FINAL GEOTECHNICAL REPORT
Santa Maria River Bridge Replacement
Arizona State Route 96, MP 10

June 11, 2025

Prepared by
Geotechnical Services
Bridge Group
Arizona Department of Transportation

ADOT Project No. 096 YV 010 F0584 01D
Federal Aid No. STBG-096-A(200)T

ARIZONA DEPARTMENT OF TRANSPORTATION

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June 11, 2025

Subject:
Final Geotechnical Report
Santa Maria River Bridge
ADOT Project No. 096 YV 010 F0584 01D

This report presents the results of our geotechnical investigation to support the planned replacement of the bridge over the Santa Maria River located on State Route 96 at about milepost 10. The project site is located southwest of Bagdad, in western Yavapai County, within the Northwest District of the Arizona Department of Transportation (ADOT).

The purpose of this project is to replace the existing bridge structure to improve the safety of the bridge.

A geotechnical field investigation included conducting a geotechnical investigation at the site of the bridge for the purpose of evaluating the surficial and subsurface soil conditions at the site to develop bridge foundation capacities and provide geotechnical pavement parameters.

The results of the field investigation as well as design recommendations for the proposed construction are presented in this report.

Should there be any questions regarding the contents of this report or its appropriate incorporation into designs, please do not hesitate to contact us.

Sincerely,

Tad C. Niemyjski, P.E.
Geotechnical Design Engineer

Reviewed by:

Patrice P. Brun, P.E.
Geotechnical Services Manager

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1.0 INTRODUCTION

This report presents the results of our geotechnical engineering evaluation for the replacement of the existing bridge structure (Structure No. 225) for State Route (SR) 96 over the Santa Maria River and the associated roadway construction to accommodate the new structure. The project area is located on SR 96 between mileposts 10 and 11, in Yavapai County, Arizona. The purpose of these services is to provide information and recommendations regarding:

- foundation design parameters for deep foundations
- design parameters for pavement design
- earthwork design factors

The main purpose of the project is to replace the existing bridge over the Santa Maria River which was constructed in 1939. This bridge structure had a Sufficiency Rating of 77.3 in 2021 and has been determined to be scour vulnerable and is listed as being under capacity. This bridge reconstruction project is proposed to increase the safety and operational characteristics of this bridge crossing.

1.1 Project Description

The project consists of replacing the existing bridge structure which was constructed in 1939 as a 392’-0” long five-span steel bridge structure. The bridge abutments and piers are founded on driven H-pile foundations. The current bridge currently has a clear roadway width of 22 feet consisting of two 10 ft., 11 in. wide lanes.

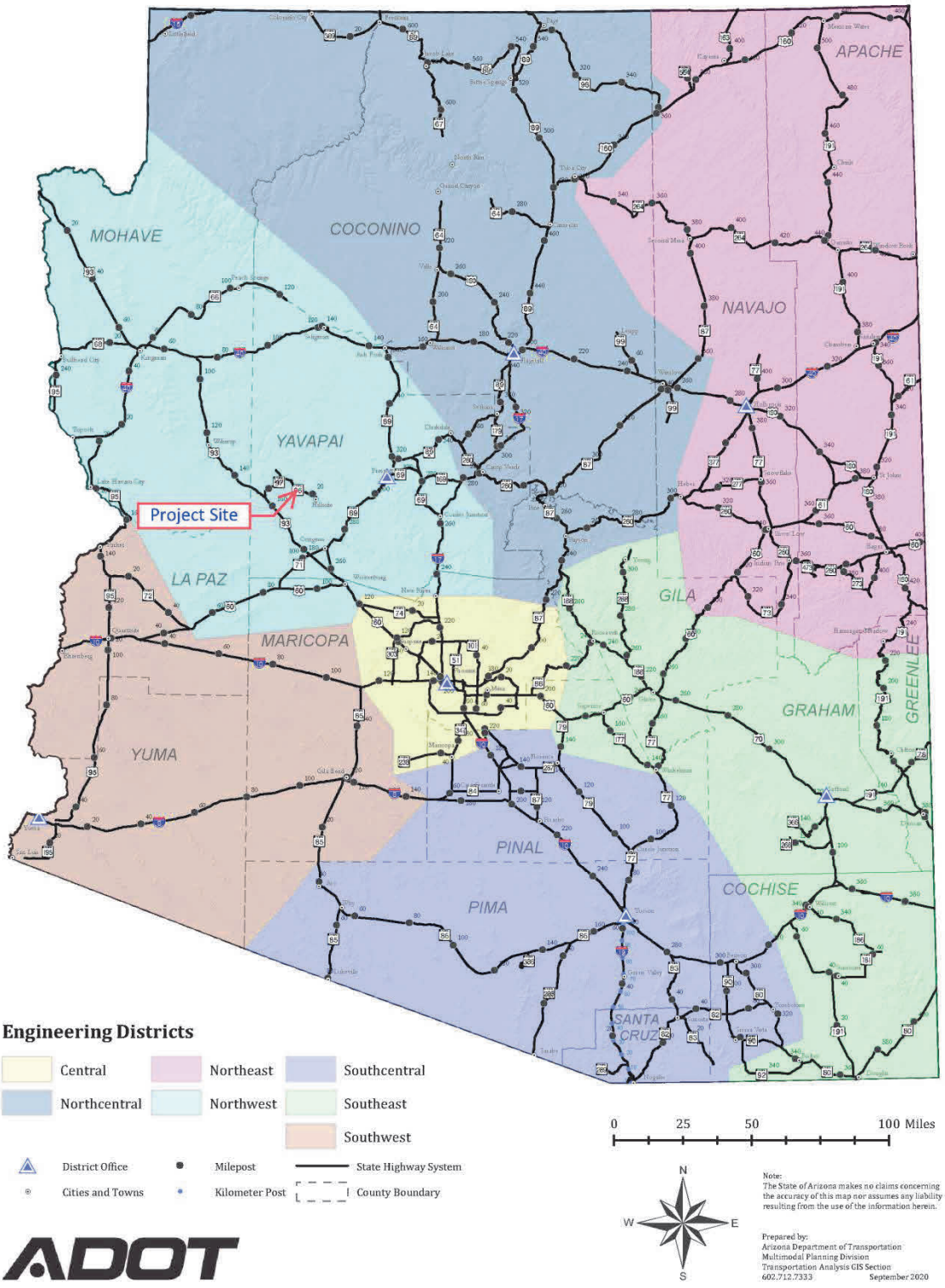

Figure 1: Location of the Santa Maria Bridge project site

1.2 Site Description

The Santa Maria Bridge replacement project carries SR 96 traffic over the Santa Maria River between mileposts 10 and 11, southeast of Bagdad, Arizona. The project will be largely completed within the existing ADOT right of way, some areas of TCE will be needed for construction access.

The project area consists of flat to rolling hill terrain with elevations ranging from about 2,340 and 2,260 feet above mean sea level (MSL). This environment is considered a high desert transition region where the vegetation consists of native shrub land with sparse grass coverage.

Figure 2: Aerial view of the Santa Maria Bridge location.

The existing bridge structure is a two span steel girder bridge structure with an overall length of about 392 feet in length with a clear roadway with of 22 feet. The bridge existing bridge structure is founded on driven steel h-piles with pile caps.

Figure 3: View of the existing Santa Maria Bridge looking to the southwest

1.3 Site Geology

Section 3.2 of the Geotechnical Data Report completed by WSP for this project describes the geological conditions for the site. Existing rock cut slopes on the northern side of the Santa Maria River channel exposes the Tertiary basin fill (Tbf) deposits and Quaternary alluvial fill soils.

The Tertiary basin fill deposits are well exposed in the existing roadway cuts on the northern side of the Santa Maria River channel. The Quaternary older alluvial (Qoa) deposits are exposed on the southern side of the Santa Maria River. Quaternary alluvial (Qal) soils are deposited in the Santa Maria River flood plain and tributary washes.

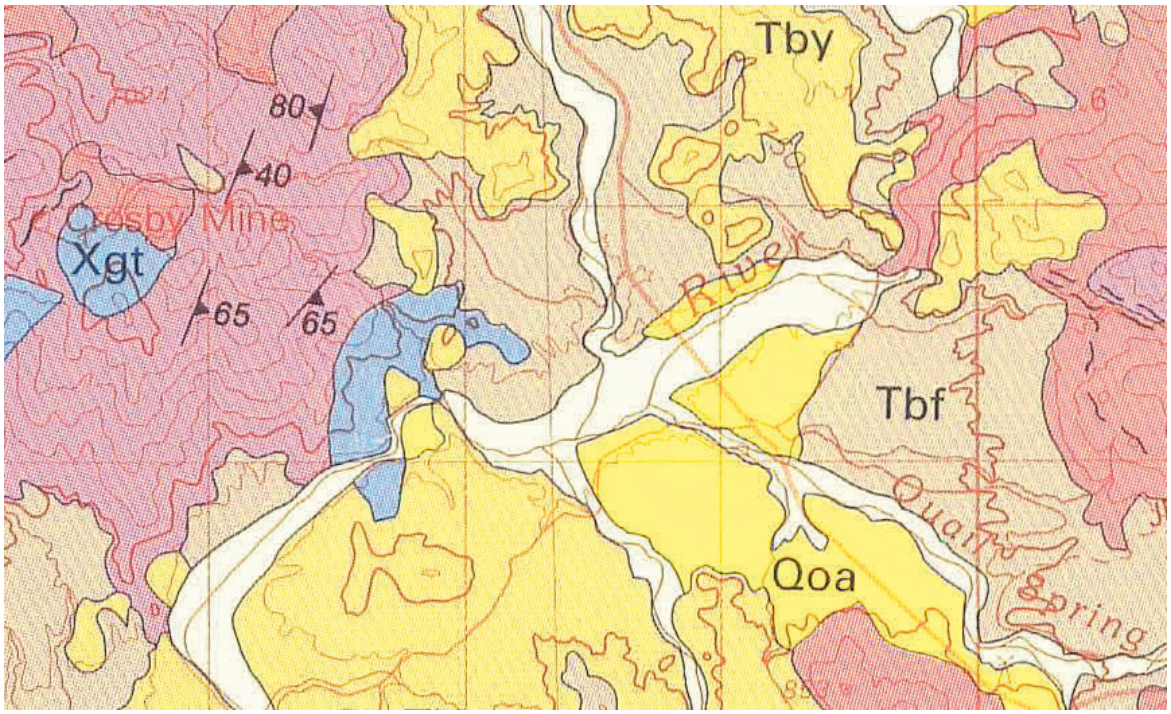

Figure 4: Geology of the Santa Maria Bridge area (Bryant, 1995)

2.0 SUBSURFACE INVESTIGATION

2.1 Test Borings

The subsurface investigation included advancing four test borings to depths ranging from approximately 100 and 120 feet below the ground surface (bgs) at the proposed bridge abutments and pier locations (see Table 1 for details). The test borings performed by Geomechanics Southwest, Inc. (GSI) were drilled with a CME-75 track-mounted tubex drill rig utilizing a hollow-stem auger with an 8-inch outside diameter. The subsurface borings were logged and completed by WSP. The test boring logs are included in the Geotechnical Data Report presented in Appendix A of this report.

Upon completion of the sampling, test boring B-1A (alternate location for boring B-1) was converted to a piezometer to monitor the ground water elevation at the site. The piezometer completion diagram is included as Figure 4 of the Geotechnical Data report included in Appendix A of this report.

Figure 5: Subsurface investigation, boring B-3, on December 6th, 2024

The subsurface soils were then sampled with a split spoon sampler or with a ring-lined barrel sampler. The sampling of the subsurface soils was completed at intervals of 5 feet using 2-inch O.D., 1 3/8-inch I.D. samples to obtain the standard penetration resistance. Relatively undisturbed samples were also obtained with 3-inch O.D. samples lined with 2.42 I.D. brass rings.

Table 1: Summary of Test Borings

Test Boring No.	Feature	Station, Offset	Ground Elevation (ft)	Bottom Elevation (ft)	Overall Depth of Boring (ft)
B-1A*	Abutment 2	30+20, 15' Rt.	2,278	2,177	100.8
B-2	Pier 2	28+85, 10' Rt.	2,265	2,165	100.3
B-3	Pier 1	27+65, 10' Rt.	2,265	2,145	120.1
B-4	Abutment 1	26+65, 10' Rt.	2,270	2,170	100.3

* This was the alternate location for Boring B-1

The four bridge boreholes were abandoned by backfilling the borings with a slurry of bentonite and Portland cement in accordance with Arizona Department of Water Resources (ADWR) regulations.

2.2 Test Pits

A geotechnical field investigation for the bridge approach roadways was performed on February 19, 2025 and included four backhoe test pits (designated TP-1 through TP-4) excavated to depths ranging from approximately 1 to 5 feet bgs. The test pits were excavated with a CAT 420 backhoe using a two-foot-wide bucket. The bulk samples were collected, logged and bagged. The investigation was performed by the ADOT Geotechnical Operations field crew. Test Pit logs are presented in Appendix B of this report.

2.3 Laboratory Testing

The soil and rock core samples obtained during the field investigation were delivered to the ADOT Construction and Materials Group Central Laboratory. Select samples were tested in general conformance with the procedures listed in the following table.

Table 2: Test Methods for Representative Soil and Rock Samples

Geotechnical Test	Test Procedure
Sieve Analysis (Grain Size)	ARIZ 201d
Atterberg Limits (Plasticity)	AASHTO T 89 and T 90
Maximum Density and Optimum Moisture Density of Soils	ARIZ 225b
R-Value (Subgrade Support)	AASHTO T 190
Moisture Content of Soils	AASHTO T265
In-Place Dry Density	ASTM D2937

The results of the laboratory tests completed on the soil and rock samples obtained during the field investigation are included in Appendix C of this report.

3.0 SUBSURFACE CONDITIONS

3.1 Surficial Soils

The near surface soils on the south side of Santa Maria River were found to consist primarily of medium dense to dense sands and gravels with varying amounts of silt, clay and gravel. At at depth of about 50 feet below the ground surface the subsurface soils appear to transition to the partially cemented tertiary basin fill deposits (TBF).

The near surface soils on the north side of Santa Maria River were found to consist primarily of very dense gravels with varying amounts of sand. At 10 to 15 feet below the ground surface the soil appears to transition to the partially cemented tertiary basin fill deposits (TBF).

The soil in the active Santa Maria River channel consisted of sands with varying amounts of silt, gravel and cobbles. These soils were found to be medium dense to very dense. The tertiary basin fill deposits (TBF) underly these alluvial soils.

3.2 Groundwater Conditions

Tubex drilling methods were used to advance the subsurface borings and free groundwater was encountered at elevation ranging from 2,246 and 2,260 during the subsurface investigation.

The groundwater level can be expected to naturally fluctuate seasonally and might be found at a higher elevation than that of the drilled shaft. For example, during the wet seasons (generally summer and winter) the water level can vary where the water level might occur above the pier boring locations.

Table 3: Groundwater Elevations

Location	Elevation of observed GW	Date
B-2	2,258	12/11/2024
B-3	2,258	12/09/2024
B-4	2,258	12/04/2024

Boring B-1A location was converted into piezometer and will have to be abandoned in accordance with ADWR regulations prior to disturbance by the contractor during construction.

The Santa Maria River at this location could be considered an ephemeral stream, however, the frequency at which the surficial stream flow is frequent enough to assume that the stable groundwater elevation could be anticipated near the surface of the stream bed even if flowing groundwater is not observed.

3.3 Geophysical Surveys

A refraction seismic survey line was performed at one location at the project site by Michael Simpson, P.E. and Tad Niemyjski, P.E. on April 30th and May 24th of 2024 to assess geologic and geotechnical conditions within the planned cut slope areas. The refraction seismic survey was performed to aid in characterizing the subsurface geotechnical profile, provide general strength parameters for the subsurface materials, assist with developing earthwork factors, and evaluate excavation conditions. The table below presents details on the location and purpose of the survey.

Table 4: Refraction Seismic Survey Details

Survey Line	Approx. Location (station and offset)		Elevation Range (MSL)	Purpose
SL-1	38+90, 50’ L	37+70, 40’ L	2,335 to 2,338 ft.	Cut Slope
SL-2	35+85, 40’ L	34+60, 30’ L	2,308 to 2,335 ft.	Cut Slope
SL-3	16+30, 55' L	15+10, 45' L	2,310 to 2,316 ft.	Cut Slope

The refraction seismic survey line was conducted using a 24-channel, signal enhancement seismograph (Geometrics SmartSeis Model SE-24) and a sledgehammer served as the energy source for the surveys. The survey line was 120 feet long and geophones were placed at 10-foot intervals. Data was retrieved using hammer impacts at 5-foot foreshot and backshot offsets from the ends of the seismic line array. Several impacts are added together at each individual shot location to increase the total signal to obtain the seismic record. The results of the refraction seismic survey provide additional subsurface data to a depth on the order of approximately 40 feet.

The refraction seismic survey was performed in general conformance with the guidelines presented in ASTM D5777-95 Standard Guide for Using the Seismic Refraction Method for Subsurface Investigation for refraction using compression waves.

3.3.1 Refraction Seismic Survey

A refraction seismic survey line was performed along a typical section of the proposed construction cut for the project. Stratigraphic interpretation at the survey location was developed from the refraction seismic survey data and observations made of the site geology exposed in the roadway cuts. This data provides the basis to define the qualitative excavatability of bedrock and soils encountered at the project refraction seismic survey location. The results of the refraction seismic survey data and field investigation data are summarized in the table below. A subsurface P-wave velocity model interpretation of the refraction seismic data is presented in Appendix D of this report.

Table 5: Refraction Seismic Survey Results

Survey Line	Station, Offset	Station, Offset	Elevation Range (ft. MSL)	Depth Range (ft. BGS)	Average Seismic Velocity (ft./sec.)	Interpreted Geological Description
SL 1	37+55, 40' Rt.	38+55, 50'Rt.	2,337 – 2,255	Surface – 33	4,400	Very dense sand with gravel and cobbles
				Surface – 65	6,350	Partially cemented sand with gravel and cobbles
SL 2	34+40, 30' Rt.	35+40, 40' Rt.	2,338 – 2,255	Surface – 22	1,700	Medium dense sand with gravel and cobbles
				20 – 55	4,150	Partially cemented sand with gravel and cobbles
SL 3	15+20, 30' Rt.	16+20, 40' Rt.	2,315 – 2,245	Surface – 5	925	Loose sands
				4 – 45	3,400	Dense sand with gravel and cobbles
				25 – 70	3,950	Dense sand with gravel and cobbles

P-wave velocities of ground materials have been correlated to the amount of effort that will be required to excavate these materials. Caterpillar, Inc. has compiled these correlations in the Caterpillar Performance Handbook (Caterpillar, 2018) which provides guidance on which type of equipment will be required for effective excavation. The table below presents general guidance to the ease of excavation or rippability of subsurface materials. This table assumes that a Caterpillar D8R dozer equipped with a single shank ripper can be used for excavation.

Table 6: General Classification of Rock Rippability

P-wave Velocity Range (ft/sec)	Rippability
Less than 2,000	Easy
2,000 to 4,000	Moderately difficult
4,000 to 5,500	Difficult, possible blasting
5,500 to 7,000	Very difficult, probable blasting
Greater than 7,000	Blasting generally required

These rippability values may be conservative and may depend on the prevailing structure of underlying rock materials. The fracture spacing and orientation can greatly affect the effectiveness of heavy equipment.

More detailed ranges of rippability for rock materials with different equipment configurations are published in the Caterpillar Performance Handbook (Caterpillar, 2018). The rippability

3.4 Seismicity

AASHTO requires a seismic analysis based on earthquake ground motions that have a seven percent probability of exceedance in 75 years (approximate 1000-year return period). Based on the subsurface soil/rock conditions encountered in the subsurface investigation and the Site Class Definitions in Table 3.10.3.1-1 of AASHTO (2010) the bridge location is considered Site Class C. Using the USGS AASHTO-2009 web service application, the seismic design parameters were derived and are shown in the following table.

Table 7: Seismic Design Parameters for Santa Maria River Bridge

Structure No. 225			Latitude:	34.4806	
Site Class C			Longitude:	-113.0606	
Bedrock values		Site Factors		Site adjusted values	
PGA =	0.087 g	F_{PGA} =	1.2	A_S =	0.105 g
S_s =	0.203 g	F_a =	1.2	S_{DS} =	0.243 g
S_1 =	0.058 g	F_v =	1.7	S_{D1} =	0.098 g

The site specific 1-second spectral acceleration (S_{D1}) value of 0.098 for this site is less than 0.15 g threshold indicating that the site is in Seismic Zone 1 as identified in Table 3.10.6-1 of AASHTO (2013).

4.0 GEOTECHNICAL EVALUATION AND RECOMMENDATIONS

The subsurface investigation explored the subsurface conditions adjacent to the existing bridge structure that carries the SR 96 traffic across the Santa Maria River floodplain. The surface sand and gravel soils are generally medium dense fluvial to partially cemented alluvial soils.

The subsurface investigation and laboratory testing for the bridge structure borings were completed through our Geotechnical Engineering on-call consultant, WSP. This Geotechnical Data Report (Hartig and Pegnam, 2025) is included in Appendix A of this report.

4.1 Subsurface Investigation and Laboratory Test Results Discussion

The subsurface soils at the site were found to consist of quaternary alluvial and floodplain deposits to depths ranging from 13 to 42 feet below the existing ground surface. Below these alluvial soils very dense to partially cemented tertiary basin fil deposits were encountered to the termination of the borings. It is anticipated that the near surface quaternary soils could be scoured during the design flood event.

4.2 Drilled Shaft Foundations

4.2.1 Axial Capacity of Drilled Shaft Foundations

The proposed Santa Mara Bridge is planned to be founded on drilled shaft foundations which are designed in accordance with the Load and Resistance Factor Design (LRFD) methodology as presented in the AASHTO LRFD Bridge Design Specifications, 6th Edition with interim revisions (AASHTO 2013). The lateral design parameters are included in the following section of this report.

Scour for the 500-year flow event was considered in the axial capacity charts. ADOT's Initial Bridge Hydraulics Report, dated September of 2024 indicated that 22.71 feet of total scour is anticipated at the piers and abutments. Skin friction of the soils along the drilled shaft foundations was neglected to the depth of the scour elevation. The drilled shaft capacity curves are included in Appendix E of this report. The drilled shaft design parameters were based on the results of the field investigation and laboratory test data which is included in the Geotechnical Data Report provided by WSP which is included in Appendix A of this report.

4.2.2 Lateral Capacity Design Parameters for Drilled Shafts

A lateral load analysis should be performed once a drilled shaft is sized based on axial capacity considerations. The required length of the shaft will be the longer of the lengths computed in the axial and lateral load analyses. The use of the LPILE computer program or equivalent is recommended for this purpose (Isenhower and Wang, 2016). The lateral modulus and simplified subsurface profiles for input into LPILE are given in the following table. ADOT Geotechnical Design Guidance DS-3 (ADOT DS-3, 2010) provides guidance to structural engineers on performing lateral load analysis for drilled shafts. The following parameters are recommended for use in lateral pile analyses using the computer program LPILE for modeling.

Table 8: Lateral Design Subsurface Profiles

Design Profile	Associated Borings	Structural Elements
Abutment 1	B-4	Abutment 1
Pier Profile	B-2 and B-3	Piers 1 and 2
Abutment 2	B-1A	Abutment 2

Table 9: Soil Parameters for Lateral Analysis for Abutment 1

Approximate Elevation Range	Effective Unit Weight	Friction Angle	Cohesion	Soil Strain Ratio, ε_{50}	Lateral Soil Modulus, k	LPILE Soil Type
(ft.)	(pcf)	(deg)	(psf)	(pci)	(pci)	
2,270 to 2,265	115	30	0	---	90	Sand (Reese)
2,265 to 2,225*	52	30	0	---	90	Sand (Reese)
2,225 to 2,175	63	34	150	---	125	Sand (Reese)

* groundwater elevation is assumed to be at 2,265 ft. MSL

Table 10: Soil Parameters for Lateral Analysis for Piers

Approximate Elevation Range (ft.)	Effective Unit Weight (pcf)	Friction Angle (deg)	Cohesion (psf)	Soil Strain Ratio, ε_{50} (pci)	Lateral Soil Modulus, k (pci)	LPILE Soil Type
2,265 to 2,240*	48	30	0	---	90	Sand (Reese)
2,240 to 2,225	52	30	0	---	90	Sand (Reese)
2,225 to 2,152	63	34	150	---	125	Sand (Reese)

* groundwater elevation is assumed to be at 2,265 ft. MSL

Table 11: Soil Parameters for Lateral Analysis for Abutment 2

Approximate Elevation Range (ft.)	Effective Unit Weight (pcf)	Friction Angle (deg)	Cohesion (psf)	Soil Strain Ratio, ε_{50} (pci)	Lateral Soil Modulus, k (pci)	LPILE Soil Type
2,278 to 2,265*	115	30	0	---	90	Sand (Reese)
2,265 to 2,178	63	34	150	---	125	Sand (Reese)

* groundwater elevation is assumed to be at 2,265 ft. MSL

The elevation of groundwater at this site is anticipated to vary based on prevailing weather, however, the frequency of water flowing at the surface of the Santa Maria stream bed is frequent enough to consider the groundwater the groundwater elevation for the lateral analysis to be at the surface of the streambed at about 2,265 ft. above MSL.

4.2.3 Construction Considerations

The straight, drilled shaft excavations can likely be advanced with single-flight-auger and/or bucket-auger bits to the recommended depth. The subsurface conditions of the subsurface soils are primarily sands and gravels. These granular soils and the high groundwater elevation may complicate drilled shaft construction. The use of specialized stabilization techniques such as casing or slurry is likely required for drilled shaft construction due to the subsurface conditions described above.

All drilled shaft excavation techniques should be in accordance with the ADOT Standard Specifications ADOT (2021) and the project-specific special provisions. Any changes to the drilled shaft tip elevations must be approved by ADOT. Quality control during the drilled-shaft construction should include those items specifically called out in the ADOT Stored Specification of Section 609 ADOT (2019), and the project-specific special provisions. A detailed quality control report should be submitted for each drilled shaft.

4.3 Abutment, Wing Wall and Retaining Walls

4.3.1 Lateral Earth Pressures

Retaining walls planned for the wing wall and bridge box structure should be designed to resist lateral earth pressures imposed by the retained earth. The lateral earth pressures acting on the wall are a function of the retained soil type and degree of wall restraint. Retaining walls that are not restrained at the top, such as wing walls, may be designed using active earth pressures when lateral movement of at least 0.002 times the height of the retaining wall is expected. The active earth pressure can be represented by an equivalent fluid pressure of 35 psf/ft for level surface backfill.

Retaining walls with restraint at the top, such as bridge box abutments, may be designed using at-rest earth pressures when little or no lateral movement is expected. The at-rest earth pressure can be represented by an equivalent fluid pressure of 55 psf/ft for level surface backfill.

The highway live-load surcharge and additional earth pressures on the wall due to the live load surcharge should, when appropriate, be estimated and applied as described in Article 3.11.6.4 of the LRFD Bridge Specifications (AASHTO 2013). Seismic design loads, if applicable, should be determined and applied in accordance with Section 3.10 of the LRFD Bridge Specifications (AASHTO 2013).

These lateral earth pressure design values are based on the retained material to be free-draining structural backfill with a compacted moist unit weight of 110 pcf with an effective (drained) angle of internal friction of 30 degrees. The surface of the retained backfill is also to be level. Additionally, wall drainage provisions, such as weep holes, are to be implemented to prevent hydrostatic pressures from developing behind the retaining walls. If free-draining backfill or backfill drainage provisions are not implemented, a full hydrostatic pressure of 62 pcf should be included in the design of the retaining walls.

