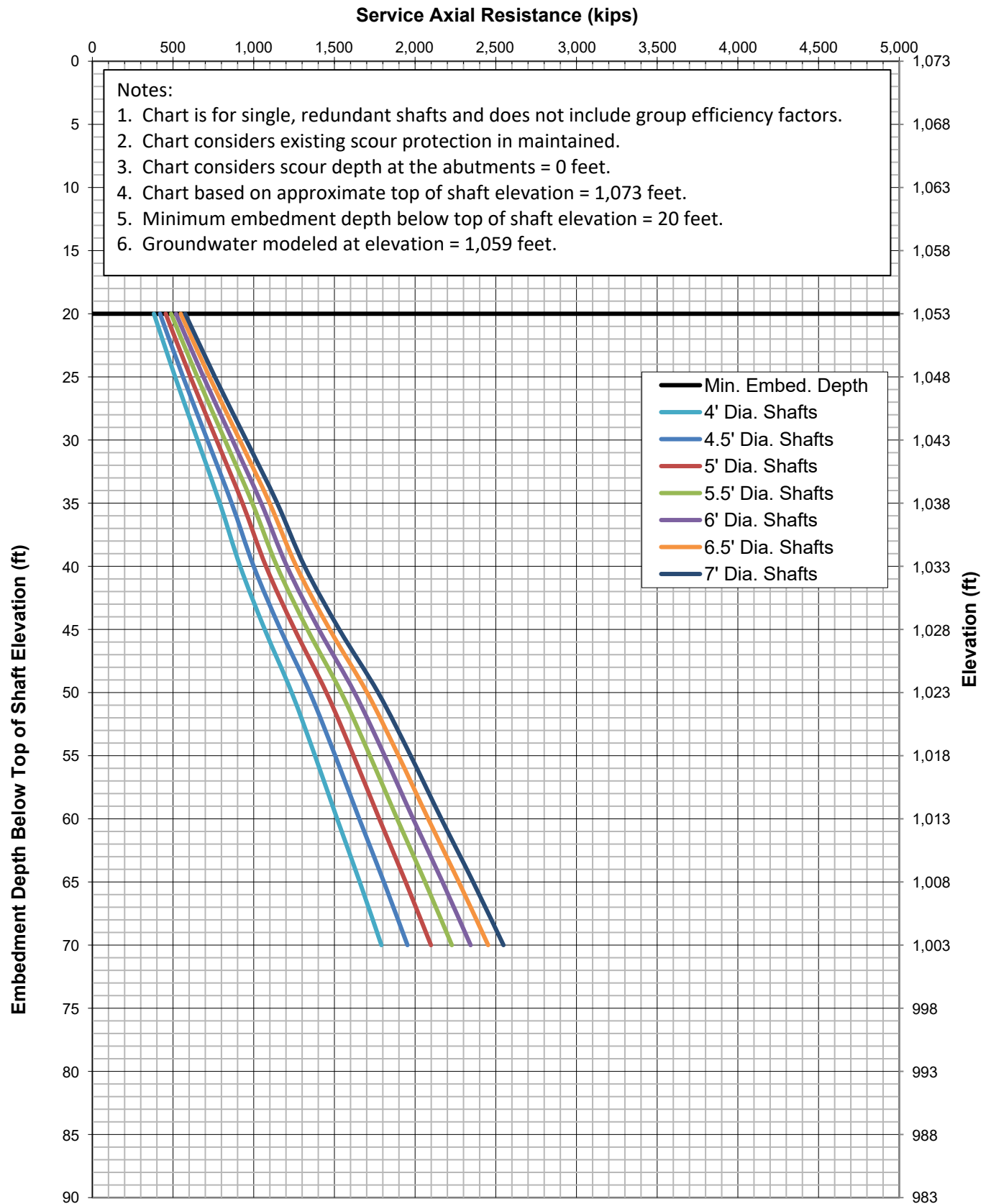
Date:

J. Huston

10/24/2024



		DRILLED SHAFT FOUNDATION DESIGN CHART Strength Limit Axial Resistance in Kips Northern Avenue, 103rd Avenue to 91st Avenue New River Bridge Abutments (with Scour Protection) Based on Borings NR-1 to NR-5	Figure C6
Designer:	Date:		
J. Huston	10/24/2024		



DRILLED SHAFT FOUNDATION DESIGN CHART
Service Limit (0.25-Inch Settlement) - Axial Resistance in Kips

Northern Avenue, 103rd Avenue to 91st Avenue
 New River Bridge Abutments (with Scour Protection)
 Based on Borings NR-1 to NR-5

Figure

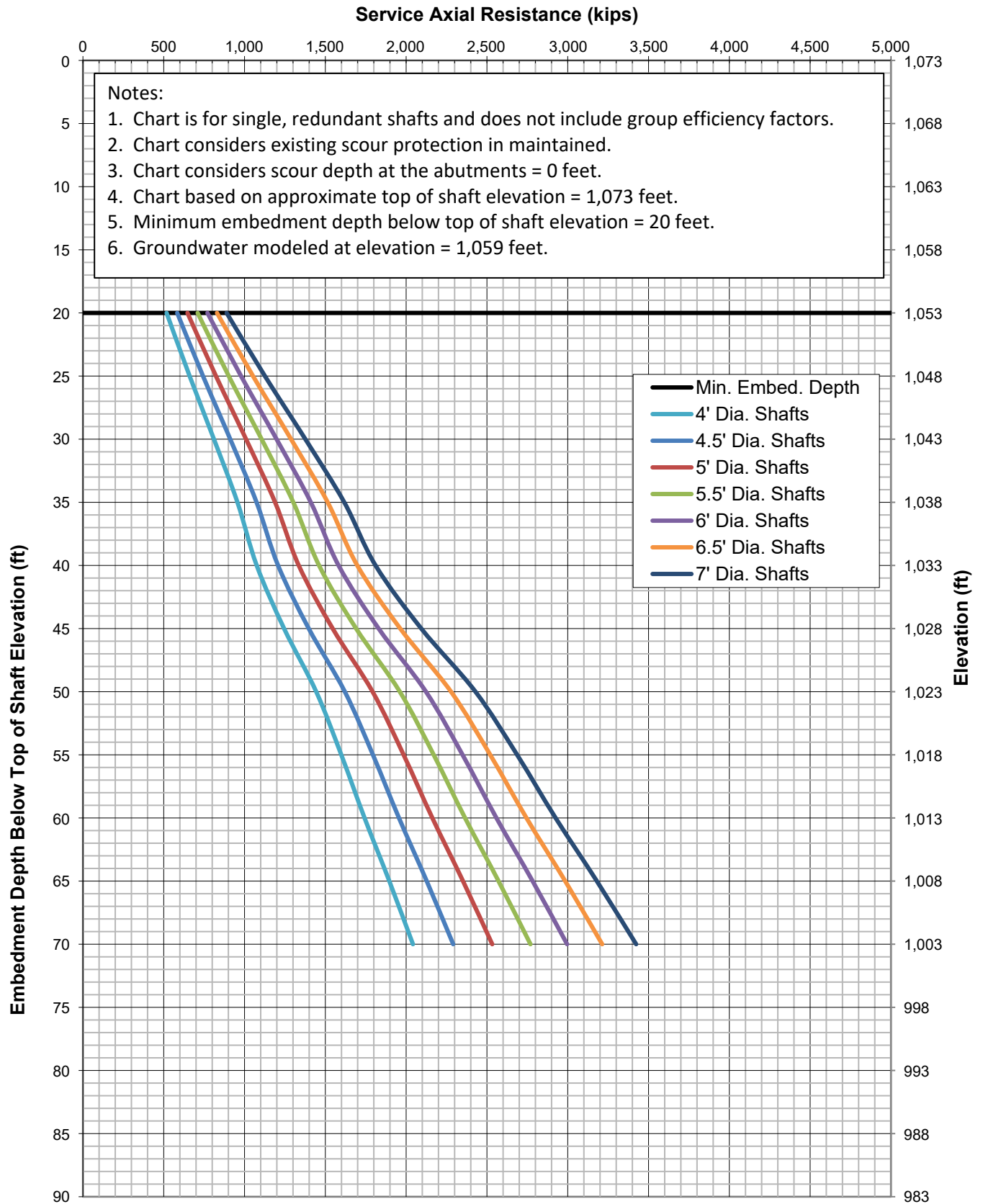
C7

Designer:

Date:

J. Huston

10/24/2024



DRILLED SHAFT FOUNDATION DESIGN CHART
Service Limit (0.5-Inch Settlement) - Axial Resistance in Kips

Northern Avenue, 103rd Avenue to 91st Avenue
New River Bridge Abutments (with Scour Protection)
Based on Borings NR-1 to NR-5

