Geotechnical Study and Foundation Recommendation Report

N5012 Sanostee Wash Bridge
Sanostee, New Mexico
Project # 19-517-00007

Prepared for:

Wilson & Company, Inc., Engineers and Architects
4401 Masthead St. NE #150, Albuquerque, New Mexico 87109

5/30/2019

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Amended 7/25/2019
Project No. 19-517-00007

Wilson & Company, Inc., Engineers and Architects
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Albuquerque, NM 87109

Attention: Myra Candelaria, P.E.

Subject: **Geotechnical Study and Foundation Recommendations Report**
N5012 Sanostee Wash Bridge
Sanostee, New Mexico

Dear Myra Candelaria, P.E.:

Wood Environment and Infrastructure Solutions, Inc. (Wood E&IS), has completed this Geotechnical Study and Foundation Recommendation Report in support of the proposed improvements of Navajo Department of Transportation (NDOT) Route N5012 Sanostee Wash Bridge project. *This report has been amended to incorporate review comments from the Navajo Division of Transportation. Amendments are shown in italics.*

The sections of this report include a project description, discussions of the geotechnical profile encountered at the site, and foundation recommendations for the planned bridge system.

We at Wood E&IS appreciate the opportunity to be of service on this project. If you have any questions regarding this report, or any aspects of the project, please feel free to contact our office.

Sincerely,

Wood Environment and Infrastructure Solutions, Inc.

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PROJECT SUMMARY

Wood Environment & Infrastructure Solutions (Wood E&IS) is providing geotechnical engineering support for the N5012 Sanostee Wash Bridge Improvement project. N5012 is planned to be re-routed around the town of Sanostee to provide access to the proposed crossing. The beginning of project (BOP) is defined at Station 0+00, approximately at the intersection of the proposed location of N5012 and N34. The planned bridge for Navajo *Division* of Transportation (NDOT) Route N5012 is located at approximately station 46+00. The end of project (EOP) is located at Station 74+56, approximately ½ mile north of the proposed bridge, and along the existing route N5012. Refer to Figure 1 for the Site Map. The Navajo *Division* of Transportation has commissioned Wilson & Company to provide design engineering for improvements to the existing N5012 alignment, Design of the Sanostee Wash bridge, and Design of a new alignment south of the proposed bridge to provide access while by-passing the town of Sanostee. Wood is supporting the Wilson & Company team with geotechnical and foundation design support.

This Report presents data and data interpretation including:

- discussions of the terrain and geologic features at the project site;
- discussion of subsurface conditions based on the field investigations, and drilling summary sheets;
- pavement design and construction recommendations; and
- foundation selection for N5012 Wash Bridge and design recommendations

Foundation design recommendations presented in this report are specific to the construction of the Sanostee Wash Bridge. Recommendations for retaining walls are also provided in this report. Applicable standards include the 2014 edition of The Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects and the 8th Edition, 2017 AASHTO LRFD Bridge Design Specification in U.S. Customary Units.

Subsurface conditions underlying the proposed bridge location are considered to be fairly consistent with sand, gravel, and cobbles in the upper 10′ to 20′. Weathered shale bedrock is encountered nominally 50′ below the top of existing embankment at the crossing. The rock is observed to vary in quality fairly significantly between the explored depths of 45′ and 75′ below the surface. The proposed bridge is recommended to be supported using deep foundations. Geotechnical issues with construction of deep foundations at the site include groundwater conditions, obstructions while driving piles or drilling shafts, and excavation instability.

There is a risk working near the Sanostee Wash of varying seasonal groundwater at the site. The Contractor should anticipate groundwater and anticipate using the casing construction method or slurry-displacement if the dry construction method is inadequate to prevent sidewall caving conditions.

1.0 PROJECT DESCRIPTION

N5012 Sanostee Wash Bridge project is located in Sanostee, New Mexico. The proposed bridge will replace a previously constructed embankment which has since been washed away. The original embankment was constructed with large corrugated metal culverts to provide means of seasonal surface water flow to pass beneath the crossing. It is proposed that a new bridge be constructed bearing on stabilized portions of the remaining embankment on each side each side of the wash.

This project includes 1.41 miles of roadway realignment, cut/fill, replacing culverts, installing new culverts, grades and drain improvements, and paving along with the construction of the new bridge. This report provides preliminary recommendations for paving and the construction of the new bridge at station 46+00.

2.0 GEOTECHNICAL PROFILE

The following sections of text present our observations, measurements, and interpretations regarding surface, soil, and groundwater at the project site.

2.1 Geologic Setting

According to published geologic maps (Geologic map of New Mexico, 2003), soil and rock conditions in the site vicinity are characterized by Holocene-aged and/or Pleistocene-aged Quaternary alluvial and eolian deposit, and Upper Cretaceous-aged sandstone. The Quaternary deposits are comprised of alluvial deposits and windblown silt and sand deposits. The native soils encountered during the subsurface exploration at the bridge site consist primarily of coarse-grained soil mixtures of clay, silt, sand, gravel and occasional cobbles overlaying bedrock. The sandstone typically is fine-grained and gray with lamination. The exploration logs (enclosed in Appendix A) provide a detailed description of the soil strata encountered in our subsurface explorations.

2.2 Soil Conditions

Unconsolidated granular alluvial soils were encountered at the ground surface overlying claystone and black shale. The soils comprised mixtures of silt, sand and gravel with the percent of gravel increasing with boring depth. The boring was terminated at 70 feet due to auger refusal. Rock coring was performed in two locations *(B-09 and B-10)* to examine the condition of the in-place rock between 4/29/2019-5/4/2019. *Location B-08 was terminated at the depth bedrock was encountered. Location B-11 was performed on February 25, 2019 and advanced through approximately 20 feet of bedrock. Samples of the rock at B-11 were not retrieved due to pulverization of the samples caused by boring.*

2.3 Laboratory Testing

Laboratory tests were performed on the representative split spoon samples obtained during our subsurface exploration to evaluate and characterize the site soils for the engineering design and analysis. The following tests were performed in general accordance with applicable America Association of State Highway and Transportation Office (AASHTO) test methods. In absences of an AASHTO test method, ASTM methods were used.

- Sieve Analysis
- Moisture
- Plasticity Index
- Direct Shear Test
- Unconfined Compressive Strength of Rock (yet to be conducted)

- R-Value
- Sulfate and chloride content, pH, and resistivity

3.0 SUBSURFACE CONDITIONS

3.1 Subsurface Exploration

The initial surface and subsurface exploration for this project was performed from February 25 to February 27, 2019. Field direction, sample collection and logging of boring were performed by Jacob Hays, PE of Wood E&IS. Because rock was encountered and the drilling subcontractor did not have the ability to perform rock coring, a later site visit was performed to core and sample the rock to assist in determining quality and strength. Logs of all borings are presented in Appendix A of this report. The deep borings, B-08, B-09, B-10, and B-11, encountered bedrock at 45-50 feet.

The second site visit to complete rock coring operations was completed May 4, 2019 by Greg Davies, EIT. Rock coring was performed at locations B-09 and B-10 to depths of 15 to 30 feet beyond the depth for which rock is encountered in two of the locations. Figure 1 shows the site vicinity and the boring location maps respectively.

Boring B-11 was completed by Geomat with a truck -mounted CME-55 drill rig utilizing a continuous flight hollow-stem auger. Boring was performed at location B-11 to a depth of 70 feet. *Rock was encountered at B-11 at a depth of 45 feet. The boring was advanced through rock using the auger and blow counts were performed at intervals of 5 feet to evaluate whether the boring had encountered bed rock, boulders, or cemented soils. It was determined that the materials encountered at depths between 45 and 70 feet at B-11 were bedrock and that it would be necessary to re-visit the site to collect core samples of the bedrock at a later date*.

B-08, B-09, and B-10 were performed by Enviro-drill with a truck -mounted CME-75 drill rig utilizing a continuous flight hollow-stem auger and split barrel coring bits. In addition, visual surface reconnaissance of the site was also conducted.

The specific locations, and depths of our borings were selected by Wood E&IS and Wilson & Company, Inc., Engineers and Architects, and field-adjusted based on existing site features, under the constraints of surface access, underground utility locations, and budget considerations. We estimated the relative location of each exploration by measuring from existing features and scaling these measurements onto a layout plan supplied to us, and then we estimated their elevations by interpolating between contour lines shown on this same plan. Consequently, the data listed in Table 1 and the locations depicted on figures should be considered accurate only to the degree permitted by our data sources and implied by our measuring methods.

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

3.2 Subsurface Profiles

3.2.1 Sanostee Wash Bridge

Subsurface conditions at the proposed locations of Abutment 1 (South) were evaluated based on boring B-08 and B-09. Subsurface conditions at the proposed locations of Abutment 2 (North) were evaluated based on boring B-10 and B-11. The borings were positioned on top of the existing embankment and on each side of the abutments. The soils beneath the top of the embankment are granular with varying

amounts of silt, gravel, and cobble. These soils extend to approximately 45 feet and can be described as medium dense to very dense. Weathered Mancos Shale Bedrock is encountered at a depth of 50' below the surface for Abutment 1 (South), and 45' below the surface for Abutment 2 (North).

A generalized subsurface profile was developed using these borings for the abutments (Abutments 1 and 2). It is recognized that soil properties vary within short horizontal and vertical deviations from the locations drilled. Tables 1 and 2 present a profile of the subsurface conditions for Abutments 1 and 2, respectively.

Table 1: Subsurface Conditions at Abutment 1 (South)

Description of Soil Unit [(1)]	**Estimated Top Elevation (feet)**	**Estimated Thickness (feet)**	**Typical Soil Type(s)**
Soil Unit A: medium dense silty sand with gravel.	5923'	5	SW, SM
Soil Unit B: medium dense to dense sand with gravel and cobble.	5918'	30	SM, SP, SW
Soil Unit C: Loose to medium dense clean sand.	5888'	5	SP
Soil Unit D: Silty sand, low plasticity clay	5883'	10	SM, SC
Soil Unit E: Weathered Mancos Shale Bedrock/Claystone	5873'	Unknown[(2)]	Bedrock

(1) Geotechnical staff used field moisture, SPT values and laboratory results to profile the subunits.
(2) Rock coring was performed and extended 18' into bedrock during the week of April 29, 2019

Table 2: Subsurface Conditions at Abutment 2 (North)

Description of Soil Unit [(1)]	**Estimated Top Elevation (feet)**	**Estimated Thickness (feet)**	**Typical Soil Type(s)**
Soil Unit A: medium dense silty sand with gravel.	5923'	5	SW, SM
Soil Unit B: medium dense to dense sand with gravel and cobble.	5918'	25	SM, SP, SW
Soil Unit C: Loose to medium dense clean sand.	5893'	5	SP
Soil Unit D: Silty sand, low plasticity clay	5888'	10	SM, SC
Soil Unit E: Weathered Mancos Shale Bedrock/Claystone	5878'	Unknown[(2)]	Bedrock

(1) Geotechnical staff used field moisture, SPT values and laboratory results to profile the subunits.
(2) Rock coring was performed and extended 25' into bedrock during the week of April 29, 2019

3.2.2 N5012 Roadway Alignment

Subsurface conditions between stations 0+00 to 21+00 are predominately clayey. The portion of N5012 north of the bridge site is also considered to be clayey based on the field investigation and the

laboratory results. A significant portion along the alignment between stations 21+00 and 52+00 are more granular within the upper 5 feet observed.

Dynamic Cone Penetrometer testing near station 21+00 was performed to evaluate potential for settlement of large corrugated metal structures to a depth of 10 feet. It was determined that the subgrade soils are granular with some silt and clay, and are typically medium dense. A maximum allowable bearing capacity of 2000 pounds per square foot would be recommended for use in design of embankments and culverts for this project.

3.3 Groundwater and Soil Moisture Conditions

At the time of the original drilling (February 25, 2019), the groundwater was encountered at about 24 feet below the top of existing embankment at boring B-11. The next visit (April 29, 2019), groundwater was encountered at about 25, 24, and 19 feet below the top of existing embankment at borings B-08, B-09, and B-10 respectively. Moisture content of the soil above the water table was determined and used to evaluate the on-site soil moisture characteristics. The site soils above the groundwater surface were generally described as dry to moist with moisture content varying from 2 to 18%.

Seasonal variations could cause fluctuations in groundwater depth and depth to groundwater could be shallower or deeper than indicated this report.

3.4 Site Seismicity

Seismic design parameters at the project location for peak horizontal acceleration and the horizontal spectral response acceleration of 1.0-second duration with a 7-percent probability of exceedance during a 75-year period are presented below in table 3. The site class design parameters recommended for the project are based on subsurface investigations at the site.

Table 3: Seismic Design Parameters

Design Parameter	Value	AASHTO Reference (2014)
Peak Ground Acceleration Coefficient (PGA)	0.046	Figure 3.10.2.1-1
Acceleration Coefficient, S_s	0.110	Figure 3.10.2.1-2
Acceleration Coefficient, S_l	0.030	Figure 3.10.2.1-3
Acceleration Coefficient, S_{DS}	0.176	Eq. 3.10.4.2-3
Acceleration Coefficient, S_{D1}	0.072	Eq. 3.10.4.2-6
Site Class	D	Table 3.10.3.1-1
A_s	0.074	Eq. 3.10.4.2-2

Abbreviations
g = Acceleration due to gravity
PGA_m = Site peak ground acceleration

4.0 GEOTECHNICAL DESIGN RECOMMENDATIONS

The following sections provide information on the recommended foundation types for the proposed bridge structure *and pavement design*.

4.1.1 Soils Testing

Seventeen AASHTO/ASTM soil classification and four R-value tests were performed on surface soils along the alignment. Results are presented in the table below:

Table 4: R-Values and Soil Classification

Boring No.	Depth (feet)	R-value[1]	ATSM Classification[2]	AASHTO Classification
B-1	0.0-5.0′	2	CH	A-7-6
B-2	0.0-5.0′		CH	A-7-6
B-3	0.0-5.0′		CH	A-7-6
B-4	0.0-5.0′	18	SM	A-6
B-5	0.0-5.0′		CL	A-6
B-6	0.0-5.0′	41	SM	A-6
B-7	0.0-5.0′		SM	A-2-4
B-16	0.0-5.0′		SM	A-4
B-12	0.0-5.0′		SM	A-4
B-13	0.0-5.0′	3	CL	A-6
B-14	0.0-5.0′		CL	A-6
B-15	0.0-5.0′		CL	A-6

Notes: (1) R-values performed on combined samples as indicated
(2) As classified in the field

4.1.2 Soils Chemical Testing

Tests for pH (AASHTO T289), Sulfate Content (AASTHO T290), Chloride Content (AASHTO T291), and Resistivity testing (AASHTO T-288) are presented below. The tests performed for this study were included as per The Federal Highway Administration's Geotechnical Technical Guidance Memo.

Table 5 Chemical Test Results

Boring	Soil Type	Sample Depth, ft	pH (S.U.)	Sulfate Content (ppm)	Chloride Content (ppm)
B-6, B-7, B-12, and B-16	Silty Sand	0′-5′	8.3	563	33
B-13, B-14, and B-15	Clayey sand	0′-5′	8.1	1255	33
B-11	Sand with natural gravel/cobble	25′-26.5′	8.9	152	11

S.U. = Standard Unit; ppm = part per million

The sulfate test result for the sample representing soils at the bridge were 152 ppm, and indicates that the Exposure Class has "Negligible" potential for sulfate reaction with the concrete. The cement type required for "Negligible" Exposure Class is ASTM C150 Type I Cement. It would be recommended to select a Type II.

Laboratory test results indicate that the onsite soils for the project have pH values ranging from 8.1 to 8.9 and Chloride content between 11 and 33 ppm.

Corrosion of metals is an electrochemical process which involves oxidation and reduction reactions on metal surfaces. For metals in soils and water, corrosion is typically a result of contact with soluble salts or an acidic (pH of 4.5 or less) environment. Per FHWA recommendations, the maximum range for the "Moderately Corrosive Range" (Resistivity from 5000 to 2000 ohm-cm) is 100 ppm for chloride ions and 200 ppm for sulfates. The tested chloride content (11-33 ppm) in all samples is lower than the recommended limit, but the sulfates (152 – 1255) are much higher than FHWA limits. The measurement of pH on the soil samples shows that the soils are alkaline. Very strong alkalinity soils (pH greater than 10) are generally associated with significant corrosion rates. None of the pH tests for the bridge and have pH values greater than 10.