4.3.2 Resistance to Lateral Loads

Retaining walls should be designed for lateral load analysis in accordance with Article 11 of AASHTO (2013) and ADOT Geotechnical Design Policies SF-2 and SF-3.

4.3.3 Sliding Resistance

The resistance to sliding can be derived from the frictional resistance to sliding between the foundation element and the founding soil and the passive resistance of the soil. The nominal sliding resistance should be calculated using equation 10.6.3.4-2 of the LRFD Bridge Specifications (AASHTO 2013). A sliding resistance value of 0.5 ksf is recommended for determining the sliding resistance between the foundation and the native soil.

The resistance factors are presented in the table below should be used in conjunction with Equation 10.6.3.4-1 of the LRFD Bridge Specifications (AASHTO 2010).

Table 12: Sliding Resistance Factors

Variable	Condition	Resistance Factor
ϕ_τ	Precast Concrete on sand	0.90
	Cast-in-place concrete on clay	0.80
ϕ_{ep}	Passive earth pressure	0.50

The nominal passive resistance of soil can be included below a depth of 5 feet below the finished grade which is not subject to scour. The passive resistance applied to the edges of retaining walls, footings or stem walls in contact with properly compacted backfill or native granular soils could be considered as an equivalent fluid pressure of 250 psf per foot of embedment. The passive resistance values should be considered only when a minimum horizontal distance of 10 feet between is maintained between the foundation edge and sloping ground.

4.3.4 Limiting Eccentricity Criteria

The maximum allowable eccentricity, e, should be calculated in accordance with ADOT Geotechnical Design Policy SF-2, Limiting Eccentricity Criteria for Spread Footings based on Load and Resistance Factor Design (LRFD) Methodology (ADOT 2010). This policy supersedes the limiting eccentricity requirements in Article 10.6.3.3 and Article 11.6.3.3 of AASHTO (2010). The value for maximum eccentricity is determined as:

$e \leq B[(1/3) - (\beta/320)]$ for footings on soils

$e \leq B[(3/7) - (\beta/500)]$ for footings on rock

where:

B = the footing dimension (width or length) for which eccentricity is being calculated

β = the slope angle (degrees) of the soil retained above the wall (with a maximum of 26.6 degrees)

4.4 Earthwork Factors

Earthwork factors are dependent on the existing soil conditions, contractor methods of handling the materials, wind losses and compaction achieved during construction. Potential bidders should consider these factors in preparing the estimates and are encouraged to review all available data and make their own conclusions regarding excavation conditions. For preliminary design estimation, Earthwork Factors are recommended in the following table.

Table 13: Earthwork Factors

Material	Station	Ground Compaction	Excavation Factor
Soils (Embankment and Cut slope)	Sta. 16+00 to Sta. 33+00	0.1 feet	5% swell
Soils (Cut slope)	Sta. 33+00 to Sta. 41+00	0.1 feet	15% swell

It is anticipated that a ground compaction factor of 0.1 feet be used for this project. The ground compaction factor indicates the amount of ground loss that could be expected to occur during the compaction of the exposed subgrade soils and construction of the pavement section or embankment fill.

4.5 Pavement Design Information

Bulk samples were retrieved and tested according to the ADOT Geotechnical Project Development Manual. (ADOT, 2024) The test results are tabulated in Appendix C. Statistical analyses of the laboratory correlated and tested R-values were performed in accordance with the procedure presented in Section 2.1.5.2 of the ADOT Pavement Design Manual. (ADOT, 2017)

Laboratory R-value tests were performed on selected samples obtained from site. The tested and correlated R-Values of the soil samples obtained from the roadway test pits are presented in the following table.

Table 14: Correlated and Tested R-Values

Test Location	Depth (ft.)	% -200 Sieve	PI	Tested R-Value	Correlated R-Value
TP-1	0 – 4	12	NP		84
TP-2	0 – 5	6	9	76	65
TP-3	0 – 5	30	NP	82	67
TP-4	0 – 1	16	NP		79

It is recommended that an R-Value of 30 be used for the design and construction of the approach roadways. Material used as a fill material within three feet below the finished subgrade elevation shall meet the Subgrade Acceptance Chart. Recommendations for pavement design are presented in a separate Materials Design Memorandum (MDR) and Pavement Design Summary (PDS) prepared by ADOT Pavement Design Section.

4.6 Fill Requirements

Based on field investigation and laboratory test results, the materials within the project area would be suitable for use as engineered fill requirements as detailed in Section 203 of ADOT Standard Specifications.

The soils within three feet of final pavement base are to fall within the acceptable range of the Subgrade Acceptance Chart provided in the Pavement Design Memorandum.

4.7 Water Requirements

Approximately 80 gallons of water per cubic yard may be estimated for compaction of base and subgrade materials. This estimate is based on the tested optimum compaction moisture content and includes a conservative overrun for losses due to seepage, evaporation, inadequate mixing, spillage, etc. Precipitation before and/or during construction may also reduce the required amount of water significantly.

4.8 Embankment and Fill Slopes

Permanent embankment fill slopes for this project are to be constructed in accordance with ADOT Construction Standard Drawing C-02.20. It is recommended that temporary embankment fill slope inclinations not exceed 2:1 (H:V). New embankment fill slopes are to be benched laterally in to any existing embankment areas in accordance with Section 203-10.03 (A) of the 2008 ADOT Standard Specifications.

4.9 Excavations

Based on the subsurface information gathered during the field investigation the silty and clayey sands can be excavated with conventional earthmoving equipment. The contractor should provide safely sloped or adequately braced shoring systems in compliance with OSHA regulations.

4.10 Borrow Information

Borrow shall be as specified in Section 203-9 of the Standard Specifications. Borrow placed within three feet of finished subgrade shall meet the following requirements. The Plasticity Index (PI) and the percent passing the #200 sieve (Minus 200), when used in the equation below, shall give a value of X that does not exceed 87.

$$X = (\text{Minus } 200) + [2.83\ (PI)]$$

4.11 Aggregate Availability, Weight and Hauls

No source of aggregate material will be designated. A Materials Pavement Design Report will be prepared under separate cover for this project that contains estimated haul distances, unit weights and asphalt content for asphaltic concrete materials that can be used for estimating purposes.

5.0 TEST BORING (SUBGRADE) LOG LIMITATIONS

General soil strata descriptions and indicated boundaries are based on engineering interpretation of available subsurface information by the geotechnical engineer and may not reflect actual variation in subsurface conditions between test pit/test boring and sample locations. The locations of the contacts between strata shown on the logs are approximate, and changes between material types may be gradual rather than abrupt. Classification of soil materials is in general accordance with ASTM D2488 and is based on field observation unless accompanied by mechanical analysis.

The observed groundwater levels and/or moisture conditions indicated on the logs are as recorded at the time of exploration. These groundwater levels and/or moisture conditions may vary considerably, with time, according to the prevailing climate, rainfall or other factors and are otherwise dependent upon the duration of and methods used in the exploration program.

Sound engineering judgment was exercised in preparing the subsurface information presented on the subgrade logs. This information was prepared for and is intended for design and preliminary quantity estimate purposes. Its presentation on the plans or elsewhere is for the purpose of providing intended users with access to the same information as the State and its designers. This subsurface information and interpretation is presented in good faith and is not intended as a substitute for independent investigation, interpretation or judgment of the contractor or other users of this report.

6.0 REFERENCES

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APPENDIX A

Geotechnical Data Report for Bridge Foundation Borings

Arizona Department of Transportation

Santa Maria River Bridge Replacement

Geotechnical Data Report

2025-05-09

Contract No.: 2023-009.03
WSP Project No.: US0029828.9292
TRACS Number: F0584 01D

SANTA MARIA RIVER BRIDGE REPLACEMENT

GEOTECHNICAL DATA REPORT

ARIZONA DEPARTMENT OF TRANSPORTATION

CONTRACT NO.: 2023-009.03
WSP PROJECT NO.: US0029828.9292
TRACS NUMBER: F0584 01D
DATE: MAY 2025

WSP USA INC.
1230 WEST WASHINGTON STREET, SUITE 405
TEMPE, ARIZONA 85288-1245

T: +1 480-966-8295

WWW.WSP.COM

May 9, 2025

Attn: Tad C. Niemyjski, PE
ARIZONA DEPARTMENT OF TRANSPORTATION
Bridge Group, Geotechnical Services
205 S. 17th Ave., Room 217
MD 613E
Phoenix, AZ 85007

Re: Geotechnical Data Report
Santa Maria River Bridge Replacement on SR96
Yavapai County, Arizona

Our Geotechnical Data Report for the subject project is submitted herewith for your use. This report includes descriptions of the geologic setting, site investigations completed for exploring the geotechnical conditions, laboratory testing, the geotechnical profile including soil properties underlying the site and lithologic logs of the boreholes.

Please do not hesitate to contact us if you have any questions concerning this report.

Respectfully submitted
WSP USA Inc.,

Mark Hartig, PE
Senior Geotechnical Engineer

Mike Pegnam, PE
Senior Geotechnical Engineer

cc: Addressee (PDF)

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Tempe, Arizona 85288-1245

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1 INTRODUCTION & PROJECT DESCRIPTION

The Santa Maria River Bridge replacement project area is located on SR 96 near milepost 10.8, approximately 9 miles southeast of Bagdad, in Yavapai County, Arizona, as shown in Figure 1. We understand that the existing multi-span bridge will be replaced with a new bridge and associated roadway approaches.

The new bridge will include a three-span structure with modified approaches. The new bridge will be located just downstream and off alignment of the existing bridge. The length of the new bridge will be on the order of 355 feet.

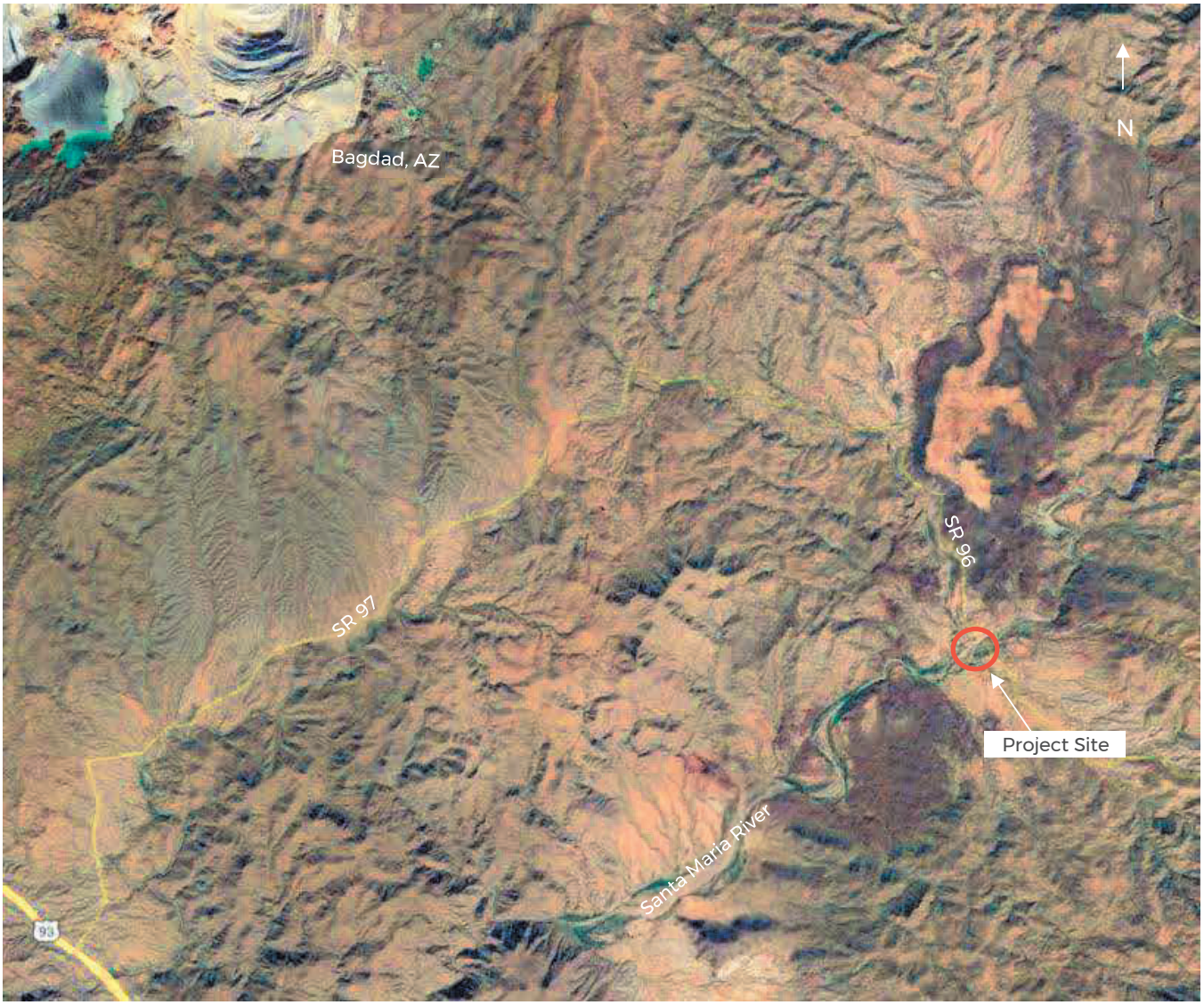

Figure 1: Site Location

It is understood that ADOT will perform the design of the new bridge including new foundation elements. WSP completed a subsurface investigation at the site with the objective of collecting data on the geologic and geotechnical profile beneath the bridge to aid ADOT in their analysis and design recommendations required for design. The results of the investigation are summarized herein and include descriptions of the geologic setting and physical properties of the underlying soil encountered in the borings drilled for the new foundation elements for the proposed structures. The work described herein included 4 borings for the future bridge supports (abutments and piers).

2 INVESTIGATION

2.1 REVIEW OF AVAILABLE DATA

A review of available data was completed prior to and concurrent with the field investigation and included the following items:

- Record Drawings for the existing four-span bridge,
- Google aerial imagery for the area,
- Topographic maps of the general area,
- Groundwater data, and
- Published geologic literature for the area including geologic units and fault maps.

2.2 FIELD PREPARATION AND UTILITY CLEARANCE

Prior to mobilization to the field with drill crews, WSP in conjunction with the ADOT Geotechnical Group, prepared a Boring and Access Plan (BAP) for the project using Google Earth imagery. The bridge borings included locations downstream of the existing bridge and access to the locations was to be from the southbound shoulder near the north abutment. A traffic control plan was prepared for the field investigation since the work was completed within ADOT right of way. The traffic control plan and the BAP were included in an encroachment permit submitted to the ADOT Northcentral District. Encroachment Permit No. 1234718 from the Northcentral District Encroachment Permit Office was issued to WSP on October 18th, 2024. ADOT Geotechnical Group secured the environmental clearance required for the project.

Utility clearance for the boring locations was obtained through AZ811 Services prior to mobilizing to the project. Borehole layout based on the BAP and utility clearance was completed upon mobilization to the project site.

A health and safety plan was prepared for work by WSP prior to mobilization. The plan included a description of safety preventative procedures related to the planned field investigation.

2.3 FIELD INVESTIGATION

The field investigation consisted of a brief geologic reconnaissance and subsurface drilling at four locations to characterize the geologic profile. The drilling was completed by Geomechanics Southwest, Inc. with a track-mounted CME-75 drill rig, working under the direction of WSP to penetrate the subsurface materials and to collect in-situ samples. The borings were advanced using air percussion (Tubex) drilling techniques. Three borings (B-1a, B-2, and B-4) were completed to an approximate depth of about 100 feet and one boring (B-3) was advanced to 120 feet per ADOT's direction. The approximate boring locations are shown on the Boring Location Plan (Figure 3) included at the end of this report.

A piezometer was installed at boring location B-1a to enable collection of groundwater elevation readings. The piezometer is 2.5-inch-diameter PVC and is slotted between the approximate depths of 80 to 100 feet below the ground surface. The slotted portion is backfilled with sand and sealed with slow-release bentonite chips and the remaining borehole was grouted to the ground surface. Surface completion included a concrete/metal vault. A completion diagram of the piezometer construction is depicted in Figure 4.

A field engineer was present to oversee the drilling, to prepare lithologic logs and to obtain representative samples for laboratory testing. Soil samples were visually inspected, logged and classified in general accordance with ASTM D2488, the Unified Soil Classification System (USCS), ADOT standards and WSP Project sampling

guidelines. All borehole logs are presented in Appendix A, attached with this report. A list of the borings precedes the logs in Appendix A.

Standard penetration testing (SPT) or open-end drive sampling generally was performed at five-foot intervals or less in the borings, driven by automatic hammers with impact energy efficiency as noted on the boring logs. Soil cuttings in the upper five feet were also collected.

2.4 LABORATORY TESTING

Laboratory testing was performed by ACS Services, Inc. The test results are presented in Appendix B and includes a summary table presented as Table B-1.

The laboratory testing program included the following:

- Sieve analysis (ASTM C136) and plasticity index (Atterberg limits) (ASTM D4318) – Used for soil classification.
- Density of tube samples (ASTM D2937) – Determination of in-place density and moisture at depth, used in drilled shaft computations.
- pH and resistivity (Ariz 236b)– Determination of the corrosive properties of soil.
- Total soluble sulfates and chlorides (Ariz 733/736) – Determination of the corrosive properties of soil.

3 SITE CONDITIONS

3.1 SURFACE CONDITIONS

SR 96 is a two-lane asphaltic concrete paved roadway generally oriented in a northwest-southeast direction in the project vicinity, as shown on Figure 2. The roadway has 11-foot-wide lanes and 1-foot shoulders and is classified as a rural major collector with a posted speed limit of 45 miles per hour within the project limits. The surrounding terrain is generally flat with some gently rolling hills. The project elevation is roughly 2,285 feet above sea level. The Santa Maria River is ephemeral and flows to the southwest.

Record Drawings of the bridge provided by ADOT show that the existing five-span steel bridge is 392 feet long and is supported on steel H-piles and by a spread footing at the west (north) abutment. The H-piles are on the order of 30 feet in length and the abutments include bank protection.

Figure 2: Project Location

3.2 GEOLOGIC CONDITIONS

This project area is in West-central Arizona near the Transition Zone, which separates the Basin and Range Province from the Colorado Plateau Zone. The Basin and Range province is characterized by rugged isolated fault-bounded, northwestern trending mountain ranges that are separated by broad alluvium-filled valleys.

A geologic overview of the site is depicted on Figures 5A and 5B. The main geologic units exposed at the site are Tertiary and Quaternary sedimentary units derived from the washes originating from the surrounding mountains. The Quaternary units consist of active stream deposits (QAL), which are composed primarily of sand with gravel and scattered cobbles. The surrounding active floodplain deposits (QAF) and terrace deposits (QTG) are composed mainly of silty gravel and sand with cobbles and/or boulders associated with higher flow

events. The Quaternary units overlie the older Tertiary-age basin-fill deposits (TBF), which generally consist of soft fine-grained interbedded sandstone, siltstone, and conglomerate.

3.3 GEOTECHNICAL PROFILE

Four borings were drilled in support of bridge foundation design. Two borings (B-2 & B-3) were drilled in the riverbed to depths ranging from about 100 feet to 120 feet below ground surface. Two borings (B-1a & B-4) were drilled near the proposed abutments to approximate depths of 99 feet below existing grade. Boring B-1a was drilled from the top of the embankment at the north abutment due to access constraints.

The geotechnical profile generally consists of approximately 30 to 40 feet of active alluvial stream and floodplain deposits (QAL/QAF) overlying older Tertiary basin-fill deposits (TBF). The active stream deposits consist of a mix of sand, gravel and cobbles with few scattered boulders. These deposits are dense to very dense. At the north abutment, approximately 10 to 12 feet of man-placed fill was encountered overlying the floodplain deposits. Basin-fill deposits were encountered underlying these active channel deposits at depths ranging from 30 to 50 feet below existing ground. These finer-grained deposits contain a variable quantity of gravel and are characterized by refusal blow counts, which consistently resulted in minor recovery of materials in the sampler.

Our interpretation of the geotechnical profile is presented on Figure 6. The elevations shown on Figure 6 are approximate and were estimated from Google Earth imagery.

3.4 GROUNDWATER CONDITIONS

Groundwater was encountered in our borings at depths ranging from 7 to 40 feet at the time of drilling, which corresponds to approximate elevations of 2246 to 2260 feet. As noted above, a piezometer was installed in boring B-1a with the understanding that groundwater level measurements will be taken by others to record the groundwater fluctuations at the site. Construction details of the piezometer are provided on the attached Figure 4.

Groundwater is anticipated to be a constraint to design and construction of the planned improvements and should be considered by the contractor. Groundwater levels should be expected to vary based on seasonal precipitation, flows in nearby drainages, and other factors.

3.5 GEOLOGIC HARZARDS

The primary geologic hazard within the project area is seismic activity associated with the Arizona Mountain Seismic Zone. The Arizona Mountain Seismic Zone is characterized by a higher level of seismicity, abundant quaternary faults and northwesterly trends and physiography. It is an area of active block faulting being broken off and downfaulted from the Colorado Plateau; however, the seismic sources within this zone are discrete and fault displacement occurs at a slow rate.

The mapped faults closest to the project site are the Williamson Valley grabens located about 24 miles northeast of the site. The Williamson Valley grabens is a middle to late Quaternary normal fault with a southeast dip direction and average strike of N12°E, and a slip rate of 0.2 mm per year.

3.6 SITE SEISMICITY

The project seismic criteria included in this report are in accordance with Section 3.10 of the AASHTO LRFD Bridge Design Specifications (2012). The horizontal design acceleration is defined as having a 7 percent chance of exceedance during a 75-year recurrence interval. The probabilistic horizontal spectral acceleration values for the designated return period and corresponding peak horizontal ground acceleration (PGA) were obtained from the

United States Geological Survey (USGS) seismic hazards program website (USGS 2013). The values obtained from the website are based on 2009 AASHTO Guide Specifications for LRFD Seismic Bridge Design and use 2002 USGS seismic hazard data.

Based on the review of the soil borings, the site soils are considered very dense to hard, generally with an average N-value between 15 and 50 blows per foot. As such, in accordance with AASHTO (2012), the site was conservatively classified as Site Class D. The seismic design parameters are presented in Table 3.1.

Table 3.1: Summary of Seismic Design Parameters

STRUCTURE NAME	LATITUDE & LONGITUDE[1]	SITE CLASS	SEISMIC DESIGN PARAMETER	PERIOD, T (SECOND)	SPECTRAL ACCELERATION VALUE, G [2]
Structure #00225 Santa Maria Bridge	34.480°N 113.060°W	D	A_s	0.0	0.139
			S_{DS}	0.2	0.324
			S_{D1}	1.0	0.138

Note: [1] Latitude and longitude of location used to determine seismic design coefficients from USGS website.
[2] Spectral acceleration values did not vary significantly across the project.

Based on the mapped value of S_{D1}, the project site falls into a Seismic performance Zone 1, in accordance with Section 3.10.6-1 (AASHTO, 2012). The horizontal response spectral acceleration coefficient (S_{D1}) is less than the threshold value of 0.15 g for Seismic Zone 1, Table 3.10.6-1. Article 4.7.4.1 (AASHTO 2012) states, "Bridges in Seismic Zone 1 need not be analyzed for seismic loads. However, the minimum requirements, as specified in Articles 4.7.4.4 and 3.10.9 (AASHTO 2012), shall apply."

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— Bryant, Bruce, 1995. Geologic Map, Cross Section, Isotopic Dates and Mineral Deposits of The Alamo Lake 30'x60' Quadrangle, of West-Central Arizona, Miscellaneous Investigations Series Map I-2489.

— United States Geological Survey (USGS), 2013. U.S. Seismic Design Maps. Version 3.1.0. http://earthquake.usgs.gov/designmaps/us/application.php (Accessed December 2024).