Figure

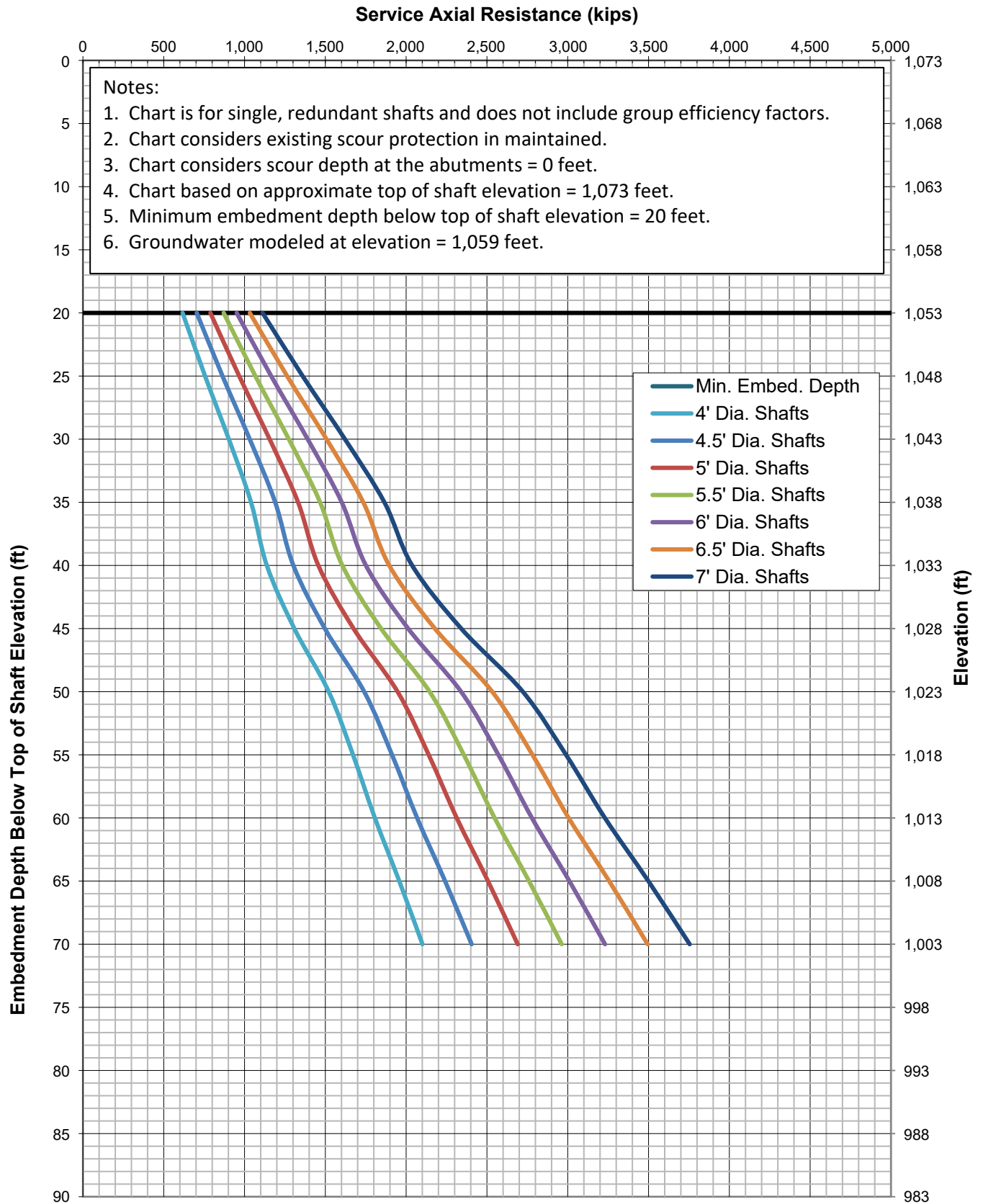
C8

Designer:

Date:

J. Huston

10/24/2024



DRILLED SHAFT FOUNDATION DESIGN CHART
Service Limit (0.75-Inch Settlement) - Axial Resistance in Kips

Northern Avenue, 103rd Avenue to 91st Avenue
New River Bridge Abutments (with Scour Protection)
Based on Borings NR-1 to NR-5

Figure

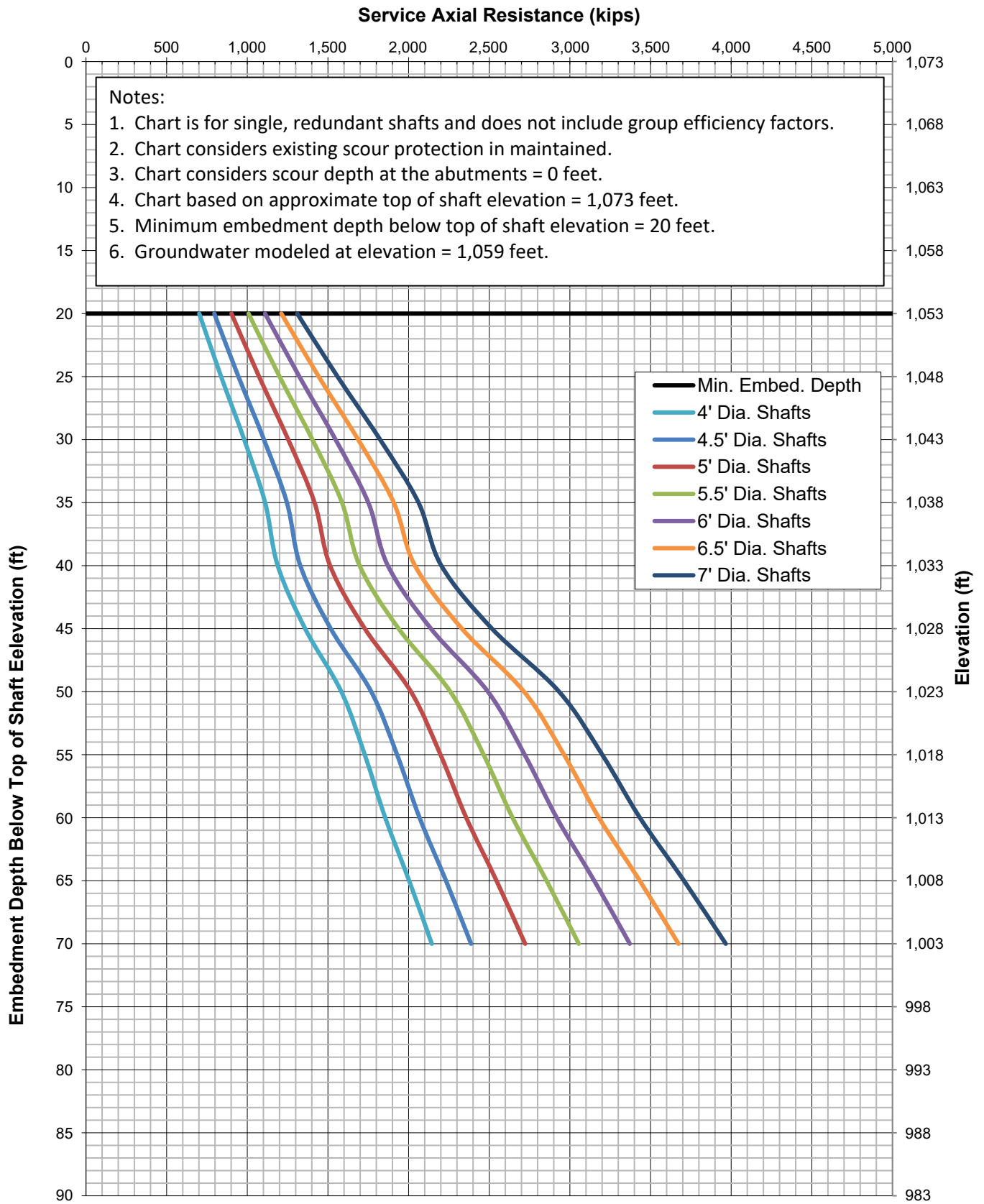
C9

Designer:

Date:

J. Huston

10/24/2024



DRILLED SHAFT FOUNDATION DESIGN CHART
Service Limit (1 Inch Settlement) - Axial Resistance in Kips

Northern Avenue, 103rd Avenue to 91st Avenue
New River Bridge Abutments (with Scour Protection)
Based on Borings NR-1 to NR-5

Figure

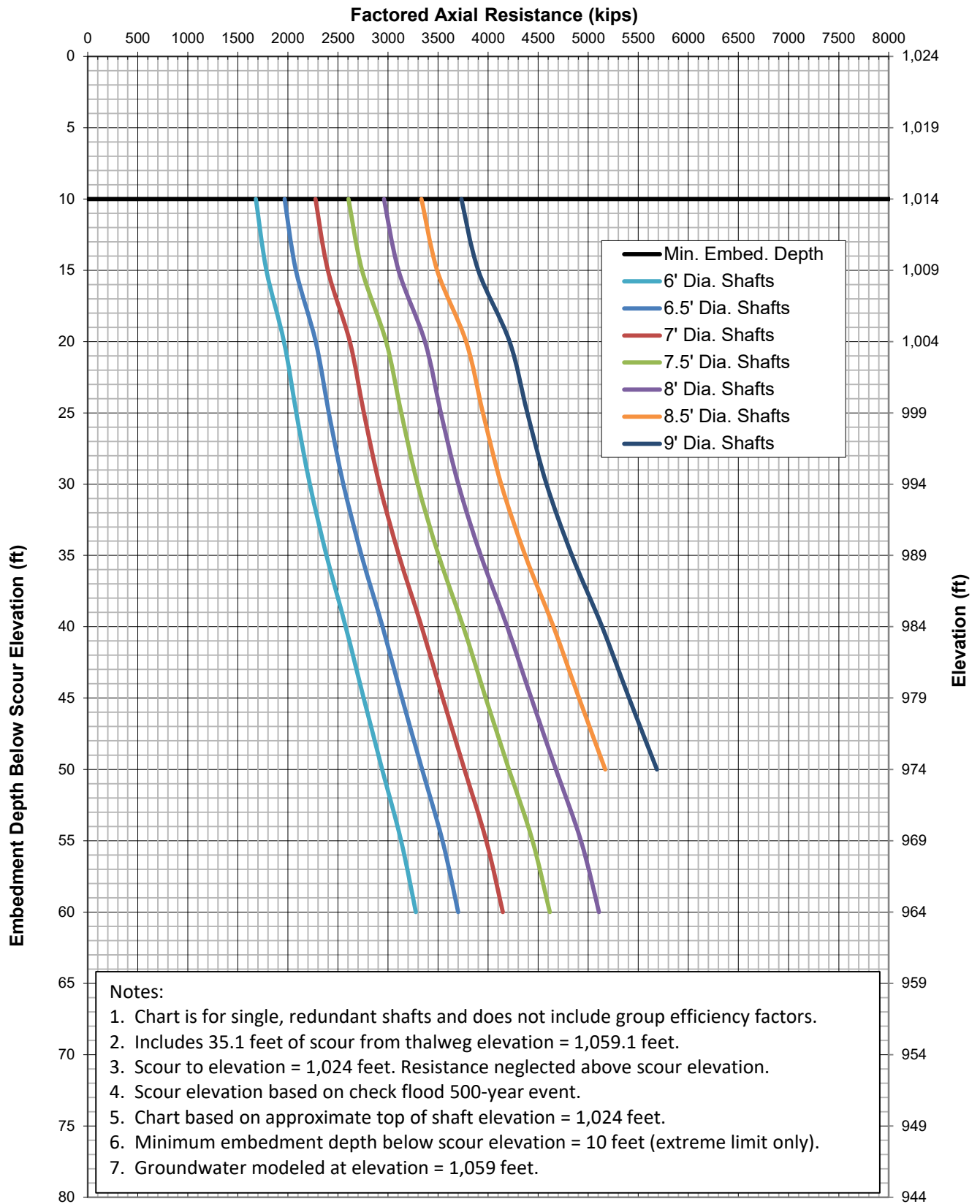
C10

Designer:

Date:

J. Huston

10/24/2024



DRILLED SHAFT FOUNDATION DESIGN CHART
Extreme Limit Axial Resistance in Kips

Northern Avenue, 103rd Avenue to 91st Avenue
New River Bridge Abutments and Piers
Based on Borings NR-1 to NR-5

Figure

C11

Designer:

Date:

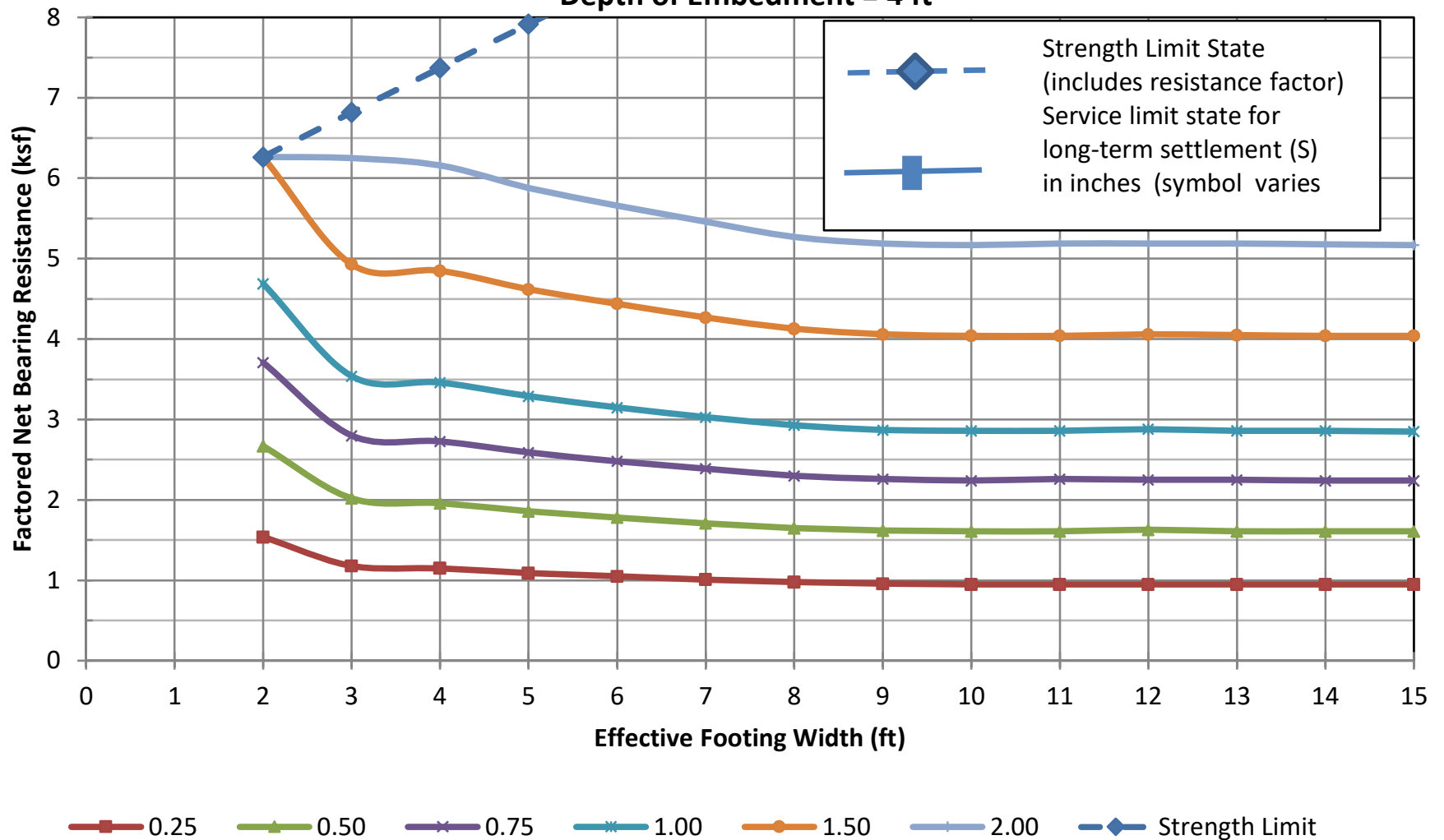
J. Huston

10/24/2024

APPENDIX D

Spread Footing Factored Bearing Resistance Charts

Figure D1 - Northern Parkway, 103rd Ave to 91st Ave
SR 101 Ramp A Retaining Wall
Depth of Embedment = 4 ft



APPENDIX E

Percolation Test Results

ACS SERVICES LLC

ENGINEERING DESIGN • MATERIAL TESTING • CONSTRUCTION INSPECTION

August 19, 2021

Project 2101595

Keith Dahlen, P.E.
Ethos Engineering, LLC
9180 South Kyrene Road, #104
Tempe, AZ 85284

RE: DOUBLE-RING INFILTRMETER PERCOLATION TEST REPORT
Northern Parkway
99th Avenue to 87th Avenue
Glendale, AZ 85361

Dear Keith:

As requested, this firm is submitting a Double Ring Infiltrometer Percolation Test Report for the project listed above.

Double-Ring Infiltrometer Percolation Test

On July 29, 2021 two (2) double ring infiltrometer percolation tests were conducted in the area depicted on the attached site plan (See Figure 2). The double ring infiltrometer tests were conducted in general accordance with ASTM D 3385. The rate of water decline was measured in 10 minute time intervals to accommodate obtaining a reasonable number of readings to establish a stable infiltration rate. Refer to the attached results of the double ring infiltrometer percolation tests.

The inner ring stabilized infiltration rate for P-1 was $0.19 \text{ ft}^3/\text{hr}/\text{ft}^2$ and has not been de-rated. This is equivalent to a percolation rate of approximately 2.3 inches per hour.

The inner ring stabilized infiltration rate for P-2 was $0.18 \text{ ft}^3/\text{hr}/\text{ft}^2$ and has not been de-rated. This is equivalent to a percolation rate of approximately 2.2 inches per hour.

These rates are actual rates and may need to be de-rated in accordance with design requirements.

Exploratory soil test pits were excavated. The excavations were advanced to a depth of approximately 3.0 feet below the original surface grade by means of a backhoe. Backhoe refusal was encountered. Representative samples from the spoils were presented to the field engineer for field classification purposes and were also retained and transported back to our lab to be held in case testing is deemed to be necessary.

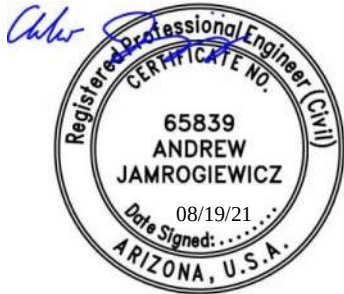
August 19, 2021
Double Ring Infiltrometer Percolation Test Report
Northern Avenue, 99th Avenue to 87th Avenue
Glendale, AZ
Project No. 2101595



Should any questions arise concerning the content of this report, please feel free to contact this office at your earliest convenience.