Given all of the corrosivity data available, it is our opinion that the soils present at the project are potentially corrosive given the sulfate content and pH level. Resistivity testing was performed onsite and it was concluded that the resistivity of soils for abutment 1 (south) were on average 6176 Ohm-cm, and 11227 Ohm-m. This suggests that the onsite soils near the bridge are "Mildly Corrosive" to "Non-Corrosive" per FHWA aggressiveness criteria. Other Resistivity testing was performed near station 24+00 to evaluate corrosivity near proposed corrugated metal culverts. The results at station 24+00 were 7580 Ohm-cm on average, which also places the soils in the "Mildly Corrosive" aggressiveness category.

Samples of site soil was submitted for sulfate content to evaluate potential for lime treating onsite soils for fill and pavement design purposes. The highest result was 1255 ppm. Generally, the upper limit permitted for lime treating soils is 3,000 ppm. Given that the result is less than the upper limit recommended, it appears that lime treatment of the site soils is feasible. Given that the result of 1255 ppm is relatively close to the upper limit it will be recommended to allow lime/soil mixtures to "mellow" for a period of 48 hours prior to final fill placement as recommended FHWA/TX-06/0-4240-3 "Recommendations for Stabilization of High Sulfate in Soils."

4.1.3 Rock Testing

It was necessary to quantify the properties of the rock mass encountered to make recommendations for end bearing (tip resistance). AASHTO 2014 Sections 10.8.3.5.4c-1 and 10.8.3.5.4b were reviewed and utilized to quantify the properties of the rock. A GSI of 35 and RQD of 26% were derived using the "Quantification of the Geological Strength Index chart" by E. Hoek, et al. Unconfined compressive testing was performed on select samples using ASTM D7012. Results of unconfined compression testing are shown below. It can be observed that the results are highly variable. Not all of the tests are considered to be representative due to sample disturbance during removal from core drill in the field and drying shrinkage during specimen transport. A representative value of 2400 psi was utilized for unconfined compressive strength of the rock deposit given the data and our experience with the shales present in this part of the state.

Table 6: Unconfined Compressive Strength of Rock

Boring No.	Depth (feet)	Density (lbs/cu. ft)	Unconfined Compressive Strength (psi)
B-9	55	124	181
B-10	63	157	7907
B-10	67	150	2419
B-10	69	114	45

4.2 Geotechnical Foundation Design Parameters

Geotechnical design parameters for the project were derived from interpreted soil boundaries, samples collected and described in the field, SPT testing, laboratory testing, correlations with AASHTO design charts, and past project experience. The soil parameters, presented in Tables 7 and 8, are site-specific values developed for use in the foundation design calculations.

Table 7: Geotechnical Design Parameters for Abutment 1 (South)

Design Soil Parameter	Soil Unit A	Soil Unit B	Soil Unit C	Soil Unit D	Soil Unit E
N_{60} Value	13-41	18-42	7	50	100+
Friction angle Φ, degrees	22	30	--	--	--
Cohesion, c, psf	246	0	--	--	--
Estimated Moist Unit Weight, γ_m, pcf	120-123	123-143	120	115	150
Uniaxial Compressive Strength, q_u, psi	--	--	--	--	2400

Table 8: Geotechnical Design Parameters for Abutment 2 (North)

Design Soil Parameter	Soil Unit A	Soil Unit B	Soil Unit C	Soil Unit D	Soil Unit E
N_{60} Value	13-41	18-42	7	50	100+
Friction angle Φ, degrees	22	30	--	--	--
Cohesion, c, psf	246	0	--	--	--
Estimated Moist Unit Weight, γ_m, pcf	120-123	123-143	120	115	150
Uniaxial Compressive Strength, q_u, psi	--	--	--	--	2400

4.3 Pavement Design

In accordance with the Federal Lands Highway Project Development and Design Manual, pavement design has been performed to support the proposed alignment for N5012. Structural pavement thickness design was performed using the AASHTO '93 method.

4.3.1 Traffic

The FHWA requires a minimum of 50,000 ESALs for consideration in the design of newly paved surfaces. *Average Daily Traffic (ADT) was determined to be 334 vehicles per day for year 2013 and projected to be 496 vehicles per day for year 2033. Truck/vehicle percentages were not included in the referenced ADT summary. Given the minimum required ESAL's of 50,000 and the provided ADT data, the total ESAL's for the roadway will be less than the minimum required considering a growth rate less than 2.1% and a vehicle distribution of 99% personally operated vehicles, and 1% of mixed tuck traffic with an average ESAL Factor of 1.14.*

4.3.2 Soil Support

Based on the results of the study, the soils between stations 0+00 to 21+00 are predominately clayey with an R-value of 2. The portion of N5012 north of the bridge site is also considered to be clayey based on the field investigation and has similar R-Value laboratory results. The soils between stations 21+00 and 52+00 were observed to be more granular and samples tested resulted in an R-Value of 18. Two soil support conditions were modeled for providing these recommendations. Soil Support A represents the soil conditions between Stations 21+00 and 52+00 with a Resilient Modulus (M_r) 7,000 psi using Mechanistic and Empirical Design Correlations (MEPDG). Soil support B represents the clayey portions of the project alignment, and was modeled using a resilient modulus of 2,500 psi.

4.3.3 Hot Mix Asphalt Pavement Sections

As required by the FHWA design manual, a reliability of 75%, combined standard error of 0.49, initial serviceability index of 4.2, and final serviceability index of 2.0 was used for calculating allowable ESALs. This analysis did not consider frost/heave susceptibility of subgrade. The analysis resulted in recommended structural numbers of 2.0 for Soil Support A, and 2.9 for Soil Support B. The table below provides possible thickness design for both Soil Support A and B using layer coefficients for treated soils, unbound granular base course, and hot mix asphalt as 0.08/inch, 0.10/inch, and 0.40/inch respectively.

Table 9: Hot Mix Asphalt Pavement Sections

Pavement Section/Soil Support	A	B
HMA (Item FP-401)	3.5"	3.5"
BC (Item FP-301)	6"	6"
Treated Subgrade (per FP-14 specifications)	0"	12"
Subgrade (Item FP-204)	12"	6"

*HMA = Hot Mix Asphalt (superpave), BC = Unbound Aggregate Base Course

4.3.4 Chip Seal Recommendations

In lieu of paving with hot mix asphalt, a "Double Course Chip Seal" may be utilized as a surfacing material. The FHWA does not provide period of performance requirements for preventative maintenance projects such as chip seal. FP14-Specification Section 407 "Chip Seal" requires placement

of chip seal over either new asphalt patch areas, existing asphalt surfaces (including recycled asphalt pavements), or aggregate base course surfaces. For this project, it would be recommended to place a layer of aggregate base course material over prepared subgrade on the existing unsurfaced roadway prior to chip sealing operations.

If it is not desired to provide a section meeting the structural design requirements for unsurfaced gravel roads as recommended in the following paragraphs, it is recommended to place a minimum of 6" of aggregate base course over the prepared subgrade for chip seal placement.

The FHWA does provide a period of performance of five to ten years for aggregate surfaced roads. The recommended thickness of aggregate base course to be placed under the chip seal surfacing will consider the minimum ESAL's required by the FHWA for gravel road. The minimum number of ESAL's for Gravel Surfaced Roads for FHWA projects is 10,000.

The proposed area to be chip sealed includes the portion of roadway north of the bridge. A combined sample of the borings performed north of the bridge (B-13, B-14, and B-15) was tested for soil support characteristics. The combined sample was determined to have an R-Value of 3. This roughly corresponds to a resilient modulus of 3,000 psi.

Given this analysis, a structural number of 2.1 is recommended for the pavement section beneath chip seal to meet the minimum traffic requirement of the FHWA. Potential pavement sections meeting this are shown below:

Table 10: Chip Seal Pavement Sections

Pavement Section	Option 1	Option 2	Option 3
Double Course Chip Seal (Item FP-407)	Type 2A/2B	Type 2A/2B	Type 2A/2B
BC (Item FP-301)	6"	6"	14"
Treated Subgrade (per FP-14 specifications)	12"	-	-
Import Subgrade R-Value > 55 (Item FP-204)	-	12"	-
Existing Subgrade (Item FP-204)	6"	6"	6"

*BC = Unbound Aggregate Base Course

4.4 Bridge Foundation Selection

Wood E&IS has considered conventional foundation alternatives for support of the bridge. Due to the presence of gravel, cobbles and ground water in conjunction with the depth of bedrock, drilled shafts are the preferred option.

- Drilled Shafts: Drilled shafts are a standard method used to support high vertical and lateral loads and can be constructed in dry and wet conditions. Drilled shafts are a good option for extending below scour zones into stable, scour-resistance formations. Specialty construction contractors are generally required to install drilled shafts which makes them more expensive than driven piles. The subsurface of the bridge site is characterized by site soils which consist of a mixture of silt, sands, gravel and cobbles, which will may result in difficult drilling conditions and/or susceptibility to scouring during and after construction. Due to potential sidewall instability, casing or slurry-displacement method may be required during the drilled shaft excavation to maintain the stability of the hole. In addition, crosshole sonic testing should be used during construction to confirm the integrity of the shaft.
- Driven H-Piles: Driven piles are usually the most cost-effective deep foundation solution. However, due to the presence of gravel and cobbles (encountered in boring *and* observed on the surface in boring location), pile drivability is a concern. A pile must satisfy two aspects of drivability. First, the pile must have sufficient stiffness to transmit driving forces large enough to overcome soil resistance. Second, the pile must have sufficient structural strength to

withstand the driving forces without damage. The difficult ground conditions at the site would require predrilling to facilitate installation of the piles. The use of predrilling will result in greater soil disturbance than considered in standard static pile capacity calculations. McClelland et al. (1969) reported that a decrease in shaft resistance over a predrilled depth can range from 50 to 85% of that calculated without predrilling, depending on the size of the predrilled hole. Predrilling should be avoided whenever possible. Although drilled shafts are generally more expensive than driven piles, it is our opinion that drilled shafts will be more economical in terms of constructability and time.

- Spread Footings: The use of spread footings to support highway bridges has many advantages. Spread footings are typically only recommended to support bridge abutments and center piers (if applicable) when the depth to rock is less than 10 to 15 ft. Given the depths to bedrock of 45' to 50' spread footings will not be recommended as an alternative foundation for this project.

4.4.1 Drilled Shafts

Drilled shafts designed in both end bearing and side friction due to the poor quality of the bedrock encountered in the field. The un-factored capacities of the drilled shafts having different diameters are presented in **Figures 2 and 3.** The weight of the shaft should be considered in the total load. Since the design will require consideration of side friction, it will be necessary to place the piles a minimum of three diameters apart for efficiency,

Shafts in groups should be drilled and filled alternately, allowing the concrete to set at least eight hours before drilling an adjacent shaft.

4.4.1.1 Drilled Shaft Geotechnical Resistance

Drilled shaft analysis was performed by Wood in accordance with the 2014 AASHTO LRFD Bridge Design Specifications. Design shaft resistance values were computed for preliminary design at the Strength Limit State. The shaft resistance summary table, presented below, is based on reactions for a single shaft. It should be noted that the upper 5 feet of soil was not considered to provide side friction resistance as is typical in the design of deep foundations for substructure elements.

Table 11: Drilled Shaft Geotechnical Resistance Summary

Substructure Location (Diameter/ Number of Drilled Shafts)	**Drilled Shaft Estimated Length (feet)**	**Factored Strength Combination Load Qu (1) (kips)**	**Nominal Total Skin Resistance R_s (kips)**	**Nominal Total Tip Resistance R_p (kips)**	**Factored Total Geotechnical Resistance R_R (2) (kips)**
Abutment #1 (36"/4 Shaft Configuration)	55	681	922	636	825
Abutment #2 (36"/ 4 Shaft Configuration)	50	681	785	636	750

(1) Based on Wilson & Co. Structural Design Loads (2725 kips/4 Shafts)

(2) Resistance Factor (φ_{stat} =0.50) tip resistance in rock and Resistance Factor (φ_{stat} =0.55) skin friction in sand per AASHTO 2014 Table 10.5.5.2.4-1

4.4.1.2 Settlement

Design shaft settlement was computed at both abutments. The settlement is based on service limit state for a single drilled shaft interpolated from normalized load-settlement curves (AASHTO, 2014). The summary of the results is presented in Table 8.

Table 12: Drilled Shaft Load Transfer Settlement

Location	Length (feet)	Service Load Combination (kips)	Estimated Deflection (inches)
Abutment 1 South	55	486*	< ½"
Abutment 2 North	50	486*	< ½"

*Strength 1 Ultimate Load divided by average load factor of 1.4.

4.4.1.3 Lateral Loading

AASHTO Section 10.7.2.4 states that horizontal pile foundation movement should be "estimated using procedures that consider soil-structure interaction." Tables 12 and 13 provide parameters for lateral load analysis using LPile 2016. These programs are based on the P-y method of analysis that approximates the soil resistance using P-y curves. For pile groups, the P-Multiplier concept described in AASHTO Section 10.7.2.4 should be applied. For additional information on lateral analysis of piles, the reader is referred to AASHTO and Hannigan *et al* (2006). Group lateral reduction factors are recommended to be applied in the analysis for loading parallel with the abutment given one single row of shafts will be selected for the project.

Table 13: Recommended Soil Geotechnical Properties for Lateral Analysis at Abutment 1 (South)

Depth Range from Top of Pile (ft)	*LPile Model*	*Material Type*	*Effective Unit Weight, γ' pcf (pci)*	*Cohesion, psf (psi)*	*Friction Angle (degrees)*	*Uniaxial compress.s trength (psi)*	*Lateral Soil Modulus k (pci)*
0 - 5	*API Sand*	*Silty Sand*	*120 (0.0694)*	*--*	*31*	*--*	*60*
*5 – 35**	*API Sand*	*Silty Sand/Sandy Gravel & Cobbles*	*130 (0.0752)*	*--*	*36*	*--*	*160*
35 - 40	*API Sand*	*Sandy Silt*	*48 (0.0278)*	*--*	*32*	*--*	*95*
40 - 50	*API Sand*	*Poorly Graded Sand with Clay*	*58 (0.033)*	*--*	*31*	*--*	*40*
50 - 65	*Reese*	*Weak Rock*	*150 (0.0868)*	*--*	*--*	*2400*	*--*

Groundwater encountered at 24 feet bgs

Table 14: Recommended Soil Geotechnical Properties for Lateral Analysis at Abutment 2 (North)

Depth Range from Top of Pile (ft)	LPile Model	Material Type	Effective Unit Weight, γ' pcf (pci)	Cohesion, psf (psi)	Friction Angle (degrees)	Uniaxial compress. strength (psi)	Lateral Soil Modulus k (pci)
0 - 5	API Sand	Silty Sand	120 (0.0694)	--	31	--	60
5 – 30*	API Sand	Silty Sand/Sandy Gravel & Cobbles	130 (0.0752)	--	36	--	160
30 - 35	API Sand	Sandy Silt	48 (0.0278)	--	32	--	95
35 - 45	API Sand	Poorly Graded Sand with Clay	58 (0.033)	--	31	--	40
45 - 65	Reese	Weak Rock	150 (0.0868)	--	--	2400	--

***Groundwater encountered at 24 feet bgs**

5.0 RECOMMENDED ADDITIONAL SERVICES

Because the future performance of the bridge will depend largely on proper site preparation and construction procedures, monitoring and testing by experienced geotechnical personnel should be considered an integral part of the construction process. Consequently, we recommend the following geotechnical construction monitoring be performed:

Attend a pre-construction conference with the design team and contractor to discuss important geotechnical construction issues; and

Observe all exposed geotechnical profile to confirm that the bedrock/suitable soil conditions have been reached and to determine if further drilling is required.

Upon request, Wood E&IS could submit a proposal for construction monitoring services. A proposal is best prepared after the project plans and specifications have been approved for construction.

6.0 CLOSURE

The conclusions and recommendations presented in this report are based, in part, on the explorations Wood E&IS performed and used for this study; therefore, if variations in the subgrade conditions are observed at a later time, we may need to modify this report to reflect those changes. In addition, because the future performance and integrity of foundations depend largely on proper initial subgrade preparation, and backfilling procedures, monitoring and testing by experienced geotechnical personnel should be considered an integral part of the construction process. Wood E&I is available to provide geotechnical monitoring, soils testing, and other services throughout construction upon request.