FIGURES

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Legend

Approximate Boring Locations

Boring Location Plan

Figure 3

Santa Maria River Bridge
TRACS No. F0584 01D
WSP Project Number: US0029828.9292

PROJECT NUMBER	WELL NUMBER		
US0029828.9292	**B-1a**	SHEET 1	OF 1

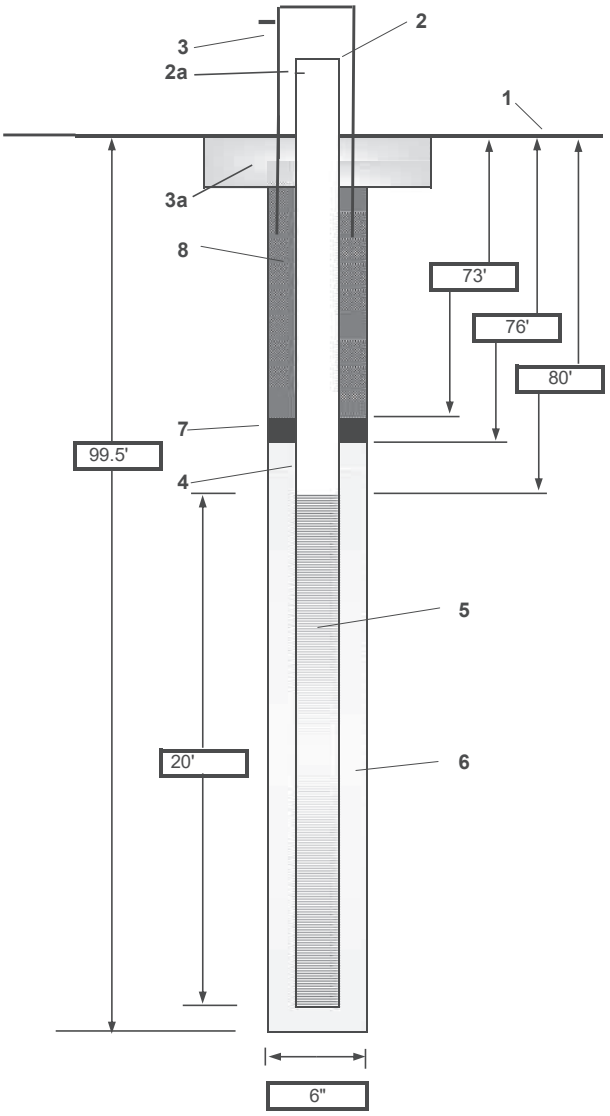
PIEZOMETER COMPLETION DIAGRAM

PROJECT : SR 96 Santa Maria River Bridge LOCATION : Yavapai County, Arizona

DRILLING CONTRACTOR : GSI

DRILLING METHOD AND EQUIPMENT USED : CME 75; Tubex drilling method

WATER LEVELS : ~40' DATE: 12/13/2024 LOGGER : Sai Singhar



1- Ground elevation at well: 2278' (estimated)

2- Top of casing elevation: 30" above ground
a) vent hole? yes

3- Wellhead protection cover type: steel vault w/ locking lid
a) steel vault dimensions: 6" diameter X 5' tall
b) concrete pad dimensions: 2' diameter x 1.5' thick

4- Dia./type of well casing: 2" Sch 40 PVC

5- Type/slot size of screen: 0.02" PVC

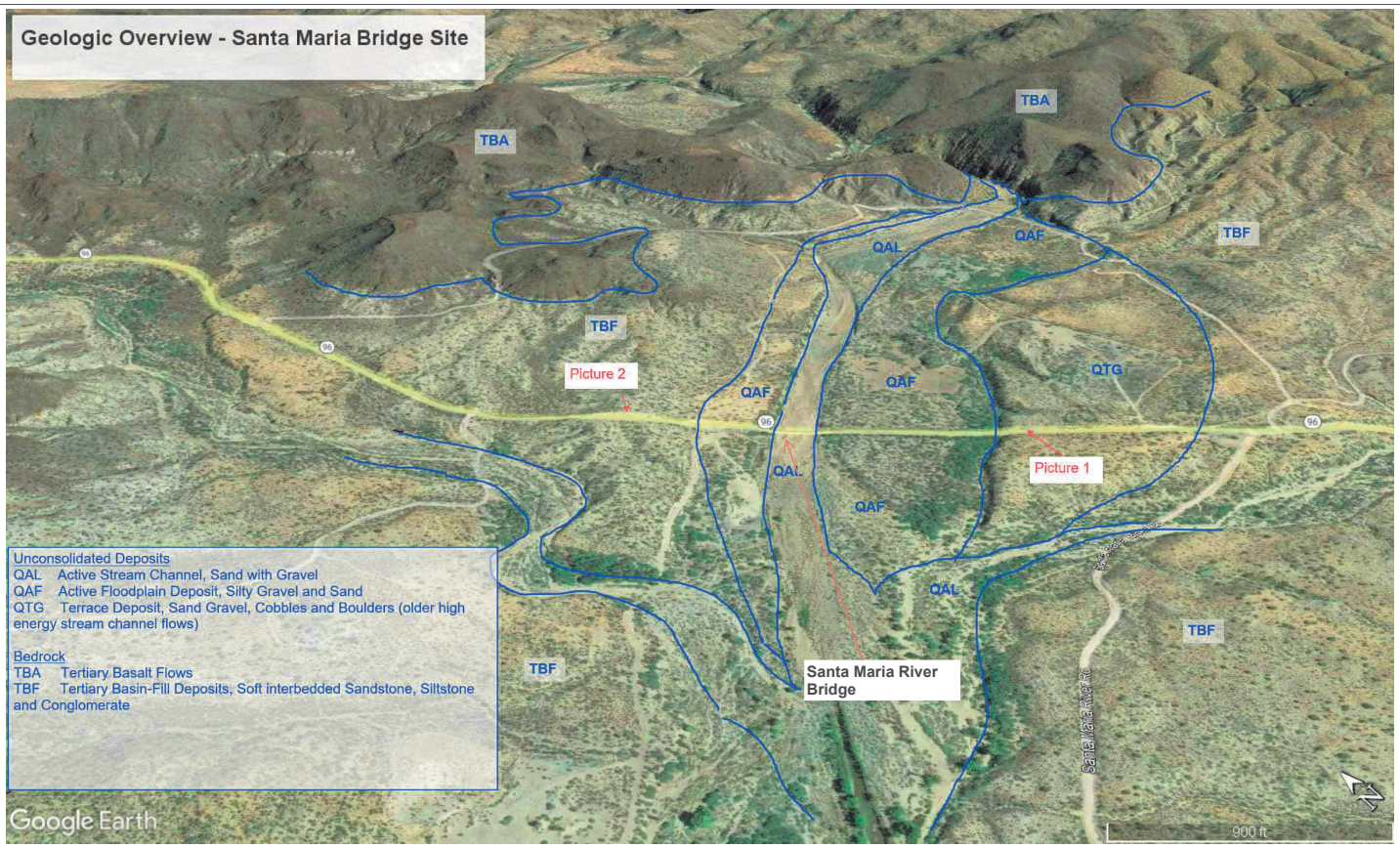
6- Type screen filter: 10/20 sand
a) Quantity used: 8 bags

7- Type of seal: bentonite chips
a) Quantity used: 1 box

8- Grout
a) Grout mix used: cement/water
b) Quantity: 12 bags

Comments

Figure 4



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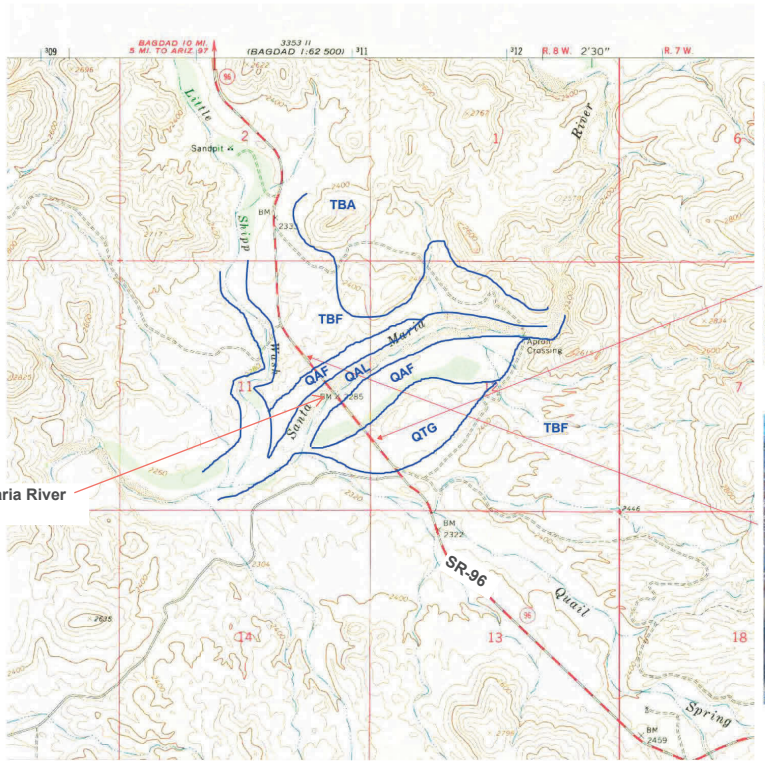
Geologic Overview

Figure 5a

Santa Maria River Bridge
TRACS No. F0584 01D
WSP Project Number: US0029828.9292



Santa Maria River Bridge

Picture 1 Coarse-grained Terrace Deposit
Similar materials may be encountered within the alluvial profile above the Basin-Fill Deposits

Picture 2 Bedded Basin-Fill Deposits
Underlies the site below young alluvial deposits

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Geologic Overview

Figure 5b

Santa Maria River Bridge
TRACS No. F0584 01D
WSP Project Number: US0029828.9292

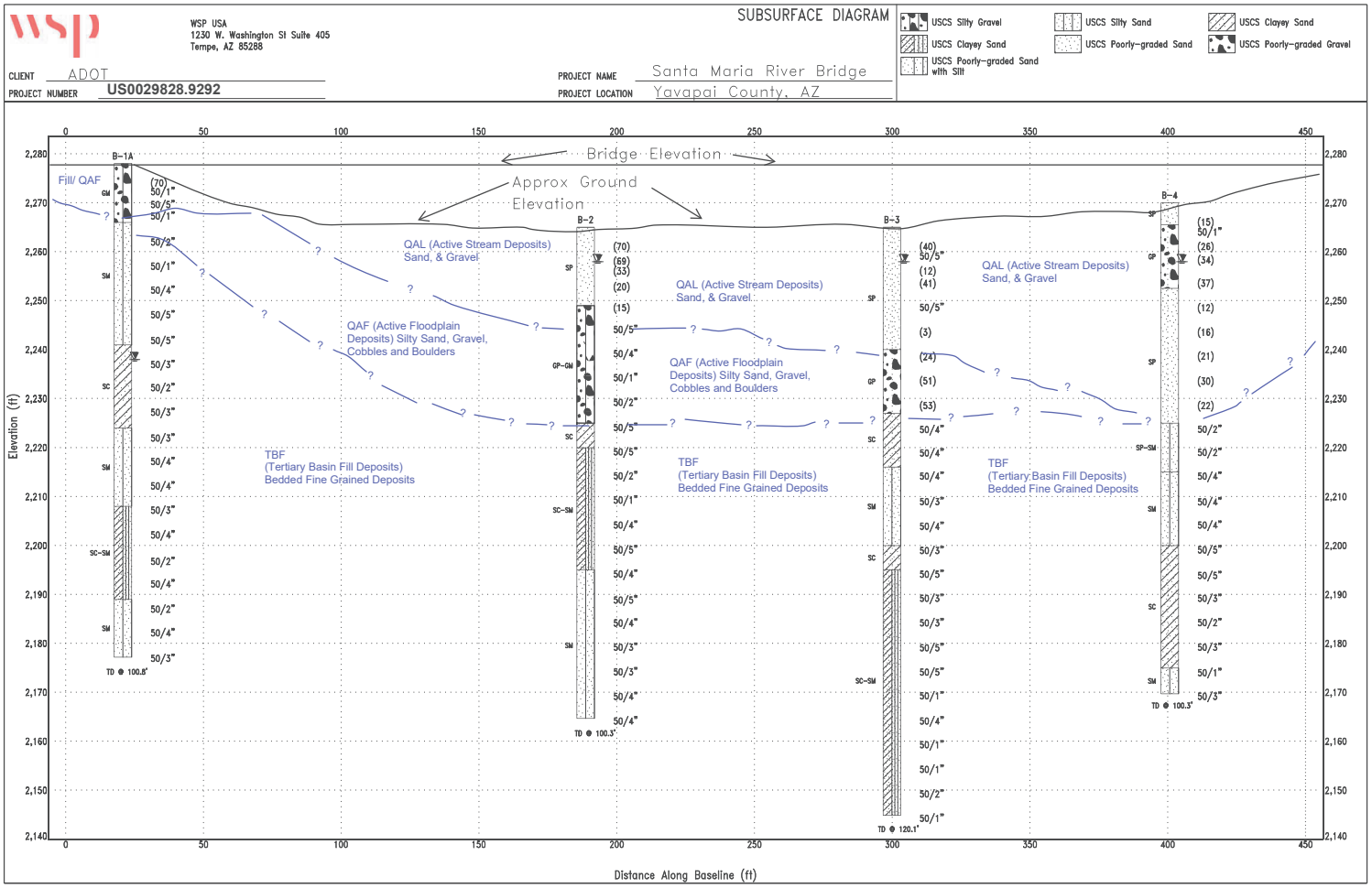

WSP USA
1230 W. Washington St Suite 405
Tempe, AZ 85288
SUBSURFACE DIAGRAM
CLIENT ADOT
PROJECT NUMBER US0029828.9292
PROJECT NAME Santa Maria River Bridge
PROJECT LOCATION Yavapai County, AZ
USCS Silty Gravel
USCS Silty Sand
USCS Clayey Sand
USCS Clayey Sand
USCS Poorly-graded Sand
USCS Poorly-graded Gravel
USCS Poorly-graded Sand with Silt
Bridge Elevation
Approx Ground Elevation
B-1A
B-2
B-3
B-4
Fill/ QAF
QAL (Active Stream Deposits) Sand, & Gravel
QAF (Active Floodplain Deposits) Silty Sand, Gravel, Cobbles and Boulders
TBF (Tertiary Basin Fill Deposits) Bedded Fine Grained Deposits
TD @ 100.8'
TD @ 100.3'
TD @ 120.1'
TD @ 100.3'
Elevation (ft)
Distance Along Baseline (ft)

Figure 6

APPENDIX

A BORING LOGS

Boring List

Santa Maria River Bridge

Boring	Depth	Purpose	Rig	Duration (hr)	Day/Night	Comments
B-1a	99	Bridge	Track	20	Day	Minor brush clearing may be needed
B-2	99	Bridge	Track	20	Day	
B-3	120	Bridge	Track	20	Day	
B-4	99	Bridge	Track	20	Day	Minor brush clearing may be needed

FIELD EQUIPMENT AND PROCEDURES

Description of Subsurface Exploration Methods

Auger Boring – Drilling through soils is commonly performed with a drill rig equipped with hollow stem auger drill steel. The drill rig manufacturer may include Central Mine Equipment (CME), Diedrich or Mobile. The hollow stem auger is advanced by rotating the steel with a cutting head at the leading end of the auger with welded spiral flights on the outside of the steel to remove the drill cuttings from the hole as the head advances and the auger turns. The cutting head typically has carbide teeth inserts to aid in cutting through the soils. The rig is commonly mounted on a rubber-wheeled truck or track-mounted vehicle. The size of the auger and the make and model of the drill rig used are indicated on the boring log.

This method is suited for drilling in fine-grained soils with limited cementation and relatively loose granular soils or soft and/or highly weathered bedrock. The hollow stem auger method is less suited for drilling coarser grained deposits of sand, gravel, and cobbles (locally referred to as SGC) or “river-run” material, cobbles & boulders, strongly cemented soils, or harder bedrock and can reach auger refusal. In-situ sampling through the center of the auger can be performed without removing the drill steel to minimize the disturbance and maintain the integrity of the sample. Samples of auger cuttings may also be obtained as desired as the auger flights carry the cuttings to the surface. Sampling procedures are noted in a different section.

Percussion Dual-Wall Air Rotary (Odex/Tubex/Stratex) – This method uses a dual-walled drive pipe with an outer casing to stabilize the hole and an inner drill steel fitted with a down-hole hammer that strikes both the casing shoe and the formation materials to penetrate the formation. The percussion system manufacturer brands include Odex, Tubex and/or Stratex, which all use the eccentric bit system. The drill bit below the down-hole hammer includes a leading carbide tungsten button bit to advance through the formation and an eccentric second bit that swings out to under ream the hole below the outer casing. The under-reaming eccentric bit enlarges the hole to a slightly larger diameter than the outer casing. The down-hole hammer striking the casing shoe pulls the casing down as the hole is advanced. Cuttings are evacuated from the bottom of the hole passing between the inner and outer casing using compressed air. Samples of the cuttings may be obtained as they exit the top of the outer casing. The size of drive casing and drill rig make, and model used are indicated on the boring logs. In-situ drive samples can be collected by lowering sampling tools through the outer casing to the bottom of the hole below the outer casing shoe after the inner drill steel and down-hole hammer is removed. All collected samples and types are documented on the boring logs.

This method is suited for drilling in coarse-grained unconsolidated deposits that are subject to borehole wall caving like sand, gravel, and cobbles (locally referred to as SGC) or “river-run” material, cobbles & boulders, with limited application in cemented soils. The system may reach an effective refusal on strongly cemented soils or hard bedrock. The depth is also limited by the capacity of the equipment and formation conditions. Heaving sands can be problematic for in-situ sampling where pulling the inner string of steel pulls the formation sands into the casing.

Sampling Procedures

Dynamically driven tube samples are obtained at selected intervals in the borings. In many cases, 2-inch O.D., 1 3/8-inch I.D. samples are used to obtain the standard penetration resistance in accordance with ASTM D1586. Relatively “undisturbed” samples are often obtained with 3-inch O.D. samples lined with 2.42-inch I.D. brass rings in accordance with ASTM D3550. The driving energy is generally recorded as the number of blows of a 140-pound, 30-inch free fall drop above ground hammer required to advance the samples in 6-inch increments. These values are expressed in blows per 6 inches on the boring logs. "Undisturbed" sampling of softer soils is sometimes performed with thin-walled Shelby tubes (ASTM D1587). Where samples of rock are required, they are obtained by diamond core drilling (ASTM D2113). Tube samples are labeled and placed in watertight containers to maintain field moisture contents for testing. When necessary for testing, larger bulk samples are taken from drill cuttings.

Boring Logs

Soils are visually classified in the field by our on-site field engineer or geologist during the exploration in general accordance with the Description and Identification of Soils (Visual-Manual Procedure) (ASTM D2488), the Unified Soil Classification System (ASTM D2487) and WSP procedures.

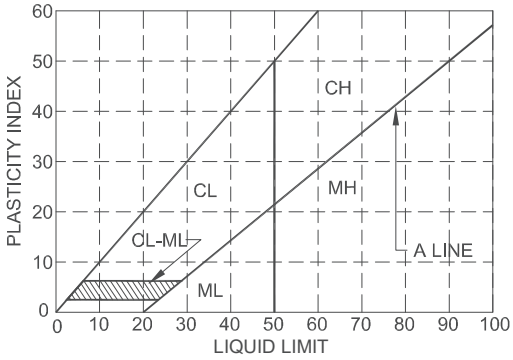
UNIFIED CLASSIFICATION SYSTEM FOR SOILS

Soils are visually classified by the United Soil Classification System on the boring logs presented in this report. Grain-size analysis and Atterberg Limits Tests are often performed on selected samples to aid in classification. The classification system is briefly outlined on this chart. For a more detailed description of the system, see "The Unified Soil Classification System" ASTM Designation: D2487

MAJOR DIVISION				GRAPH SYMBOL	GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE-GRAINED SOILS (Less than 50% passes No. 200 sieve)	GRAVELS (More than 50% of coarse fraction retained on No. 4 sieve)	CLEAN GRAVELS (Less than 5% passes No. 200 sieve)			GW	Well graded gravels, gravel-sized mixtures or sand-gravel-cobble mixture.
					GP	Poorly graded gravels, gravel-sized mixtures or sand-gravel-cobble mixture.
		GRAVELS WITH FINES (More than 12% passes No. 200 sieve)	PI <4 or plots below "A" line		GM	Silty gravels, gravel-sand-silt mixture.
			PI >7 and plots on or above "A" line		GC	Clayey gravels, gravel-sand-clay mixture.
	SANDS (50% or more of coarse fraction passes No. 4 sieve)	CLEAN SANDS (Less than 5% passes No. 200 sieve)			SW	Well graded sands, gravelly sands.
					SP	Poorly graded sands, gravelly sands.
		SANDS WITH FINES (More than 12% passes No. 200 sieve)	PI <4 or plots below "A" line		SM	Silty sands, sand-silt mixtures.
			PI >7 and plots on or above "A" line		SC	Clayey sands, sand-clay mixtures.
FINE-GRAINED SOILS (50% or more passes No. 200 sieve)	SILTS PI <4 or plots below "A" line	SILTS OF LOW PLASTICITY (Liquid limit less than 50)			ML	Inorganic silts, clayey silts with slight plasticity.
		SILTS OF HIGH PLASTICITY (Liquid limit 50 or more)			MH	Inorganic silts of high plasticity, silty soils, elastic silts.
	CLAYS PI >7 and plots on or above "A" line	CLAYS OF LOW PLASTICITY (Liquid limit less than 50)			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
		CLAYS OF HIGH PLASTICITY (Liquid limit 50 or more)			CH	Inorganic clays of high plasticity, fat clays, silty and sandy clays of high plasticity.

NOTE: Coarse-grained soils with between 5% to 12% passing the No. 200 sieve and fine-grained soils with limits plotting in the hatched zone on the plasticity chart have a dual symbol.

PLASTICITY CHART



DEFINITIONS OF SOIL FRACTIONS

Amount Modifiers	
Rare	<2%
Occasional	<5%
Trace	10%
Some	20%
Considerable	30%

Term	Size (mm)	Sieve Size
Boulders	>300	>12 in
Cobbles	75 to 300	3 to 12 in
Gravel (coarse)	19 to 75	3/4 to 3 in
Gravel (fine)	4.75 to 19	#4 to 3/4 in
Sand (coarse)	2 to 4.75	#10 to #4
Sand (medium)	0.425 to 2	#40 to #10
Sand (fine)	0.075 to 0.425	#200 to #40
Silt/Clay	<0.075	<#200

WSP/Tempe-2018 version

TERMINOLOGY USED TO DESCRIBE THE RELATIVE DENSITY, CONSISTENCY OR FIRMNESS OF SOILS

The terminology used on the boring logs to describe the relative density, consistency or firmness of soils relative to the standard penetration resistance is presented below. The standard penetration resistance (N) in blows per foot is obtained by the ASTM D1586 procedure using 2" O.D., 1 3/8" I.D. samplers. When a modified California sampler is used (ASTM D3550), an approximate N-value is obtained by multiplying by two-thirds.

1. **Relative Density.** Terms for description of relative density of cohesionless, uncemented sands and sand-gravel mixtures.

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

2. **Relative Consistency.** Terms for description of clays which are saturated or near saturation.

N	Relative Consistency	Remarks
0-2	Very soft	Easily penetrated several inches with fist.
3-4	Soft	Easily penetrated several inches with thumb.
5-8	Medium stiff	Can be penetrated several inches with thumb with moderate effort.
9-15	Stiff	Readily indented with thumb, but penetrated only with great effort.
16-30	Very stiff	Readily indented with thumbnail.
30+	Hard	Indented only with difficulty by thumbnail.

3. **Relative Firmness.** Terms for description of partially saturated and/or cemented soils that commonly occur in the Southwest including clays, cemented granular materials, silts and silty and clayey granular soils.

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

TERMINOLOGY USED TO DESCRIBE CEMENTATION

Uncemented	No reaction to HCl, or easily broken with finger pressure
Weakly	Reacts with HCl, and some calcium carbonate filaments, and possibly nodules, and crumbles with moderate finger pressure and N>15
Moderately	Reacts strongly with HCl, and filaments continuous throughout, and nodules present, and sample is white/gray, and considerable finger pressure required to break soil into chunks, and blowcount for 3rd interval >30
Strongly	Reacts strongly with HCl, filaments continuous and almost indistinguishable, nodules are larger, and sample is white, and will not crumble with firm finger pressure, and refusal blowcounts (blowcount >50 for 6-inch interval)

BORING LOG I.D.: B-1A

PROJECT NAME:	Santa Maria River Bridge		**PROJECT #:**	US0029828.9292	
LOGGER:	Sai Singhar		**PROJECT LOCATION:**	Yavapai County, AZ	
DRILLER:	Chuck		**STATION/OFFSET:**		
DRILLER FIRM:	GSI		**REFERENCE:**		
RIG TYPE:	CME 75		**COORDINATES:**	34.481292, -113.061202	
BORING TYPE:	Tubex	**BORING DIA.:** 5.5	**COORDINATE SYS:**	WGS84	
ORIENTATION:	Vertical		**SURFACE ELEV. (FT):**	2278	
HAMMER CALIBRATION-ENERGY TRANSFER RATIO:	83.2		**VERTICAL DATUM:**	NAD88	
START DATE:	12/11/24	**START TIME:** 16:10	**COMPLETION DATE:**	12/13/24	**COMPLETION TIME:** 11:00

Elevation in Feet	Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count / Pocket pen. (tsf)	Lab Tests: Dry Density (pcf)	Lab Tests: Moisture Content (%) of Dry Weight	Lab Tests: Liquid Limit (%)	Lab Tests: Plasticity Index	Lab Tests: Percent passing #200 Sieve	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
	0				B			1.3	20	2	16	GM	Slightly moist Very dense	**POSSIBLE FILL - SILTY GRAVEL WITH COBBLES AND SAND**, some predominantly cobbles, occasional boulders, fine to medium grained sand, Predominantly coarse grained gravel, weakly lime cemented, non-plastic, Light tan brown
2275.0					S	22-33-37 (70)								
	5				U	50/1"								
2270.0					S	50/5"								
	10				U	50/1"								
2265.0												SM	Slightly moist Very dense	**SILTY SAND**, trace clay, considerable coarse to fine grained subrounded to subangular gravel, predominantly fine to medium grained sand, weakly lime cemented, non-plastic to low plasticity, Brown and light brown
	15				S	46-50/2"								
2260.0														
	20													

(Continued Next Page)

GROUNDWATER

	TIME	DATE
▽		12/13/24
▼		
▽		

METHOD _____

SAMPLE TYPE
B - Bulk Sample
S - 2" O.D. 1.38" I.D. Split Spoon Sample
U - 3" O.D. 2.42" I.D. Ring Sample
NR - No Recovery

BORING LOG I.D.: B-1A

PROJECT: Santa Maria River Bridge | **PROJECT LOCATION:** Yavapai County, AZ

Elevation in Feet	Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count / Pocket pen. (tsf)	Lab Tests: Dry Density (pcf)	Lab Tests: Moisture Content (%) of Dry Weight	Lab Tests: Liquid Limit (%)	Lab Tests: Plasticity Index	Lab Tests: Percent passing #200 Sieve	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
	20				S	30-50/1"						SM	Slightly moist Very dense	**SILTY SAND**, trace clay, considerable coarse to fine grained subrounded to subangular gravel, predominantly fine to medium grained sand, weakly lime cemented, non-plastic to low plasticity, Brown and light brown
2255.0														
	25				S	50/4"								
2250.0														
	30				U	50/5"		11.2	NP	NP	15			
2245.0														
	35				S	36-50/5"								Note: increase in amount of clay; sample moist at 35'
2240.0												SC	Wet Very dense	**CLAYEY SAND WITH SILT**, some coarse grained gravel, predominantly fine to medium grained sand, low plasticity, Brown
	40				S	16-50/3"							▽	
2235.0														
	45													

GROUNDWATER

	TIME	DATE
▽		12/13/20
▼		
▽		

METHOD _____

SAMPLE TYPE
B - Bulk Sample
S - 2" O.D. 1.38" I.D. Split Spoon Sample
U - 3" O.D. 2.42" I.D. Ring Sample
NR - No Recovery

(Continued Next Page)

BORING LOG I.D.: B-1A

PROJECT: Santa Maria River Bridge | **PROJECT LOCATION:** Yavapai County, AZ

Elevation in Feet	Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count / Pocket pen. (tsf)	Lab Tests: Dry Density (pcf)	Lab Tests: Moisture Content (%) of Dry Weight	Lab Tests: Liquid Limit (%)	Lab Tests: Plasticity Index	Lab Tests: Percent passing #200 Sieve	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
	45				S	50/2"						SC	Wet Very dense	**CLAYEY SAND WITH SILT**, some coarse grained gravel, predominantly fine to medium grained sand, low plasticity, Brown
2230.0														
	50				U	50/3"								
2225.0														
	55				S	25-50/3"						SM	Wet Very dense	**SILTY SAND**, some gravel, trace clay, predominantly fine grained sand, non-plastic to low plasticity, Gray
2220.0														
	60				U	50/4"			NP	NP	14			Note: Brown below 60'
2215.0														
	65				S	50/4"								
2210.0														
	70													

GROUNDWATER

	TIME	DATE
▽		12/13/20
▼		
▼		

METHOD _____

SAMPLE TYPE
B - Bulk Sample
S - 2" O.D. 1.38" I.D. Split Spoon Sample
U - 3" O.D. 2.42" I.D. Ring Sample
NR - No Recovery

(Continued Next Page)

BORING LOG I.D.: B-1A

PROJECT: Santa Maria River Bridge

PROJECT LOCATION: Yavapai County, AZ

Elevation in Feet	Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count / Pocket pen. (tsf)	Lab Tests: Dry Density (pcf)	Lab Tests: Moisture Content (%) of Dry Weight	Lab Tests: Liquid Limit (%)	Lab Tests: Plasticity Index	Lab Tests: Percent passing #200 Sieve	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
	70				U	50/3"						SC-SM	Wet Very dense	**SILTY CLAYEY SAND WITH GRAVEL**, coarse to fine grained gravel, predominantly fine to medium grained sand, non-plastic to low plasticity, Brown to reddish brown
2205.0														
	75				S	50/4"								
2200.0														
	80				S	14-34-50/2"								Note: increase in amount of clay; low to medium plasticity; some coarse grained sand at 80'
2195.0														
	85				S	50/4"								
2190.0														
	90				S	35-50/2"		25.8	NP	NP	37	SM	Wet Very dense	**SILTY SAND**, some to considerable gravel, fine grained sand, Non-plastic, Grayish brown
2185.0														
	95													

GROUNDWATER

	TIME	DATE
▽		12/13/20
▼		
▼		

METHOD _____

SAMPLE TYPE
B - Bulk Sample
S - 2" O.D. 1.38" I.D. Split Spoon Sample
U - 3" O.D. 2.42" I.D. Ring Sample
NR - No Recovery

(Continued Next Page)

BORING LOG I.D.: B-1A

PROJECT: Santa Maria River Bridge

PROJECT LOCATION: Yavapai County, AZ

Elevation in Feet	Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count / Pocket pen. (tsf)	Lab Tests: Dry Density (pcf)	Lab Tests: Moisture Content (%) of Dry Weight	Lab Tests: Liquid Limit (%)	Lab Tests: Plasticity Index	Lab Tests: Percent passing #200 Sieve	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
	95				S	50/4"						SM	Wet Very dense	**SILTY SAND**, some to considerable gravel, fine grained sand, Non-plastic, Grayish brown
2180.0														
	100				S	20-50/3"								
														End boring at 100.8'. Installed Piezometer.
2175.0														
	105													
2170.0														
	110													
2165.0														
	115													
2160.0														
	120													