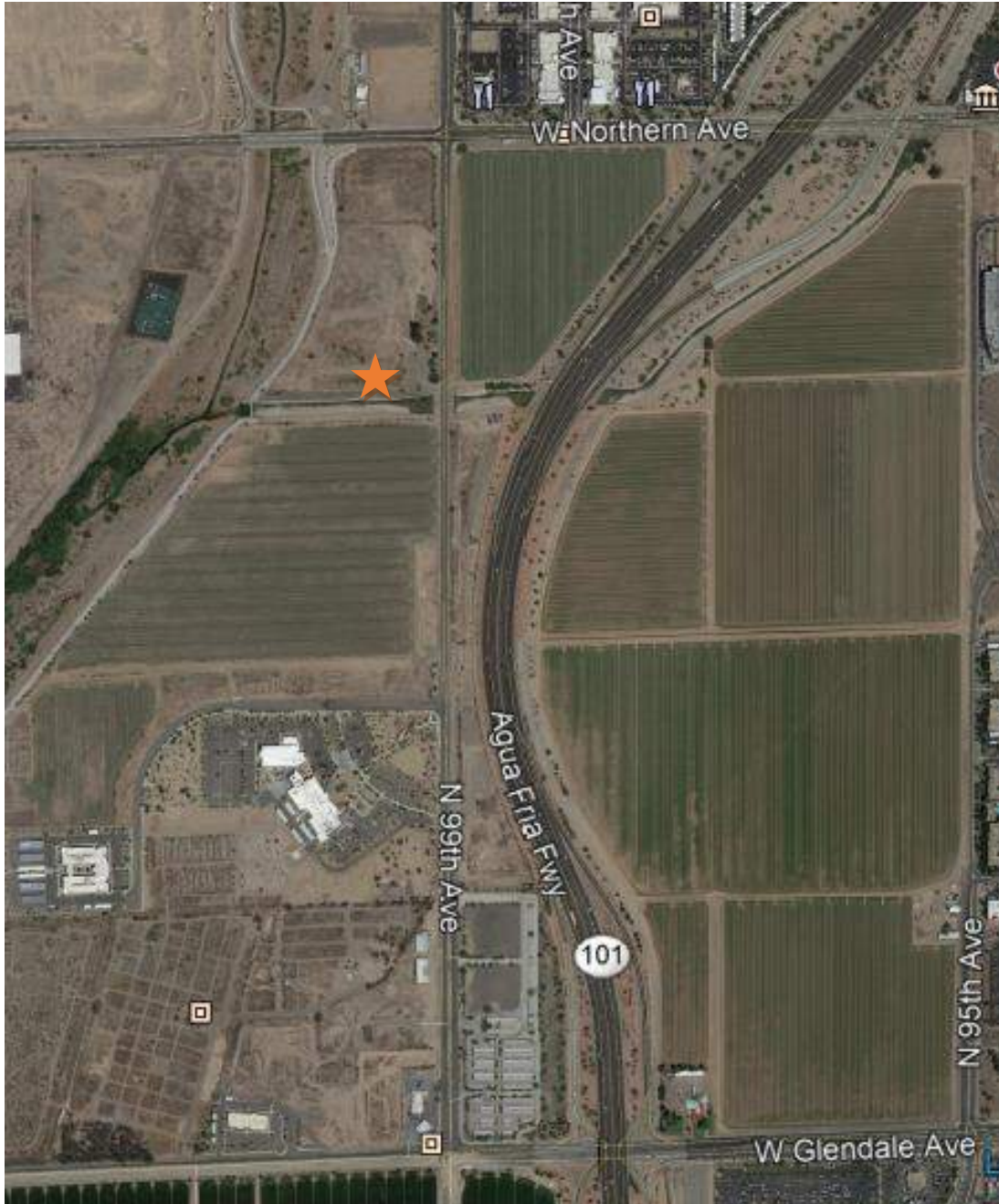
Respectfully submitted,

ACS SERVICES LLC



Andrew Jamrogiewicz, P.E.
Engineering Department Manager

cc: (1) Addressee via email (pdf copy)



★ Site Location

NORTH
N.T.S. ↑

PROJECT NUMBER: 2101595

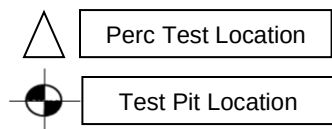
FIGURE 1

ACS SERVICES LLC

2235 W BROADWAY RD
MESA, ARIZONA 85202
(480) 968-0190
(480) 968-0156 FAX
WWW.ACSSERVICESLLC.COM

VICINITY MAP

Northern Parkway
99th Avenue to 87th Avenue
Glendale, AZ



NORTH
N.T.S. ↑

PROJECT NUMBER: 2101595

FIGURE 2

ACS SERVICES LLC

2235 W BROADWAY RD
MESA, ARIZONA 85202
(480) 968-0190
(480) 968-0156 FAX
WWW.ACSSERVICESLLC.COM

**SITE PLAN & APPROXIMATE
PERC LOCATIONS**

Northern Parkway
99th Avenue to 87th Avenue
Glendale, AZ

ACS SERVICES LLC

ENGINEERING DESIGN • MATERIAL TESTING • CONSTRUCTION INSPECTION

A S T M	ACS Project #	2101595	Double Ring Infiltrometer - Inner and Annular Ring Constants				
	Project Address	Northm Parkway 99th Ave to 87th Ave	Apparatus	Diameter (cm)	Area (cm2)	Depth of Liquid in Ring (cm)	Penetration of Ring (cm)
			Inner Ring	31.75	791.73	30	8
	Site Description		Outer Ring	60.96	2918.64	30	8
D	Tested by	Adrianne Roberts	Flow Reading Constants (Graduated Cylinder Properties)				
3	Test Location	Perc 1	Apparatus	Diameter (cm)	Area (cm2)	Liquid Level Gauge	
3	Liquid used (pH)	ACS Tap Water (7)	Graduated Cylinder Connected to Inner Ring	9	63.62	Flow Control Valve	
8	Depth to Water Table (ft)	N/A	Graduated Cylinder Connected to Annular Ring	15	176.72	Flow Control Valve	
5							

[illegible]

Notes:	Presoak period of one hour
---------------	----------------------------

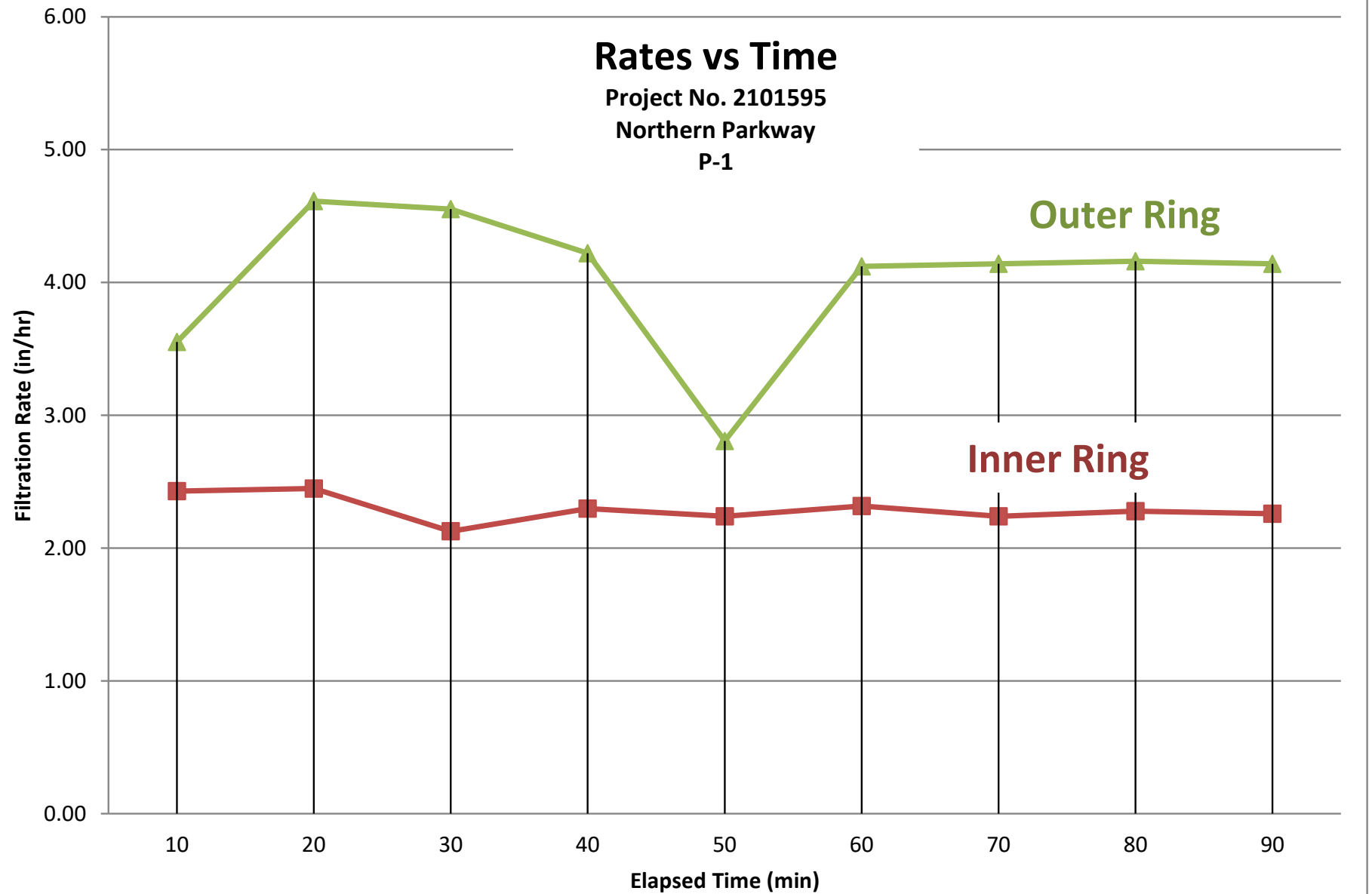
ACS Services LLC / 2235 West Broadway Road / Mesa, AZ 85202 / 480-968-0190 FAX 480-968-0156

Rates vs Time

Project No. 2101595

Northern Parkway

P-1



ACS SERVICES LLC

ENGINEERING DESIGN • MATERIAL TESTING • CONSTRUCTION INSPECTION

A S T M	ACS Project #	2101595	Double Ring Infiltrometer - Inner and Annular Ring Constants				
	Project Address	Northrn Parkway 99th Ave to 87th Ave	Apparatus	Diameter (cm)	Area (cm2)	Depth of Liquid in Ring (cm)	Penetration of Ring (cm)
			Inner Ring	31.75	791.73	30	8
	Site Description		Outer Ring	60.96	2918.64	30	8
D	Tested by	Adrianne Roberts	Flow Reading Constants (Graduated Cylinder Properties)				
3	Test Location	Perc 2	Apparatus	Diameter (cm)	Area (cm2)	Liquid Level Gauge	
8	Liquid used (pH)	ACS Tap Water (7)	Graduated Cylinder Connected to Inner Ring	9	63.62	Flow Control Valve	
5	Depth to Water Table (ft)	N/A	Graduated Cylinder Connected to Annular Ring	15	176.72	Flow Control Valve	