References

American Association of State Highway and Transportation Officials (AASHTO), 2014. AASHTO LRFD Bridge Design Specifications. 7th Edition. Washington, DC: American Association of State Highway and Transportation Officials

Federal Highway Administration (FHWA), 2009. Corrosion/Degradation of Soil Reinforcements for Mechanically Stabilized Earth Walls and Reinforced Soil Slopes. Federal Highway Administration, U.S. Department of Transportation. November 2009

Federal Highway Administration (FHWA), 2007. Geotechnical Technical Guidance Manual. Federal Highway Administration, U.S. Department of Transportation. May 2007.

Federal Highway Administration (FHWA), 2014. Federal Lands Highway Project Development and Design Manual. Federal Highway Administration, U.S. Department of Transportation. December 2014.

Hoek, E., et al. Quantification of the Geological Strength Index Chart. American Rock Mechanics Association (ARMA), 2013.

Portland Cement Association (PCA), 2011. Design and Control of Concrete Mixtures. Portland Cement Association 2011.

Zieglar, D.L., 1955. Preliminary Geologic Map of the Toadlena Quadrangle, San Juan County, New Mexico. U.S. Geological Society, Coal Investigations Map C-30.

Limitations

1. The work performed in the preparation of this report and the conclusions presented are subject to the following:
    a. The Standard Terms and Conditions which form a part of our Master Services Contract with Wilson & Company;
    b. The Scope of Services;
    c. Time and Budgetary limitations as described in our Contract; and
    d. The Limitations stated herein.
2. No other warranties or representations, either expressed or implied, are made as to the professional services provided under the terms of our Contract, or the conclusions presented.
3. The conclusions presented in this report were based, in part, on visual observations of the Site and subsurface explorations. Our conclusions cannot and are not extended to include those portions of the Site, which are not reasonably available, in Wood's opinion, for direct observation.
4. The Site history research included obtaining information from third parties. No attempt has been made to verify the accuracy of any information provided, unless specifically noted in our report.
5. Where testing was performed, it was carried out in accordance with the terms of our contract providing for testing. Other substances, or different quantities of substances testing for, may be present on-site and may be revealed by different or other testing not provided for in our contract.
6. Because of the limitations referred to above, different environmental conditions from those stated in our report may exist. Should such different conditions be encountered, Wood must be notified in order that it may determine if modifications to the conclusions in the report are necessary.
7. The utilization of Wood's services during the implementation of any remedial measures will allow Wood to observe compliance with the conclusions and recommendations contained in the report. Wood's involvement will also allow for changes to be made as necessary to suit field conditions as they are encountered.
8. This report is for the sole use of the party to whom it is addressed unless expressly stated otherwise in the report or contract. Any use which any third party makes of the report, in whole or the part, or any reliance thereon or decisions made based on any information or conclusions in the report is the sole responsibility of such third party. Wood accepts no responsibility whatsoever for damages or loss of any nature or kind suffered by any such third party as a result of actions taken or not taken or decisions made in reliance on the report or anything set out therein.
9. This report is not to be given over to any third party for any purpose whatsoever without the written permission of Wood.
10. Provided that the report is still reliable, and less than 12 months old, Wood will issue a third-party reliance letter to parties that the client identifies in writing, upon payment of the then current fee for such letters. All third parties relying on Wood's report, by such reliance agree to be bound by our proposal and Wood's standard reliance letter. Wood's standard reliance letter indicates that in no event shall Wood be liable for any damages, howsoever arising, relating to third-party reliance on Wood's report. No reliance by any party is permitted without such agreement.

FIGURES

P:\consulting\projects\19\19-517-00007.Sanostee Wash Bridge\GIS-CAD\1951700007_Site and Exploration Plan-Imperial.dwg

PROJECT:
SANOSTEE WASH BRIDGE
Sanostee,
New Mexico

TITLE:
SITE AND EXPLORATION PLAN

DWN BY: JT

CHK'D BY: JH

DATUM: N/A

PROJECTION: N/A

SCALE: AS SHOWN

LEGEND

B-01 Boring Number & Approximate Location

CLIENT:
Wilson & Company, Inc.

wood.
Environment and Infrastructure Solutions, Inc.
8519 Jefferson, N.E.
Albuquerque, NM 87113

REV. NO.:

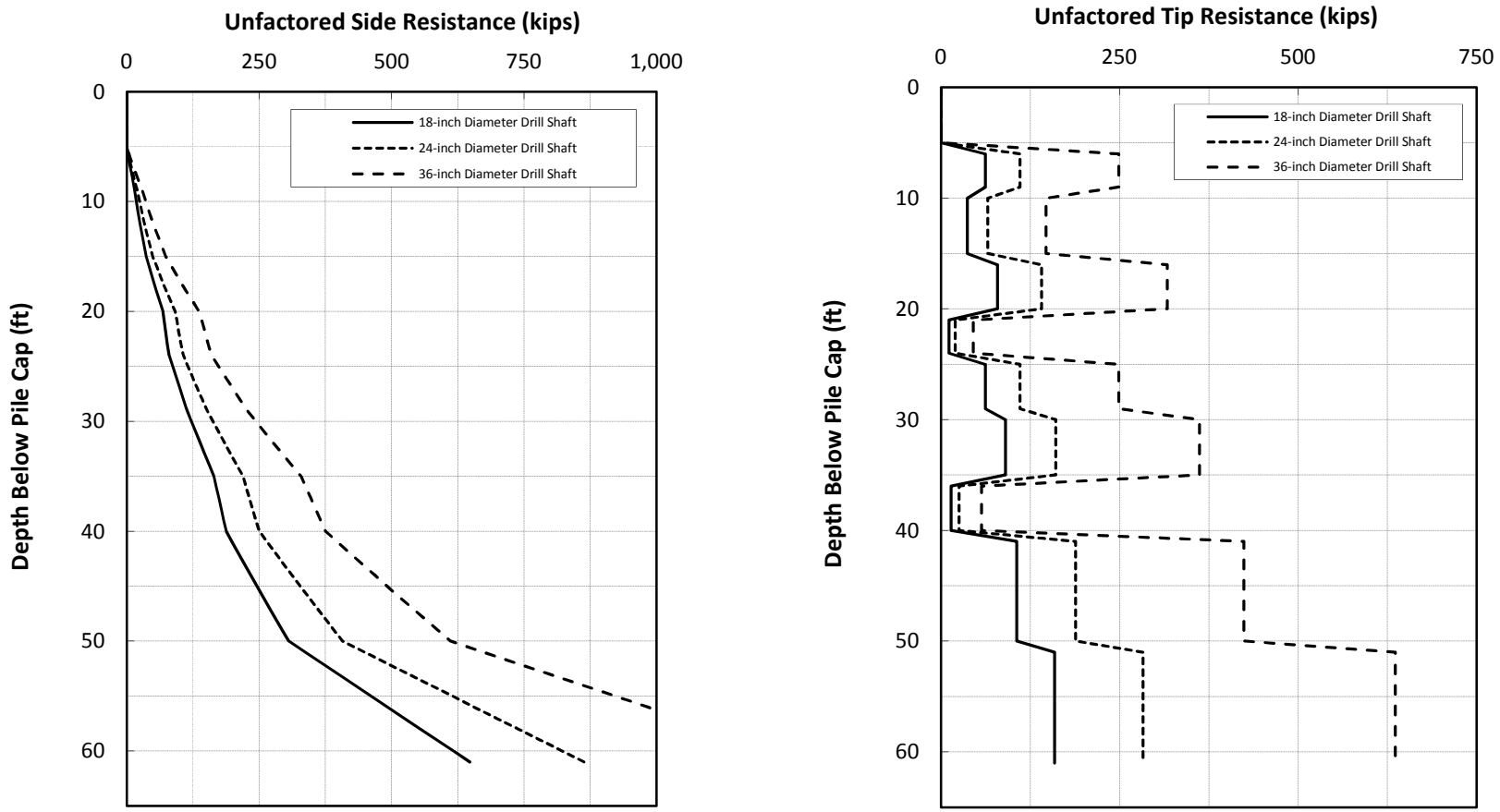
DATE: 4/15/2019

PROJECT NO: 18-517-00007

CONTRACT NO: N/A

FIGURE NO: **1**

18-, 24-, and 36-inch Diameter Drill Shaft

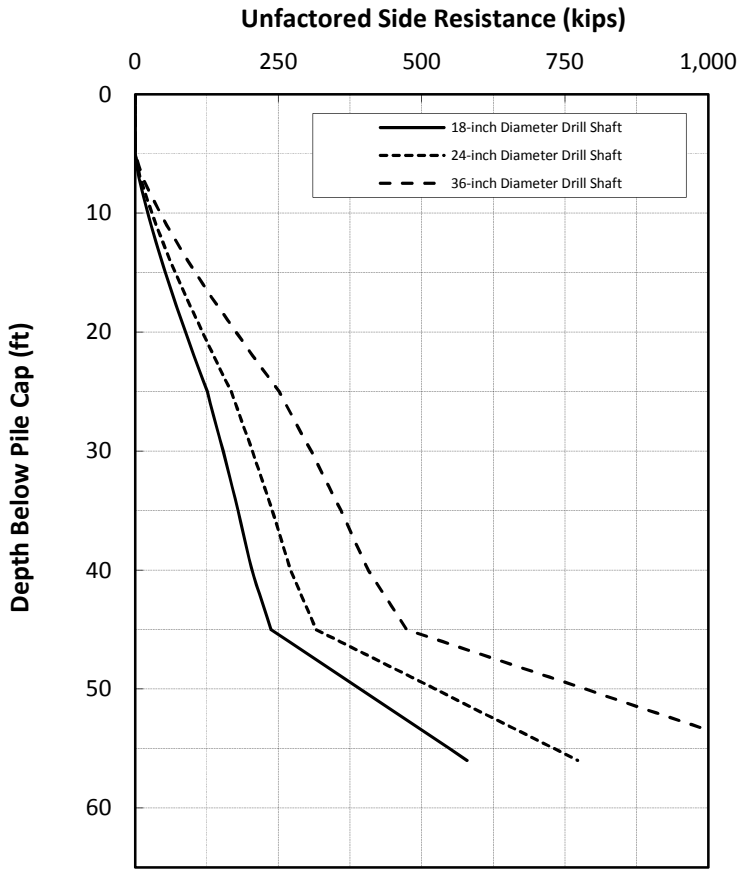


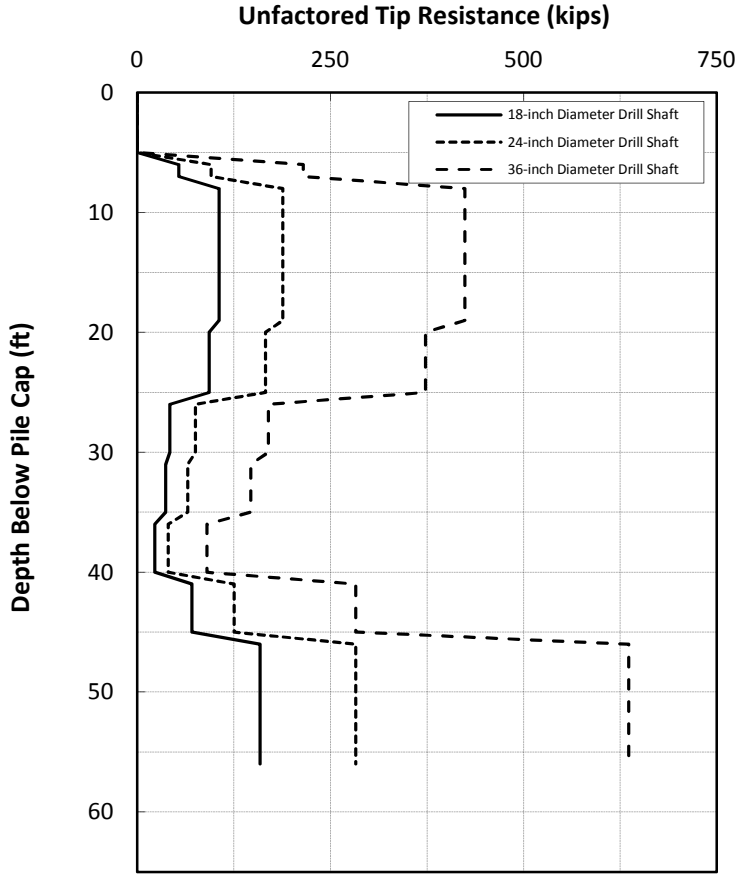
Notes:

1. The plots above present the unfactored resistance as determined by the β Method for the upper 50 feet of sand and the estimation of drilled shaft resistance in rock as defined in Sections10.8.3.5.2 and 10.8.3.5.4 respectively of 2014 AASHTO LRFD Bridge Design Specifications.
2. Resistance Factors must be applied to the values above based upon the Limit State under consideration.
3. A group reduction factor may be approriate depending upon group geometry and pile loading considerations.

Sanostee Bridge Abutment #1 South	Estimated Axial Capacity for Drill Shaft Piles	Figure 2

18-, 24-, and 36-inch Diameter Drill Shaft





Notes:

1. The plots above present the unfactored resistance as determined by the β Method for the upper 45 feet of sand and the estimation of drilled shaft resistance in rock as defined in Sections10.8.3.5.2 and 10.8.3.5.4 respectively of 2014 AASHTO LRFD Bridge Design Specifications.
2. Resistance Factors must be applied to the values above based upon the Limit State under consideration.
3. A group reduction factor may be approriate depending upon group geometry and pile loading considerations.

Sanostee Bridge Abutment #2 North	Estimated Axial Capacity for Drill Shaft Piles	Figure 3

Appendix A

Field Exploration Procedures and Logs

APPENDIX A

FIELD EXPLORATION PROCEDURES AND LOGS

The following paragraphs describe our procedures associated with the field explorations and field tests Wood E&IS, conducted for this project. Descriptive logs of our explorations are enclosed in this appendix.

Auger Boring Procedures

Our exploratory borings were advanced with a solid-stem auger, using a trailer-mounted drill rig operated by Wood E&IS personnel. A Wood E&IS engineer continuously observed the borings, logged the subsurface conditions, and collected representative soil samples. All samples were stored in watertight containers and later transported to our laboratory for further visual examination and testing. After each boring was completed, the borehole was backfilled with a mixture of bentonite chips and soil cuttings, and the surface was patched with asphalt or concrete (where appropriate).

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

PROJECT Sanostee Wash Bridge
Sanostee, New Mexico
DATE 2/26/19
WOOD E & IS PROJECT NO. 19-517-00007

wood.

 BORING NO. B-1

LOCATION See Site Plan
DRILLING CO.
RIG TYPE CME-55
BORING TYPE 8" Auger/Split Spoon
SURFACE ELEV.

Depth in Feet	Relative Drilling Resistance	Graphical Log	Sample	Sample Type	Blows/ft. 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								CH		**CLAY** tan with some fine grained sand, high plasticity, wet
5										End of Boring @ 5'
10										
15										
20										
25										
30										
35										
40										
45										
50										
55										
60										

GROUNDWATER

	DEPTH	HOUR	DATE
▽	none		
▼			

SAMPLE TYPE
A-Auger Cuttings; NR-No Recovery
RC - Rock Core
S-2" O.D., 1.38" I.D. tube sample
U-3" O.D. 2.42" I.D. tube sample
T-3" O.D. thin walled Shelby tube

Wood Environment & Infrastructure Solutions, Inc.
8519 Jefferson Street NE
Albuquerque, NM 87113
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FAX (505) 821-7371

PROJECT Sanostee Wash Bridge
Sanostee, New Mexico
DATE 2/26/19
WOOD E & IS PROJECT NO. 19-517-00007

wood.

 BORING NO. B-2

LOCATION See Site Plan
DRILLING CO.
RIG TYPE CME-55
BORING TYPE 8" Auger/Split Spoon
SURFACE ELEV.

Depth in Feet	Relative Drilling Resistance	Graphical Log	Sample	Sample Type	Blows/ft. 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								CH		**CLAY** brown at surface, high plasticity, wet
										tan at 2'
5										End of Boring @ 5'
10										
15										
20										
25										
30										
35										
40										
45										
50										
55										
60										

GROUNDWATER

	DEPTH	HOUR	DATE
▽	none		
▼			

SAMPLE TYPE
A-Auger Cuttings; NR-No Recovery
RC - Rock Core
S-2" O.D., 1.38" I.D. tube sample
U-3" O.D. 2.42" I.D. tube sample
T-3" O.D. thin walled Shelby tube

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Sanostee, New Mexico
DATE 2/26/19
WOOD E & IS PROJECT NO. 19-517-00007

wood.