GROUNDWATER

	TIME	DATE
▽		12/13/20
▼		
▼		

METHOD _____

SAMPLE TYPE

B - Bulk Sample
S - 2" O.D. 1.38" I.D. Split Spoon Sample
U - 3" O.D. 2.42" I.D. Ring Sample
NR - No Recovery

BORING LOG I.D.: B-2

PROJECT NAME:	Santa Maria River Bridge			**PROJECT #:**	US0029828.9292
LOGGER:	Sai Singhar			**PROJECT LOCATION:**	Yavapai County, AZ
DRILLER:	Chuck			**STATION/OFFSET:**	
DRILLER FIRM:	GSI			**REFERENCE:**	
RIG TYPE:	CME 75			**COORDINATES:**	34.480885, -113.060916
BORING TYPE:	Tubex	**BORING DIA.:**	5.5	**COORDINATE SYS:**	WGS84
ORIENTATION:	Vertical			**SURFACE ELEV. (FT):**	2265
HAMMER CALIBRATION-ENERGY TRANSFER RATIO:	83.2			**VERTICAL DATUM:**	NAD88
START DATE:	12/9/24	**START TIME:**	16:25	**COMPLETION DATE:**	12/11/24 **COMPLETION TIME:** 11:40

Elevation in Feet	Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count / Pocket pen. (tsf)	Lab Tests: Dry Density (pcf)	Lab Tests: Moisture Content (%) of Dry Weight	Lab Tests: Liquid Limit (%)	Lab Tests: Plasticity Index	Lab Tests: Percent passing #200 Sieve	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
2265.0	0				B			1.0	NP	NP	3	SP	Wet Medium dense	**POORLY GRADED SAND WITH GRAVEL**, some cobbles & boulders (1.5' dia), coarse grained gravel, predominantly medium grained sand, non-plastic, Grayish brown
					S	18-23-47 (70)								
2260.0	5				U	31-38 (69)								
					S	18-22-11 (33)								
2255.0	10				U	9-11 (20)			NP	NP	2.4			
2250.0	15				S	3-6-9 (15)								Note: hard drilling below 16'
												GP-GM	Wet Medium dense to very dense	**POORLY GRADED GRAVEL WITH SILT AND SAND**, Some cobbles, Considerable fine to medium grained sand, predominantly fine to coarse grained gravel, Non-plastic to low plasticity, Brown to light gray
2245.0	20													

GROUNDWATER

		TIME	DATE
▽			12/10/24
▼	7.0		12/11/24
▽			

METHOD _____

SAMPLE TYPE
B - Bulk Sample
S - 2" O.D. 1.38" I.D. Split Spoon Sample
U - 3" O.D. 2.42" I.D. Ring Sample
NR - No Recovery

(Continued Next Page)

BORING LOG I.D.: B-2

PROJECT: Santa Maria River Bridge

PROJECT LOCATION: Yavapai County, AZ

Elevation in Feet	Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count / Pocket pen. (tsf)	Lab Tests: Dry Density (pcf)	Lab Tests: Moisture Content (%) of Dry Weight	Lab Tests: Liquid Limit (%)	Lab Tests: Plasticity Index	Lab Tests: Percent passing #200 Sieve	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
2245.0	20				S	50/5"						GP-GM	Wet Medium dense to very dense	**POORLY GRADED GRAVEL WITH SILT AND SAND**, Some cobbles, Considerable fine to medium grained sand, predominantly fine to coarse grained gravel, Non-plastic to low plasticity, Brown to light gray
2240.0	25				S	50/4"								Note: increase fines below 25'
2235.0	30				U	50/1"								
2230.0	35				S	50/2"								Note: trace clay at 35'
2225.0	40				S	50/5"						SC	Wet Very dense	**CLAYEY SAND WITH GRAVEL**, coarse grained gravel, predominantly fine to medium grained sand, low plasticity, Yellowish brown
2220.0	45													

GROUNDWATER

	TIME	DATE
▽		12/10/24
▼	7.0	12/11/24
▼		

METHOD _____

SAMPLE TYPE
B - Bulk Sample
S - 2" O.D. 1.38" I.D. Split Spoon Sample
U - 3" O.D. 2.42" I.D. Ring Sample
NR - No Recovery

(Continued Next Page)

BORING LOG I.D.: B-2

PROJECT: Santa Maria River Bridge | **PROJECT LOCATION:** Yavapai County, AZ

Elevation in Feet	Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count / Pocket pen. (tsf)	Lab Tests: Dry Density (pcf)	Lab Tests: Moisture Content (%) of Dry Weight	Lab Tests: Liquid Limit (%)	Lab Tests: Plasticity Index	Lab Tests: Percent passing #200 Sieve	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
2220.0	45				U	50/5"						SC-SM	Wet Very dense	**SILTY CLAYEY SAND WITH GRAVEL**, some fines, coarse grained gravel, predominantly coarse to fine grained sand, non-plastic to low plasticity, Brown
2215.0	50				U	50/2"								
2210.0	55				S	50/1"								Note: decrease in amount of gravel below 55'
2205.0	60				S	50/4"								
2200.0	65				S	50/5"								
2195.0	70													

GROUNDWATER

	TIME	DATE
▽		12/10/24
▼	7.0	12/11/24
▼		

METHOD _____

SAMPLE TYPE
B - Bulk Sample
S - 2" O.D. 1.38" I.D. Split Spoon Sample
U - 3" O.D. 2.42" I.D. Ring Sample
NR - No Recovery

(Continued Next Page)

BORING LOG I.D.: B-2

PROJECT: Santa Maria River Bridge

PROJECT LOCATION: Yavapai County, AZ

Elevation in Feet	Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count / Pocket pen. (tsf)	Lab Tests: Dry Density (pcf)	Lab Tests: Moisture Content (%) of Dry Weight	Lab Tests: Liquid Limit (%)	Lab Tests: Plasticity Index	Lab Tests: Percent passing #200 Sieve	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
2195.0	70				U	50/4"						SM	Wet Very dense	**SILTY SAND**, some fines, Some coarse grained gravel, predominantly coarse to fine grained sand, non-plastic to low plasticity, Brown
2190.0	75				S	32-50/5"		22.7	71	37	29			
2185.0	80				U	50/4"								Note: increase fine grained gravel below 80'
2180.0	85				S	50/3"								
2175.0	90				S	50/3"								
2170.0	95													

GROUNDWATER

	TIME	DATE
▽		12/10/24
▼	7.0	12/11/24
▼		

METHOD _____

SAMPLE TYPE
B - Bulk Sample
S - 2" O.D. 1.38" I.D. Split Spoon Sample
U - 3" O.D. 2.42" I.D. Ring Sample
NR - No Recovery

(Continued Next Page)

BORING LOG I.D.: B-2

PROJECT: Santa Maria River Bridge | **PROJECT LOCATION:** Yavapai County, AZ

Elevation in Feet	Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count / Pocket pen. (tsf)	Lab Tests: Dry Density (pcf)	Lab Tests: Moisture Content (%) of Dry Weight	Lab Tests: Liquid Limit (%)	Lab Tests: Plasticity Index	Lab Tests: Percent passing #200 Sieve	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
2170.0	95				S	50/4"						SM	Wet Very dense	**SILTY SAND**, some fines, Some coarse grained gravel, predominantly coarse to fine grained sand, non-plastic to low plasticity, Brown
2165.0	100				S	50/4"								End boring at 100.3'. Backfilled with cutting and grouted top 20'.
2160.0	105													
2155.0	110													
2150.0	115													
2145.0	120													

GROUNDWATER

	TIME	DATE
▽		12/10/24
▼	7.0	12/11/24
▼		

METHOD _____

SAMPLE TYPE
B - Bulk Sample
S - 2" O.D. 1.38" I.D. Split Spoon Sample
U - 3" O.D. 2.42" I.D. Ring Sample
NR - No Recovery

BORING LOG I.D.: B-3

PROJECT NAME:	Santa Maria River Bridge	**PROJECT #:**	US0029828.9292
LOGGER:	Sai Singhar	**PROJECT LOCATION:**	Yavapai County, AZ
DRILLER:	Chuck	**STATION/OFFSET:**	
DRILLER FIRM:	GSI	**REFERENCE:**	
RIG TYPE:	CME 75	**COORDINATES:**	34.480656, -113.060672
BORING TYPE:	Tubex	**BORING DIA.:** 5.5	**COORDINATE SYS:** WGS84
ORIENTATION:	Vertical	**SURFACE ELEV. (FT):**	2265
HAMMER CALIBRATION-ENERGY TRANSFER RATIO:	83.2	**VERTICAL DATUM:**	NAD88
START DATE:	12/5/24 **START TIME:** 8:45	**COMPLETION DATE:**	12/9/24 **COMPLETION TIME:** 13:30

Elevation in Feet	Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count / Pocket pen. (tsf)	Lab Tests: Dry Density (pcf)	Lab Tests: Moisture Content (%) of Dry Weight	Lab Tests: Liquid Limit (%)	Lab Tests: Plasticity Index	Lab Tests: Percent passing #200 Sieve	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
2265.0	0				B			0.9	NP	NP	1.8	SP	Slightly moist Dense	**POORLY GRADED SAND WITH COBBLES AND GRAVEL**, occasional boulders, predominantly medium to coarse grained subrounded to subangular sand, non-plastic, Gray
					S	15-20-20 (40)								
2260.0	5				U	50/5"								Note: brown below 6'
					S	12-5-7 (12)								
												SP	Wet Dense	**POORLY GRADED SAND WITH GRAVEL**, occasional cobbles, trace silt, predominantly medium to coarse grained subrounded to subangular sand, non-plastic, Brown
2255.0	10				U	20-21 (41)	117.2	16.2						
2250.0	15				S	21-24-50/5"								Note: trace clay at 15'
2245.0	20													

GROUNDWATER

	TIME	DATE
▽		12/6/24
▼	7.0	12/9/24
▽		

METHOD _____

SAMPLE TYPE
B - Bulk Sample
S - 2" O.D. 1.38" I.D. Split Spoon Sample
U - 3" O.D. 2.42" I.D. Ring Sample
NR - No Recovery

(Continued Next Page)

BORING LOG I.D.: B-3

PROJECT: Santa Maria River Bridge | **PROJECT LOCATION:** Yavapai County, AZ

Elevation in Feet	Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count / Pocket pen. (tsf)	Lab Tests: Dry Density (pcf)	Lab Tests: Moisture Content (%) of Dry Weight	Lab Tests: Liquid Limit (%)	Lab Tests: Plasticity Index	Lab Tests: Percent passing #200 Sieve	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
2245.0	20				S	4-2-1 (3)						SP	Wet Dense	**POORLY GRADED SAND WITH GRAVEL**, occasional cobbles, trace silt, predominantly medium to coarse grained subrounded to subangular sand, non-plastic, Brown
2240.0	25				S	9-12-12 (24)						GP	Wet Dense to very dense	**POORLY GRADED GRAVEL WITH SAND**, considerable cobbles, fine to coarse grained sand, predominantly coarse grained subrounded to subangular gravel, non-plastic, Dark reddish brown to light gray
2235.0	30				U	24-27 (51)			NP	NP	1.5			
2230.0	35				S	16-28-25 (53)								
2225.0	40				S	21-35-50/4"			36	13	17	SC	Wet Very dense	**CLAYEY SAND WITH GRAVEL**, some silt, coarse grained gravel, predominantly coarse to fine grained sand, low plasticity, Brown
2220.0	45													

GROUNDWATER

	TIME	DATE
▽		12/6/24
▼	7.0	12/9/24
▼		

METHOD _____

SAMPLE TYPE
B - Bulk Sample
S - 2" O.D. 1.38" I.D. Split Spoon Sample
U - 3" O.D. 2.42" I.D. Ring Sample
NR - No Recovery

(Continued Next Page)

BORING LOG I.D.: B-3

PROJECT: Santa Maria River Bridge

PROJECT LOCATION: Yavapai County, AZ

Elevation in Feet	Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count / Pocket pen. (tsf)	Lab Tests: Dry Density (pcf)	Lab Tests: Moisture Content (%) of Dry Weight	Lab Tests: Liquid Limit (%)	Lab Tests: Plasticity Index	Lab Tests: Percent passing #200 Sieve	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
2220.0	45				S	18-50/4"						SC	Wet Very dense	**CLAYEY SAND WITH GRAVEL**, some silt, coarse grained gravel, predominantly coarse to fine grained sand, low plasticity, Brown
2215.0	50				U	50/4"						SM	Wet Very dense	**SILTY SAND WITH GRAVEL**, some clay, coarse grained gravel, predominantly coarse to fine grained sand, low plasticity, Brown
2210.0	55				S	27-50/3"		24.1	47	15	32			
2205.0	60				S	39-50/4"								
2200.0	65				S	32-50/3"						SC	Wet Very dense	**CLAYEY SAND WITH GRAVEL**, some silt, coarse grained gravel, predominantly coarse to fine grained sand, low plasticity, Brown
2195.0	70													

GROUNDWATER

	TIME	DATE
▽		12/6/24
▼	7.0	12/9/24
▽		

METHOD _____

SAMPLE TYPE
B - Bulk Sample
S - 2" O.D. 1.38" I.D. Split Spoon Sample
U - 3" O.D. 2.42" I.D. Ring Sample
NR - No Recovery

(Continued Next Page)

BORING LOG I.D.: B-3

PROJECT: Santa Maria River Bridge | **PROJECT LOCATION:** Yavapai County, AZ

Elevation in Feet	Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count / Pocket pen. (tsf)	Lab Tests: Dry Density (pcf)	Lab Tests: Moisture Content (%) of Dry Weight	Lab Tests: Liquid Limit (%)	Lab Tests: Plasticity Index	Lab Tests: Percent passing #200 Sieve	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
2195.0	70				U	50/5"						SC-SM	Wet Very dense	**CLAYEY SILTY SAND with GRAVEL**, coarse grained gravel, predominantly coarse to fine grained sand, low plasticity, Brown
2190.0	75				S	50/3"								
2185.0	80				S	50/3"								
2180.0	85				S	50/5"								Note: decrease clay and increase silt
2175.0	90				U	50/5"								
2170.0	95													

GROUNDWATER

	TIME	DATE
▽		12/6/24
▼	7.0	12/9/24
▼		

METHOD _____

SAMPLE TYPE
B - Bulk Sample
S - 2" O.D. 1.38" I.D. Split Spoon Sample
U - 3" O.D. 2.42" I.D. Ring Sample
NR - No Recovery

(Continued Next Page)

BORING LOG I.D.: B-3

PROJECT: Santa Maria River Bridge | **PROJECT LOCATION:** Yavapai County, AZ

Elevation in Feet	Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count / Pocket pen. (tsf)	Lab Tests: Dry Density (pcf)	Lab Tests: Moisture Content (%) of Dry Weight	Lab Tests: Liquid Limit (%)	Lab Tests: Plasticity Index	Lab Tests: Percent passing #200 Sieve	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
2170.0	95				S	50/1"						SC-SM	Wet Very dense	**CLAYEY SILTY SAND with GRAVEL**, coarse grained gravel, predominantly coarse to fine grained sand, low plasticity, Brown
2165.0	100				S	50/4"								
2160.0	105				S	50/1"								
2155.0	110				S	50/1"								
2150.0	115				S	50/2"								
2145.0	120													

GROUNDWATER

	TIME	DATE
▽		12/6/24
▼	7.0	12/9/24
▼		

METHOD _____

SAMPLE TYPE
B - Bulk Sample
S - 2" O.D. 1.38" I.D. Split Spoon Sample
U - 3" O.D. 2.42" I.D. Ring Sample
NR - No Recovery

(Continued Next Page)

BORING LOG I.D.: B-3

PROJECT: Santa Maria River Bridge

PROJECT LOCATION: Yavapai County, AZ

Elevation in Feet	Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count / Pocket pen. (tsf)	Lab Tests: Dry Density (pcf)	Lab Tests: Moisture Content (%) of Dry Weight	Lab Tests: Liquid Limit (%)	Lab Tests: Plasticity Index	Lab Tests: Percent passing #200 Sieve	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
2145.0	120					50/1"								End boring at 120.1'. Backfilled with cutting and grouted top 20'.
2140.0	125													
2135.0	130													
2130.0	135													
2125.0	140													
2120.0	145													

GROUNDWATER

	TIME	DATE
▽		12/6/24
▼	7.0	12/9/24
▼		

METHOD _____

SAMPLE TYPE

B - Bulk Sample
S - 2" O.D. 1.38" I.D. Split Spoon Sample
U - 3" O.D. 2.42" I.D. Ring Sample
NR - No Recovery

BORING LOG I.D.: B-4

PROJECT NAME:	Santa Maria River Bridge			**PROJECT #:**	US0029828.9292
LOGGER:	Sai Singhar			**PROJECT LOCATION:**	Yavapai County, AZ
DRILLER:	Chuck			**STATION/OFFSET:**	
DRILLER FIRM:	GSI			**REFERENCE:**	
RIG TYPE:	CME 75			**COORDINATES:**	34.480478, -113.06041
BORING TYPE:	Tubex	**BORING DIA.:**	5.5	**COORDINATE SYS:**	WGS84
ORIENTATION:	Vertical			**SURFACE ELEV. (FT):**	2270
HAMMER CALIBRATION-ENERGY TRANSFER RATIO:	83.2			**VERTICAL DATUM:**	NAD88
START DATE:	12/2/24	**START TIME:**	12:20	**COMPLETION DATE:**	12/4/24 **COMPLETION TIME:** 12:40

Elevation in Feet	Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count / Pocket pen. (tsf)	Lab Tests: Dry Density (pcf)	Lab Tests: Moisture Content (%) of Dry Weight	Lab Tests: Liquid Limit (%)	Lab Tests: Plasticity Index	Lab Tests: Percent passing #200 Sieve	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
2270.0	0				B							SP	Slightly moist Medium dense	**POORLY GRADED SAND WITH COBBLES AND GRAVEL**, occasional boulders 1.5' in dia, coarse to fine grained subrounded to subangular gravel, predominantly fine to medium grained sand, non-plastic, Grayish brown
					S	8-7-8 (15)								
2265.0	5				U	24-50/1"						GP	Slightly moist Medium dense to dense	**POORLY GRADED GRAVEL WITH COBBLES AND SAND**, occasional boulders 1.5' in dia, fine to medium grained sand, predominantly coarse to fine grained subrounded to subangular gravel, non-plastic, Grayish brown
					S	9-8-18 (26)								
2260.0	10				U	14-20 (34)		2.6	NP	NP	4.8			Note: brown and reddish brown below 11'
													▼	Note: cutting becomes wet
2255.0	15				S	4-15-22 (37)								Note: wet sample at 15'
2250.0	20											SP	Wet Dense	**POORLY GRADED SAND WITH GRAVEL**, occasional cobbles, coarse to fine grained subrounded to subangular gravel, predominantly fine to medium grained sand, non-plastic, Grayish brown

GROUNDWATER

	TIME	DATE
▽		12/3/24
▼	12.0	12/4/24
▽		

METHOD _____

SAMPLE TYPE
B - Bulk Sample
S - 2" O.D. 1.38" I.D. Split Spoon Sample
U - 3" O.D. 2.42" I.D. Ring Sample
NR - No Recovery

(Continued Next Page)

BORING LOG I.D.: B-4

PROJECT: Santa Maria River Bridge | **PROJECT LOCATION:** Yavapai County, AZ

Elevation in Feet	Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count / Pocket pen. (tsf)	Lab Tests: Dry Density (pcf)	Lab Tests: Moisture Content (%) of Dry Weight	Lab Tests: Liquid Limit (%)	Lab Tests: Plasticity Index	Lab Tests: Percent passing #200 Sieve	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
2250.0	20				S	17-10-2 (12)						SP	Wet Medium dense	**POORLY GRADED SAND WITH GRAVEL**, occasional cobbles, coarse to fine grained subrounded to subangular gravel, predominantly fine to medium grained sand, non-plastic, Grayish brown
2245.0	25				S	4-4-12 (16)								Note: 2" clay seam in the sampler at 25' Note: 3-5' of heaving sand encountered at 25-27.5'
2240.0	30				U	8-13 (21)			NP	NP	0.9			Note: increasae coarse sand below 30'
2235.0	35				S	11-20-10 (30)								Note: increase fines below 35'
2230.0	40				S	8-15-7 (22)								Note: black fines in wash out between 42-44'
2225.0	45													

GROUNDWATER

	TIME	DATE
▽		12/3/24
▼	12.0	12/4/24
▽		

METHOD _____

SAMPLE TYPE
B - Bulk Sample
S - 2" O.D. 1.38" I.D. Split Spoon Sample
U - 3" O.D. 2.42" I.D. Ring Sample
NR - No Recovery

(Continued Next Page)

BORING LOG I.D.: B-4

PROJECT: Santa Maria River Bridge | **PROJECT LOCATION:** Yavapai County, AZ

Elevation in Feet	Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count / Pocket pen. (tsf)	Lab Tests: Dry Density (pcf)	Lab Tests: Moisture Content (%) of Dry Weight	Lab Tests: Liquid Limit (%)	Lab Tests: Plasticity Index	Lab Tests: Percent passing #200 Sieve	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
2225.0	45				S			11.8	23	2	5.8	SP-SM	Wet Very dense	**POORLY GRADED SAND WITH SILT AND GRAVEL**, Trace of clay, coarse to fine grained subrounded to subangular gravel, predominantly coarse to fine grained sand, low plasticity, Light brown and gray
2220.0	50				U	34-50/2"								Note: hard drilling between 50-55'
2215.0	55				S	50/4"						SM	Wet Very dense	**SILTY SAND**, trace gravel and clay, predominantly coarse to fine grained sand, low plasticity, Tan brown
2210.0	60				S	36-50/4"								
2205.0	65				S	50/4"								Note: increase fine grained sand below 65'
2200.0	70													

GROUNDWATER

	TIME	DATE
▽		12/3/24
▼	12.0	12/4/24
▼		

METHOD _____

SAMPLE TYPE
B - Bulk Sample
S - 2" O.D. 1.38" I.D. Split Spoon Sample
U - 3" O.D. 2.42" I.D. Ring Sample
NR - No Recovery

(Continued Next Page)

BORING LOG I.D.: B-4

PROJECT: Santa Maria River Bridge

PROJECT LOCATION: Yavapai County, AZ

Elevation in Feet	Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count / Pocket pen. (tsf)	Lab Tests: Dry Density (pcf)	Lab Tests: Moisture Content (%) of Dry Weight	Lab Tests: Liquid Limit (%)	Lab Tests: Plasticity Index	Lab Tests: Percent passing #200 Sieve	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
2200.0	70				U				32	13	15	SC	Wet Very dense	**CLAYEY SAND WITH GRAVEL**, some to considerable silt, coarse to fine grained subrounded to subangular gravel, predominantly coarse to fine grained sand, low plasticity, Yellowish brown
2195.0	75				S	38-50/5"								
2190.0	80				S	50/3"								Note: hard drilling; increase gravel with depths; stratified with sand
2185.0	85				S	50/2"								
2180.0	90				S	50/3"								
2175.0	95													

GROUNDWATER

	TIME	DATE
▽		12/3/24
▼	12.0	12/4/24
▼		

METHOD _____

SAMPLE TYPE
B - Bulk Sample
S - 2" O.D. 1.38" I.D. Split Spoon Sample
U - 3" O.D. 2.42" I.D. Ring Sample
NR - No Recovery

(Continued Next Page)

BORING LOG I.D.: B-4

PROJECT: Santa Maria River Bridge

PROJECT LOCATION: Yavapai County, AZ

Elevation in Feet	Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count / Pocket pen. (tsf)	Lab Tests: Dry Density (pcf)	Lab Tests: Moisture Content (%) of Dry Weight	Lab Tests: Liquid Limit (%)	Lab Tests: Plasticity Index	Lab Tests: Percent passing #200 Sieve	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
2175.0	95				S	32-50/1"						SM	Wet Very dense	**SILTY SAND WITH GRAVEL (POSSIBLE DECOMPOSED MUDSTONE OR SILTSTONE)**, fine grained gravel, predominantly fine grained sand, low plasticity, Light pinkish brown
2170.0	100				S	50/3"								End boring at 100.3'. Backfilled with cutting and grouted top 20'.
2165.0	105													
2160.0	110													
2155.0	115													
2150.0	120													

GROUNDWATER

		TIME	DATE
▽			12/3/24
▼	12.0		12/4/24
▼			

METHOD _____

SAMPLE TYPE

B - Bulk Sample
S - 2" O.D. 1.38" I.D. Split Spoon Sample
U - 3" O.D. 2.42" I.D. Ring Sample
NR - No Recovery

APPENDIX

B LABORATORY TEST RESULT

Table B-1
Summary of Laboratory Results

Boring #	Depth (ft)	Sample Type	U.S.C.S. Classification	Moisture Content (%)	Dry Density (PCF)	OMC (%)	Max Density (pcf)	Direct Shear	Consolidation	Gravel (%)	Sand (%)	Fines (%)	Liquid Limit	Plasticity Index	R-value	Minimum Resistivity (Ohm cm)	Chloride Content (ppm)	Sulfate Content (ppm)	pH
B-1a	0-5	Bulk	SM	1.3						12.0	72.0	16.0	20	2		1160	640	31	8.03
B-1a	30-30.4	Rings	SM	11.2						18.0	67.0	15.0	NP	NP					
B-1a	60-60.3	Rings	SM							9.0	77.0	14.0	NP	NP					
B-1a	90-90.7	SPT	SM	25.8						7.0	56.0	37.0	NP	NP					
B-2	0-5	Bulk	SP	1.0						22.0	75.0	3.0	NP	NP					
B-2	10-11.0	Rings	SP							28.0	69.6	2.4	NP	NP					
B-2	75-75.9	SPT	SM							7.0	64.0	29.0	71	37					
B-3	10-11.0	Rings		16.2	117.2														
B-3	0-5	Bulk	SP							17.0	81.2	1.8	NP	NP		15880	13	23	9.36
B-3	30-31	Rings	GP							85.0	13.5	1.5	NP	NP					
B-3	40-41.3	SPT	SC	14.2						10.0	73.0	17.0	36	13					
B-3	55-55.8	SPT	SM	24.1						0.0	68.0	32.0	47	15					
B-4	10-11.0	Rings	GP	2.6	125.8					49.0	46.1	4.9	NP	NP					
B-4	30-31.0	Rings	SP							42.0	57.1	0.9	NP	NP					
B-4	45-46.2	SPT	SP-SM	11.8						17.0	77.6	5.4	23	2					
B-4	70-70.4	SPT	SC							13.0	74.0	13.0	32	13					

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2401992	Material Type:	Soils
ACS Lab #	24-5934-1	Supplier:	Client
Client:	WSP	Sample Date:	12/20/2024
Project Name:	Santa Maria Bridge	Sampled By:	Client
Project Address:	-	Test Date:	12/27/2024
Project City	-	Tested By:	Colin Eggebrecht
Sample Location:	B1-A @ 0-5	Reviewed By:	Keagen Mayfield

Sieve Analysis (ASTM C-136 / AASHTO T 27 / ARIZ 201)			
Sieve Size	**% Retained**	**% Passed**	**Specs**
6"	0	100	
3"	0	100	
2 1/2"	0	100	
2"	0	100	
1 1/2"	0	100	
1"	0	100	
3/4"	0	100	
1/2"	1	99	
3/8"	2	97	
1/4"	5	92	
#4	4	88	
#8	10	78	
#10	3	75	
#16	9	66	
#30	17	49	
#40	7	42	
#50	6	36	
#100	11	24	
#200	9	16	

Liquid Limit (ASTM D4318)	20
Plastic Limit (ASTM D4318)	18
Plasticity Index (ASTM D4318)	2
Moisture Content (ASTM D2216)	1.3
USCS Soil Classification	SM