[illegible]

Notes:	Presoak period of one hour
---------------	----------------------------

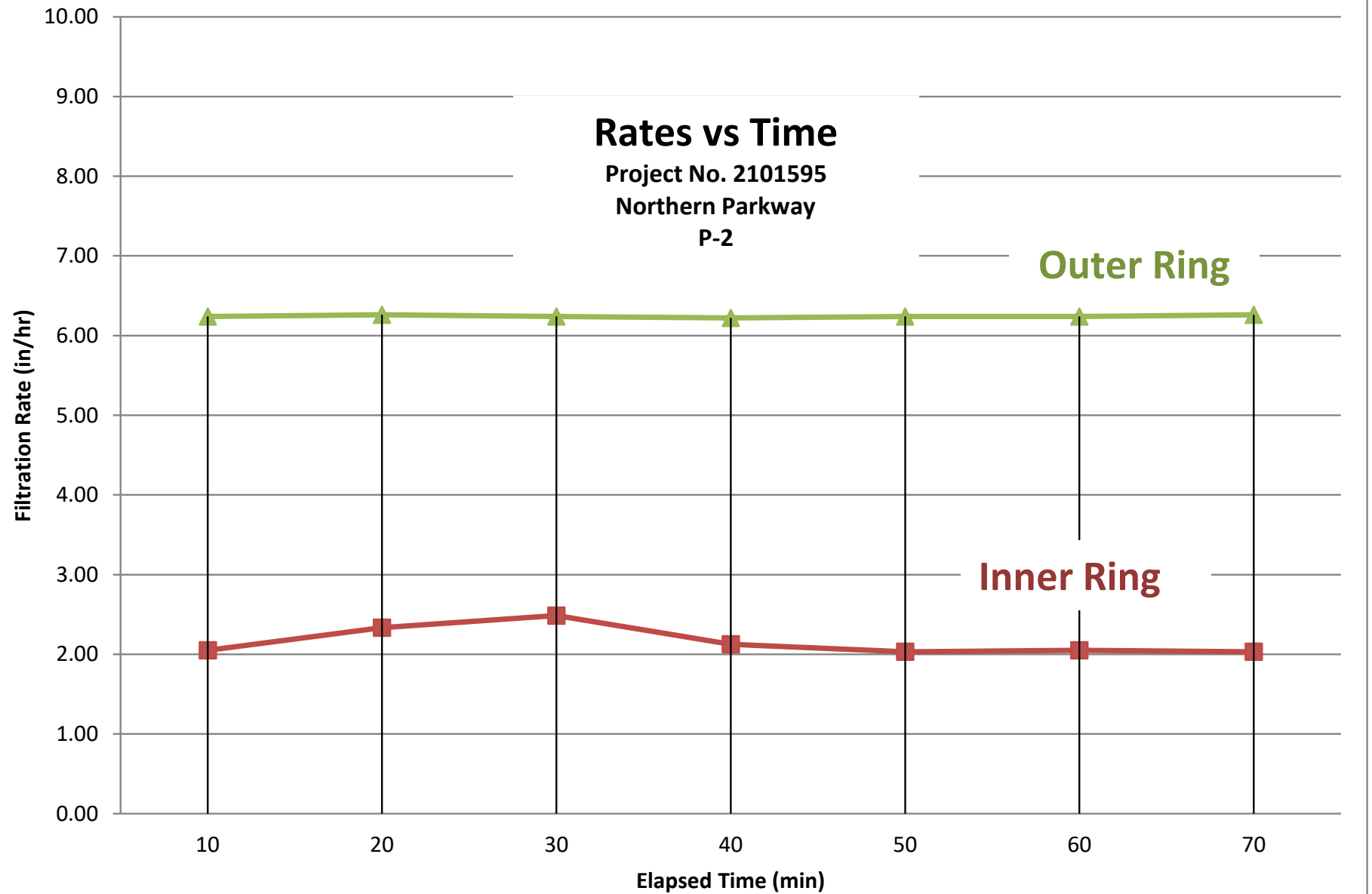
ACS Services LLC / 2235 West Broadway Road / Mesa, AZ 85202 / 480-968-0190 FAX 480-968-0156

Rates vs Time

Project No. 2101595

Northern Parkway

P-2



ACS SERVICES LLC

ENGINEERING DESIGN • MATERIAL TESTING • CONSTRUCTION INSPECTION

March 21, 2023

Project 2301920

Mr. Jesse Huston
Ethos Engineering
Phone: 480-226-4646
Email: jhuston@ethosengineers.com

**RE: GEOTECHNICAL INVESTIGATION REPORT
DOUBLE RING PERC TESTS
NORTHERN AVE & 103rd AVE
GLENDALE, ARIZONA 85307**

Dear Jesse:

As requested, this firm is submitting a Double Ring Infiltrometer Percolation Test Report for the project address listed above.

Double-Ring Infiltrometer Percolation Test – Floodway Residence

On March 20 & 21, 2023, four (4) double ring infiltrometer percolation test was conducted at a location determined by the client at the above referenced address in Glendale, Arizona. The double ring infiltrometer test was conducted in general accordance with ASTM D 3385. D1 & D2 were conducted at 0.5 feet, D5 was conducted at 4 feet, and D6 was conducted at 5 feet. After the excavation was completed the double ring apparatus was assembled and presoak began. Both rings were refilled with water as needed to maintain a constant head condition. Refer to the attached results of the double ring infiltrometer retention percolation tests.

The rate of water decline was measured in 15-minute time intervals for a period of approximately 2.5 hours. The inner ring stabilized infiltration rate for D1 was 0.0825 ft³/hr/ft² and has not been de-rated. This is equivalent to a percolation rate of approximately 0.99 inches per hour. The double ring percolation test ended early due to the weather conditions.

The rate of water decline was measured in 15-minute time intervals for a period of approximately 2 hours. The inner ring stabilized infiltration rate for D2 was 0.0371 ft³/hr/ft² and has not been de-rated. This is equivalent to a percolation rate of approximately 0.45 inches per hour. The double ring percolation test ended early due to the weather conditions.

The rate of water decline was measured in 5-minute time intervals for a period of approximately 2.5 hours. The inner ring stabilized infiltration rate for D5 was 0.6777 ft³/hr/ft² and has not been de-rated. This is equivalent to a percolation rate of approximately 7.78 inches per hour.

March 21, 2023

Project 2301290 – Double Ring Perc Tests

Northern Ave & 103rd Ave

Glendale, AZ 85307

Double-Ring Infiltrometer Percolation Test and Report



The rate of water decline was measured in 5-minute time intervals for a period of approximately 2 hours. The inner ring stabilized infiltration rate for D6 was 0.3554 ft³/hr/ft² and has not been de-rated. This is equivalent to a percolation rate of approximately 4.26 inches per hour.

Should any questions arise concerning the content of this report, please feel free to contact this office at your earliest convenience.

Respectfully submitted,

ACS SERVICES LLC



Andrew Jamrogiewicz, P.E.

Engineering Department Manager

cc: (1) Addressee via email (pdf copy)

APPENDIX F

Pavement Design Analyses

ESAL's Calculation Spreadsheet

Location	Northern Avenue			D_L Lane Factor, (Table 10.2.3)	0.7
From	Agua Fria River Bridge			Direction Factor	0.5
To	New River Bridge			Traffic Growth	5.00%
By	PG	Date	4/14/2023	Design Life (years)	20
Reviewed By	JH	Date	4/28/2023	OGF, Overall Growth Factor $[(1 + g)^n - 1]/g1$	33.07

Traffic Classification Assuming Following Traffic Distribution

Alternative 1 - Northern Avenue

Design ADT			Class	Description	Percent	ESAL Equivalencies	ESALs
Direction 1	Direction 2	Total					
			2	Cars & Trailers	93.0%	0.0008	130,426
-	-	41,500	4	Heavy Trucks	7.0%	1.2000	14,725,476
					100.0%		14,855,902

MCDOT Roadway Design Manual, 2023
Chapter 10 - Pavement Design Guide

From	West of 103rd Avenue
To	103rd Avenue

SEGMENT 1

Boring	Depth	USCS	% Minus 200	PI	Expansion	Tested R-Value	Correlated R-Value
	--	--	--	--	--	--	--
	--	--	--	--	--	--	--
	--	--	--	--	--	--	--
	--	--	--	--	--	--	--
	--	--	--	--	--	--	--
P-7	1.0-5.0	SC-SM	23	9	--	--	42
P-8	1.5-5.0	SC	20	8	--	57	47
P-9	2.0-6.0	SM	38	0	0.8	--	70
P-10	1.0-5.0	SC	39	14	--	30	23
P-11	1.0-5.0	SC	41	15	--	--	21
P-12	1.5-2.5	SC-SM	14	6	--	77	59
P-13	1.0-5.0	SC	38	15	1.3	--	22
P-14	1.0-5.0	SC	36	14	--	38	24
P-15	1.0-5.0	SC	26	17	--	--	22
P-16	1.0-5.0	GC	26	21	2.8	--	17
--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--
--	--	--	--	--	--	4	10

R-Value Mean (R_{mean}) Calculation

MCDOT Roadway Classification
Min. Structural #

Principal Arterial
2.88

R-Value Tests

Number	4
Mean	50.5
Strd. Dev.	21.0
Adjusted Average	39.5

$$R_{mean} = \frac{2 N_t R_t \sigma_c^2 + N_c R_c \sigma_t^2}{2 N_t \sigma_c^2 + N_c \sigma_t^2}$$