 BORING NO. B-3

LOCATION See Site Plan
DRILLING CO.
RIG TYPE CME-55
BORING TYPE 8" Auger/Split Spoon
SURFACE ELEV.

Depth in Feet	Relative Drilling Resistance	Graphical Log	Sample	Sample Type	Blows/ft. 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								CH		**CLAY** tan, high plasticity, wet
5										End of Boring @ 5'
10										
15										
20										
25										
30										
35										
40										
45										
50										
55										
60										

GROUNDWATER

	DEPTH	HOUR	DATE
▽	none		
▼			

SAMPLE TYPE
A-Auger Cuttings; NR-No Recovery
RC - Rock Core
S-2" O.D., 1.38" I.D. tube sample
U-3" O.D. 2.42" I.D. tube sample
T-3" O.D. thin walled Shelby tube

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PROJECT Sanostee Wash Bridge
Sanostee, New Mexico
DATE 2/26/19
WOOD E & IS PROJECT NO. 19-517-00007

wood.

 BORING NO. B-4

LOCATION See Site Plan
DRILLING CO.
RIG TYPE CME-55
BORING TYPE 8" Auger/Split Spoon
SURFACE ELEV.

Depth in Feet	Relative Drilling Resistance	Graphical Log	Sample	Sample Type	Blows/ft. 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								SM		**SILTY SAND** light brown, moist, dry after 2'
5										End of Boring @ 5'
10										
15										
20										
25										
30										
35										
40										
45										
50										
55										
60										

GROUNDWATER

	DEPTH	HOUR	DATE
▽	none		
▼			

SAMPLE TYPE
A-Auger Cuttings; NR-No Recovery
RC - Rock Core
S-2" O.D., 1.38" I.D. tube sample
U-3" O.D. 2.42" I.D. tube sample
T-3" O.D. thin walled Shelby tube

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Sanostee, New Mexico
DATE 2/26/19
WOOD E & IS PROJECT NO. 19-517-00007

wood.

 BORING NO. B-5

LOCATION See Site Plan
DRILLING CO.
RIG TYPE CME-55
BORING TYPE 8" Auger/Split Spoon
SURFACE ELEV.

Depth in Feet	Relative Drilling Resistance	Graphical Log	Sample	Sample Type	Blows/ft. 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								CL		**SILTY SAND** medium grained, reddish to light brown, damp to moist
5										End of Boring @ 5'
10										
15										
20										
25										
30										
35										
40										
45										
50										
55										
60										

GROUNDWATER

	DEPTH	HOUR	DATE
▽	none		
▼			

SAMPLE TYPE

A-Auger Cuttings; NR-No Recovery
RC - Rock Core
S-2" O.D., 1.38" I.D. tube sample
U-3" O.D. 2.42" I.D. tube sample
T-3" O.D. thin walled Shelby tube

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PROJECT Sanostee Wash Bridge
Sanostee, New Mexico
DATE 2/26/19
WOOD E & IS PROJECT NO. 19-517-00007

wood.

 BORING NO. B-6

LOCATION See Site Plan
DRILLING CO.
RIG TYPE CME-55
BORING TYPE 8" Auger/Split Spoon
SURFACE ELEV.

Depth in Feet	Relative Drilling Resistance	Graphical Log	Sample	Sample Type	Blows/ft. 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								SM		**SILTY** moist, reddish-brown
5										End of Boring @ 5'
10										
15										
20										
25										
30										
35										
40										
45										
50										
55										
60										

GROUNDWATER

	DEPTH	HOUR	DATE
▽	none		
▼			

SAMPLE TYPE
A-Auger Cuttings; NR-No Recovery
RC - Rock Core
S-2" O.D., 1.38" I.D. tube sample
U-3" O.D. 2.42" I.D. tube sample
T-3" O.D. thin walled Shelby tube

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PROJECT Sanostee Wash Bridge
Sanostee, New Mexico
DATE 2/26/19
WOOD E & IS PROJECT NO. 19-517-00007

wood.

 BORING NO. B-7

LOCATION See Site Plan
DRILLING CO.
RIG TYPE CME-55
BORING TYPE 8" Auger/Split Spoon
SURFACE ELEV.

Depth in Feet	Relative Drilling Resistance	Graphical Log	Sample	Sample Type	Blows/ft. 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								SM		**SILTY SAND** reddish-brown, moist dry at 1.5', tannish
5										End of Boring @ 5'
10										
15										
20										
25										
30										
35										
40										
45										
50										
55										
60										

GROUNDWATER

	DEPTH	HOUR	DATE
▽	none		
▼			

SAMPLE TYPE
A-Auger Cuttings; NR-No Recovery
RC - Rock Core
S-2" O.D., 1.38" I.D. tube sample
U-3" O.D. 2.42" I.D. tube sample
T-3" O.D. thin walled Shelby tube

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Boring Log

wood.	Project: Sanostee Wash Bridge 1951700007	Page 1 of 2	Boring No.: **B-08**
	Location: Sanostee, NM		
Date Started: 4/29/2019	Driller / Company: Enviro-Drill, Inc	Backfill: Soil Cuttings	
Date Completed: 4/30/2019	Drilling Method: HSA	Total Depth: 50.3 ft	
Northing 197,915	Drill Rig Type: CME 75	Casing Type: NA	Depth: 50.3 ft
Easting 2,418,302	Field Observation / Logging: G Davies	Depth to Groundwater: 25 ft	
Surface Elevation: 5923 ft	Checked By: Date:		

Depth (ft)	Legend	Material Description	Elevation (ft)	Field: Sample ID	Field: Blow Count 6"-12"-18" (N)	Field: Sample	Field: Sample Type	Field: Recovery (%)	Lab: LL (%)	Lab: PI (%)	Lab: Moisture (%)	Lab: % Passing 1"	Lab: % Passing #4	Lab: % Passing #10	Lab: % Passing #40	Lab: % Passing #100	Lab: % Passing #200
1		Gravelly silty **SAND (SM),** predominantly fine grained, nonplastic, brown.		B-8; 0'	3-4-12		SS	100			7						
2																	
3				B-8; 2.5'	17-12-22		SS	100	NV	NP	3	100	69	62	51	28	17
4																	
5																	
6				B-8; 5'	9-12-12		SS	150			7						
7																	
8				B-8; 7.5'	9-16-14		SS	100			5						
9																	
10																	
11				B-8; 10'	8-16		RS	100			2						
12																	
13																	
14																	
15																	
16				B-8; 15'	13-39		RS	100			2						
17																	
18																	
19																	
20																	
21				B-8; 20'	1-5		RS	30									
22																	
23																	
24																	
25			5898.0														
		ATD 4/30/2019															
26				B-8; 25'	33-12-10		SS	100			13						
27																	
28		Gravelly silty **SAND (SM),** gravel to 3/4", predominantly fine grained, nonplastic, brown-tan brown.															
29																	
30																	
31				B-8; 30'	23-14-18		SS	100	NV	NP	12	100	68	57	44	22	14
32																	
33																	
34																	
35																	
36				B-15; 36'	3-2-3		SS	45			10						
37																	

AMEC BORING LOG 1951700007 PT 2.GPJ RANT 2017.GDT 5/22/19

ATD- At Time of Drilling

Boring Log

wood.	Project: Sanostee Wash Bridge 1951700007	Page 2 of 2	Boring No.: **B-08**
	Location: Sanostee, NM		
Date Started: 4/29/2019	Driller / Company: Enviro-Drill, Inc	Backfill: Soil Cuttings	
Date Completed: 4/30/2019	Drilling Method: HSA	Total Depth: 50.3 ft	
Northing 197,915	Drill Rig Type: CME 75	Casing Type: NA	Depth: 50.3 ft
Easting 2,418,302	Field Observation / Logging: G Davies		
Surface Elevation: 5923 ft	Checked By: Date:	Depth to Groundwater: 25 ft	

Depth (ft)	Legend	Material Description	Elevation (ft)	Field: Sample ID	Field: Blow Count 6"-12"-18" (N)	Field: Sample	Field: Sample Type	Field: Recovery (%)	Lab: LL (%)	Lab: PI (%)	Lab: Moisture (%)	Lab: % Passing 1"	Lab: % Passing #4	Lab: % Passing #10	Lab: % Passing #40	Lab: % Passing #100	Lab: % Passing #200
38		Gravelly silty **SAND (SM),** gravel to 3/4", predominantly fine grained, nonplastic, brown-tan brown.															
39																	
40																	
41				B-8; 40'	3-18-21	X	SS	100			14						
42																	
43																	
44																	
45			5878.0														
46		Silty **SAND (SM),** with gravel, fine grained, nonplastic, dark brown. (Completely Weathered Shale)		B-8; 45'	43-50/5	X	SS	100	NV	NP	11	100	85	78	66	34	19
47																	
48																	
49																	
50			5872.7	B-8; 50'	50/4	X	SS	100			16						
		Stopped Auger at 50' Sampler Refused at 50'4"															

AMEC BORING LOG 1951700007 PT 2.GPJ RANT 2017.GDT 5/22/19

ATD- At Time of Drilling

Boring Log

wood.

Project:	Sanostee Wash Bridge 1951700007	Page 1 of 2	Boring No.: **B-09**
Location:	Sanostee, NM		
Date Started: 4/30/2019	Driller / Company: Enviro-Drill, Inc	Backfill: Soil Cuttings	
Date Completed: 5/1/2019	Drilling Method: HSA	Total Depth: 68.0 ft	
Northing 1,979,155	Drill Rig Type: CME 75	Casing Type: NA	Depth: 68.0 ft
Easting 2,418,318	Field Observation / Logging: G Davies		
Surface Elevation: 5923 ft	Checked By: Date:	Depth to Groundwater: 20 ft	

Depth (ft)	Legend	Material Description	Elevation (ft)	Field: Sample ID	Field: Blow Count 6"-12"-18" (N)	Field: Sample	Field: Sample Type	Field: Recovery (%)	Lab: LL (%)	Lab: PI (%)	Lab: Moisture (%)	Lab: % Passing 1"	Lab: % Passing #4	Lab: % Passing #10	Lab: % Passing #40	Lab: % Passing #100	Lab: % Passing #200
1		Sandy **GRAVEL (GP-GM),** some silt, fine to medium grained, nonplastic, brown.		B-9; 0'	3-4-6		SS	73			7						
2																	
3				B-9; 2.5'	26-21		RS	100			4						
4																	
5																	
6				B-9; 5'	12-11-11		SS	87			4						
7																	
8				B-9; 7.5'	19-15		RS	100			2						
9																	
10																	
11				B-9; 10'	6-7-6		SS	0	NV	NP	3	81	44	38	31	18	11
12																	
13																	
14			5909.0														
15		Silty **SAND (SM)** with gravel, gravel to 1", predominantly fine to medium grained, nonplastic, brown-gray.															
16				B-9; 15'	37-36-23		SS	87			3						
17																	
18																	
19																	
20		ATD 4/30/2019															
21			5902.0	B-9; 20'	11-16-17		SS	100	NV	NP	11	94	71	59	37	19	13
22		Gravelly silty **SAND (SM),** gravel to 1", predominantly fine to medium grained, nonplastic, brown-gray.															
23																	
24																	
25																	
26				B-9; 25'	14-14-12		SS	87			13						
27																	
28																	
29																	
30																	
31				B-9; 30'	10-50/6"		SS	80	NV	NP	12	91	58	50	38	21	13
32																	
33																	
34			5889.0														
35		Sandy **CLAY (CL),** low to medium plasticity, red-brown.															
36				B-15; 36'	3-3-3		SS	47			26						
37																	

AMEC BORING LOG 1951700007 PT 2.GPJ RANT 2017.GDT 5/22/19

ATD- At Time of Drilling

Boring Log

wood.	Project: Sanostee Wash Bridge 1951700007	Page 2 of 2	Boring No.: **B-09**
	Location: Sanostee, NM		
Date Started: 4/30/2019	Driller / Company: Enviro-Drill, Inc	Backfill: Soil Cuttings	
Date Completed: 5/1/2019	Drilling Method: HSA	Total Depth: 68.0 ft	
Northing 1,979,155	Drill Rig Type: CME 75	Casing Type: NA	Depth: 68.0 ft
Easting 2,418,318	Field Observation / Logging: G Davies		
Surface Elevation: 5923 ft	Checked By: Date:	Depth to Groundwater: 20 ft	

Depth (ft)	Legend	Material Description	Elevation (ft)	Field: Sample ID	Field: Blow Count 6"-12"-18" (N)	Field: Sample	Field: Sample Type	Field: Recovery (%)	Lab: LL (%)	Lab: PI (%)	Lab: Moisture (%)	Lab: % Passing 1"	Lab: % Passing #4	Lab: % Passing #10	Lab: % Passing #40	Lab: % Passing #100	Lab: % Passing #200
38		Sandy **CLAY (CL),** low to medium plasticity, red-brown.															
39																	
40			5883.0														
41		Gravelly **CLAY (CL),** gravel to 1", low plasticity, gray. (Completely Weathered Shale)		B-9; 40'	8-19-27	X	SS	53			13						
42																	
43																	
44																	
45																	
46				B-9; 45'	41-28-32	X	SS	47			14						
47																	
48																	
49																	
50			5873.0														
51		**SHALE,** fresh to slightly weathered, highly fractured.		B-9; 50'	50/0.5"		SS	100									
52																	
53																	
54																	
55																	
56																	
57																	
58																	
59																	
60																	
61																	
62																	
63																	
64																	
65																	
66																	
67																	
68			5855.0														
		Stopped Coring at 68'															

AMEC BORING LOG 1951700007 PT 2.GPJ RANT 2017.GDT 5/22/19

ATD- At Time of Drilling

Boring Log

wood.

Project:	Sanostee Wash Bridge 1951700007	Page 1 of 2	Boring No.: **B-10**
Location:	Sanostee, NM		
Date Started: 5/2/2019	Driller / Company: Enviro-Drill, Inc	Backfill: Soil Cuttings	
Date Completed: 5/4/2019	Drilling Method: HSA	Total Depth: 71.0 ft	
Northing 1,979,288	Drill Rig Type: CME 75	Casing Type: NA	Depth: 71.0 ft
Easting 2,418,363	Field Observation / Logging: G Davies		
Surface Elevation: 5923 ft	Checked By: Date:	Depth to Groundwater: 20 ft	

Depth (ft)	Legend	Material Description	Elevation (ft)	Field: Sample ID	Field: Blow Count 6"-12"-18" (N)	Field: Sample	Field: Sample Type	Field: Recovery (%)	Lab: LL (%)	Lab: PI (%)	Lab: Moisture (%)	Lab: % Passing 1"	Lab: % Passing #4	Lab: % Passing #10	Lab: % Passing #40	Lab: % Passing #100	Lab: % Passing #200
1		Gravelly silty **SAND (SM),** gravel to 3/4", fine to medium grained, nonplastic, brown.		B-10; 0'	6-10-13	X	SS	53			5						
2																	
3				B-10; 2.5'	9-29-31	X	SS	67			4						
4																	
5																	
6				B-10; 5'	5-12-9	X	SS	100			6						
7																	
8				B-10; 7.5'	16-22-31	X	SS	73			3						
9																	
10																	
11				B-10; 10'	16-42-19	X	SS	80	NV	NP	3	100	65	54	36	20	14
12																	
13																	
14																	
15																	
16				B-10; 15'	35-29-36	X	SS	100			3						
17																	
18																	
19			5904.0														
20		▽ ATD 5/2/2019															
21				B-10; 20'	19-30	■	RS	100			6						
22																	
23		Gravelly **SAND (SP-SM),** some silt, some cobbles, gravel to 1", predominantly fine grained, nonplastic, gray-brown.															
24																	
25																	
26				B-10; 25'	12-15-12	X	SS	73			12						
27																	
28																	
29																	
30																	
31				B-10; 30'	7-13	■	RS	100			9						
32																	
33																	
34																	
35																	
36				B-15; 36'	12-32-28	X	SS	67	NV	NP	13	91	55	45	33	19	12
37																	

AMEC BORING LOG 1951700007 PT 2.GPJ RANT 2017.GDT 5/22/19

ATD- At Time of Drilling

Boring Log

wood.	Project: Sanostee Wash Bridge 1951700007	Page 2 of 2	Boring No.: **B-10**
	Location: Sanostee, NM		
Date Started: 5/2/2019	Driller / Company: Enviro-Drill, Inc	Backfill: Soil Cuttings	
Date Completed: 5/4/2019	Drilling Method: HSA	Total Depth: 71.0 ft	
Northing 1,979,288	Drill Rig Type: CME 75	Casing Type: NA	Depth: 71.0 ft
Easting 2,418,363	Field Observation / Logging: G Davies		
Surface Elevation: 5923 ft	Checked By: Date:	Depth to Groundwater: 20 ft	