Group Name (ASTM D2487)
Silty SAND

Keagen Mayfield
Laboratory Manager

Keagen Mayfield
Signature

ACS Services LLC

Soil pH and Resistivity Determination

AASHTO T-289 AASHTO T-288 / ARIZ 236

Project #	2401992	Material Type:	Soils
Lab #	24-5934-1	Supplier:	Client
Client:	WSP	Sample Date:	12/20/2024
Project Name:	Santa Maria Bridge	Sampled By:	Client
Project Address:	-	Test Date:	Monday, December 30, 2024
Project City:	-	Tested By:	Mahalia Davis
Sample Source:	B1-A @ 0-5	Resistivity Box:	
		Reviewed By:	Keagen Mayfield

pH Reading = 8.03

P = (SBF) x R x M

Where:

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

Water Added	SBF (cm)	Dial Reading (OHMS)	Multiplier	**P** (OHM-cm)
200	7.22	2.6	100	1880
50	7.22	2.2	100	1590
50	7.22	2	100	1440
50	7.22	1.9	100	1370
50	7.22	1.8	100	1300
50	7.22	1.8	100	1300
50	7.22	1.8	100	1300
50	7.22	1.8	100	1300
50	7.22	1.6	100	1160
50	7.22	1.7	100	1230

Colin Eggebrecht
Lab Supervisor

Keagen Mayfield
Laboratory Manager

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2401992	Material Type:	Soils
ACS Lab #	24-5934-2	Supplier:	Client
Client:	WSP	Sample Date:	12/20/2024
Project Name:	Santa Maria Bridge	Sampled By:	Client
Project Address:	-	Test Date:	12/27/2024
Project City	-	Tested By:	Mahalia Davis
Sample Location:	B1-A @ 30-30.4	Reviewed By:	Keagen Mayfield

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

Sieve Size	% Retained	% Passed	Specs
6"	0	100	
3"	0	100	
2 1/2"	0	100	
2"	0	100	
1 1/2"	0	100	
1"	0	100	
3/4"	4	96	
1/2"	4	91	
3/8"	2	90	
1/4"	4	86	
#4	4	82	
#8	10	72	
#10	5	67	
#16	5	62	
#30	15	46	
#40	4	42	
#50	6	37	
#100	10	27	
#200	12	15	

Liquid Limit (ASTM D4318)	
Plastic Limit (ASTM D4318)	
Plasticity Index (ASTM D4318)	NP
Moisture Content (ASTM D2216)	11.2
USCS Soil Classification	SM

Group Name (ASTM D2487)
Silty SAND with gravel

Keagen Mayfield
Laboratory Manager

Keagen Mayfield
Signature

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2401992	Material Type:	Soils
ACS Lab #	24-5934-3	Supplier:	Client
Client:	WSP	Sample Date:	12/20/2024
Project Name:	Santa Maria Bridge	Sampled By:	Client
Project Address:	-	Test Date:	12/27/2024
Project City	-	Tested By:	Colin Eggebrecht
Sample Location:	B1-A @ 60-60.3	Reviewed By:	Keagen Mayfield

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

Sieve Size	% Retained	% Passed	Specs
6"	0	100	
3"	0	100	
2 1/2"	0	100	
2"	0	100	
1 1/2"	0	100	
1"	4	96	
3/4"	0	96	
1/2"	1	95	
3/8"	1	94	
1/4"	2	92	
#4	1	91	
#8	9	82	
#10	3	79	
#16	10	70	
#30	18	52	
#40	8	43	
#50	8	36	
#100	12	23	
#200	9	14	

Liquid Limit (ASTM D4318)	
Plastic Limit (ASTM D4318)	
Plasticity Index (ASTM D4318)	NP
Moisture Content (ASTM D2216)	0.0
USCS Soil Classification	SM

Group Name (ASTM D2487)
Silty SAND

Keagen Mayfield
Laboratory Manager

Keagen Mayfield
Signature

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2401992	Material Type:	Soils
ACS Lab #	24-5934-4	Supplier:	Client
Client:	WSP	Sample Date:	12/20/2024
Project Name:	Santa Maria Bridge	Sampled By:	Client
Project Address:	-	Test Date:	12/27/2024
Project City	-	Tested By:	Mahalia Davis
Sample Location:	B1-A @ 90-90.7	Reviewed By:	Keagen Mayfield

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

Sieve Size	% Retained	% Passed	Specs
6"	0	100	
3"	0	100	
2 1/2"	0	100	
2"	0	100	
1 1/2"	0	100	
1"	0	100	
3/4"	0	100	
1/2"	2	98	
3/8"	1	97	
1/4"	2	95	
#4	2	93	
#8	6	87	
#10	4	83	
#16	4	79	
#30	10	69	
#40	4	64	
#50	5	59	
#100	9	50	
#200	13	37	

Liquid Limit (ASTM D4318)	
Plastic Limit (ASTM D4318)	
Plasticity Index (ASTM D4318)	NP
Moisture Content (ASTM D2216)	25.8
USCS Soil Classification	SM

Group Name (ASTM D2487)
Silty SAND

Keagen Mayfield
Laboratory Manager

Keagen Mayfield
Signature

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2401992	Material Type:	Soils
ACS Lab #	24-5935-1	Supplier:	Client
Client:	WSP	Sample Date:	12/20/2024
Project Name:	Santa Maria Bridge	Sampled By:	Client
Project Address:	-	Test Date:	12/26/2024
Project City	-	Tested By:	Mahalia Davis
Sample Location:	B-2 @ 0-5	Reviewed By:	Keagen Mayfield

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

Sieve Size	% Retained	% Passed	Specs
6"	0	100	
3"	0	100	
2 1/2"	0	100	
2"	0	100	
1 1/2"	0	100	
1"	0	100	
3/4"	0	100	
1/2"	2	98	
3/8"	6	92	
1/4"	9	83	
#4	5	78	
#8	12	66	
#10	6	60	
#16	15	44	
#30	30	14	
#40	5	9	
#50	3	6	
#100	2	4	
#200	1	3.0	

Liquid Limit (ASTM D4318)	
Plastic Limit (ASTM D4318)	
Plasticity Index (ASTM D4318)	NP
Moisture Content (ASTM D2216)	1.0
USCS Soil Classification	SP

Group Name (ASTM D2487)
Poorly graded SAND with gravel

Keagen Mayfield
Laboratory Manager

Keagen Mayfield
Signature

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2401992	Material Type:	Soils
ACS Lab #	24-5935-2	Supplier:	Client
Client:	WSP	Sample Date:	12/20/2024
Project Name:	Santa Maria Bridge	Sampled By:	Client
Project Address:	-	Test Date:	12/27/2024
Project City	-	Tested By:	Mahalia Davis
Sample Location:	B-2 @ 10-11.0	Reviewed By:	Keagen Mayfield

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

Sieve Size	% Retained	% Passed	Specs
6"	0	100	
3"	0	100	
2 1/2"	0	100	
2"	0	100	
1 1/2"	0	100	
1"	11	89	
3/4"	1	87	
1/2"	8	79	
3/8"	3	77	
1/4"	3	74	
#4	3	72	
#8	11	60	
#10	4	56	
#16	13	43	
#30	25	17	
#40	5	12	
#50	5	8	
#100	4	4	
#200	1	2.4	

Liquid Limit (ASTM D4318)	
Plastic Limit (ASTM D4318)	
Plasticity Index (ASTM D4318)	NP
Moisture Content (ASTM D2216)	0.0
USCS Soil Classification	SP

Group Name (ASTM D2487)
Poorly graded SAND with gravel

Keagen Mayfield
Laboratory Manager

Keagen Mayfield
Signature

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2401992	Material Type:	Soils
ACS Lab #	24-5935-3	Supplier:	Client
Client:	WSP	Sample Date:	12/20/2024
Project Name:	Santa Maria Bridge	Sampled By:	Client
Project Address:	-	Test Date:	12/26/2024
Project City	-	Tested By:	Mahalia Davis
Sample Location:	B-2 @ 75-75.9	Reviewed By:	Keagen Mayfield

Sieve Analysis (ASTM C-136 / AASHTO T 27 / ARIZ 201)			
Sieve Size	**% Retained**	**% Passed**	**Specs**
6"	0	100	
3"	0	100	
2 1/2"	0	100	
2"	0	100	
1 1/2"	0	100	
1"	0	100	
3/4"	2	98	
1/2"	0	98	
3/8"	1	97	
1/4"	2	95	
#4	2	93	
#8	7	86	
#10	4	82	
#16	5	77	
#30	19	59	
#40	6	53	
#50	6	47	
#100	9	38	
#200	9	29	

Liquid Limit (ASTM D4318)	71
Plastic Limit (ASTM D4318)	34
Plasticity Index (ASTM D4318)	37
Moisture Content (ASTM D2216)	22.7
USCS Soil Classification	SM

Group Name (ASTM D2487)
Silty SAND

Keagen Mayfield
Laboratory Manager

Keagen Mayfield
Signature

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2401992	Material Type:	Soils
ACS Lab #	24-5936-1	Supplier:	Client
Client:	WSP	Sample Date:	12/20/2024
Project Name:	Santa Maria Bridge	Sampled By:	Client
Project Address:	-	Test Date:	12/27/2024
Project City	-	Tested By:	Colin Eggebrecht
Sample Location:	B-3 @ 0 - 5	Reviewed By:	Keagen Mayfield

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

Sieve Size	% Retained	% Passed	Specs
6"	0	100	
3"	0	100	
2 1/2"	0	100	
2"	0	100	
1 1/2"	0	100	
1"	0	100	
3/4"	0	100	
1/2"	1	99	
3/8"	3	97	
1/4"	8	88	
#4	6	83	
#8	14	69	
#10	7	62	
#16	19	43	
#30	32	11	
#40	4	7	
#50	3	4	
#100	2	3	
#200	1	1.8	

Liquid Limit (ASTM D4318)	
Plastic Limit (ASTM D4318)	
Plasticity Index (ASTM D4318)	NP
Moisture Content (ASTM D2216)	0.9
USCS Soil Classification	SP

Group Name (ASTM D2487)
Poorly graded SAND with gravel

Keagen Mayfield
Laboratory Manager

Keagen Mayfield
Signature

ACS Services LLC

Soil pH and Resistivity Determination

AASHTO T-289 AASHTO T-288 / ARIZ 236

Project #	2401992	Material Type:	Soils
Lab #	24-5936-1	Supplier:	Client
Client:	WSP	Sample Date:	12/20/2024
Project Name:	[redacted] Santa Maria Bridge	Sampled By:	Client
Project Address:	-	Test Date:	Friday, December 27, 2024
Project City:	-	Tested By:	Mahalia Davis
Sample Source:	B-3 @ 0 - 5	Resistivity Box:	
		Reviewed By:	Keagen Mayfield

pH Reading = 9.36

P = (SBF) x R x M

Where:

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

Water Added	SBF (cm)	Dial Reading (OHMS)	Multiplier	**P** (OHM-cm)
200	7.22	4.2	1000	30320
50	7.22	3.3	1000	23830
50	7.22	2.6	1000	18770
50	7.22	2.4	1000	17330
50	7.22	2.2	1000	15880
50	7.22	2.3	1000	16610

Colin Eggebrecht
Lab Supervisor

Keagen Mayfield
Laboratory Manager

ACS Services LLC

Job #	2401992	Material Type:	Soils
Lab #	24-5936	Extraction Date:	12/20/2024
Client:	WSP	Extracted By:	Client
Project Name:	Santa Maria Bridge	Laboratory Test Date	12/26/2024
Project Address:	-	Laboratory Tested By:	Mahalia Davis
Project City:	-	Reviewed By:	Keagen Mayfield
Material Source:	-		

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

ID #	Sample Location	Wet Wt. (g)	Moisture Dry Wt. (g)	**Moist Content**	# Of Rings	Wet Wt'+Rings (g)	Wt. of Rings (g)	**Dry Density (pcf)**
24-5936-2	B-3 @ 10-11.0	493.6	424.7	16.2%	3	629.8	136.2	117.2

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2401992	Material Type:	Soils
ACS Lab #	24-5936-3	Supplier:	Client
Client:	WSP	Sample Date:	12/20/2024
Project Name:	Santa Maria Bridge	Sampled By:	Client
Project Address:	-	Test Date:	12/27/2024
Project City	-	Tested By:	Colin Eggebrecht
Sample Location:	B-3 @ 30 - 31.0	Reviewed By:	Keagen Mayfield

Sieve Analysis (ASTM C-136 / AASHTO T 27 / ARIZ 201)			
Sieve Size	**% Retained**	**% Passed**	**Specs**
6"	0	100	
3"	0	100	
2 1/2"	0	100	
2"	39	61	
1 1/2"	11	50	
1"	11	39	
3/4"	6	33	
1/2"	7	26	
3/8"	4	21	
1/4"	4	17	
#4	2	15	
#8	3	12	
#10	1	11	
#16	1	10	
#30	5	5	
#40	1	5	
#50	1	4	
#100	1	2	
#200	1	1.5	

Liquid Limit (ASTM D4318)	
Plastic Limit (ASTM D4318)	
Plasticity Index (ASTM D4318)	NP
Moisture Content (ASTM D2216)	0.0
USCS Soil Classification	GP

Group Name (ASTM D2487)
Poorly graded GRAVEL

Testing sizes reduced from standard minimums due to lack of material

Keagen Mayfield
Laboratory Manager

Keagen Mayfield
Signature

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2401992	Material Type:	Soils
ACS Lab #	24-5936-4	Supplier:	Client
Client:	WSP	Sample Date:	12/20/2024
Project Name:	Santa Maria Bridge	Sampled By:	Client
Project Address:	-	Test Date:	12/27/2024
Project City	-	Tested By:	Mahalia Davis
Sample Location:	B-3 @ 40 - 41.3	Reviewed By:	Keagen Mayfield

Sieve Analysis (ASTM C-136 / AASHTO T 27 / ARIZ 201)			
Sieve Size	**% Retained**	**% Passed**	**Specs**
6"	0	100	
3"	0	100	
2 1/2"	0	100	
2"	0	100	
1 1/2"	0	100	
1"	0	100	
3/4"	1	99	
1/2"	0	98	
3/8"	1	97	
1/4"	4	93	
#4	3	90	
#8	11	79	
#10	4	75	
#16	5	70	
#30	21	49	
#40	5	44	
#50	7	37	
#100	10	27	
#200	10	17	

Liquid Limit (ASTM D4318)	36
Plastic Limit (ASTM D4318)	23
Plasticity Index (ASTM D4318)	13
Moisture Content (ASTM D2216)	14.2
USCS Soil Classification	SC

Group Name (ASTM D2487)
Clayey SAND

Keagen Mayfield
Laboratory Manager

Keagen Mayfield
Signature

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2401992	Material Type:	Soils
ACS Lab #	24-5936-5	Supplier:	Client
Client:	WSP	Sample Date:	12/20/2024
Project Name:	Santa Maria Bridge	Sampled By:	Client
Project Address:	-	Test Date:	12/27/2024
Project City	-	Tested By:	Mahalia Davis
Sample Location:	B-3 @ 55 - 55.8	Reviewed By:	Keagen Mayfield

Sieve Analysis (ASTM C-136 / AASHTO T 27 / ARIZ 201)			
Sieve Size	**% Retained**	**% Passed**	**Specs**
6"	0	100	
3"	0	100	
2 1/2"	0	100	
2"	0	100	
1 1/2"	0	100	
1"	0	100	
3/4"	0	100	
1/2"	0	100	
3/8"	0	100	
1/4"	0	100	
#4	0	100	
#8	3	97	
#10	1	96	
#16	5	91	
#30	15	77	
#40	6	70	
#50	5	65	
#100	16	48	
#200	16	32	

Liquid Limit (ASTM D4318)	47
Plastic Limit (ASTM D4318)	32
Plasticity Index (ASTM D4318)	15
Moisture Content (ASTM D2216)	24.1
USCS Soil Classification	SM

Group Name (ASTM D2487)
Silty SAND

Keagen Mayfield
Laboratory Manager

Keagen Mayfield
Signature

ACS Services LLC

Job #	2401992	Material Type:	Soils
Lab #	24-5937	Extraction Date:	12/20/2024
Client:	WSP	Extracted By:	Client
Project Name:	Santa Maria Bridge	Laboratory Test Date	12/26/2024
Project Address:	-	Laboratory Tested By:	Mahalia Davis
Project City:	-	Reviewed By:	Keagen Mayfield
Material Source:	-		

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

ID #	Sample Location	Wet Wt. (g)	Moisture Dry Wt. (g)	**Moist Content**	# Of Rings	Wet Wt'+Rings (g)	Wt. of Rings (g)	**Dry Density (pcf)**
24-5937-1	B-4 @ 10-11.0	820.3	799.5	2.6%	5	995.9	216.5	125.8

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2401992	Material Type:	Soils
ACS Lab #	24-5937-1	Supplier:	Client
Client:	WSP	Sample Date:	12/20/2024
Project Name:	Santa Maria Bridge	Sampled By:	Client
Project Address:	-	Test Date:	12/24/2024
Project City	-	Tested By:	Colin Eggebrecht
Sample Location:	B - 4 @ 10 - 11.0	Reviewed By:	Keagen Mayfield

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

Sieve Size	% Retained	% Passed	Specs
6"	0	100	
3"	0	100	
2 1/2"	0	100	
2"	0	100	
1 1/2"	0	100	
1"	18	82	
3/4"	11	71	
1/2"	10	61	
3/8"	2	59	
1/4"	4	55	
#4	4	51	
#8	11	40	
#10	3	37	
#16	6	31	
#30	13	18	
#40	4	14	
#50	3	11	
#100	4	7	
#200	2	4.9	

Liquid Limit (ASTM D4318)	
Plastic Limit (ASTM D4318)	
Plasticity Index (ASTM D4318)	NP
Moisture Content (ASTM D2216)	0.0
USCS Soil Classification	GP

Group Name (ASTM D2487)
Poorly graded GRAVEL with sand

Keagen Mayfield
Laboratory Manager

Keagen Mayfield
Signature

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2401992	Material Type:	Soils
ACS Lab #	24-5937-2	Supplier:	Client
Client:	WSP	Sample Date:	12/20/2024
Project Name:	Santa Maria Bridge	Sampled By:	Client
Project Address:	-	Test Date:	12/27/2024
Project City	-	Tested By:	Mahalia Davis
Sample Location:	B - 4 @ 30 - 31.0	Reviewed By:	Keagen Mayfield

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

Sieve Size	% Retained	% Passed	Specs
6"	0	100	
3"	0	100	
2 1/2"	0	100	
2"	0	100	
1 1/2"	15	85	
1"	4	81	
3/4"	11	70	
1/2"	5	64	
3/8"	1	63	
1/4"	3	60	
#4	3	58	
#8	14	43	
#10	6	37	
#16	15	22	
#30	17	5	
#40	2	4	
#50	2	2	
#100	1	1	
#200	0	0.9	

Liquid Limit (ASTM D4318)	
Plastic Limit (ASTM D4318)	
Plasticity Index (ASTM D4318)	NP
Moisture Content (ASTM D2216)	0.0
USCS Soil Classification	SP

Group Name (ASTM D2487)
Poorly graded SAND with gravel

Keagen Mayfield
Laboratory Manager

Keagen Mayfield
Signature

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2401992	Material Type:	Soils
ACS Lab #	24-5937-3	Supplier:	Client
Client:	WSP	Sample Date:	12/20/2024
Project Name:	Santa Maria Bridge	Sampled By:	Client
Project Address:	-	Test Date:	12/27/2024
Project City	-	Tested By:	Colin Eggebrecht
Sample Location:	B - 4 @ 45 - 46.2	Reviewed By:	Keagen Mayfield

Sieve Analysis (ASTM C-136 / AASHTO T 27 / ARIZ 201)			
Sieve Size	**% Retained**	**% Passed**	**Specs**
6"	0	100	
3"	0	100	
2 1/2"	0	100	
2"	0	100	
1 1/2"	0	100	
1"	0	100	
3/4"	2	98	
1/2"	5	93	
3/8"	1	92	
1/4"	4	87	
#4	4	83	
#8	18	66	
#10	6	60	
#16	9	51	
#30	21	30	
#40	5	25	
#50	6	19	
#100	7	12	
#200	7	5.4	

Liquid Limit (ASTM D4318)	23
Plastic Limit (ASTM D4318)	21
Plasticity Index (ASTM D4318)	2
Moisture Content (ASTM D2216)	11.8
USCS Soil Classification	SP-SM

Group Name (ASTM D2487)
Poorly graded SAND with silt and gravel

Testing sizes reduced from standard minimums due to lack of material

Keagen Mayfield
Laboratory Manager

Keagen Mayfield
Signature

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2401992	Material Type:	Soils
ACS Lab #	24-5937-4	Supplier:	Client
Client:	WSP	Sample Date:	12/20/2024
Project Name:	Santa Maria Bridge	Sampled By:	Client
Project Address:	-	Test Date:	12/27/2024
Project City	-	Tested By:	Colin Eggebrecht
Sample Location:	B - 4 @ 70 - 70.4	Reviewed By:	Keagen Mayfield

Sieve Analysis (ASTM C-136 / AASHTO T 27 / ARIZ 201)			
Sieve Size	**% Retained**	**% Passed**	**Specs**
6"	0	100	
3"	0	100	
2 1/2"	0	100	
2"	0	100	
1 1/2"	0	100	
1"	0	100	
3/4"	2	98	
1/2"	1	98	
3/8"	2	96	
1/4"	5	91	
#4	4	87	
#8	20	67	
#10	4	62	
#16	11	52	
#30	15	36	
#40	6	30	
#50	5	25	
#100	8	17	
#200	5	13	

Liquid Limit (ASTM D4318)	32
Plastic Limit (ASTM D4318)	19
Plasticity Index (ASTM D4318)	13
Moisture Content (ASTM D2216)	0.0
USCS Soil Classification	SC

Group Name (ASTM D2487)
Clayey SAND

Keagen Mayfield
Laboratory Manager

Keagen Mayfield
Signature

MOTZZ LABORATORY, INC.

Report: 953794
Reported: 1/3/2025
Received: 12/31/2024
PO: 2401992

Laboratory Analysis Report

ACS Services LLC
Keagen Mayfield
2235 W Broadway Road
Mesa, AZ 85202

Project: 2401992

Lab Number	Sample ID	
953794-1	24-5931-1	B-1A (0-5)

Test Parameter

Test	*Method*	*Result*	*Units*
Sulfate	ARIZ 733b	640	ppm
Chloride	ARIZ 736b	31	ppm

MOTZZ LABORATORY, INC.

Report: 953796
Reported: 1/3/2025
Received: 12/31/2024
PO: 2401992

Laboratory Analysis Report

ACS Services LLC
Keagen Mayfield
2235 W Broadway Road
Mesa, AZ 85202

Project: 2401992

Lab Number	Sample ID	
953796-1	24-5936-1	B-3 (0-5)

Test Parameter

Test	*Method*	*Result*	*Units*
Sulfate	ARIZ 733b	23	ppm
Chloride	ARIZ 736b	13	ppm

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APPENDIX B

Test Pit Logs

Project Name	Santa Maria River Bridge	**Test Pit**	
Project No.	F0584 01D		
Location	SR 96, MP 10.59	**TP-1**	
Station, Offset	-		
Lat/Long, elev	34.48343, -113.06334 at 2326'		
Field Engineer	Omied Arianejad	Date	02/19/2025
Field Operator	ADOT Geotechnical Operations	Backhoe	CAT 420

Depth (ft)	Elevation (ft)	Graphic Log	Sample Type	Visual Classification	Lab			
					% Gravel	% Sand	% Fines	Atterberg Limits (LL-PL-PI)
1 2 3 4	2325		Bulk	**SILTY SAND WITH GRAVEL** (**SM**): brown; non-plastic; no cementation; slightly damp. 4.0	19	65	12	NP

Backhoe refusal at 4 feet. No groundwater encountered in test pit.

Project Name	Santa Maria River Bridge	**Test Pit**	
Project No.	F0584 01D		
Location	SR 96, MP 10.76	**TP-2**	
Station, Offset	-		
Lat/Long, elev	34.48149, -113.06143 at 2294'		
Field Engineer	Omied Arianejad	Date	02/19/2025
Field Operator	ADOT Geotechnical Operations	Backhoe	CAT 420

Depth (ft)	Elevation (ft)	Graphic Log	Sample Type	Visual Classification	Lab				Samples	
					% Gravel	% Sand	% Fines	Atterberg Limits (LL-PL-PI)	In-Situ Dry Density (PCF)	In-Situ Moisture Content (%)
1 2 3 4 5	2290		Bulk	**WELL-GRADED SAND WITH CLAY AND GRAVEL** (**SW-SC**): brown; high plasticity; no cementation; slightly damp. 5.0	36	56	6	27-18-9	117.6	3.5

Stopped test pit excavation at 5 feet. No groundwater encountered in test pit.

Project Name	Santa Maria River Bridge	**Test Pit**	
Project No.	F0584 01D		
Location	SR 96, MP 10.95	**TP-3**	
Station, Offset	-		
Lat/Long, elev	34.47946, -113.05941 at 2285'		
Field Engineer	Omied Arianejad	Date	02/19/2025
Field Operator	ADOT Geotechnical Operations	Backhoe	CAT 420

Depth (ft)	Elevation (ft)	Graphic Log	Sample Type	Visual Classification	Lab				Samples	
					% Gravel	% Sand	% Fines	Atterberg Limits (LL-PL-PI)	In-Situ Dry Density (PCF)	In-Situ Moisture Content (%)
1 2 3 4 5	2280		Bulk	**SILTY SAND** (**SM**): brown; non-plastic; no cementation; slightly damp. 5.0	6	65	29	NP		

Stopped test pit excavation at 5 feet. No groundwater encountered in test pit.

Project Name	Santa Maria River Bridge
Project No.	F0584 01D
Location	SR 96, MP 11.03
Station, Offset	-
Lat/Long, elev	34.47844, -113.05846 at 2298'
Field Engineer	Omied Arianejad
Field Operator	ADOT Geotechnical Operations

Test Pit

TP-4

Date	02/19/2025
Backhoe	CAT 420

Depth (ft)	Elevation (ft)	Graphic Log	Sample Type	Visual Classification	Lab: % Gravel	Lab: % Sand	Lab: % Fines	Lab: Atterberg Limits (LL-PL-PI)
1			Bulk	**SILTY SAND** (**SM**): light brown; non-plastic; no cementation; slightly damp. 1.0	9	74	17	NP

Backhoe refusal at 1 foot. No groundwater encountered in test pit.