Correlated R-Values

Number	10
Mean	34.7
Strd. Dev.	18.5
Adjusted Average	26.2

Mean R-value	31.3
Design R-value	28.0

Resilient Modulus (M_R) Calculation

M_R	16661	psi
ADOT M_R	26000	psi

M_R Design	16661	psi
SVF (Peoria)	1.0	

$$M_R = \frac{1815 + 225 * R_{mean} + 2.4 * R_{mean}^2}{0.6 * SVF^{0.6}}$$

Structural Number Calculation

MCDOT Design Guidelines

Standard Normal Deviate	-1.645
Standard Error (Arterial)	0.45
Design Serviceability Loss	1.9
Equiv. 18-k Single Axle Loads	14,855,902
Equation Balance	-0.00051

Structural Number	4.11
Min. Structural Number	4.11

$$\log_{10}(W_{18}) = Z_R * S_o + 9.36 * \log_{10}(SN + 1) - 0.20 + \frac{\log_{10} \frac{\Delta PSI}{4.2 - 1.5}}{0.40 + \frac{1094}{(SN + 1)^{5.19}}} + 2.32 * \log_{10}(M_R) - 8.07$$

Pavement Recommendations Alternatives - Northern Avenue

Alternative 1 - AC over AB

Material Type	Drainage Coefficient	Maximum Coefficient	Inches	SN
Asphalt Rubber		0.61		0
Asphalt Concrete		0.42	5.0	2.1
Cement Treated or Bituminous Treated Base		0.28		0
Cement or Lime Treated Subgrade		0.16		0
Aggregate Base	1.00	0.12	17.0	2.04
Aggregate Subbase	1.00	0.11		0
			22.0	4.14

Alternative 2 - PMTR AC over AC over AB

Material Type	Drainage Coefficient	Maximum Coefficient	Inches	SN
PMTR Asphalt Concrete		0.42	2.0	0.84
Asphalt Concrete		0.42	3.0	1.26
Cement Treated or Bituminous Treated Base		0.28		0
Cement or Lime Treated Subgrade		0.16		0
Aggregate Base	1.00	0.12	17.0	2.04
Aggregate Subbase	1.00	0.11		0
			22.0	4.14

Alternative 3 - Full Depth AC

Material Type	Drainage Coefficient	Maximum Coefficient	Inches	SN
Asphalt Rubber		0.61		0
Asphalt Concrete		0.42	10.0	4.2
Cement Treated or Bituminous Treated Base		0.28		0
Cement or Lime Treated Subgrade		0.16		0
Aggregate Base	1.00	0.12		0
Aggregate Subbase	1.00	0.11		0
			10.0	4.20

MCDOT Roadway Design Manual, 2023
Chapter 10 - Pavement Design Guide

From	103rd Avenue
To	New River Bridge

SEGMENT 2

[illegible]

R-Value Mean (R_{mean}) Calculation

MCDOT Roadway Classification
Min. Structural #

Principal Arterial
2.88

R-Value Tests

Number	2
Mean	70.5
Strd. Dev.	3.5
Adjusted Average	70.5

$$R_{mean} = \frac{2 N_t R_t \sigma_c^2 + N_c R_c \sigma_t^2}{2 N_t \sigma_c^2 + N_c \sigma_t^2}$$

Correlated R-Values

Number	6
Mean	70.0
Strd. Dev.	0.0
Adjusted Average	70.0

Mean R-value	70.0
Design R-value	43.0

Resilient Modulus (M_R) Calculation

M_R	26546	psi
ADOT M_R	26000	psi
M_R Design	26000	psi
SVF (Peoria)	1.0	

$$M_R = \frac{1815 + 225 * R_{mean} + 2.4 * R_{mean}^2}{0.6 * SVF^{0.6}}$$

Structural Number Calculation

MCDOT Design Guidelines

Standard Normal Deviate	-1.645
Standard Error (Arterial)	0.45
Design Serviceability Loss	1.9
Equiv. 18-k Single Axle Loads	14,855,902
Equation Balance	-0.00067

Structural Number	3.51
Min. Structural Number	3.51

$$\log_{10}(W_{18}) = Z_R * S_o + 9.36 * \log_{10}(SN + 1) - 0.20 + \frac{\log_{10} \frac{\Delta PSI}{4.2 - 1.5}}{0.40 + \frac{1094}{(SN + 1)^{5.19}}} + 2.32 * \log_{10}(M_R) - 8.07$$

Pavement Recommendations Alternatives - Northern Avenue

Alternative 1 - AC over AB

Material Type	Drainage Coefficient	Maximum Coefficient	Inches	SN
Asphalt Rubber		0.61		0
Asphalt Concrete		0.42	7.5	3.15
Cement Treated or Bituminous Treated Base		0.28		0
Cement or Lime Treated Subgrade		0.16		0
Aggregate Base	1.00	0.12	4.0	0.48
Aggregate Subbase	1.00	0.11		0
			11.5	3.63

Alternative 2 - PMTR AC over AC over AB

Material Type	Drainage Coefficient	Maximum Coefficient	Inches	SN
PMTR Asphalt Concrete		0.42	2.0	0.84
Asphalt Concrete		0.42	3.0	1.26
Cement Treated or Bituminous Treated Base		0.28		0
Cement or Lime Treated Subgrade		0.16		0
Aggregate Base	1.00	0.12	12.0	1.44
Aggregate Subbase	1.00	0.11		0
			17.0	3.54

Alternative 3 - Full Depth AC

Material Type	Drainage Coefficient	Maximum Coefficient	Inches	SN
Asphalt Rubber		0.61		0
Asphalt Concrete		0.42	8.5	3.57
Cement Treated or Bituminous Treated Base		0.28		0
Cement or Lime Treated Subgrade		0.16		0
Aggregate Base	1.00	0.12		0
Aggregate Subbase	1.00	0.11		0
			8.5	3.57

Location	Northern Avenue		
From	99th Avenue		
To	87th Avenue		
By	PG	Date	4/22/2023
Reviewed By	KHD	Date	4/24/2023

D_L , Lane Factor, (Table 10.2.3)	0.7
Direction Factor	0.5
Traffic Growth	6.00%
Design Life (years)	20
OGF , Overall Growth Factor $[(1 + g)^n - 1]/g$	36.79

Design ADT			Class	Description	Percent	ESAL Equivalencies	ESALs
Direction 1	Direction 2	Total	2	Cars & Trailers	93.0%	0.0008	138,105
-	-	39,500	4	Heavy Trucks	7.0%	1.2000	15,592,474
					100.0%		15,730,579
Maximum ESALs							15,730,579

MCDOT Pavement Design Procedure

MCDOT Roadway Design Manual, 2023

Chapter 10 - Pavement Design Guide

Northern Avenue

From 99th Avenue
To 87th Avenue

SEGMENT 3

Correlated R-Value Table

Boring	Depth	USCS	% Minus 200	PI	Expansion	Tested R-Value	Correlated R-Value
NP-1	0-2.5	SC-SM	44	6	--	--	43
NP-2	0-2.5	CL	65	11	1.2	22	26
NP-3	0-2.5	SC	33	8	--	--	46
NP-4	0-2.5	SC	33	9	--	--	45
	--	--	--	--	--	--	--
	--	--	--	--	--	--	--
	--	--	--	--	--	--	--
	--	--	--	--	--	--	--
NP-9	0.0-2.5	SC	34	9	0.4	--	44
	--	--	--	--	--	--	--
	--	--	--	--	--	--	--
NP-12	0.0-2.5	SC-SM	40	7	1.6	--	44
NP-13	0.0-2.5	SC	26	12	--	35	44
NP-14	0.0-2.5	SC	43	13	0.9	--	33
NP-15	0-2.5	CL-ML	58	7	1.2	--	34
	--	--	--	--	--	--	--
NP-17	0-2.5	SC	45	9	1.2	--	38
	--	--	--	--	--	--	--
NP-19	0.5-2.5	SC-SM	47	7	--	--	42
NP-20	1-2.5	SC	28	10	0.2	--	46
NP-21	1-2.5	GC	25	17	--	26	36
NP-22	0-2.5	SC	34	14	--	--	37
NP-23	0.5-2.5	SM	44	3	0.1	--	48
NP-24	0-2.5	CL	52	9	--	32	34
Total						4	16

R-Value Mean (R_{mean}) Calculation

MCDOT Roadway Classification
Min. Structural #

Principal Arterial
2.88

R-Value Tests

Number	4
Mean	28.5
Strd. Dev.	9.2
Adjusted Average	28.5

$$R_{mean} = \frac{2 N_t R_t \sigma_c^2 + N_c R_c \sigma_t^2}{2 N_t \sigma_c^2 + N_c \sigma_t^2}$$

Correlated R-Values

Number	16
Mean	39.9
Strd. Dev.	6.9
Adjusted Average	39.9

Mean R-value	37.4
Design R-value	30.0

Resilient Modulus (M_R) Calculation

M_R	17875	psi
ADOT M_R	26000	psi
M_R Design	17875	psi
SVF (Phoenix)	1.0	

$$M_R = \frac{1815 + 225 * R_{mean} + 2.4 * R_{mean}^2}{0.6 * SVF^{0.6}}$$

Structural Number Calculation

MCDOT Design Guidelines

Standard Normal Deviate	-1.645
Standard Error (Arterial)	0.45
Design Serviceability Loss	2.0
Equiv. 18-k Single Axle Loads	15,730,579
Equation Balance	-0.00005

Structural Number	4.00
Min. Structural Number	4.00

$$\log_{10}(W_{18}) = Z_R * S_o + 9.36 * \log_{10}(SN + 1) - 0.20 + \frac{\log_{10} \frac{\Delta PSI}{4.2 - 1.5}}{0.40 + \frac{1094}{(SN + 1)^{5.19}}} + 2.32 * \log_{10}(M_R) - 8.07$$