Depth (ft)	Legend	Material Description	Elevation (ft)	Field: Sample ID	Field: Blow Count 6"-12"-18" (N)	Field: Sample	Field: Sample Type	Field: Recovery (%)	Lab: LL (%)	Lab: PI (%)	Lab: Moisture (%)	Lab: % Passing 1"	Lab: % Passing #4	Lab: % Passing #10	Lab: % Passing #40	Lab: % Passing #100	Lab: % Passing #200
38		Gravelly **SAND (SP-SM),** some silt, some cobbles, gravel to 1", predominantly fine grained, nonplastic, gray-brown.															
39																	
40																	
41			5882.0	B-10; 40'	6-12-30	X	SS	73			11						
42		Sandy **CLAY (CL),** some gravel to 3/4", medium plasticity, gray.															
43																	
44																	
45			5878.0														
46		**SHALE,** fresh to slightly weathered, highly fractured.		B-10; 45'	11-31-50/5"	X	SS	100	33	16	18	100	88	85	79	67	52
47																	
48																	
49																	
50																	
51																	
52																	
53																	
54																	
55																	
56																	
57																	
58																	
59																	
60																	
61																	
62																	
63																	
64																	
65																	
66																	
67																	
68																	
69																	
70																	
71			5852.0														
		Stopped Coring at 71'															

AMEC BORING LOG 1951700007 PT 2.GPJ RANT 2017.GDT 5/22/19

ATD- At Time of Drilling

Boring Log

wood.	Project: Sanostee Wash Bridge 1951700007	Page 1 of 3	Boring No.: **B-11**
	Location: Sanostee, NM		
Date Started: 2/25/2019	Driller / Company: Geomat	Backfill: Soil Cuttings	
Date Completed: 2/25/2019	Drilling Method: HSA	Total Depth: 70.0 ft	
Northing	Drill Rig Type:	Casing Type: NA	Depth: 70.0 ft
Easting	Field Observation / Logging:	Depth to Groundwater: 24 ft	
Surface Elevation:	Checked By: Date:		

Depth (ft)	Legend	Material Description	Elevation (ft)	Field: Sample ID	Field: Blow Count 6"-12"-18" (N)	Field: Sample	Field: Sample Type	Field: Recovery (%)	Lab: LL (%)	Lab: PI (%)	Lab: Moisture (%)	Lab: % Passing 1"	Lab: % Passing #4	Lab: % Passing #10	Lab: % Passing #40	Lab: % Passing #100	Lab: % Passing #200
1		Silty **SAND (SM),** some gravel to 1/2", predominantly fine to medium grained, nonplastic, brown.															
2																	
3																	
4				B-11; 2.5'	9-14-19	X	SS		NV	NP	4	100	83	73	55	30	19
5																	
6				B-11; 5'	12-16	■	RS				4						
7																	
8																	
9																	
10		Gravelly **SAND (SP-SM),** with silt, predominantly fine to medium grained, nonplastic, gray-brown.															
11				B-11; 10'	16-17-24	X	SS				3						
12																	
13																	
14																	
15																	
16				B-11; 15'	25-40-25	X	SS				4						
17																	
18																	
19																	
20																	
21				B-11; 20'	37-29-42	X	SS		NV	NP	9	100	62	51	36	18	11
22																	
23																	
24		▽ ATD 2/22/2019 10:53:00 AM															
25																	
26				B-11; 25'	5-9-6	X	SS				11						
27																	
28																	
29																	
30																	

AMEC BORING LOG 1951700007.GPJ RANT 2017.GDT 5/22/19

ATD- At Time of Drilling

Boring Log

wood.	Project: Sanostee Wash Bridge 1951700007	Page 2 of 3	Boring No.: **B-11**
	Location: Sanostee, NM		
Date Started: 2/25/2019	Driller / Company: Geomat	Backfill: Soil Cuttings	
Date Completed: 2/25/2019	Drilling Method: HSA	Total Depth: 70.0 ft	
Northing	Drill Rig Type:		
Easting	Field Observation / Logging:	Casing Type: NA	Depth: 70.0 ft
Surface Elevation:	Checked By: Date:	Depth to Groundwater: 24 ft	

Depth (ft)	Legend	Material Description	Elevation (ft)	Field: Sample ID	Field: Blow Count 6"-12"-18" (N)	Field: Sample	Field: Sample Type	Field: Recovery (%)	Lab: LL (%)	Lab: PI (%)	Lab: Moisture (%)	Lab: % Passing 1"	Lab: % Passing #4	Lab: % Passing #10	Lab: % Passing #40	Lab: % Passing #100	Lab: % Passing #200
31		**SAND (SW-SM),** with silt, well graded, nonplastic, gray-brown.		B-11; 30'		X	SS		NV	NP	15	100	99	81	25	12	8
32																	
33																	
34																	
35																	
36																	
37		Gravelly clayey **SAND (SC),** gravel to 1", predominantly fine grained, medium plasticity, brown.		B-15; 36'	5-4-2	X	SS				18						
38																	
39																	
40																	
41				B-11; 40'	10-9-16	X	SS		25	10	12	88	51	44	35	26	20
42																	
43																	
44																	
45																	
46		**CLAYSTONE,** weathered, black.		B-11; 45'	50/5"	X	SS				17						
47																	
48																	
49																	
50																	
51				B-11; 50'	50/6"	X	SS				18						
52																	
53																	
54																	
55																	
56																	
57																	
58																	
59																	
60																	

AMEC BORING LOG 1951700007.GPJ RANT 2017.GDT 5/22/19

ATD- At Time of Drilling

Boring Log

wood.	Project: Sanostee Wash Bridge 1951700007	Page 3 of 3	Boring No.: **B-11**
	Location: Sanostee, NM		
Date Started: 2/25/2019	Driller / Company: Geomat	Backfill: Soil Cuttings	
Date Completed: 2/25/2019	Drilling Method: HSA	Total Depth: 70.0 ft	
Northing	Drill Rig Type:	Casing Type: NA	Depth: 70.0 ft
Easting	Field Observation / Logging:	Depth to Groundwater: 24 ft	
Surface Elevation:	Checked By: Date:		

Depth (ft)	Legend	Material Description	Elevation (ft)	Field: Sample ID	Field: Blow Count 6"-12"-18" (N)	Field: Sample	Field: Sample Type	Field: Recovery (%)	Lab: LL (%)	Lab: PI (%)	Lab: Moisture (%)	Lab: % Passing 1"	Lab: % Passing #4	Lab: % Passing #10	Lab: % Passing #40	Lab: % Passing #100	Lab: % Passing #200
61																	
62																	
63																	
64																	
65																	
66																	
67																	
68																	
69																	
70		Stopped auger at 70'															

AMEC BORING LOG 1951700007.GPJ RANT 2017.GDT 5/22/19

ATD- At Time of Drilling

PROJECT Sanostee Wash Bridge
Sanostee, New Mexico
DATE 2/26/19
WOOD E & IS PROJECT NO. 19-517-00007

wood.

 BORING NO. B-12

LOCATION See Site Plan
DRILLING CO.
RIG TYPE CME-55
BORING TYPE 8" Auger/Split Spoon
SURFACE ELEV.

Depth in Feet	Relative Drilling Resistance	Graphical Log	Sample	Sample Type	Blows/ft. 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								SM		trace rock 3/4" minus, reddish, dry at 1'
5										End of Boring @ 5'
10										
15										
20										
25										
30										
35										
40										
45										
50										
55										
60										

GROUNDWATER

	DEPTH	HOUR	DATE
▽	none		
▼			

SAMPLE TYPE
A-Auger Cuttings; NR-No Recovery
RC - Rock Core
S-2" O.D., 1.38" I.D. tube sample
U-3" O.D. 2.42" I.D. tube sample
T-3" O.D. thin walled Shelby tube

Wood Environment & Infrastructure Solutions, Inc.
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Albuquerque, NM 87113
(505) 821-1801
FAX (505) 821-7371

PROJECT Sanostee Wash Bridge
Sanostee, New Mexico
DATE 2/26/19
WOOD E & IS PROJECT NO. 19-517-00007

wood.

 BORING NO. B-13

LOCATION See Site Plan
DRILLING CO.
RIG TYPE CME-55
BORING TYPE 8" Auger/Split Spoon
SURFACE ELEV.

Depth in Feet	Relative Drilling Resistance	Graphical Log	Sample	Sample Type	Blows/ft. 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								CL		**CLAYEY SAND WITH ROCK** 3/4" minus, light brown dry at 2'
5										End of Boring @ 5'
10										
15										
20										
25										
30										
35										
40										
45										
50										
55										
60										

GROUNDWATER

	DEPTH	HOUR	DATE
▽	none		
▼			

SAMPLE TYPE
A-Auger Cuttings; NR-No Recovery
RC - Rock Core
S-2" O.D., 1.38" I.D. tube sample
U-3" O.D. 2.42" I.D. tube sample
T-3" O.D. thin walled Shelby tube

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Albuquerque, NM 87113
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PROJECT Sanostee Wash Bridge
Sanostee, New Mexico
DATE 2/26/19
WOOD E & IS PROJECT NO. 19-517-00007

wood.

 BORING NO. B-14

LOCATION See Site Plan
DRILLING CO.
RIG TYPE CME-55
BORING TYPE 8" Auger/Split Spoon
SURFACE ELEV.

Depth in Feet	Relative Drilling Resistance	Graphical Log	Sample	Sample Type	Blows/ft. 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								CL		**CLAYEY SAND** light brown
5										trace rock at 4'
										End of Boring @ 5'
10										
15										
20										
25										
30										
35										
40										
45										
50										
55										
60										

GROUNDWATER

	DEPTH	HOUR	DATE
▽	none		
▼			

SAMPLE TYPE
A-Auger Cuttings; NR-No Recovery
RC - Rock Core
S-2" O.D., 1.38" I.D. tube sample
U-3" O.D. 2.42" I.D. tube sample
T-3" O.D. thin walled Shelby tube

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PROJECT Sanostee Wash Bridge
Sanostee, New Mexico
DATE 2/26/19
WOOD E & IS PROJECT NO. 19-517-00007

wood.

Page 1 of 1 **BORING NO.** B-15

LOCATION See Site Plan
DRILLING CO.
RIG TYPE CME-55
BORING TYPE 8" Auger/Split Spoon
SURFACE ELEV.

Depth in Feet	Relative Drilling Resistance	Graphical Log	Sample	Sample Type	Blows/ft. 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								CL		**CLAYEY SAND** brown, moist
										dry at 2'
5										End of Boring @ 5'
10										
15										
20										
25										
30										
35										
40										
45										
50										
55										
60										

GROUNDWATER

	DEPTH	HOUR	DATE
▽	none		
▼			

SAMPLE TYPE
A-Auger Cuttings; NR-No Recovery
RC - Rock Core
S-2" O.D., 1.38" I.D. tube sample
U-3" O.D. 2.42" I.D. tube sample
T-3" O.D. thin walled Shelby tube

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PROJECT Sanostee Wash Bridge
Sanostee, New Mexico
DATE 2/26/19
WOOD E & IS PROJECT NO. 19-517-00007

wood.

BORING NO. B-16

LOCATION See Site Plan
DRILLING CO.
RIG TYPE CME-55
BORING TYPE 8" Auger/Split Spoon
SURFACE ELEV.

Depth in Feet	Relative Drilling Resistance	Graphical Log	Sample	Sample Type	Blows/ft. 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								SM		**SILTY SAND** 3/4" minus rock at surface dry at 1.5'
5										End of Boring @ 5'
10										
15										
20										
25										
30										
35										
40										
45										
50										
55										
60										

GROUNDWATER

	DEPTH	HOUR	DATE
▽	none		
▼			

SAMPLE TYPE
A-Auger Cuttings; NR-No Recovery
RC - Rock Core
S-2" O.D., 1.38" I.D. tube sample
U-3" O.D. 2.42" I.D. tube sample
T-3" O.D. thin walled Shelby tube

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Appendix B

Laboratory Testing Procedures

and Results

APPENDIX B

LABORATORY TESTING PROCEDURES AND RESULTS

The following paragraphs describe our procedures associated with the laboratory tests Wood E&I conducted for this project. Graphical results of certain laboratory tests are enclosed in this appendix.

Visual Classification Procedures

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

Moisture Content Determination Procedures

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

Grain-size Analysis Procedures

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

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

Attn: Myra Candelaria

Project Name: Sanostee Bridge

Sanostee, NM

PO Number: 1710009000-Task#14

Project Manager: Carlo Evangelisti

Report Date: March 18, 2019

Project #: 19-517-00007
Report #: 2230
Work Order #: 1
Sampled By: Jacob Hays
Date Sampled: 2/28/2019

SOILS / AGGREGATES

MOISTURE CONTENT OF SOIL (ASTM D2216-10) AND IN-SITU DENSITY

Lab #	Color & Type of Material	Sample Source	Test Method	Oven Temp. (C)	Mass less than Min Req.	Material Type *	Moisture (%)	Dry Density (pcf)
19-0095-01	Tan Clayey Sand	B-1 (0'-5')	B	110			13.1	
19-0095-02	Tan Clayey Sand	B-2 (0'-5')	B	110			12.2	
19-0095-03	Tan Clayey Sand	B-3 (0'-5')	B	110			11.8	
19-0095-04	Light Brown Sand	B-4 (0'-5')	B	110			8.1	
19-0095-05	Reddish Light Brown Sand	B-5 (0'-5')	B	110			9.6	
19-0095-06	Reddish Sandy Silt	B-6 (0'-5')	B	110			10.5	
19-0095-07	Reddish Sand	B-7 (0'-5')	B	110			2.4	
19-0095-08	Reddish Sand	B-12 (0'-5')	B	110			9.5	
19-0095-09	Light Brown Silty Sand	B-13 (0'-5')	B	110			7.8	
19-0095-10	Light Brown Silty Sand	B-14 (0'-5')	B	110			7.2	
19-0095-11	Light Brown Clayey Sand	B-15 (0'-5')	B	110			7.9	
19-0095-12	Reddish Silty Sand	B-16 (0'-5')	B	110			10.4	

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

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

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wood.