APPENDIX C

Laboratory Test Results for Test Pit Samples

096 010 F0584 01D, Santa Maria River Bridge

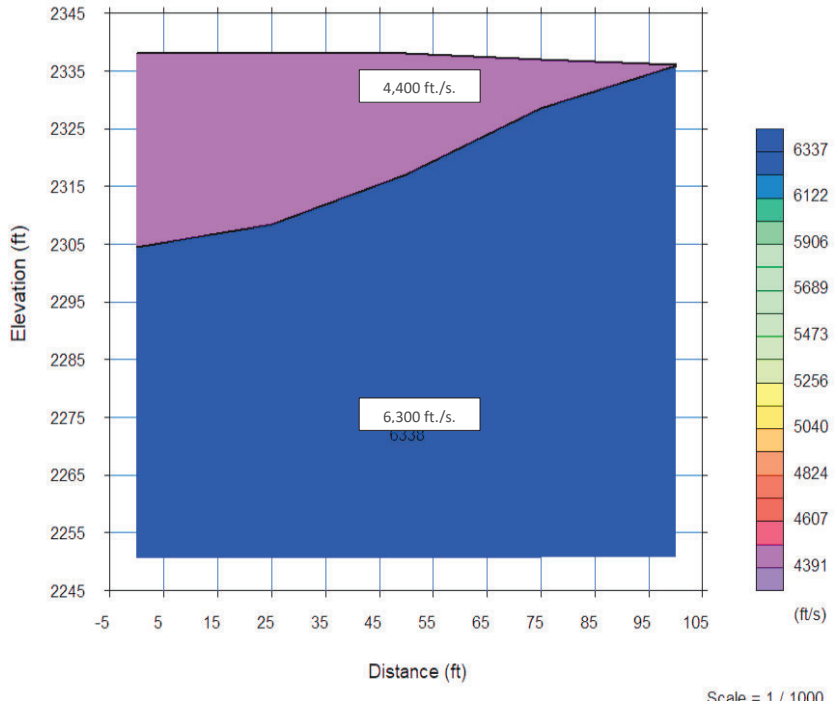
LABORATORY TEST SUMMARY

Test Location	Station, Offset	Depth (feet)	Sample Source	MECHANICAL PROPERTIES														FIELD TESTS		PARTICLE SIZE PERCENTAGE				Test Location
				Percent Passing							PI	LL	USCS	R-Value		Moisture/Density		In-situ Moisture/Density		Particle Type				
				3"	1½"	¾"	#4	#8	#40	#200				Corr.	Tested	Max. Dry Density (pcf)	Opt. Moisture Content (%)	Dry Density (pcf)	Moisture Content (%)	Cobbles	Gravel	Sands	Fines (Clay/Silt)	
TP-1		0.0 - 4.0	Bulk	96	88	85	77	71	45	12.4		NP	SM	84						4	19	65	12	TP-1
TP-2		0.0 - 5.0	Bulk	98	93	83	62	43	14	6.0	9	27	SW-SC	65	76	128.3	10.3	117.6	3.5	2	36	56	6	TP-2
TP-3		0.0 - 5.0	Bulk	100	100	98	94	90	75	29.5		NP	SM	67	82	111.5	12.8			0	6	65	30	TP-3
TP-4		0.0 - 1.0	Bulk	100	100	97	91	77	51	16.9		NP	SM	79						0	9	74	17	TP-4

APPENDIX D

Geophysical Survey Results

Figure D-1: P-wave Velocity Model for seismic refraction line SL-1 between Sta 37+00 and Sta 39+00



Southeast Northwest

ARIZONA DEPARTMENT OF TRANSPORTATION

Figure D-2: P-wave Velocity Model for seismic refraction line SL-2 between Sta 34+00 and Sta 36+00

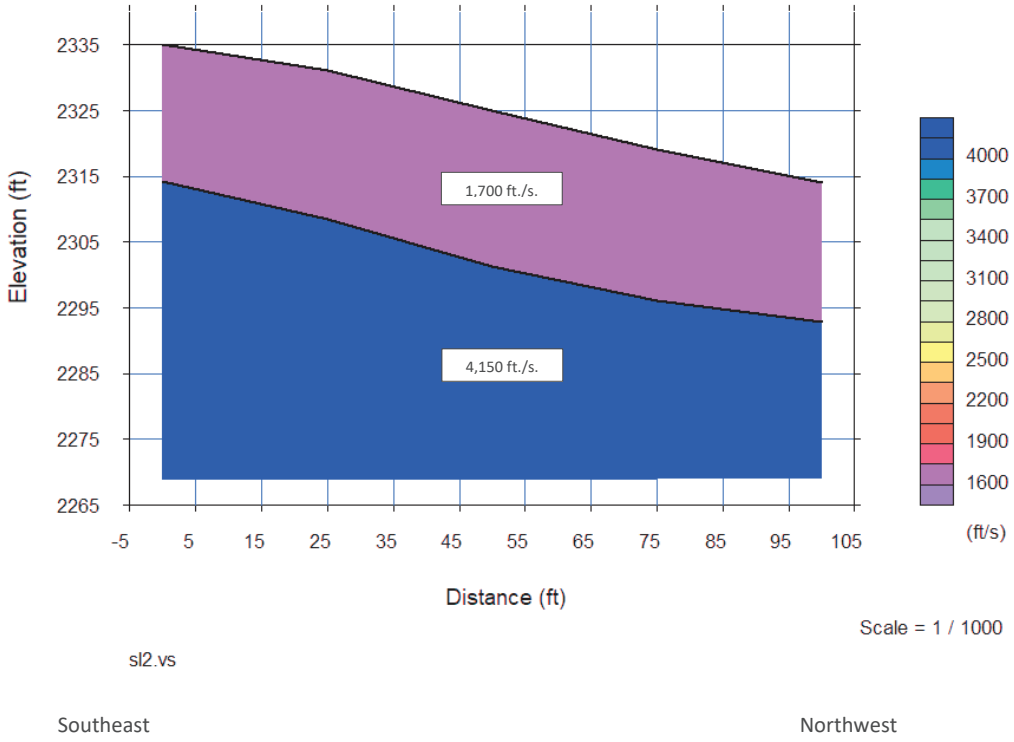
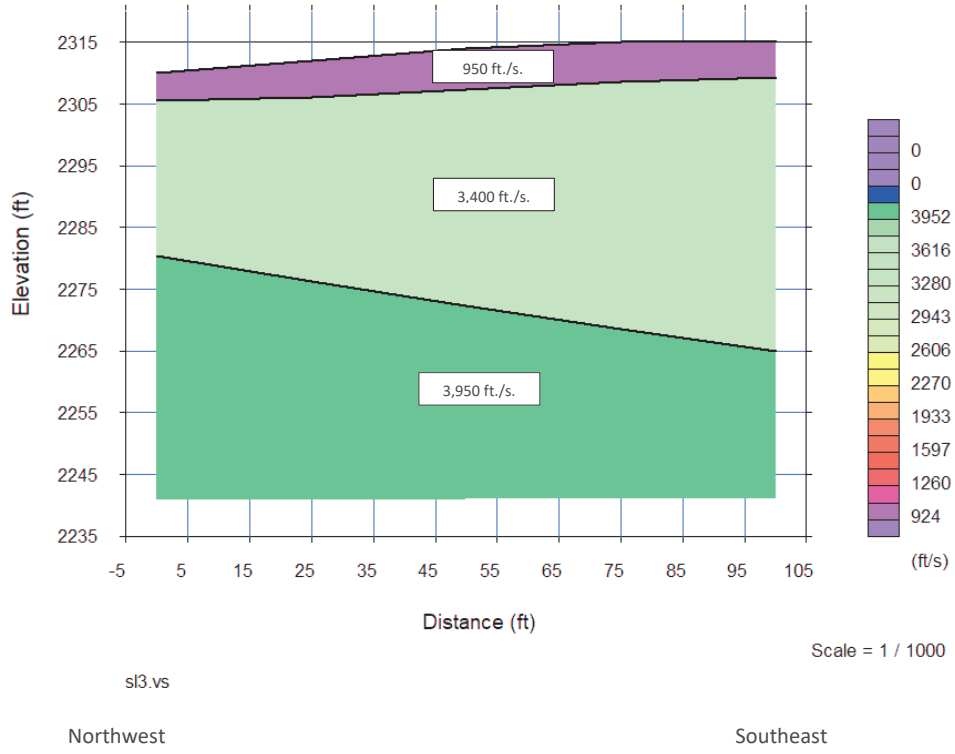
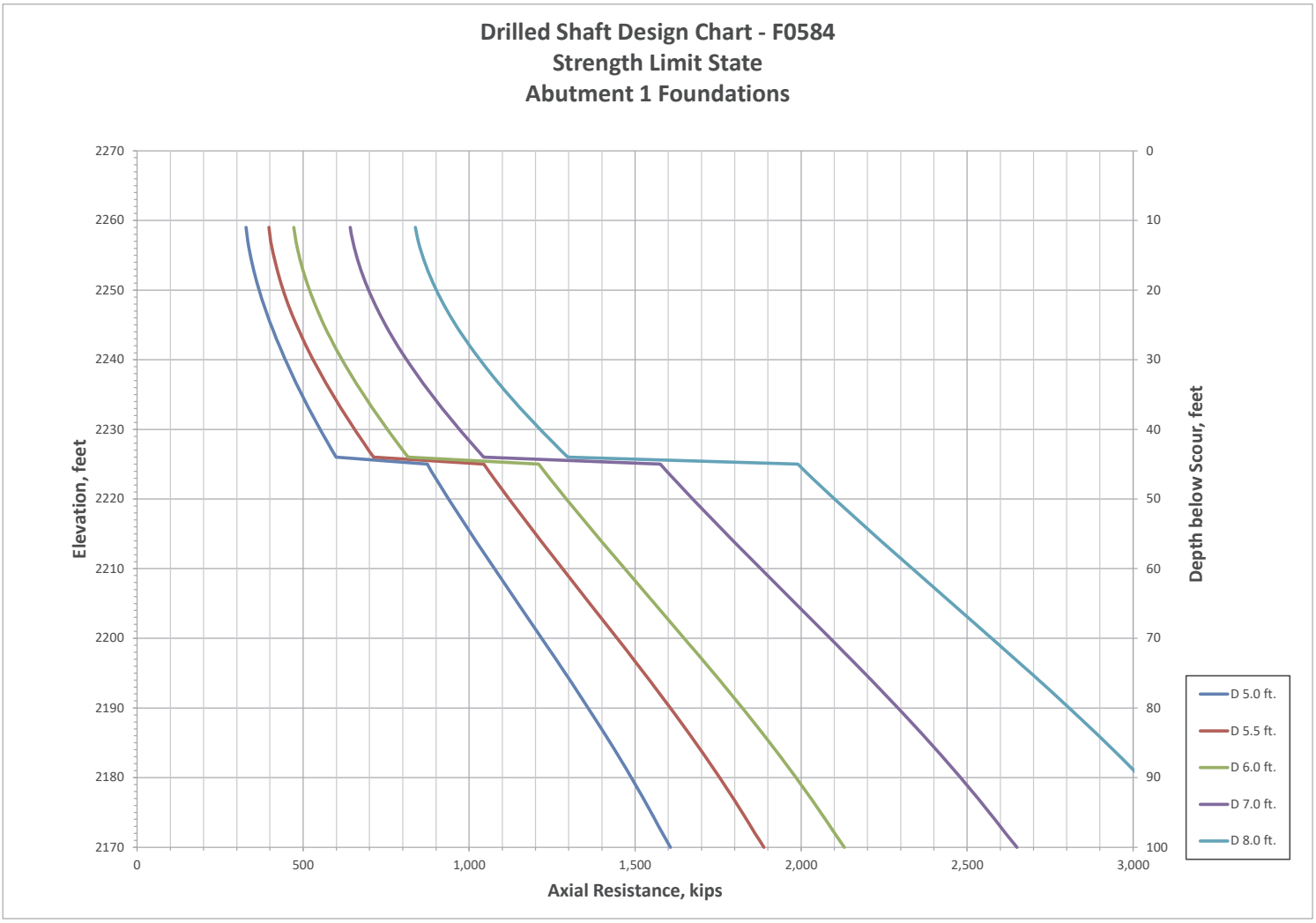


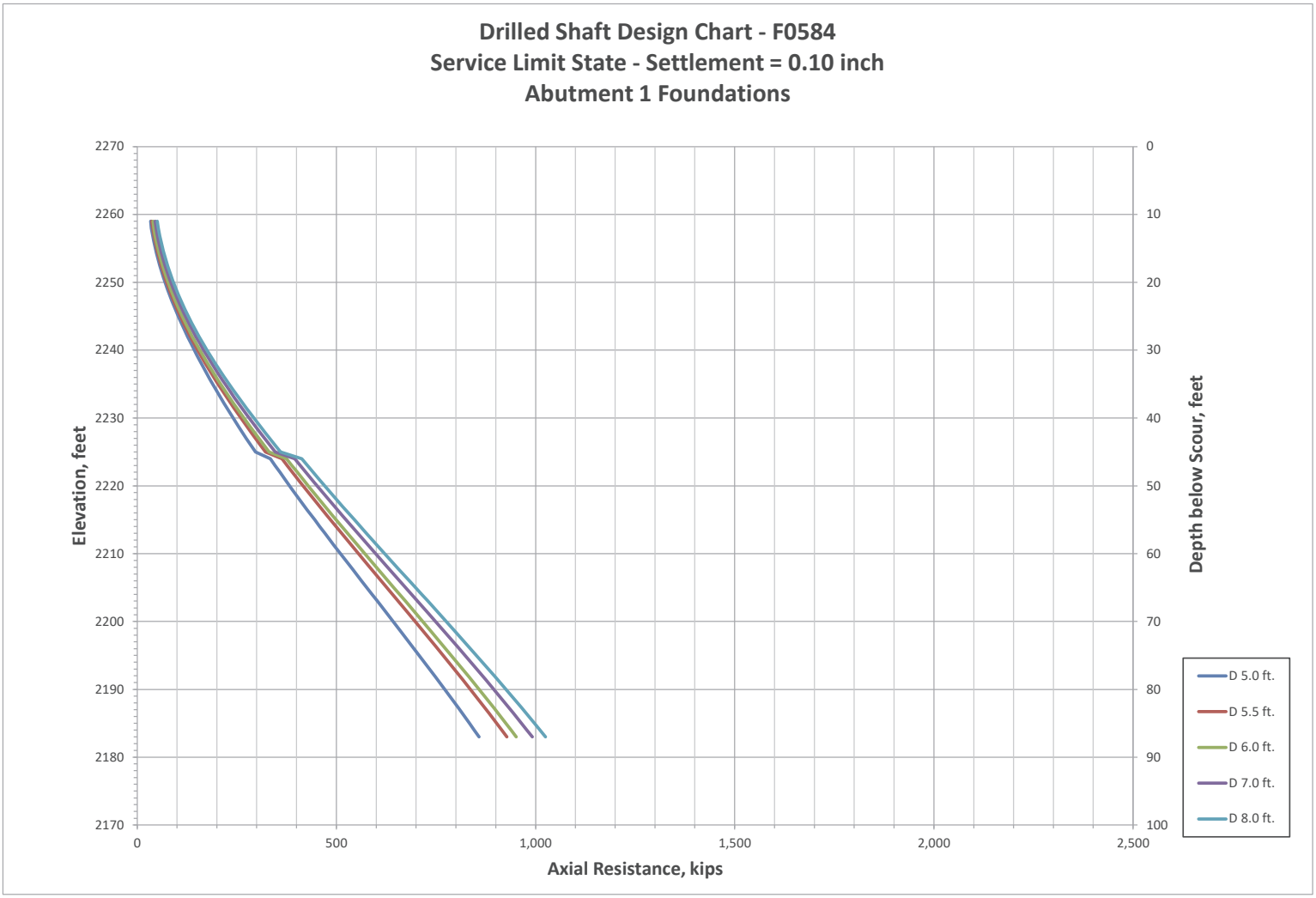
Figure D-3: P-wave Velocity Model for seismic refraction line SL-3 between Sta 15+00 and Sta 17+00

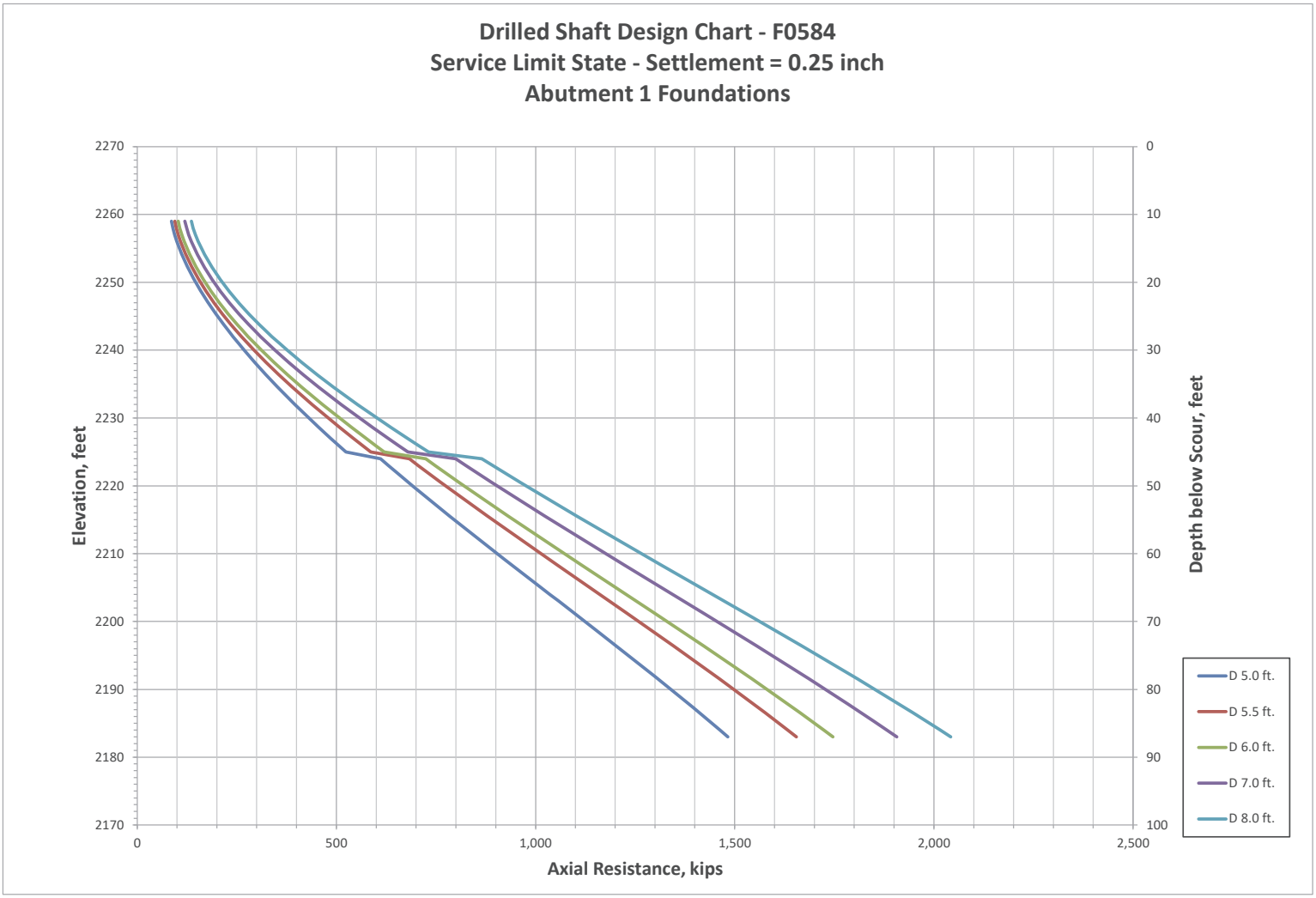


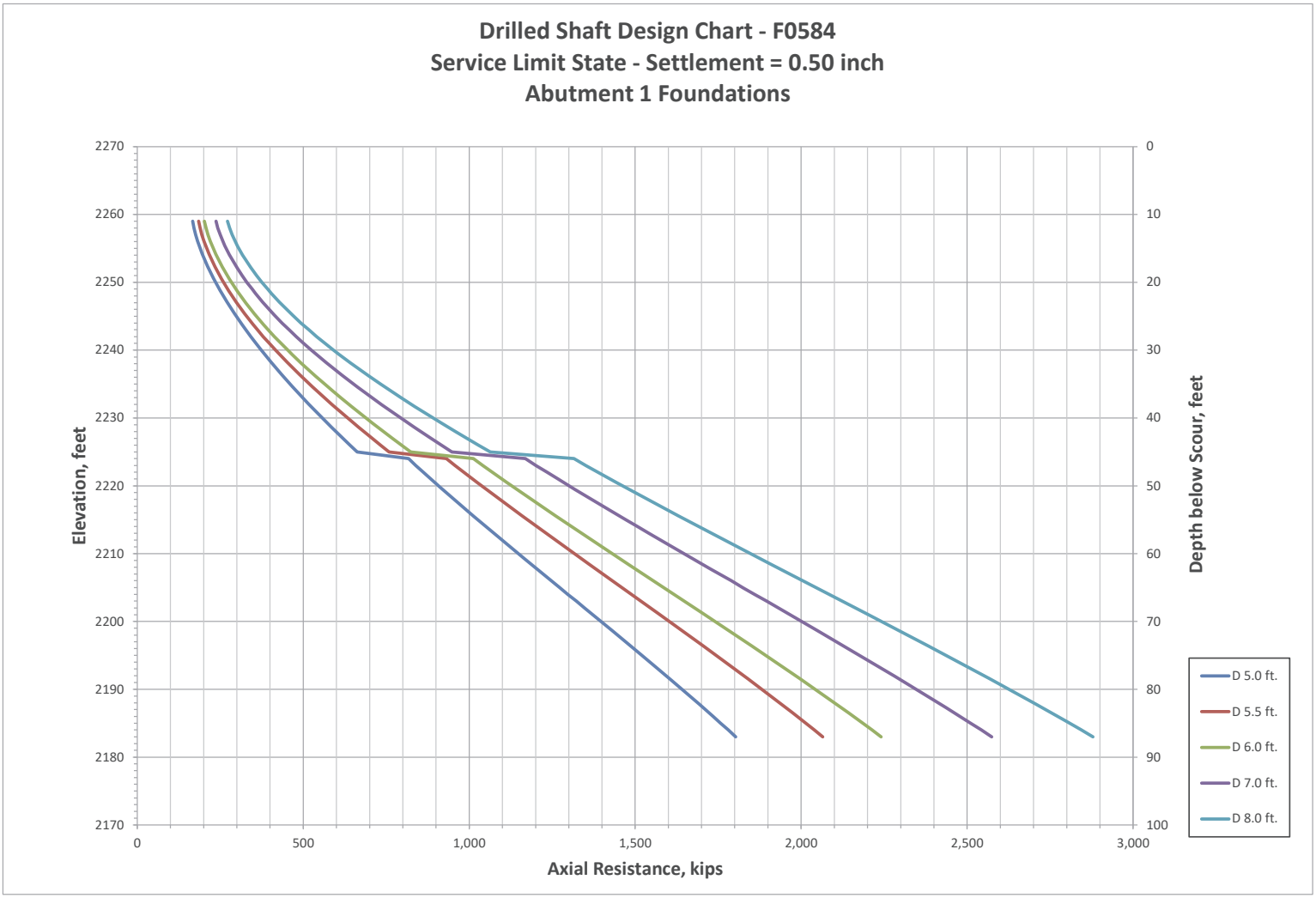
APPENDIX E

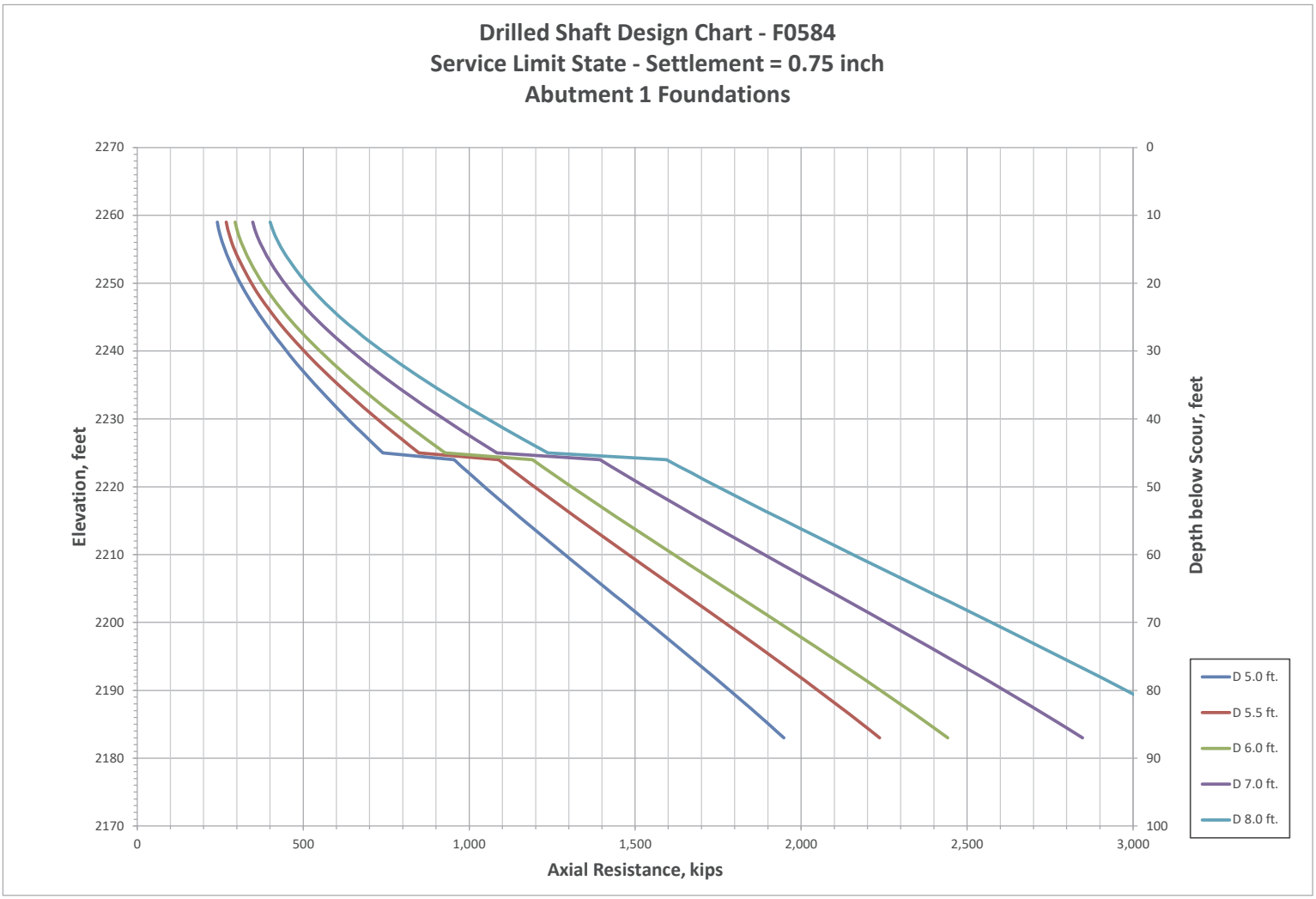
Drilled Shaft Design Charts

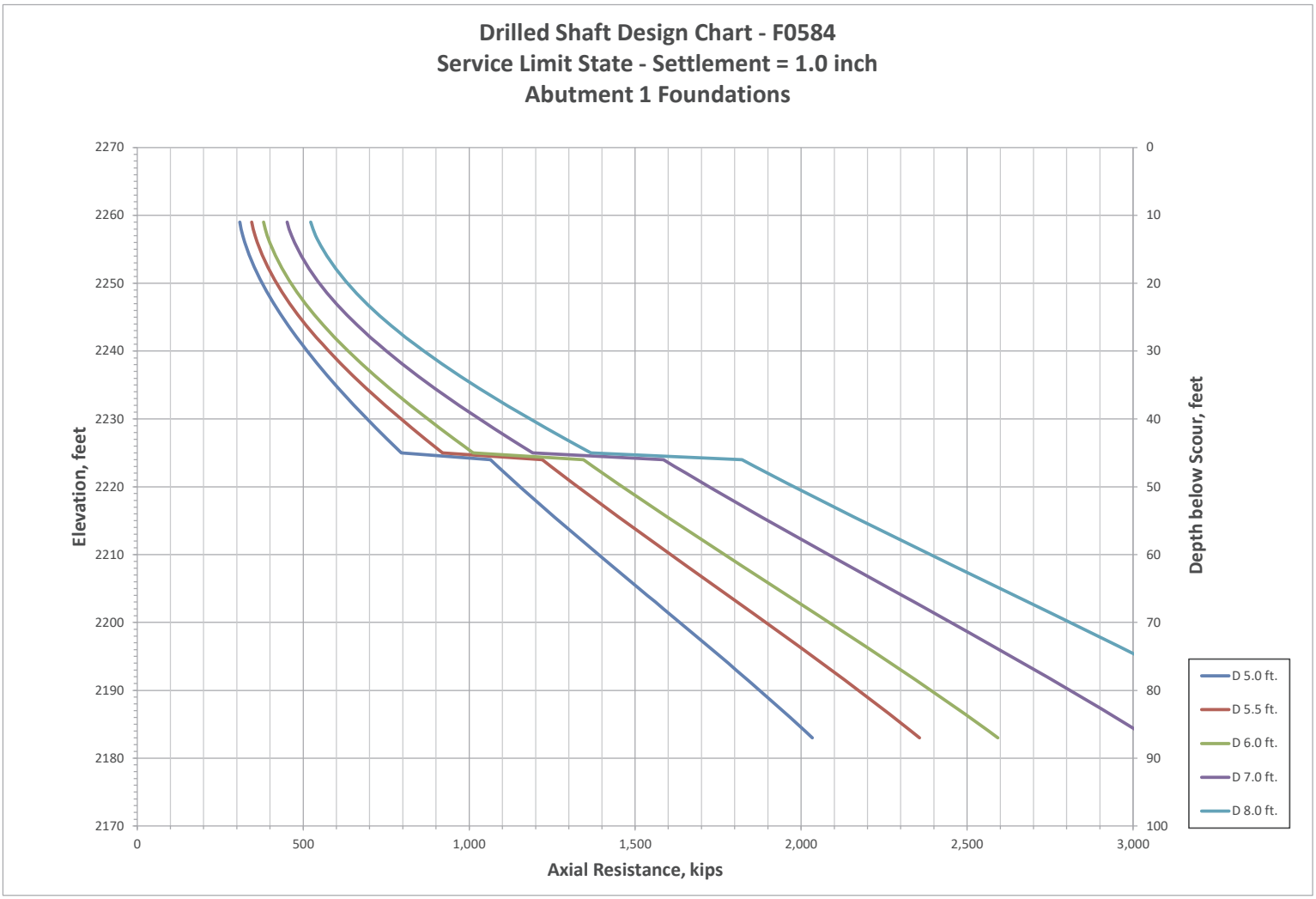

Drilled Shaft Design Chart - F0584
Strength Limit State
Abutment 1 Foundations
Elevation, feet
2270
2260
2250
2240
2230
2220
2210
2200
2190
2180
2170
0
500
1,000
1,500
2,000
2,500
3,000
Axial Resistance, kips
Depth below Scour, feet
0
10
20
30
40
50
60
70
80
90
100
D 5.0 ft.
D 5.5 ft.
D 6.0 ft.
D 7.0 ft.
D 8.0 ft.