Pavement Recommendations Alternatives - Northern Avenue

Alternative 1 - AC over AB

Material Type	Drainage Coefficient	Maximum Coefficient	Inches	SN
Asphalt Rubber		0.61		0
Asphalt Concrete		0.42	6	2.52
Cement Treated or Bituminous Treated Base		0.28		0
Cement or Lime Treated Subgrade		0.16		0
Aggregate Base	1.00	0.12	13	1.56
Aggregate Subbase	1.00	0.11		0
				4.08

Alternative 2 - AC PMTR over AC over AB

Material Type	Drainage Coefficient	Maximum Coefficient	Inches	SN
Asphalt Concrete PMTR		0.42	2	0.84
Asphalt Concrete		0.42	4	1.68
Cement Treated or Bituminous Treated Base		0.28		0
Cement or Lime Treated Subgrade		0.16		0
Aggregate Base	1.00	0.12	13	1.56
Aggregate Subbase	1.00	0.11		0
				4.08

Alternative 3 - Full Depth AC

Material Type	Drainage Coefficient	Maximum Coefficient	Inches	SN
Asphalt Concrete PMTR		0.42	2	0.84
Asphalt Concrete		0.42	7.5	3.15
Cement Treated or Bituminous Treated Base		0.28		0
Cement or Lime Treated Subgrade		0.16		0
Aggregate Base	1.00	0.12		0
Aggregate Subbase	1.00	0.11		0
				3.99

Location	99th Avenue		
From	Northern Avenue		
To	Northern Avenue		
By	PG	Date	4/22/2023
Reviewed By	KHD	Date	4/24/2023

D_L, Lane Factor, (Table 10.2.3)	0.9
Direction Factor	0.5
Traffic Growth	6.00%
Design Life (years)	20
OGF, Overall Growth Factor $[(1 + g)^n - 1]/g$	36.79

Design ADT			Class	Description	Percent	ESAL Equivalencies	ESALs
Direction 1	Direction 2	Total	2	Cars & Trailers	93.0%	0.0008	18,975
-	-	4,221	4	Heavy Trucks	7.0%	1.2000	2,142,288
					100.0%		2,161,262
Maximum ESALs							2,161,262

R-Value Mean (R_{mean}) Calculation

MCDOT Roadway Classification
Min. Structural #

Principal Arterial
2.88

R-Value Tests

Number	4
Mean	28.5
Strd. Dev.	9.2
Adjusted Average	28.5

$$R_{mean} = \frac{2 N_t R_t \sigma_c^2 + N_c R_c \sigma_t^2}{2 N_t \sigma_c^2 + N_c \sigma_t^2}$$

Correlated R-Values

Number	16
Mean	39.9
Strd. Dev.	6.9
Adjusted Average	39.9

Mean R-value	37.4
Design R-value	30.0

Resilient Modulus (M_R) Calculation

M_R	17875	psi
ADOT M_R	26000	psi
M_R Design	17875	psi
SVF (Phoenix)	1.0	

$$M_R = \frac{1815 + 225 * R_{mean} + 2.4 * R_{mean}^2}{0.6 * SVF^{0.6}}$$

Structural Number Calculation

MCDOT Design Guidelines

Standard Normal Deviate	-1.645
Standard Error (Arterial)	0.45
Design Serviceability Loss	2.0
Equiv. 18-k Single Axle Loads	2,161,262
Equation Balance	-0.00013

Structural Number	2.95
Min. Structural Number	2.95

$$\log_{10}(W_{18}) = Z_R * S_o + 9.36 * \log_{10}(SN + 1) - 0.20 + \frac{\log_{10} \frac{\Delta PSI}{4.2 - 1.5}}{0.40 + \frac{1094}{(SN + 1)^{5.19}}} + 2.32 * \log_{10}(M_R) - 8.07$$

Pavement Recommendations Alternatives

Alternative 1 - AC over AB

Material Type	Drainage Coefficient	Maximum Coefficient	Inches	SN
Asphalt Rubber		0.61		0
Asphalt Concrete		0.42	5	2.1
Cement Treated or Bituminous Treated Base		0.28		0
Cement or Lime Treated Subgrade		0.16		0
Aggregate Base	1.00	0.12	10	1.2
Aggregate Subbase	1.00	0.11		0
				3.30

Alternative 2 - AC PMTR over AC over AB

Material Type	Drainage Coefficient	Maximum Coefficient	Inches	SN
Asphalt Concrete PMTR		0.42	2	0.84
Asphalt Concrete		0.42	3	1.26
Cement Treated or Bituminous Treated Base		0.28		0
Cement or Lime Treated Subgrade		0.16		0
Aggregate Base	1.00	0.12	10	1.2
Aggregate Subbase	1.00	0.11		0
				3.30

Alternative 3 - Full Depth AC

Material Type	Drainage Coefficient	Maximum Coefficient	Inches	SN
Asphalt Concrete PMTR		0.61	2	1.22
Asphalt Concrete		0.42	5	2.1
Cement Treated or Bituminous Treated Base		0.28		0
Cement or Lime Treated Subgrade		0.16		0
Aggregate Base	1.00	0.12		0
Aggregate Subbase	1.00	0.11		0
				3.32

Location	98th Avenue		
From	Northern Avenue		
To	Northern Avenue		
By	PG	Date	4/22/2023
Reviewed By	KHD	Date	4/24/2023

D_L Lane Factor, (Table 10.2.3)	0.9
Direction Factor	0.5
Traffic Growth	6.00%
Design Life (years)	20
OGF, Overall Growth Factor $[(1 + g)^n - 1]/g$	36.79

Design ADT			Class	Description	Percent	ESAL Equivalencies	ESALs
Direction 1	Direction 2	Total	2	Cars & Trailers	93.0%	0.0008	24,549
-	-	5,461	4	Heavy Trucks	7.0%	1.2000	2,771,626
					100.0%		2,796,174
Maximum ESALs							2,796,174

R-Value Mean (R_{mean}) Calculation

MCDOT Roadway Classification
Min. Structural #

Major Collector (Industrial/Commercial)
2.88

R-Value Tests

Number	4
Mean	28.5
Strd. Dev.	9.2
Adjusted Average	28.5

$$R_{mean} = \frac{2 N_t R_t \sigma_c^2 + N_c R_c \sigma_t^2}{2 N_t \sigma_c^2 + N_c \sigma_t^2}$$

Correlated R-Values

Number	16
Mean	39.9
Strd. Dev.	6.9
Adjusted Average	39.9

Mean R-value	37.4
Design R-value	30.0

Resilient Modulus (M_R) Calculation

M_R	17875	psi
ADOT M_R	26000	psi
M_R Design	17875	psi
SVF (Phoenix)	1.0	

$$M_R = \frac{1815 + 225 * R_{mean} + 2.4 * R_{mean}^2}{0.6 * SVF^{0.6}}$$

Structural Number Calculation

MCDOT Design Guidelines

Standard Normal Deviate	-1.282
Standard Error (Arterial)	0.45
Design Serviceability Loss	2.1
Equiv. 18-k Single Axle Loads	2,796,174
Equation Balance	0.00011

Structural Number	2.88
Min. Structural Number	2.88

$$\log_{10}(W_{18}) = Z_R * S_o + 9.36 * \log_{10}(SN + 1) - 0.20 + \frac{\log_{10} \frac{\Delta PSI}{4.2 - 1.5}}{0.40 + \frac{1094}{(SN + 1)^{5.19}}} + 2.32 * \log_{10}(M_R) - 8.07$$

Pavement Recommendations Alternatives

Alternative 1 - AC over AB

Material Type	Drainage Coefficient	Maximum Coefficient	Inches	SN
Asphalt Rubber		0.61		0
Asphalt Concrete		0.42	4	1.68
Cement Treated or Bituminous Treated Base		0.28		0
Cement or Lime Treated Subgrade		0.16		0
Aggregate Base	1.00	0.12	12	1.44
Aggregate Subbase	1.00	0.11		0
				3.12

Alternative 2 - AC PMTR over AB

Material Type	Drainage Coefficient	Maximum Coefficient	Inches	SN
Asphalt Concrete PMTR		0.42	2	0.84
Asphalt Concrete		0.42	2	0.84
Cement Treated or Bituminous Treated Base		0.28		0
Cement or Lime Treated Subgrade		0.16		0
Aggregate Base	1.00	0.12	12	1.44
Aggregate Subbase	1.00	0.11		0
				3.12

Alternative 3 - Full Depth AC

Material Type	Drainage Coefficient	Maximum Coefficient	Inches	SN
Asphalt Concrete PMTR		0.42	2	0.84
Asphalt Concrete		0.42	5	2.1
Cement Treated or Bituminous Treated Base		0.28		0
Cement or Lime Treated Subgrade		0.16		0
Aggregate Base	1.00	0.12		0
Aggregate Subbase	1.00	0.11		0
				2.94

R-Value Mean (R_{mean}) Calculation

MCDOT Roadway Classification
Min. Structural #

Major Collector (Industrial/Commercial)
2.88

R-Value Tests

Number	4
Mean	28.5
Strd. Dev.	9.2
Adjusted Average	28.5

$$R_{mean} = \frac{2 N_t R_t \sigma_c^2 + N_c R_c \sigma_t^2}{2 N_t \sigma_c^2 + N_c \sigma_t^2}$$