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

Attention: Myra Candelaria

Project Name: Sanostee Bridge

Sanostee, NM

PO Number: 1710009000-Task#14

Project Manager: Carlo Evangelisti

Report Date: March 18, 2019

Project #: 19-517-00007
Work Order #: 1
Sampled By: Jacob Hays
Date Sampled: 2/28/2019

Sieve Analysis (AASHTO T11-05/T27-11)
Plasticity Index (AASHTO T89-10/T90-00)
Soil Classification (AASHTO M145-91)

SOILS / AGGREGATES

				Sieve Sizes																				Sieve Result are as Percent Passing.
Sample Location	**Soil Class.**	**L.L.**	**P.I.**	**#200**	**#100**	**#50**	**#40**	**#30**	**#16**	**#10**	**#8**	**#4**	**1/4"**	**3/8"**	**1/2"**	**3/4'**	**1"**	**1 1/4"**	**1 1/2"**	**2"**	**2 1/2"**	**3"**	**6"**	**12"**	**Lab Number**
B-1 (0'-5')	A-7-6	46	30	95	99	100																		19-0095-01
B-2 (0'-5')	A-7-6	49	33	95	99	100																		19-0095-02
B-3 (0'-5')	A-7-6	45	27	95	99	100																		19-0095-03
B-4 (0'-5')	A-6	29	15	73	88	96	98	98	99	99	99	99		100										19-0095-04
B-5 (0'-5')	A-6	26	11	69	78	91	96	98	99	99	100													19-0095-05
B-6 (0'-5')	A-6	38	20	77	93	99	100																	19-0095-06
B-7 (0'-5')	A-2-4	NV	NP	31	73	95	98	99	100															19-0095-07
B-12 (0'-5')	A-4	NV	NP	49	73	87	89	90	91	92	92	93		95	95	98	100							19-0095-08
B-13 (0'-5')	A-6	31	17	71	86	94	96	96	97	97	97	97		97	97	97	100							19-0095-09
B-14 (0'-5')	A-6	27	14	55	69	79	81	83	85	87	88	91		95	97	100								19-0095-10
B-15 (0'-5')	A-6	30	19	67	87	96	98	98	99	100														19-0095-11
B-16 (0'-5')	A-4	23	8	68	88	97	98	99	100															19-0095-12

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

Attn: Myra Candelaria

Project Name: Sanostee Bridge

PO Number: 1710009000-Task#14

Project Manager: Carlo Evangelisti

Report Date: March 18, 2019

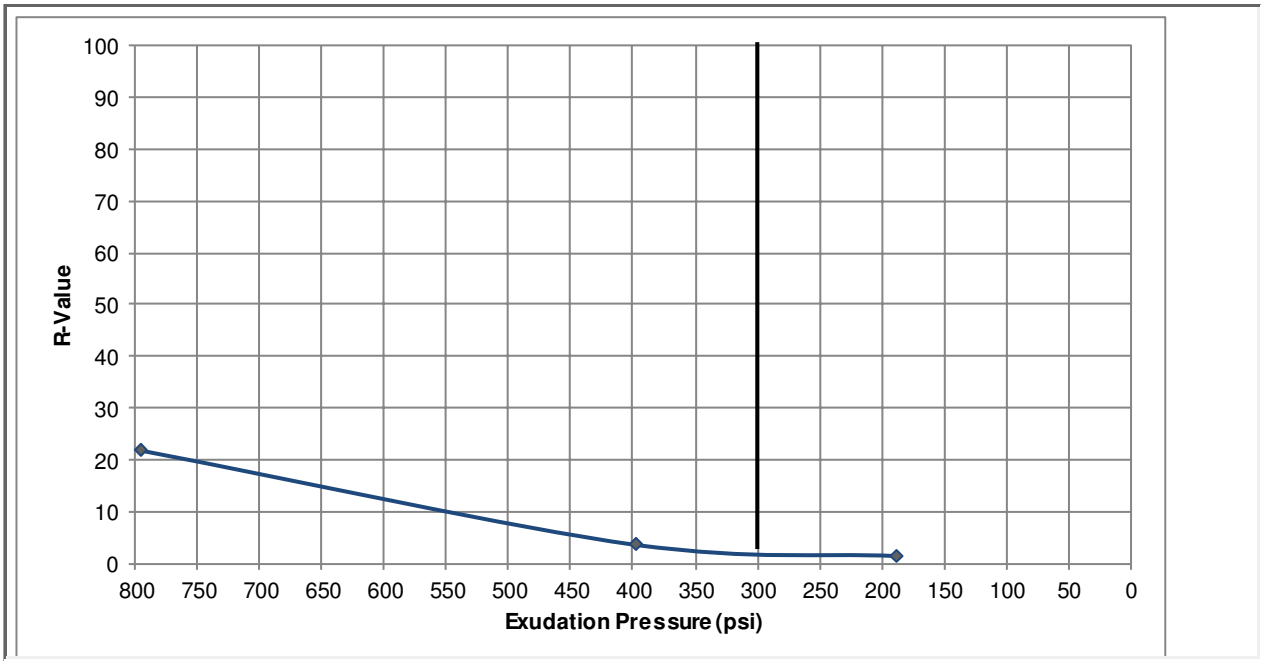
Project #: 19-517-00007
Work Order #: 1
Lab #: 19-0095-13
Sampled By: Jacob Hays
Date Sampled: 2/28/2019
Color & Type of Material: Combined Sample

Sample Source: Combined: B-1, B-2 & B-3

SOILS / AGGREGATES

RESISTANCE R-VALUE AND EXPANSION PRESSURE OF COMPACTED SOILS (AASHTO T190-09)

Specimen Id.	A	B	C
Moisture (%):	18.8%	21.2%	24.1%
Compactor Pressure (psi):	150	90	50
Specimen Height (in):	2.55	2.55	2.55
Dry Density (pcf):	106.7	106.6	99.4
Horizontal Pressure @ 1000lbs (psi):	44	70	72
Horizontal Pressure @ 2000lbs (psi):	114	150	152
Displacement:	3.61	4.31	9.54
Expansion Pressure (psi):	-0.812	0.030	-0.180
Exudation Pressure (psi):	796	398	188
R-Value:	22	4	1



R-Value at 300psi: 2

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Project Name: Sanostee Bridge

PO Number: 1710009000-Task#14

Project Manager: Carlo Evangelisti

Report Date: March 18, 2019

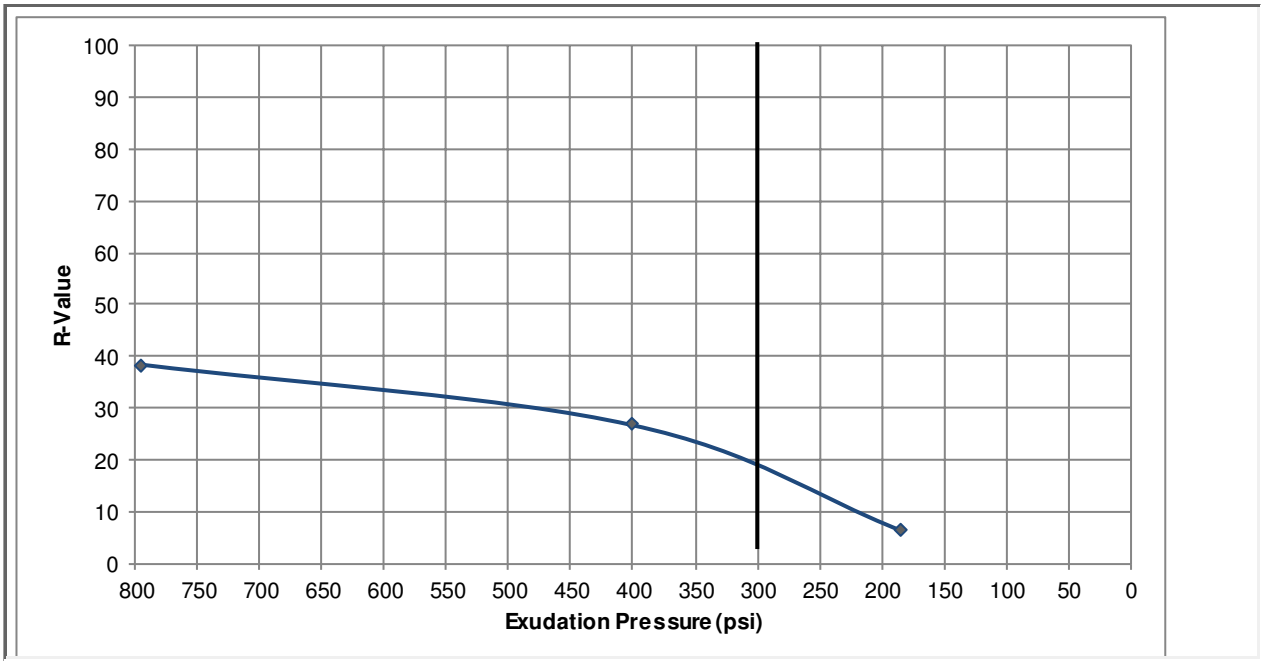
Project #: 19-517-00007
Work Order #: 1
Lab #: 19-0095-14
Sampled By: Jacob Hays
Date Sampled: 2/28/2019
Color & Type of Material: Combined Sample

Sample Source: Combined: B-4 & B-5

SOILS / AGGREGATES

RESISTANCE R-VALUE AND EXPANSION PRESSURE OF COMPACTED SOILS (AASHTO T190-09)

Specimen Id.	A	B	C
Moisture (%):	11.9%	13.3%	16.1%
Compactor Pressure (psi):	290	170	50
Specimen Height (in):	2.45	2.47	2.55
Dry Density (pcf):	118.2	116.9	110.6
Horizontal Pressure @ 1000lbs (psi):	33	43	65
Horizontal Pressure @ 2000lbs (psi):	80	100	144
Displacement:	4.03	4.06	4.09
Expansion Pressure (psi):	-0.902	-0.692	-0.120
Exudation Pressure (psi):	796	401	185
R-Value:	38	27	6



R-Value at 300psi: 18

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Project Name: Sanostee Bridge

PO Number: 1710009000-Task#14

Project Manager: Carlo Evangelisti

Report Date: March 18, 2019

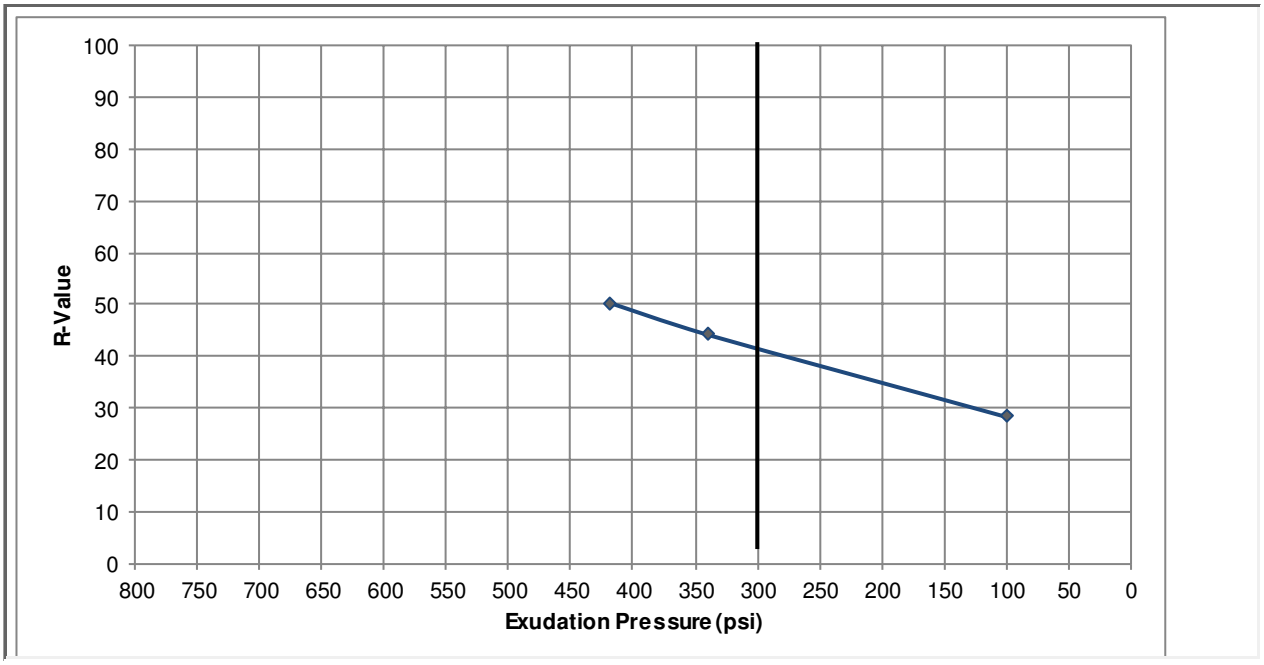
Project #: 19-517-00007
Work Order #: 1
Lab #: 19-0095-15
Sampled By: Jacob Hays
Date Sampled: 2/28/2019
Color & Type of Material: Combined Sample

Sample Source: Combined: B-6, B-7, B-12 & B-16

SOILS / AGGREGATES

RESISTANCE R-VALUE AND EXPANSION PRESSURE OF COMPACTED SOILS (AASHTO T190-09)

Specimen Id.	A	B	C
Moisture (%):	12.7%	13.7%	15.5%
Compactor Pressure (psi):	220	170	60
Specimen Height (in):	2.50	2.50	2.55
Dry Density (pcf):	110.1	116.3	116.5
Horizontal Pressure @ 1000lbs (psi):	27	27	41
Horizontal Pressure @ 2000lbs (psi):	54	59	82
Displacement:	4.85	5.37	5.99
Expansion Pressure (psi):	-0.752	-0.120	0.000
Exudation Pressure (psi):	419	340	99
R-Value:	50	44	28



R-Value at 300psi: 41

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Attn: Myra Candelaria

Project Name: Sanostee Bridge

PO Number: 1710009000-Task#14

Project Manager: Carlo Evangelisti

Report Date: March 18, 2019

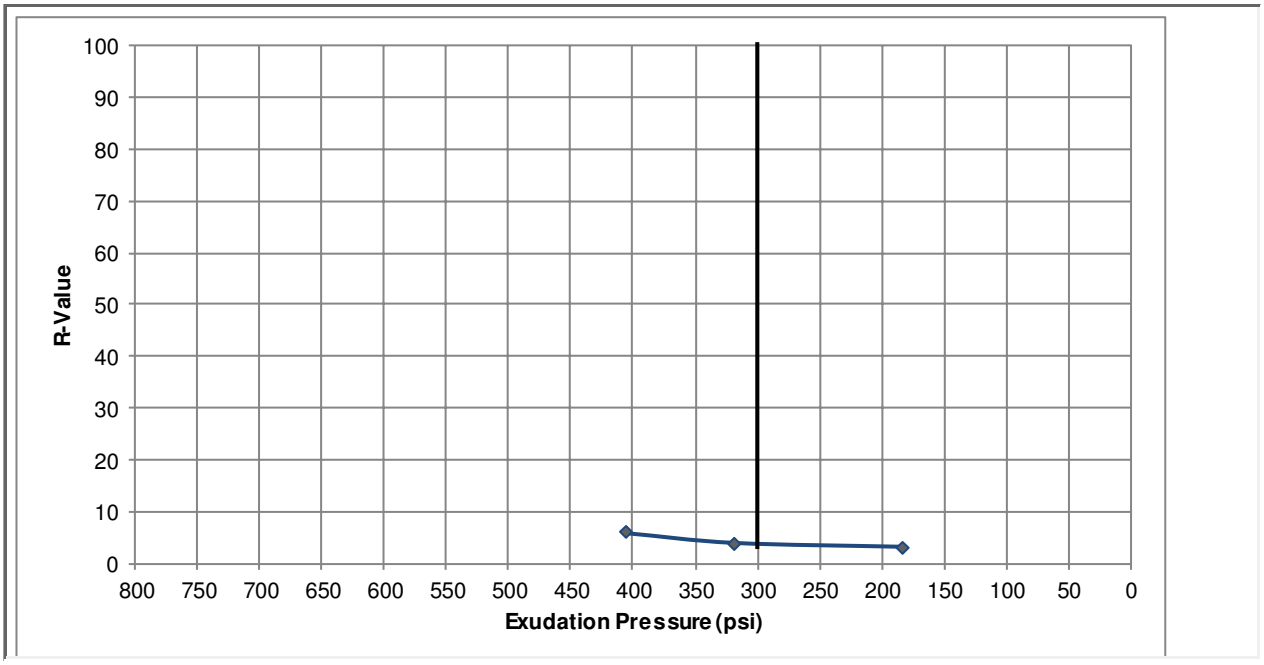
Project #: 19-517-00007
Work Order #: 1
Lab #: 19-0095-16
Sampled By: Jacob Hays
Date Sampled: 2/28/2019
Color & Type of Material: Combined Sample

Sample Source: Combined: B-13, B-14 & B-15

SOILS / AGGREGATES

RESISTANCE R-VALUE AND EXPANSION PRESSURE OF COMPACTED SOILS (AASHTO T190-09)

Specimen Id.	A	B	C
Moisture (%):	15.6%	16.6%	18.9%
Compactor Pressure (psi):	80	70	40
Specimen Height (in):	2.55	2.51	2.55
Dry Density (pcf):	111.9	109.8	105.4
Horizontal Pressure @ 1000lbs (psi):	65	65	67
Horizontal Pressure @ 2000lbs (psi):	145	148	150
Displacement:	4.08	4.98	5.24
Expansion Pressure (psi):	0.301	-0.210	0.090
Exudation Pressure (psi):	406	318	183
R-Value:	6	4	3



R-Value at 300psi: 3

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Attn: Myra Candelaria

Project Name: Sanostee Bridge

Sanostee, NM

PO Number: 1710009000-Task#14

Project Manager: Carlo Evangelisti

Report Date: March 14, 2019

Project #: 19-517-00007
Report #: 2229
Work Order #: 2
Sampled By: Jacob Hays
Date Sampled: 2/27/2019