Drilled Shaft Design Chart - F0584
Service Limit State - Settlement = 0.10 inch
Abutment 1 Foundations
Elevation, feet
2270
2260
2250
2240
2230
2220
2210
2200
2190
2180
2170
0
500
1,000
1,500
2,000
2,500
Axial Resistance, kips
Depth below Scour, feet
0
10
20
30
40
50
60
70
80
90
100
D 5.0 ft.
D 5.5 ft.
D 6.0 ft.
D 7.0 ft.
D 8.0 ft.


Drilled Shaft Design Chart - F0584
Service Limit State - Settlement = 0.25 inch
Abutment 1 Foundations
Elevation, feet
2270
2260
2250
2240
2230
2220
2210
2200
2190
2180
2170
0
500
1,000
1,500
2,000
2,500
Axial Resistance, kips
Depth below Scour, feet
0
10
20
30
40
50
60
70
80
90
100
D 5.0 ft.
D 5.5 ft.
D 6.0 ft.
D 7.0 ft.
D 8.0 ft.


Drilled Shaft Design Chart - F0584
Service Limit State - Settlement = 0.50 inch
Abutment 1 Foundations
Elevation, feet
2270
2260
2250
2240
2230
2220
2210
2200
2190
2180
2170
0
500
1,000
1,500
2,000
2,500
3,000
Axial Resistance, kips
Depth below Scour, feet
0
10
20
30
40
50
60
70
80
90
100
D 5.0 ft.
D 5.5 ft.
D 6.0 ft.
D 7.0 ft.
D 8.0 ft.


Drilled Shaft Design Chart - F0584
Service Limit State - Settlement = 0.75 inch
Abutment 1 Foundations
Elevation, feet
2270
2260
2250
2240
2230
2220
2210
2200
2190
2180
2170
0
500
1,000
1,500
2,000
2,500
3,000
Axial Resistance, kips
Depth below Scour, feet
0
10
20
30
40
50
60
70
80
90
100
D 5.0 ft.
D 5.5 ft.
D 6.0 ft.
D 7.0 ft.
D 8.0 ft.


Drilled Shaft Design Chart - F0584
Service Limit State - Settlement = 1.0 inch
Abutment 1 Foundations
Elevation, feet
2270
2260
2250
2240
2230
2220
2210
2200
2190
2180
2170
0
500
1,000
1,500
2,000
2,500
3,000
Axial Resistance, kips
Depth below Scour, feet
0
10
20
30
40
50
60
70
80
90
100
D 5.0 ft.
D 5.5 ft.
D 6.0 ft.
D 7.0 ft.
D 8.0 ft.

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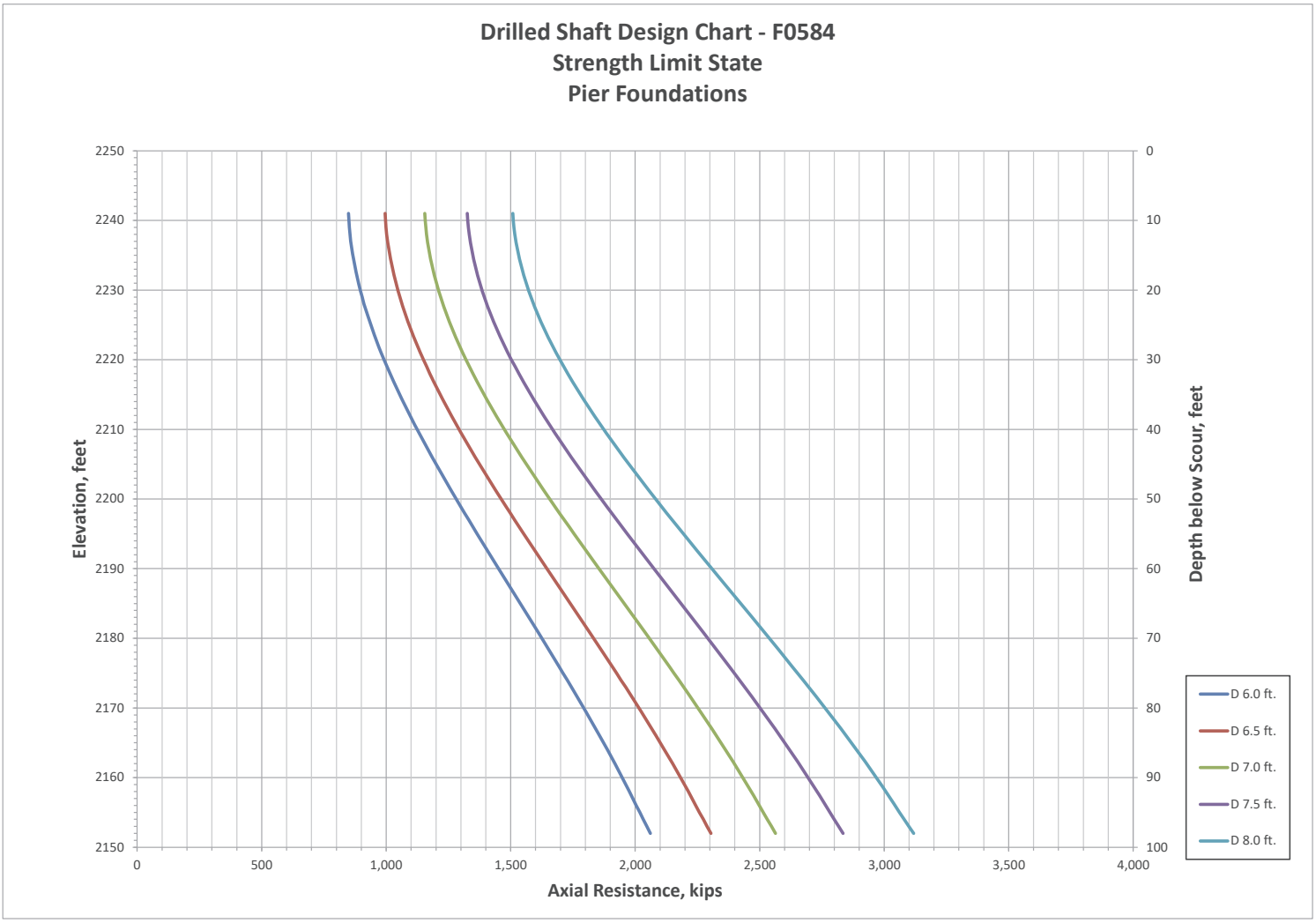
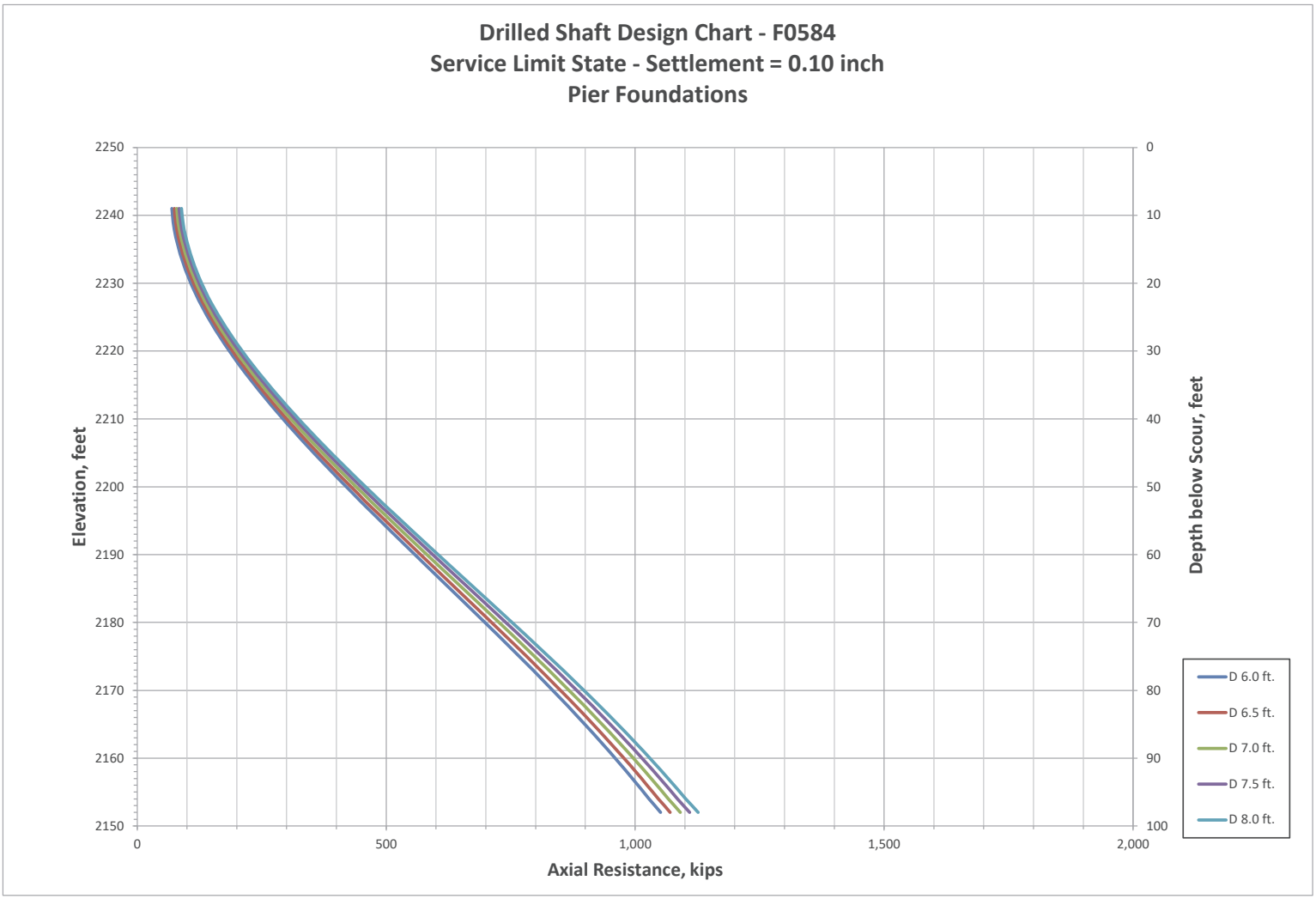
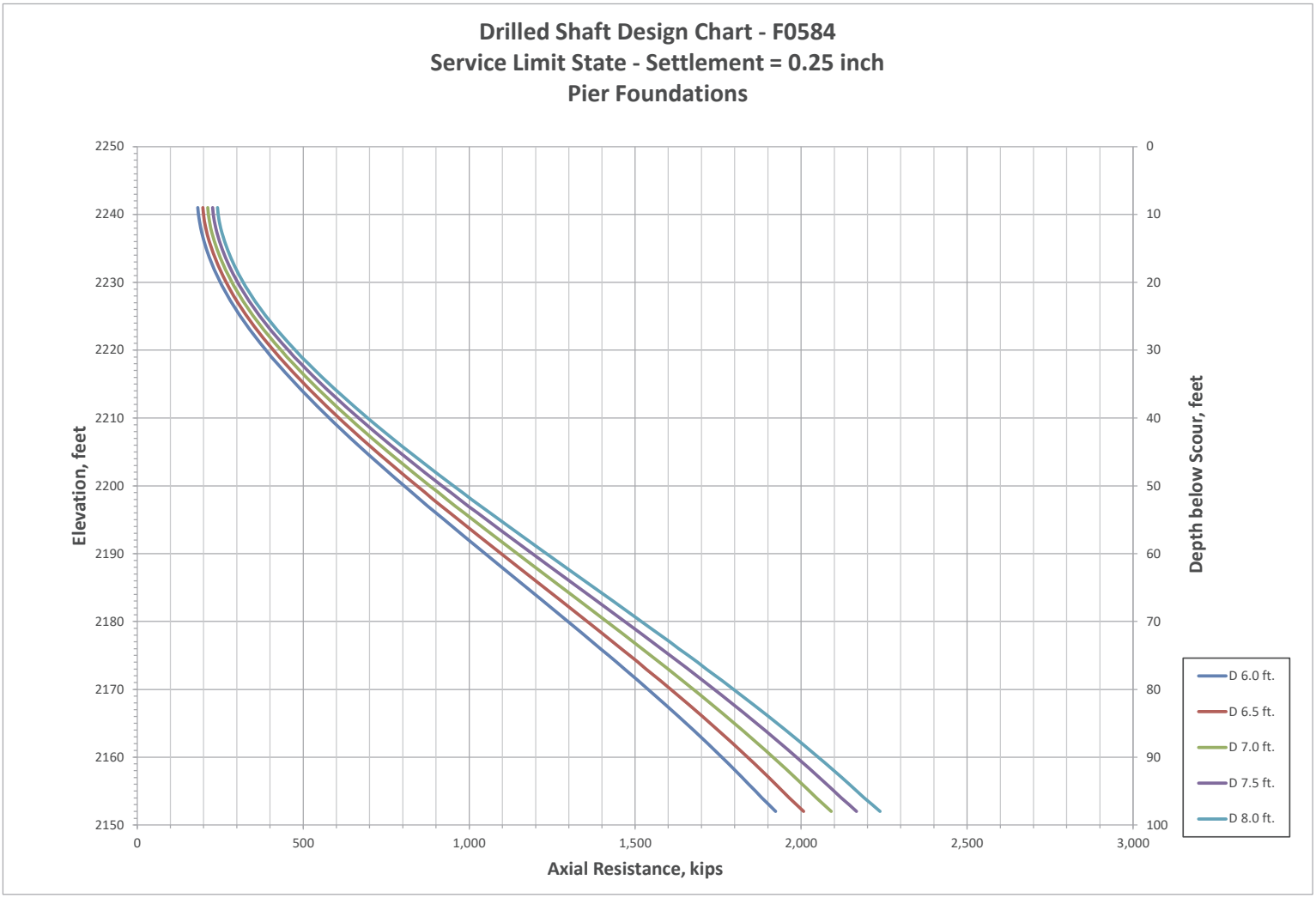
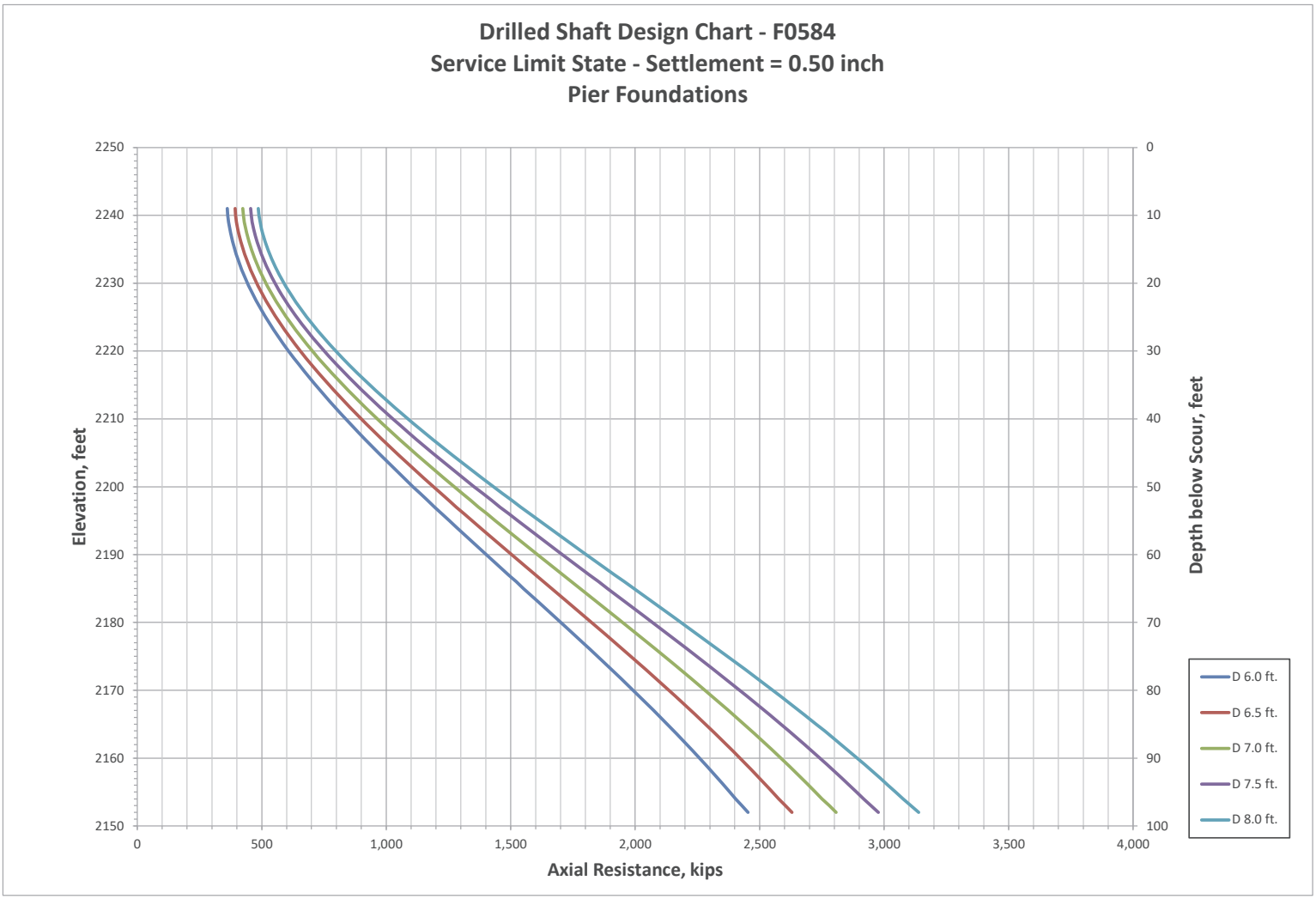
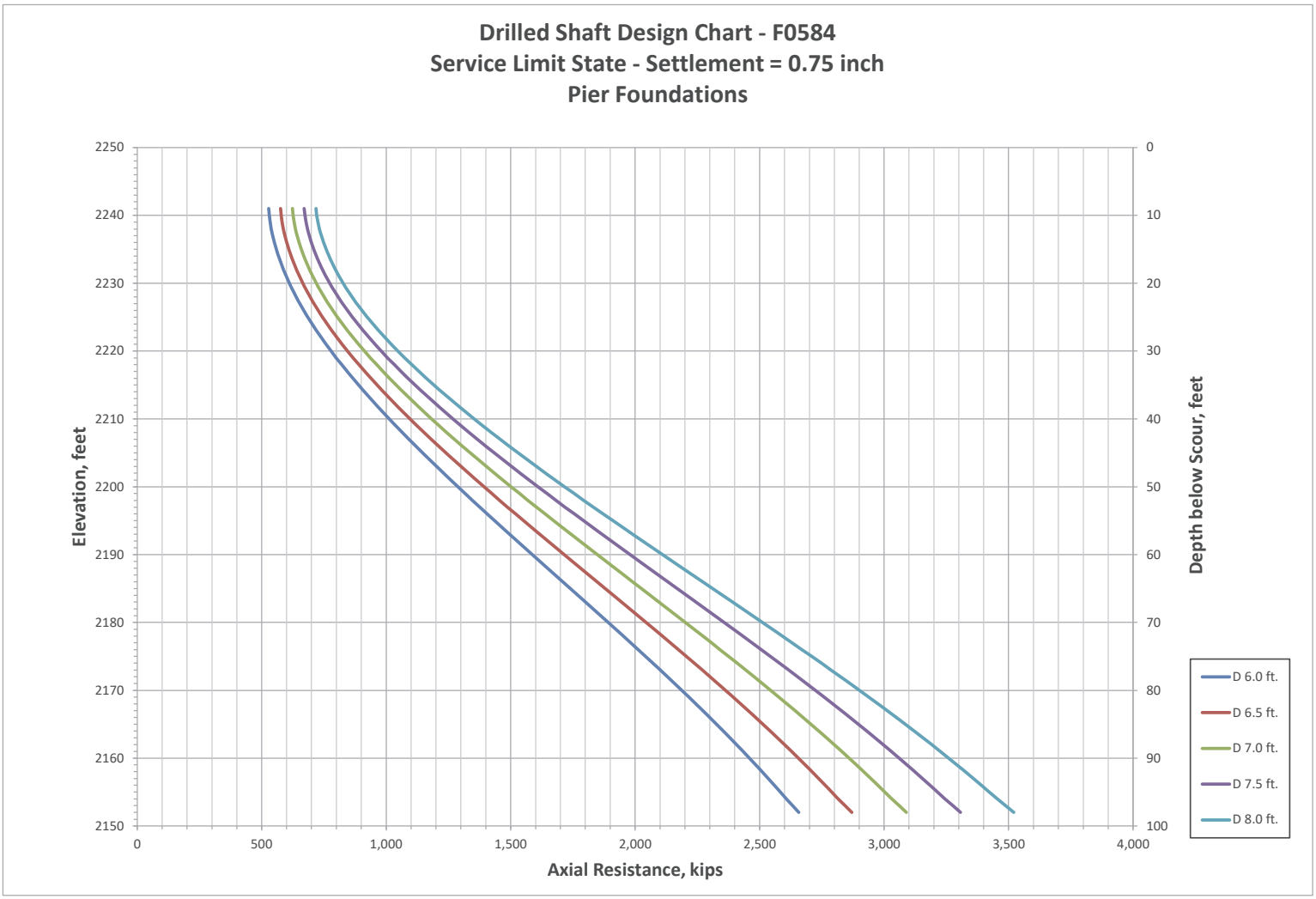
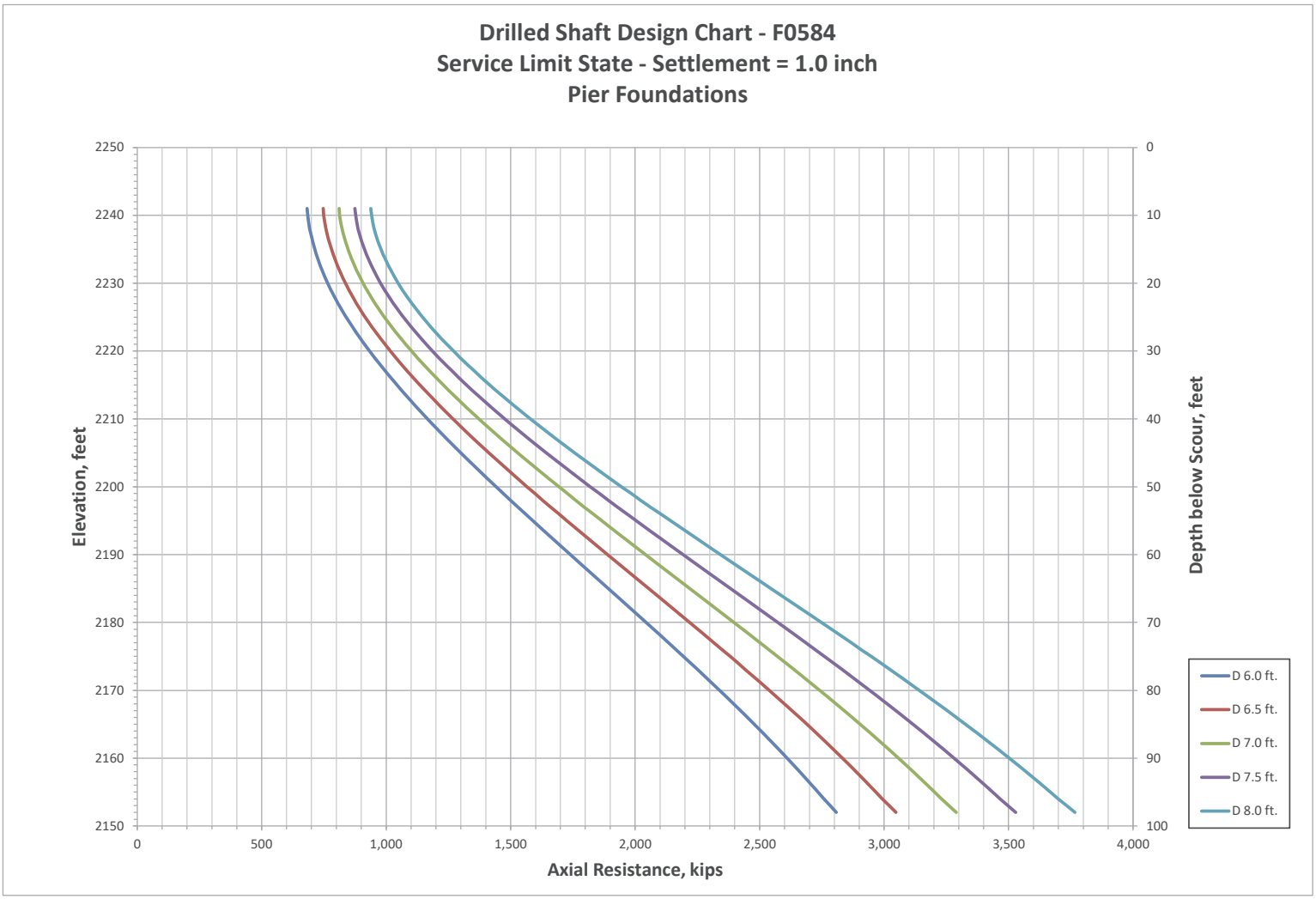

Drilled Shaft Design Chart - F0584
Strength Limit State
Pier Foundations
Elevation, feet
2250
2240
2230
2220
2210
2200
2190
2180
2170
2160
2150
Depth below Scour, feet
0
10
20
30
40
50
60
70
80
90
100
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
Axial Resistance, kips
D 6.0 ft.
D 6.5 ft.
D 7.0 ft.
D 7.5 ft.
D 8.0 ft.