Correlated R-Values

Number	16
Mean	39.9
Strd. Dev.	6.9
Adjusted Average	39.9

Mean R-value	37.4
Design R-value	30.0

Resilient Modulus (M_R) Calculation

M_R	17875	psi
ADOT M_R	26000	psi
M_R Design	17875	psi
SVF (Phoenix)	1.0	

$$M_R = \frac{1815 + 225 * R_{mean} + 2.4 * R_{mean}^2}{0.6 * SVF^{0.6}}$$

Structural Number Calculation

MCDOT Design Guidelines

Standard Normal Deviate	-1.282
Standard Error (Arterial)	0.45
Design Serviceability Loss	2.1
Equiv. 18-k Single Axle Loads	3,722,942
Equation Balance	0.00011

Structural Number	3.01
Min. Structural Number	3.01

$$\log_{10}(W_{18}) = Z_R * S_o + 9.36 * \log_{10}(SN + 1) - 0.20 + \frac{\log_{10} \frac{\Delta PSI}{4.2 - 1.5}}{0.40 + \frac{1094}{(SN + 1)^{5.19}}} + 2.32 * \log_{10}(M_R) - 8.07$$

Pavement Recommendations Alternatives

Alternative 1 - AC over AB

Material Type	Drainage Coefficient	Maximum Coefficient	Inches	SN
Asphalt Rubber		0.61		0
Asphalt Concrete		0.42	4	1.68
Cement Treated or Bituminous Treated Base		0.28		0
Cement or Lime Treated Subgrade		0.16		0
Aggregate Base	1.00	0.12	12	1.44
Aggregate Subbase	1.00	0.11		0
				3.12

Alternative 2 - AC PMTR over AC over AB

Material Type	Drainage Coefficient	Maximum Coefficient	Inches	SN
Asphalt Concrete PMTR		0.42	2	0.84
Asphalt Concrete		0.42	2	0.84
Cement Treated or Bituminous Treated Base		0.28		0
Cement or Lime Treated Subgrade		0.16		0
Aggregate Base	1.00	0.12	12	1.44
Aggregate Subbase	1.00	0.11		0
				3.12

Alternative 3 - Full Depth AC

Material Type	Drainage Coefficient	Maximum Coefficient	Inches	SN
Asphalt Concrete PMTR		0.42	2	0.84
Asphalt Concrete		0.42	5	2.1
Cement Treated or Bituminous Treated Base		0.28		0
Cement or Lime Treated Subgrade		0.16		0
Aggregate Base	1.00	0.12		0
Aggregate Subbase	1.00	0.11		0
				2.94



Location	91st Avenue		
From	Northern Avenue		
To	Northern Avenue		
By	PG	Date	4/22/2023
Reviewed By	KHD	Date	4/24/2023

D_L , Lane Factor, (Table 10.2.3)	0.9
Direction Factor	0.5
Traffic Growth	6.00%
Design Life (years)	20
OGF , Overall Growth Factor $[(1 + g)^n - 1]/g$	36.79

Design ADT			Class	Description	Percent	ESAL Equivalencies	ESALs
Direction 1	Direction 2	Total	2	Cars & Trailers	93.0%	0.0008	60,066
-	-	13,362	4	Heavy Trucks	7.0%	1.2000	6,781,627
					100.0%		6,841,692
Maximum ESALs							6,841,692

R-Value Mean (R_{mean}) Calculation

MCDOT Roadway Classification
Min. Structural #

Major Collector (Industrial/Commercial)
2.88

R-Value Tests

Number	4
Mean	28.5
Strd. Dev.	9.2
Adjusted Average	28.5

$$R_{mean} = \frac{2 N_t R_t \sigma_c^2 + N_c R_c \sigma_t^2}{2 N_t \sigma_c^2 + N_c \sigma_t^2}$$

Correlated R-Values

Number	16
Mean	39.9
Strd. Dev.	6.9
Adjusted Average	39.9

Mean R-value	37.4
Design R-value	30.0

Resilient Modulus (M_R) Calculation

M_R	17875	psi
ADOT M_R	26000	psi
M_R Design	17875	psi
SVF (Phoenix)	1.0	

$$M_R = \frac{1815 + 225 * R_{mean} + 2.4 * R_{mean}^2}{0.6 * SVF^{0.6}}$$

Structural Number Calculation

MCDOT Design Guidelines

Standard Normal Deviate	-1.645
Standard Error (Arterial)	0.45
Design Serviceability Loss	2.0
Equiv. 18-k Single Axle Loads	6,841,692
Equation Balance	-0.00088

Structural Number	3.52
Min. Structural Number	3.52

$$\log_{10}(W_{18}) = Z_R * S_o + 9.36 * \log_{10}(SN + 1) - 0.20 + \frac{\log_{10} \frac{\Delta PSI}{4.2 - 1.5}}{0.40 + \frac{1094}{(SN + 1)^{5.19}}} + 2.32 * \log_{10}(M_R) - 8.07$$

Pavement Recommendations Alternatives

Alternative 1 - AC over AB

Material Type	Drainage Coefficient	Maximum Coefficient	Inches	SN
Asphalt Rubber		0.61		0
Asphalt Concrete		0.42	5	2.1
Cement Treated or Bituminous Treated Base		0.28		0
Cement or Lime Treated Subgrade		0.16		0
Aggregate Base	1.00	0.12	12	1.44
Aggregate Subbase	1.00	0.11		0
				3.54

Alternative 2 - AC PMTR over AC over AB

Material Type	Drainage Coefficient	Maximum Coefficient	Inches	SN
Asphalt Concrete PMTR		0.42	2	0.84
Asphalt Concrete		0.42	3	1.26
Cement Treated or Bituminous Treated Base		0.28		0
Cement or Lime Treated Subgrade		0.16		0
Aggregate Base	1.00	0.12	12	1.44
Aggregate Subbase	1.00	0.11		0
				3.54

Alternative 3 - Full Depth AC

Material Type	Drainage Coefficient	Maximum Coefficient	Inches	SN
Asphalt Concrete PMTR		0.42	2	0.84
Asphalt Concrete		0.42	6.5	2.73
Cement Treated or Bituminous Treated Base		0.28		0
Cement or Lime Treated Subgrade		0.16		0
Aggregate Base	1.00	0.12		0
Aggregate Subbase	1.00	0.11		0
				3.57

Location	89th Avenue		
From	Northern Avenue		
To	Northern Avenue		
By	PG	Date	4/22/2023
Reviewed By	KHD	Date	4/24/2023

D_L , Lane Factor, (Table 10.2.3)	0.9
Direction Factor	0.5
Traffic Growth	6.00%
Design Life (years)	20
OGF , Overall Growth Factor $[(1 + g)^n - 1]/g$	36.79

Design ADT			Class	Description	Percent	ESAL Equivalencies	ESALs
Direction 1	Direction 2	Total	2	Cars & Trailers	93.0%	0.0008	16,066
-	-	3,574	4	Heavy Trucks	7.0%	1.2000	1,813,915
					100.0%		1,829,981
						Maximum ESALs	1,829,981

R-Value Mean (R_{mean}) Calculation

MCDOT Roadway Classification
Min. Structural #

Major Collector (Industrial/Commercial)
2.88

R-Value Tests

Number	4
Mean	28.5
Strd. Dev.	9.2
Adjusted Average	28.5

$$R_{mean} = \frac{2 N_t R_t \sigma_c^2 + N_c R_c \sigma_t^2}{2 N_t \sigma_c^2 + N_c \sigma_t^2}$$

Correlated R-Values

Number	16
Mean	39.9
Strd. Dev.	6.9
Adjusted Average	39.9

Mean R-value	37.4
Design R-value	30.0

Resilient Modulus (M_R) Calculation

M_R	17875	psi
ADOT M_R	26000	psi
M_R Design	17875	psi
SVF (Phoenix)	1.0	

$$M_R = \frac{1815 + 225 * R_{mean} + 2.4 * R_{mean}^2}{0.6 * SVF^{0.6}}$$

Structural Number Calculation

MCDOT Design Guidelines

Standard Normal Deviate	-1.282
Standard Error (Arterial)	0.45
Design Serviceability Loss	2.1
Equiv. 18-k Single Axle Loads	1,829,981
Equation Balance	0.00003

Structural Number	2.69
Min. Structural Number	2.88

$$\log_{10}(W_{18}) = Z_R * S_o + 9.36 * \log_{10}(SN + 1) - 0.20 + \frac{\log_{10} \frac{\Delta PSI}{4.2 - 1.5}}{0.40 + \frac{1094}{(SN + 1)^{5.19}}} + 2.32 * \log_{10}(M_R) - 8.07$$

Pavement Recommendations Alternatives

Alternative 1 - AC over AB

Material Type	Drainage Coefficient	Maximum Coefficient	Inches	SN
Asphalt Rubber		0.61		0
Asphalt Concrete		0.42	4	1.68
Cement Treated or Bituminous Treated Base		0.28		0
Cement or Lime Treated Subgrade		0.16		0
Aggregate Base	1.00	0.12	10	1.2
Aggregate Subbase	1.00	0.11		0
				2.88

Alternative 2 - AC PMTR over AC over AB

Material Type	Drainage Coefficient	Maximum Coefficient	Inches	SN
Asphalt Concrete PMTR		0.42	2	0.84
Asphalt Concrete		0.42	2	0.84
Cement Treated or Bituminous Treated Base		0.28		0
Cement or Lime Treated Subgrade		0.16		0
Aggregate Base	1.00	0.12	10	1.2
Aggregate Subbase	1.00	0.11		0
				2.88

Alternative 3 - Full Depth AC

Material Type	Drainage Coefficient	Maximum Coefficient	Inches	SN
Asphalt Concrete PMTR		0.42	2	0.84
Asphalt Concrete		0.42	5	2.1
Cement Treated or Bituminous Treated Base		0.28		0
Cement or Lime Treated Subgrade		0.16		0
Aggregate Base	1.00	0.12		0
Aggregate Subbase	1.00	0.11		0
				2.94