SOILS / AGGREGATES

MOISTURE CONTENT OF SOIL (ASTM D2216-10) AND IN-SITU DENSITY

Lab #	Color & Type of Material	Sample Source	Test Method	Oven Temp. (C)	Mass less than Min Req.	Material Type *	Moisture (%)	Dry Density (pcf)
19-0099-01	Reddish Sand	B-11 (2.5-4.0')	B	110			4.4	
19-0099-02	Reddish Sand	B-11 (5.0-5.5')	B	110			4.4	117.6
19-0099-03	Reddish Sand	B-11 (10.0-11.5')	B	110			2.6	
19-0099-04	Light Brown Sand	B-11 (15.0-16.5')	B	110			3.6	
19-0099-05	Light Brown Sand	B-11 (20.0-21.5')	B	110			9.2	
19-0099-06	Light Brown Sand	B-11 (25.0-26.5')	B	110			11.0	
19-0099-07	Coarse Sand	B-11 (30.0-31.5')	B	110			14.7	
19-0099-08	Reddish Silt	B-11 (36.0-37.0')	B	110			18.0	
19-0099-09	Tan Clay	B-11 (40.0-41.5')	B	110			11.7	
19-0099-10	Black Shale	B-11 (45.0-46.5')	B	110			16.5	
19-0099-11	Black Shale	B-11 (50.0-51.0')	B	110			17.6	
19-0099-12	Black Shale	B-11 (65.0-70.0')	B	110			18.3	

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

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

Attn: Myra Candelaria

Project Name: Sanostee Bridge

Sanostee, NM

PO Number: 1710009000-Task#14

Project Manager: Carlo Evangelisti

Report Date: May 14, 2019

Project #: 19-517-00007
Report #: 2249
Work Order #: 3
Sampled By:
Date Sampled:

SOILS / AGGREGATES

MOISTURE CONTENT OF SOIL (ASTM D2216-10) AND IN-SITU DENSITY

Lab #	Color & Type of Material	Sample Source	Test Method	Oven Temp. (C)	Mass less than Min Req.	Material Type *	Moisture (%)	Dry Density (pcf)
19-0223-01	See Boring Log	B-8; 0'	B	110			6.9	
19-0223-02	See Boring Log	B-8; 2.5'	B	110			3.2	
19-0223-03	See Boring Log	B-8; 5'	B	110			6.9	
19-0223-04	See Boring Log	B-8; 7.5'	B	110			5.1	
19-0223-05	See Boring Log	B-8; 10'	B	110			2.4	117.3
19-0223-06	See Boring Log	B-8; 15'	B	110			2.4	
19-0223-07	See Boring Log	B-8; 25'	B	110			13.4	
19-0223-08	See Boring Log	B-8; 30'	B	110			11.5	
19-0223-09	See Boring Log	B-8; 35'	B	110			10.1	
19-0223-10	See Boring Log	B-8; 40'	B	110			13.7	
19-0223-11	See Boring Log	B-8; 45'	B	110			10.9	
19-0223-12	See Boring Log	B-8; 50'	B	110			15.7	
19-0223-13	See Boring Log	B-9; 0'	B	110			6.7	
19-0223-14	See Boring Log	B-9; 2.5'	B	110			4.4	84.7
19-0223-15	See Boring Log	B-9; 5'	B	110			3.7	
19-0223-16	See Boring Log	B-9; 7.5'	B	110			2.4	115.9
19-0223-17	See Boring Log	B-9; 10'	B	110			2.8	
19-0223-18	See Boring Log	B-9; 15'	B	110			3.2	
19-0223-19	See Boring Log	B-9; 20'	B	110			10.9	
19-0223-20	See Boring Log	B-9; 25'	B	110			13.0	
19-0223-21	See Boring Log	B-9; 30'	B	110			11.8	
19-0223-22	See Boring Log	B-9; 35'	B	110			26.1	
19-0223-23	See Boring Log	B-9; 40'	B	110			13.2	
19-0223-24	See Boring Log	B-9; 45'	B	110			13.5	
19-0223-25	See Boring Log	B-10; 0'	B	110			4.7	
19-0223-26	See Boring Log	B-10; 2.5'	B	110			4.2	
19-0223-27	See Boring Log	B-10; 5'	B	110			6.2	
19-0223-28	See Boring Log	B-10; 7.5'	B	110			3.1	
19-0223-29	See Boring Log	B-10; 10'	B	110			2.8	

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

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Client: Wilson & Company
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Albuquerque, NM 87109

Attn: Myra Candelaria

Project Name: Sanostee Bridge

Sanostee, NM

PO Number: 1710009000-Task#14

Project Manager: Carlo Evangelisti

Report Date: May 14, 2019

Project #: 19-517-00007
Report #: 2249
Work Order #: 3
Sampled By:
Date Sampled:

SOILS / AGGREGATES

MOISTURE CONTENT OF SOIL (ASTM D2216-10) AND IN-SITU DENSITY

Lab #	Color & Type of Material	Sample Source	Test Method	Oven Temp. (C)	Mass less than Min Req.	Material Type *	Moisture (%)	Dry Density (pcf)
19-0223-30	See Boring Log	B-10; 15'	B	110			2.7	
19-0223-31	See Boring Log	B-10; 20'	B	110			6.4	133.0
19-0223-32	See Boring Log	B-10; 25'	B	110			11.6	
19-0223-33	See Boring Log	B-10; 30'	B	110			9.0	119.9
19-0223-34	See Boring Log	B-10; 35'	B	110			13.4	
19-0223-35	See Boring Log	B-10; 40'	B	110			11.0	
19-0223-36	See Boring Log	B-10; 45'	B	110			17.5	

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

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Attention: Myra Candelaria

Project Name: Sanostee Bridge

Sanostee, NM

PO Number: 1710009000-Task#14

Project Manager: Carlo Evangelisti

Report Date: March 14, 2019

Project #: 19-517-00007
Work Order #: 2
Sampled By: Jacob Hays
Date Sampled: 2/27/2019

Sieve Analysis (AASHTO T11-05/T27-11)
Plasticity Index (AASHTO T89-10/T90-00)
Soil Classification (AASHTO M145-91)

SOILS / AGGREGATES

				Sieve Sizes																			Sieve Result are as Percent Passing.
Sample Location	**Soil Class.**	**L.L.**	**P.I.**	**#200**	**#100**	**#50**	**#40**	**#30**	**#16**	**#10**	**#8**	**#4**	**1/4"**	**3/8"**	**1/2"**	**3/4'**	**1"**	**1 1/4"**	**1 1/2"**	**2"**	**2 1/2"**	**3"**	**6"**	**12"**	**Lab Number**
B-11 (2.5-4.0')	A-2-4	NV	NP	19	30	47	55	61	68	73	75	83		95	98	100									19-0099-01
B-11 (20.0-21.5')	A-1-b	NV	NP	11	18	31	36	40	46	51	53	62		81	88	100									19-0099-05
B-11 (30.0-31.5')	A-1-b	NV	NP	8.4	12	19	25	33	57	81	87	99		100											19-0099-07
B-11 (40.0-41.5')	A-2-4	25	10	20	26	32	35	38	41	44	45	51		59	65	72	88	100							19-0099-09

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Sanostee, NM

PO Number: 1710009000-Task#14

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Report Date: May 14, 2019

Project #: 19-517-00007

Work Order #: 3

Sampled By:

Date Sampled:

Sieve Analysis (AASHTO T11-05/T27-11)

Plasticity Index (AASHTO T89-10/T90-00)

Soil Classification (AASHTO M145-91)

SOILS / AGGREGATES

				Sieve Sizes																			Sieve Result are as Percent Passing.
Sample Location	**Soil Class.**	**L.L.**	**P.I.**	**#200**	**#100**	**#50**	**#40**	**#30**	**#16**	**#10**	**#8**	**#4**	**1/4"**	**3/8"**	**1/2"**	**3/4'**	**1"**	**1 1/4"**	**1 1/2"**	**2"**	**2 1/2"**	**3"**	**6"**	**12"**	**Lab Number**
B-8; 2.5'	A-2-4	NV	NP	17	28	45	51	54	59	62	63	69		80	86	90	100								19-0223-02
B-8; 30'	A-1-b	NV	NP	14	22	37	44	48	53	57	59	68		81	84	95	100								19-0223-08
B-8; 45'	A-2-4	NV	NP	19	34	56	66	71	75	78	79	85		92	93	100									19-0223-11
B-9; 10'	A-1-b	NV	NP	11	18	28	31	33	36	38	39	44		56	62	71	81	100							19-0223-17
B-9; 20'	A-1-b	NV	NP	13	19	31	37	43	53	59	61	71		85	89	91	94	100							19-0223-19
B-9; 30'	A-1-b	NV	NP	13	21	33	38	41	46	50	51	58		69	72	91	91	100							19-0223-21
B-10; 10'	A-1-b	NV	NP	14	20	30	36	40	48	54	57	65		77	80	86	100								19-0223-29
B-10; 35'	A-1-b	NV	NP	12	19	30	33	36	40	45	47	55		68	71	81	91	100							19-0223-34
B-10; 45'	A-6	33	16	52	67	76	79	81	84	85	86	88		91	91	91	100								19-0223-36

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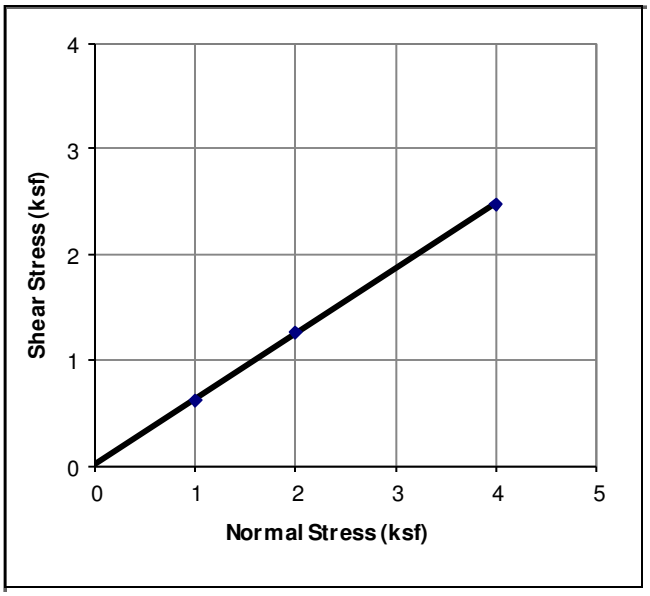
Client:	Wilson & Company 4401 Masthead St. NE, Suite 150 Albuquerque, NM 87109	**Report Date:**	May 14, 2019
		Project #:	19-517-00007
		Work Order #:	3
Attn:	Myra Candelaria	**Lab #:**	19-0223-05
Project Name:	Sanostee Bridge	**Sampled By:**	
		Date Sampled:	
	Sanostee, NM	**Visual Description of Material:**	See Boring Log
PO Number:	1710009000-Task#14	**Sample Source:**	B-8; 10'
Project Manager:	Carlo Evangelisti	**SOILS / AGGREGATES**	

Direct Shear Test of Soils Under Consolidated Drained Conditions (ASTM D3080-04)

Direct Shear Point Number:	1	2	3
Initial Diameter of specimen (in.):	2.42	2.42	2.42
Initial Thickness of specimen (in.):	1.00	1.00	1.00
Dry Mass of Specimen (g):	138.6	139.0	138.6
Initial Moisture (%):	6.9%	3.3%	3.3%
Initial Wet Density (pcf):	122.7	119.0	118.6
Initial Dry Density (pcf):	114.8	115.1	114.8
Final Thickness of specimen (in.)::	0.95	0.97	0.93
Final Moisture (%):	14.6%	14.5%	14.1%
Final Wet Density (pcf):	138.2	135.4	140.4
Final Dry Density (pcf):	120.6	118.3	123.1
Normal Stress (ksf):	1.00	2.00	4.00
Maximum Shearing Stress (ksf):	0.624	1.272	2.484
Vertical Deformation @ Max Shear (in.):	0.003	-0.001	-0.002
Horizontal Deformation @ Max Shear (in.):	0.231	0.196	0.241



Shearing Device Used:
Geomatic Direct Shear Apparatus, Model 8914

Rate of Deformation (in./min.): 0.01

Internal Friction Angle (deg.): 31.7

Cohesion (kips/sq.ft.): 0.0180

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

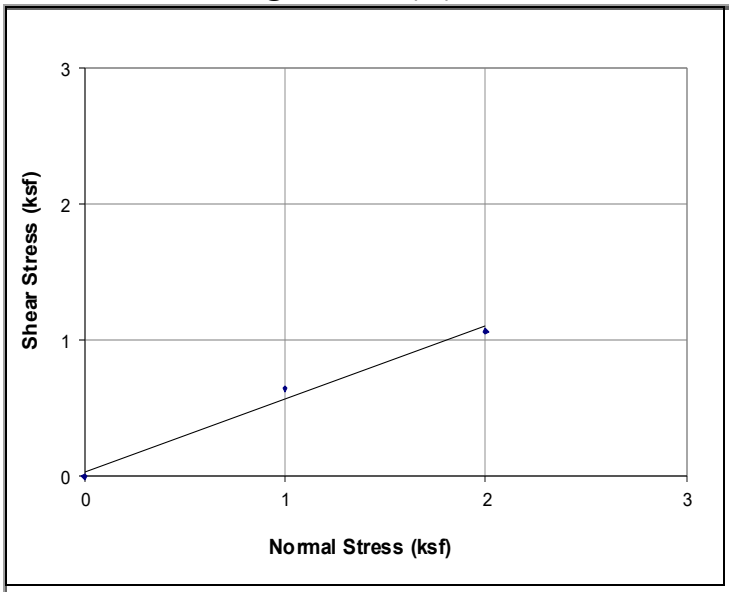
Wood Environment & Infrastructure Solutions, Inc.
8519 Jefferson NE
Albuquerque, NM 87113
Tel 5058211801
Fax 5058217371
www.woodplc.com

Client:	Wilson & Company 4401 Masthead St. NE, Suite 150 Albuquerque, NM 87109	**Report Date:**	May 14, 2019
		Project #:	19-517-00007
		Work Order #:	3
Attn:	Myra Candelaria	**Lab #:**	19-0223-16
Project Name:	Sanostee Bridge	**Sampled By:**	
		Date Sampled:	
	Sanostee, NM	**Visual Description of Material:**	See Boring Log
PO Number:	1710009000-Task#14	**Sample Source:**	B-9; 7.5'
Project Manager:	Carlo Evangelisti		

SOILS / AGGREGATES

Direct Shear Test of Soils Under Consolidated Drained Condition (ASTM D3080-04)

Direct Shear Point Number:	1	2
Initial Diameter of specimen (in.):	2.42	2.42
Initial Thickness of specimen (in.):	1.00	1.00
Dry Mass of Specimen (g):	119.6	132.8
Initial Moisture (%):	6.4%	5.2%
Initial Wet Density (pcf):	105.4	115.7
Initial Dry Density (pcf):	99.0	110.0
Final Thickness of specimen (in.):	0.92	0.92
Final Moisture (%):	14.6%	14.6%
Final Wet Density (pcf):	123.9	136.8
Final Dry Density (pcf):	108.1	119.4
Normal Stress (ksf):	1.00	2.00
Maximum Shearing Stress (ksf):	0.648	1.068
Vertical Deformation @ Max Shear (in.):	-0.010	-0.005
Horizontal Deformation @ Max Shear (in.):	0.226	0.221



Shearing Device Used:
Geomatic Direct Shear Apparatus, Model 8914

Rate of Deformation (in./min.) 0.01

Internal Friction Angle (deg.): 28.1

Cohesion (kips/sq.ft.): 0.0380

Remarks: 2 Points only - Large Aggregate in 3 rings = 2" plus.