Drilled Shaft Design Chart - F0584
Service Limit State - Settlement = 0.10 inch
Pier Foundations
Elevation, feet
2250
2240
2230
2220
2210
2200
2190
2180
2170
2160
2150
0
500
1,000
1,500
2,000
Axial Resistance, kips
Depth below Scour, feet
0
10
20
30
40
50
60
70
80
90
100
D 6.0 ft.
D 6.5 ft.
D 7.0 ft.
D 7.5 ft.
D 8.0 ft.


Drilled Shaft Design Chart - F0584
Service Limit State - Settlement = 0.25 inch
Pier Foundations
Elevation, feet
2250
2240
2230
2220
2210
2200
2190
2180
2170
2160
2150
0
500
1,000
1,500
2,000
2,500
3,000
Axial Resistance, kips
Depth below Scour, feet
0
10
20
30
40
50
60
70
80
90
100
D 6.0 ft.
D 6.5 ft.
D 7.0 ft.
D 7.5 ft.
D 8.0 ft.


Drilled Shaft Design Chart - F0584
Service Limit State - Settlement = 0.50 inch
Pier Foundations
Elevation, feet
2250
2240
2230
2220
2210
2200
2190
2180
2170
2160
2150
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
Axial Resistance, kips
Depth below Scour, feet
0
10
20
30
40
50
60
70
80
90
100
D 6.0 ft.
D 6.5 ft.
D 7.0 ft.
D 7.5 ft.
D 8.0 ft.


Drilled Shaft Design Chart - F0584
Service Limit State - Settlement = 0.75 inch
Pier Foundations
Elevation, feet
2250
2240
2230
2220
2210
2200
2190
2180
2170
2160
2150
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
Axial Resistance, kips
Depth below Scour, feet
0
10
20
30
40
50
60
70
80
90
100
D 6.0 ft.
D 6.5 ft.
D 7.0 ft.
D 7.5 ft.
D 8.0 ft.


Drilled Shaft Design Chart - F0584
Service Limit State - Settlement = 1.0 inch
Pier Foundations
Elevation, feet
2250
2240
2230
2220
2210
2200
2190
2180
2170
2160
2150
Depth below Scour, feet
0
10
20
30
40
50
60
70
80
90
100
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
Axial Resistance, kips
D 6.0 ft.
D 6.5 ft.
D 7.0 ft.
D 7.5 ft.
D 8.0 ft.

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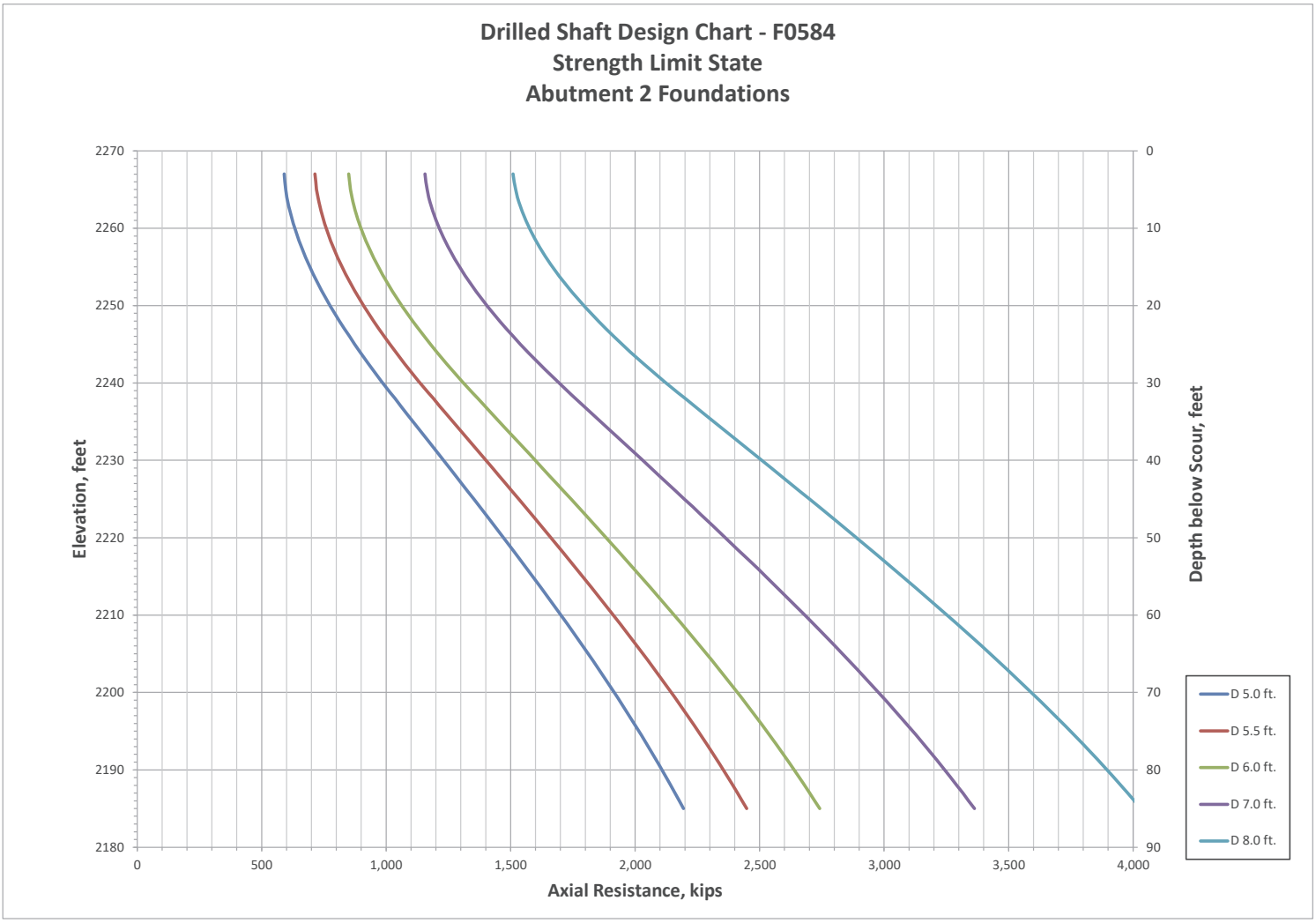
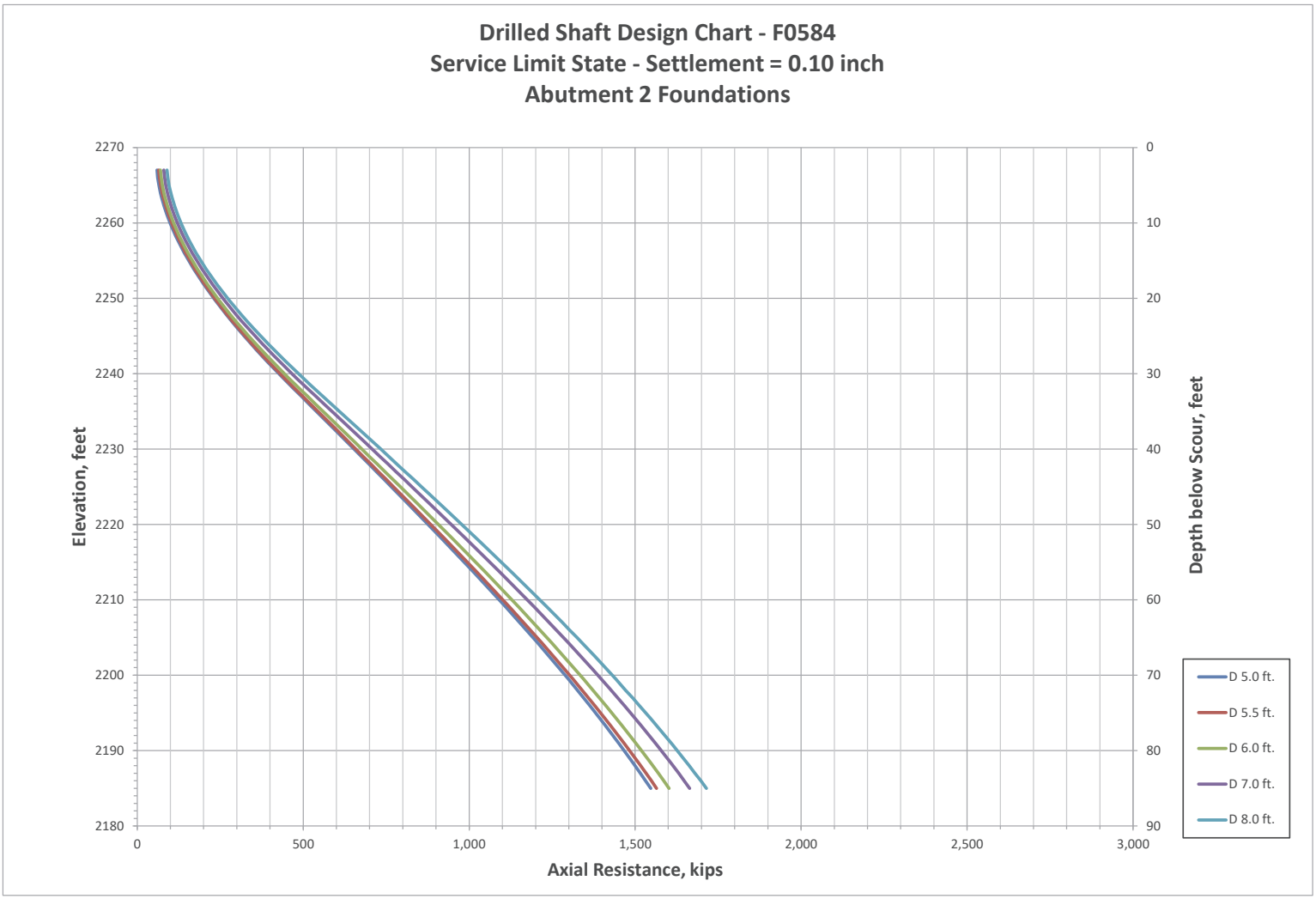

Drilled Shaft Design Chart - F0584
Strength Limit State
Abutment 2 Foundations
Elevation, feet
2270
2260
2250
2240
2230
2220
2210
2200
2190
2180
Depth below Scour, feet
0
10
20
30
40
50
60
70
80
90
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
Axial Resistance, kips
D 5.0 ft.
D 5.5 ft.
D 6.0 ft.
D 7.0 ft.
D 8.0 ft.


Drilled Shaft Design Chart - F0584
Service Limit State - Settlement = 0.10 inch
Abutment 2 Foundations
Elevation, feet
2270
2260
2250
2240
2230
2220
2210
2200
2190
2180
0
500
1,000
1,500
2,000
2,500
3,000
Axial Resistance, kips
Depth below Scour, feet
0
10
20
30
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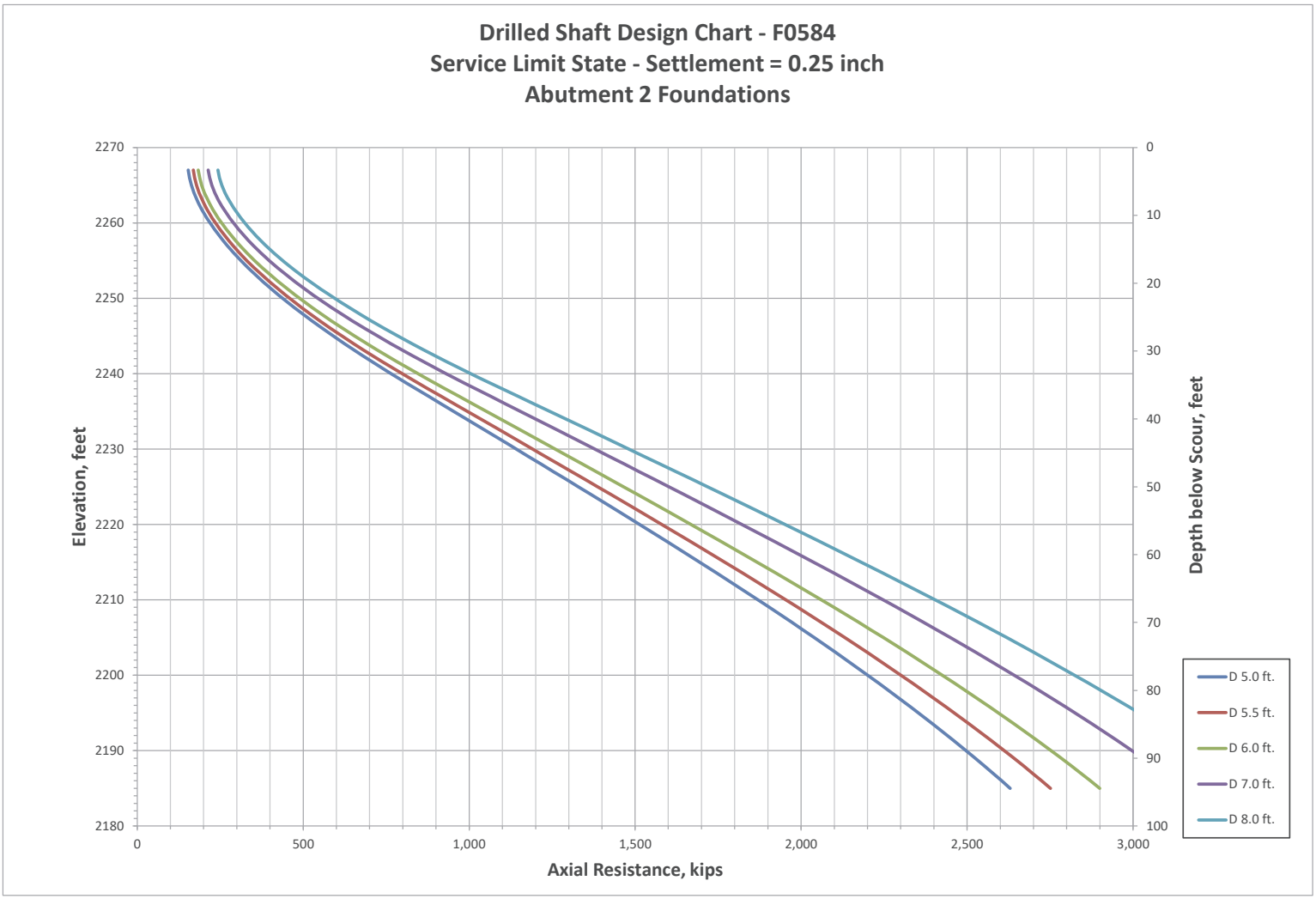
60
70
80
90
D 5.0 ft.
D 5.5 ft.
D 6.0 ft.
D 7.0 ft.
D 8.0 ft.


Drilled Shaft Design Chart - F0584
Service Limit State - Settlement = 0.25 inch
Abutment 2 Foundations
Elevation, feet
2270
2260
2250
2240
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2220
2210
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2190
2180
0
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1,500
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Axial Resistance, kips
Depth below Scour, feet
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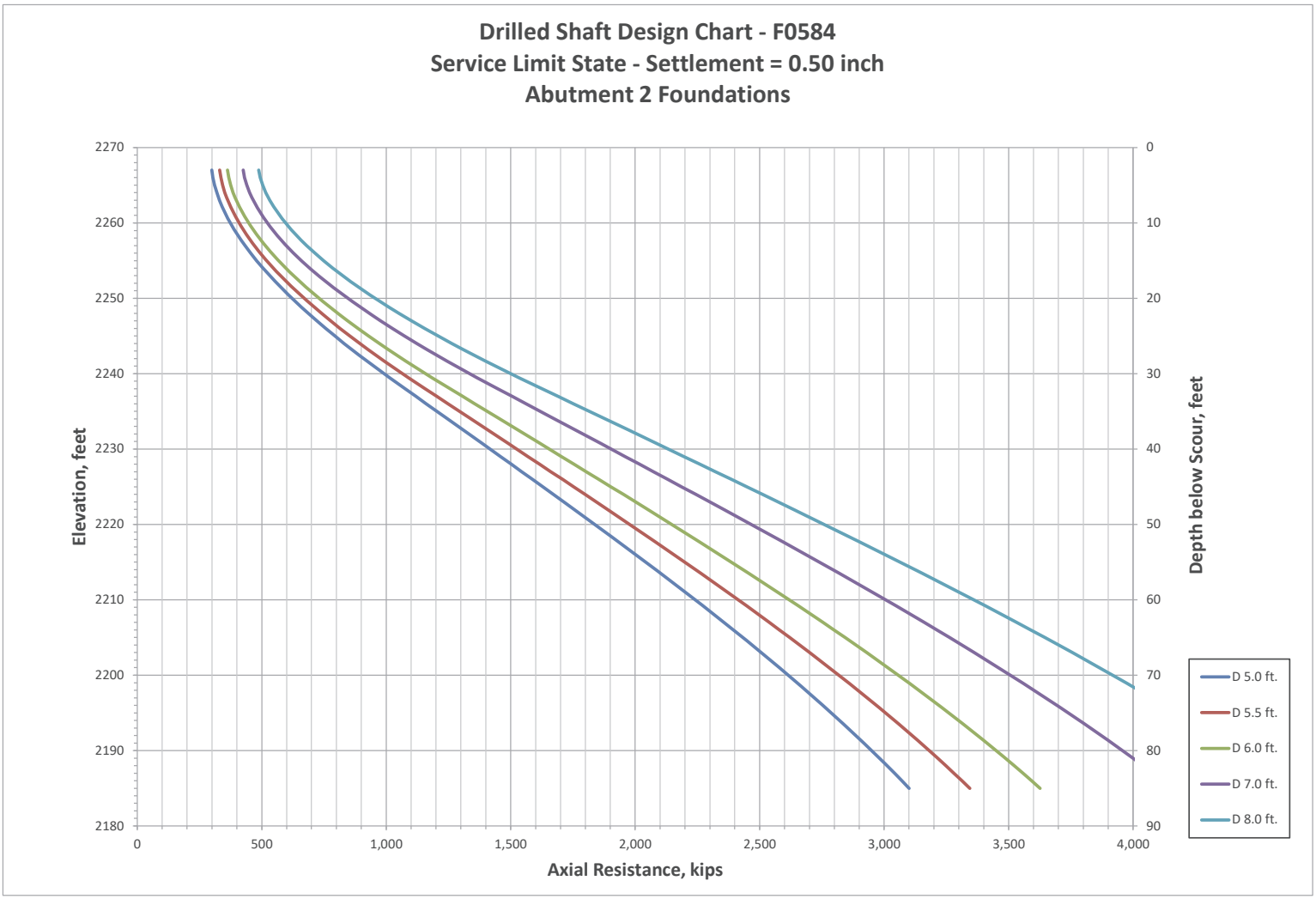
D 5.0 ft.
D 5.5 ft.
D 6.0 ft.
D 7.0 ft.
D 8.0 ft.


Drilled Shaft Design Chart - F0584
Service Limit State - Settlement = 0.50 inch
Abutment 2 Foundations
Elevation, feet
2270
2260
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2240
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Depth below Scour, feet
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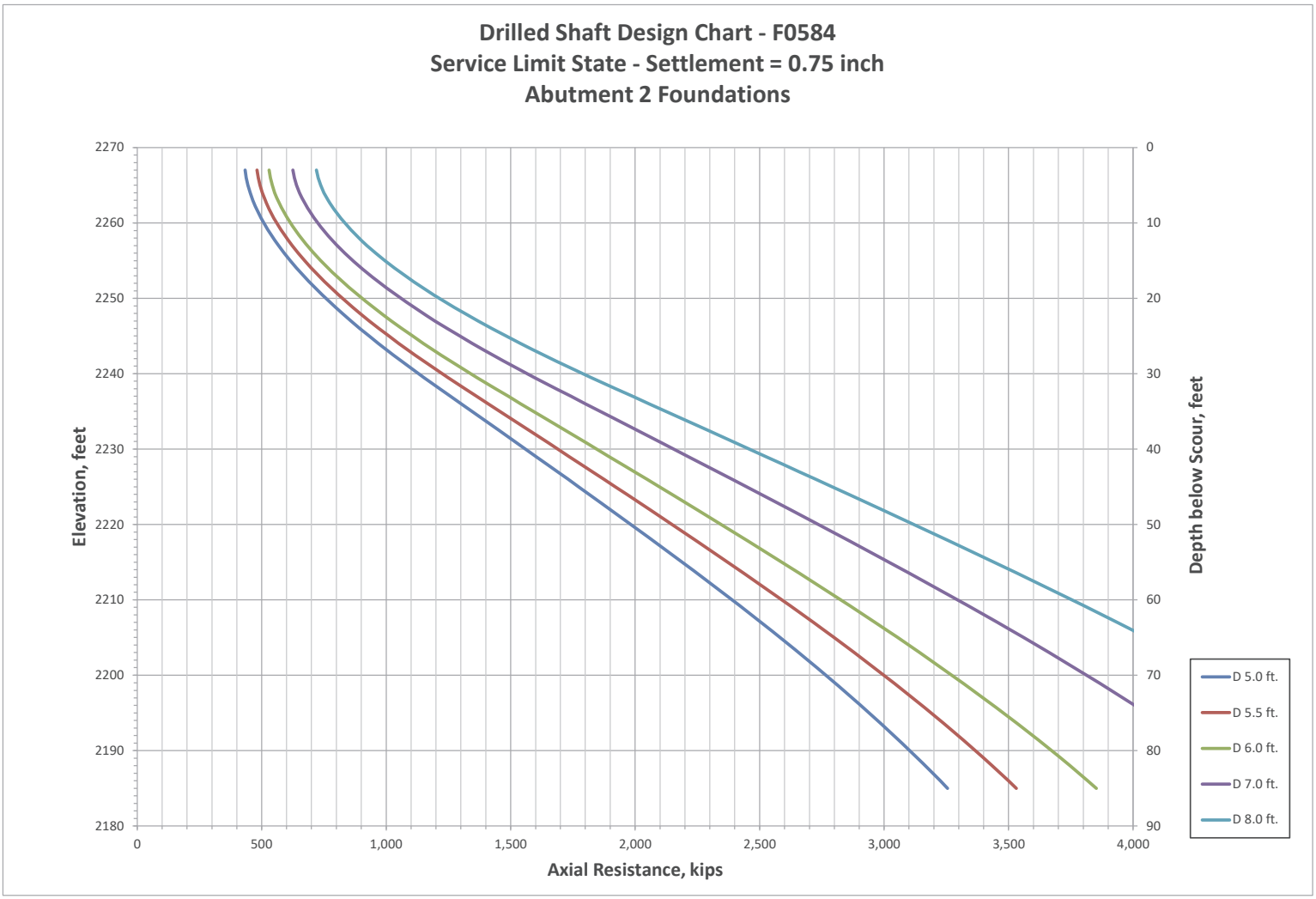
Axial Resistance, kips
D 5.0 ft.
D 5.5 ft.
D 6.0 ft.
D 7.0 ft.
D 8.0 ft.


Drilled Shaft Design Chart - F0584
Service Limit State - Settlement = 0.75 inch
Abutment 2 Foundations
Elevation, feet
2270
2260
2250
2240
2230
2220
2210
2200
2190
2180
Depth below Scour, feet
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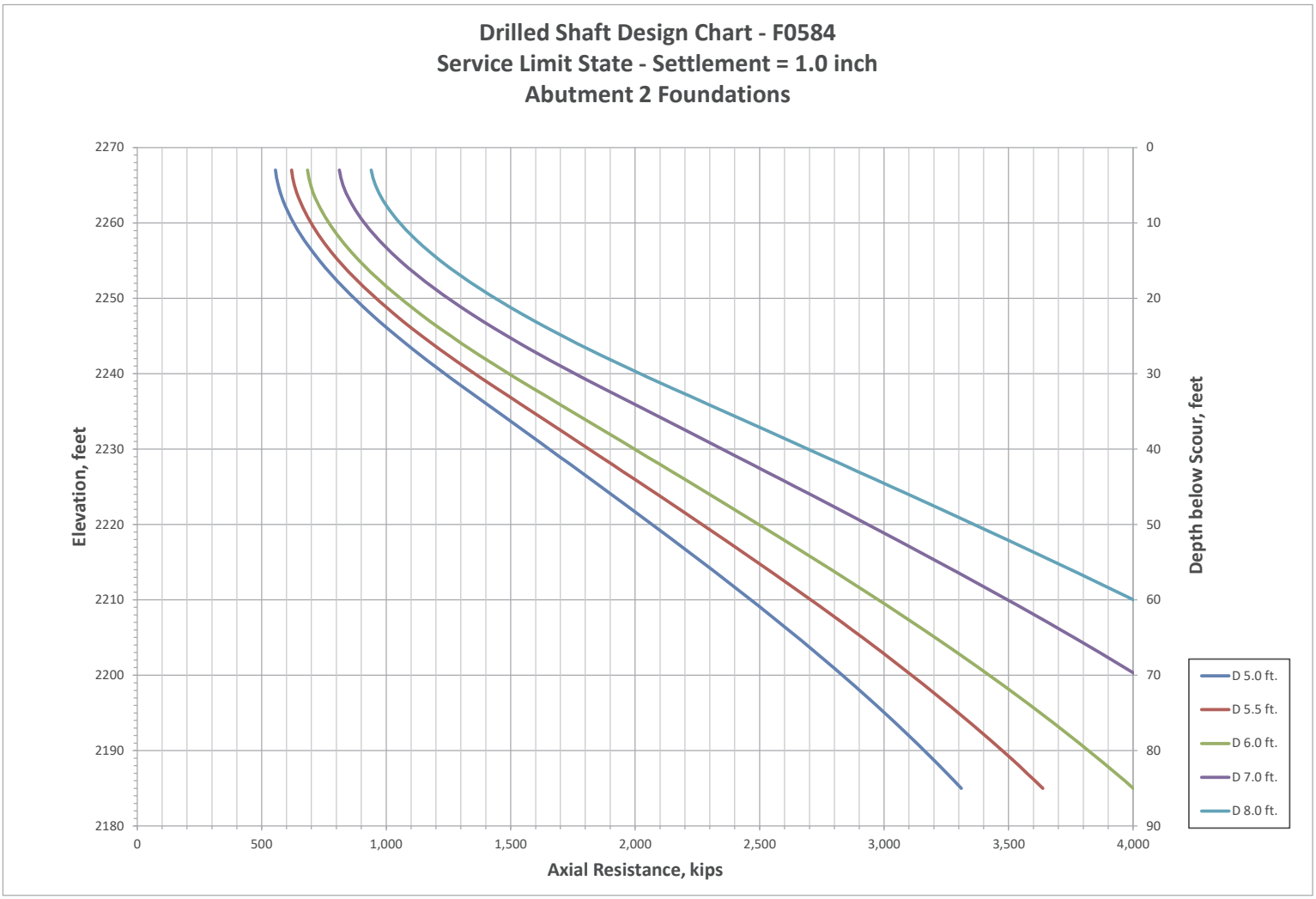
Axial Resistance, kips
D 5.0 ft.
D 5.5 ft.
D 6.0 ft.
D 7.0 ft.
D 8.0 ft.


Drilled Shaft Design Chart - F0584
Service Limit State - Settlement = 1.0 inch
Abutment 2 Foundations
Elevation, feet
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2260
2250
2240
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2220
2210
2200
2190
2180
Depth below Scour, feet
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3,500
4,000
Axial Resistance, kips
D 5.0 ft.
D 5.5 ft.
D 6.0 ft.
D 7.0 ft.
D 8.0 ft.