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

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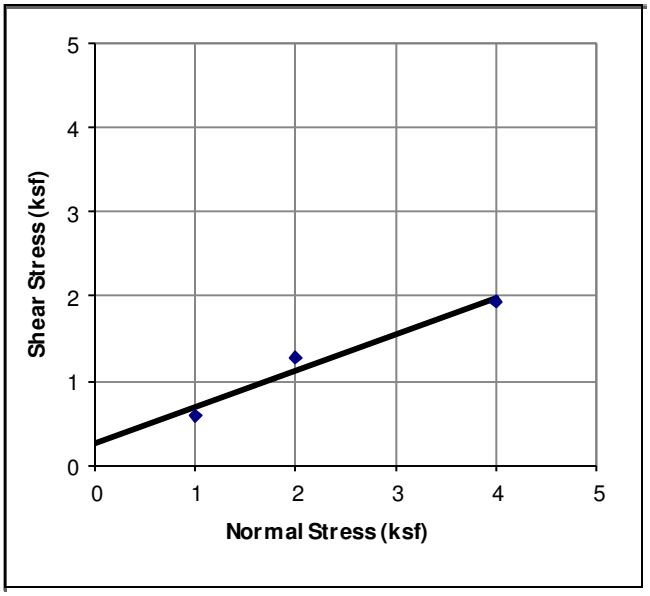
Client:	Wilson & Company 4401 Masthead St. NE, Suite 150 Albuquerque, NM 87109	**Report Date:**	March 14, 2019
		Project #:	19-517-00007
		Work Order #:	2
Attn:	Myra Candelaria	**Lab #:**	19-0099-02
Project Name:	Sanostee Bridge	**Sampled By:**	Jacob Hays
		Date Sampled:	2/27/2019
	Sanostee, NM	**Visual Description of Material:**	Reddish Sand
PO Number:	1710009000-Task#14	**Sample Source:**	B-11 (5.0-5.5')
Project Manager:	Carlo Evangelisti		

SOILS / AGGREGATES

Direct Shear Test of Soils Under Consolidated Drained Conditions (ASTM D3080-04)

Direct Shear Point Number:	1	2	3
Initial Diameter of specimen (in.):	2.42	2.42	2.42
Initial Thickness of specimen (in.):	1.00	1.00	1.00
Dry Mass of Specimen (g):	135.5	140.3	130.5
Initial Moisture (%):	4.5%	6.3%	5.0%
Initial Wet Density (pcf):	117.6	123.9	113.9
Initial Dry Density (pcf):	112.6	116.6	108.4
Final Thickness of specimen (in.)::	0.97	0.96	0.89
Final Moisture (%):	14.9%	14.1%	14.2%
Final Wet Density (pcf):	133.5	138.1	138.9
Final Dry Density (pcf):	116.2	121.0	121.6
Normal Stress (ksf):	1.00	2.00	4.00
Maximum Shearing Stress (ksf):	0.600	1.272	1.944
Vertical Deformation @ Max Shear (in.):	-0.007	-0.001	-0.019
Horizontal Deformation @ Max Shear (in.):	0.241	0.216	0.246



Shearing Device Used:
Geomatic Direct Shear Apparatus, Model 8914

Rate of Deformation (in./min.): 0.01

Internal Friction Angle (deg.): 23.4

Cohesion (kips/sq.ft.): 0.2640

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

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MOTZZ LABORATORY, INC.

Soil Analysis Report

Wood
Jesse Boam
8519 Jefferson NE
Albuquerque, NM 87114

Project: Sanostee Bridge
Date Received: 3/14/2019
Date Reported: 3/15/2019
PO Number: 1951700007

Lab Number: 927888-1 **19-0095-15 B-6, B-7, B-12, B-16**

AASHTO Methods	Method	Result	Units	Levels
pH	AASHTO T289	8.3	SU	
Sulfate, SO4	AASHTO T290	563	ppm	
Chloride, Cl	AASHTO T291	33	ppm	

Lab Number: 927888-2 **19-0095-16 B-13, B-14, B-15**

AASHTO Methods	Method	Result	Units	Levels
pH	AASHTO T289	8.1	SU	
Sulfate, SO4	AASHTO T290	1255	ppm	
Chloride, Cl	AASHTO T291	33	ppm	

Lab Number: 927888-3 **19-0099-06 B-11 (25.0-26.5)**

AASHTO Methods	Method	Result	Units	Levels
pH	AASHTO T289	8.9	SU	
Sulfate, SO4	AASHTO T290	152	ppm	
Chloride, Cl	AASHTO T291	11	ppm	

Title:	**Sanostee Bridge Rock Core Photos**	Doc. No.:	**QUA-FOR-xxxxxx**	Rev.	**0**

Client:	**Project:**	**Project Number:**
Wilson & Co, Inc.	Sanostee Bridge	19-517-00007

Boring 10, 45 feet to 71 feet below ground surface.

Client:	**Project:**	**Project Number:**
Wilson & Co, Inc.	Sanostee Bridge	19-517-00007

Boring 8, 50 feet to 68 feet.
Below ground surface.

PROJECT:	Sanostee Wash Bridge	JOB NO.:	19-517-00007
LOCATION:	Sanostee, NM	WORK ORDER NO.:	2
BOREHOLE NO.:	B-9	LAB NO.:	19-0224-02
DEPTH (ft):	55	DATE TESTED:	7-May-19
MATERIAL:	Rock Core		

UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE
ASTM D7012

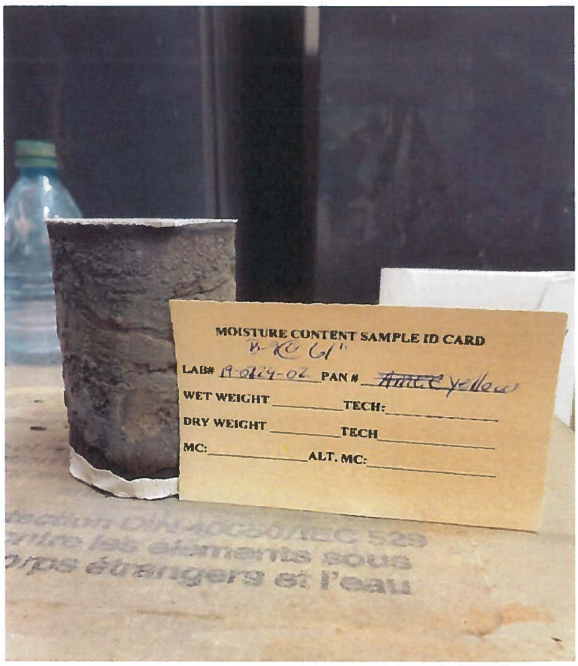
Avg. Diameter (in)	2.09	Axial Strain at Failure (%)	No Data
Avg. Length (in)	3.24	Average Strain Rate (%/min)	No Data
Area (in^2)	3.42	Force at Failure (lbs)	640
Volume (in^3)	11.08	2:1 Length to Diameter Correction Factor	0.966
Gravimetric Moisture (%)	8.0	Corrected Failure Load (lbs)	618
Dry Bulk Density (lb/ft^3)	123.8		
		Mode of Failure	N/A
		Shear Angle	N/A

Remarks:

Failure Stress (psi)	**181**

Prefailure Photo

Post-failure Photo



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PROJECT:	Sanostee Wash Bridge	JOB NO.:	19-517-00007
LOCATION:	Sanostee, NM	WORK ORDER NO.:	2
BOREHOLE NO.:	B-10	LAB NO.:	19-0224-03
DEPTH (ft):	63	DATE TESTED:	7-May-19
MATERIAL:	Rock Core		

UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE
ASTM D7012

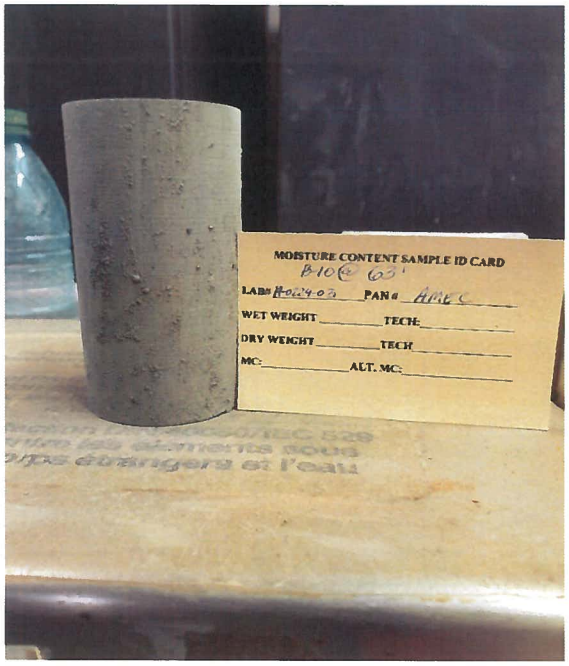
Avg. Diameter (in)	2.04
Avg. Length (in)	3.85
Area (in^2)	3.27
Volume (in^3)	12.58
Gravimetric Moisture (%)	1.8
Dry Bulk Density (lb/ft^3)	156.7

Axial Strain at Failure (%)	No Data
Average Strain Rate (%/min)	No Data
Force at Failure (lbs)	26030
2:1 Length to Diameter Correction Factor	0.993
Corrected Failure Load (lbs)	25845
Mode of Failure	N/A
Shear Angle	N/A

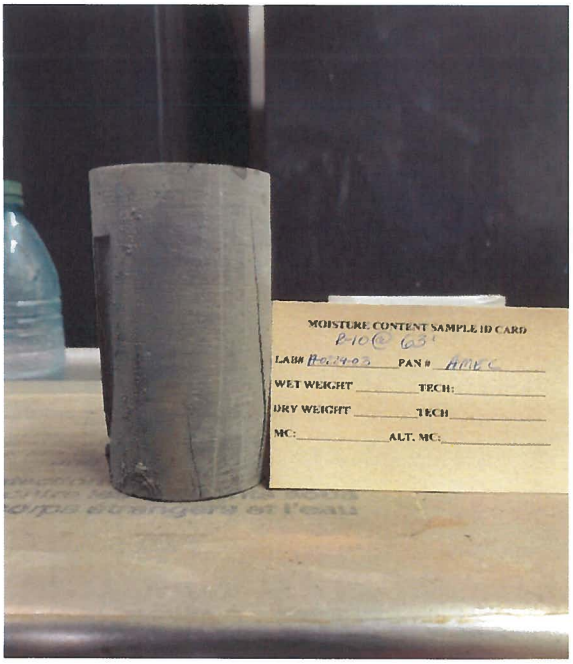
Remarks:

Failure Stress (psi)	**7907**

Prefailure Photo



Post-failure Photo



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PROJECT:	Sanostee Wash Bridge	JOB NO.:	19-517-00007
LOCATION:	Sanostee, NM	WORK ORDER NO.:	2
BOREHOLE NO.:	B-10	LAB NO.:	19-0224-04
DEPTH (ft):	67	DATE TESTED:	7-May-19
MATERIAL:	Rock Core		

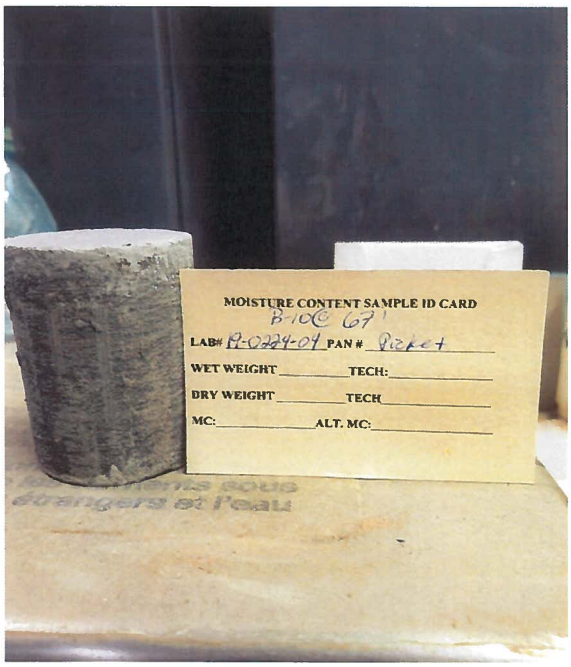
UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE
ASTM D7012

Avg. Diameter (in)	2.03	Axial Strain at Failure (%)	No Data
Avg. Length (in)	2.76	Average Strain Rate (%/min)	No Data
Area (in^2)	3.25	Force at Failure (lbs)	8300
Volume (in^3)	8.96	2:1 Length to Diameter Correction Factor	0.946
Gravimetric Moisture (%)	4.0	Corrected Failure Load (lbs)	7854
Dry Bulk Density (lb/ft^3)	149.9		
		Mode of Failure	N/A
		Shear Angle	N/A

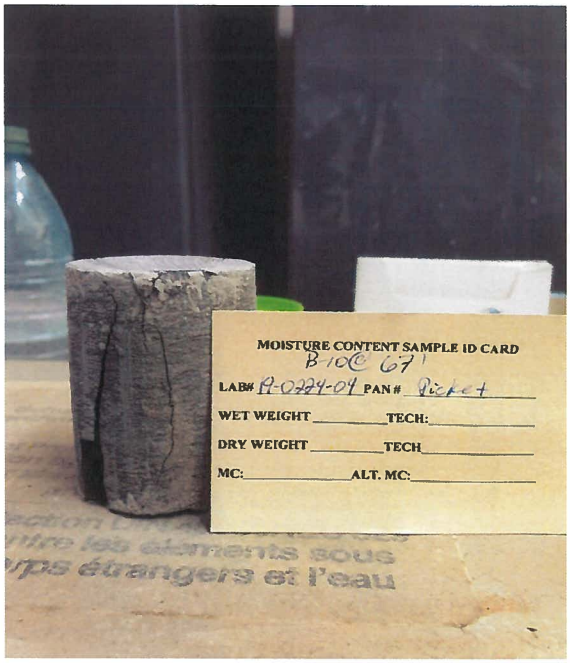
Remarks:

Failure Stress (psi)	**2419**

Prefailure Photo



Post-failure Photo



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PROJECT:	Sanostee Wash Bridge	JOB NO.:	19-517-00007
LOCATION:	Sanostee, NM	WORK ORDER NO.:	2
BOREHOLE NO.:	B-10	LAB NO.:	19-0224-05
DEPTH (ft):	69	DATE TESTED:	7-May-19
MATERIAL:	Rock Core		

UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE
ASTM D7012

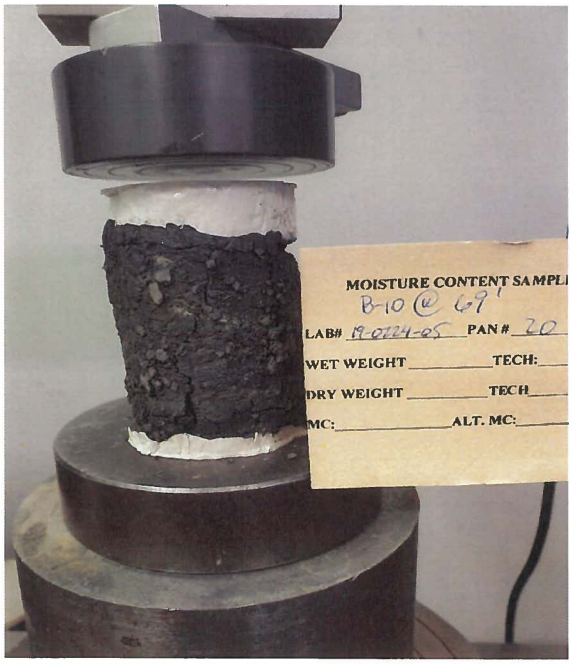
Avg. Diameter (in)	2.08
Avg. Length (in)	3.13
Area (in^2)	3.40
Volume (in^3)	10.64
Gravimetric Moisture (%)	11.0
Dry Bulk Density (lb/ft^3)	114.1

Axial Strain at Failure (%)	No Data
Average Strain Rate (%/min)	No Data
Force at Failure (lbs)	160
2:1 Length to Diameter Correction Factor	0.962
Corrected Failure Load (lbs)	154
Mode of Failure	N/A
Shear Angle	N/A

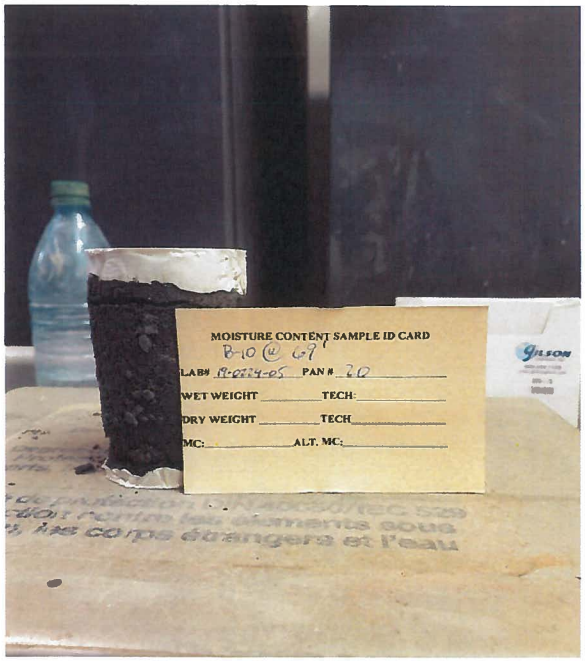
Remarks:

Failure Stress (psi)	**45**

Prefailure Photo



Post-failure Photo



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