FINAL GEOTECHNICAL REPORT

ADOT Project No. 040 AP 351 F0319 01D

Federal Identification Project No. NHPP-040-E(225)T

I-40; Allentown TI UP Bridge # 20246 Replacement

July 5, 2022

Prepared by

James J. Lemmon, R.G. and

Tad C. Niemyjski, P.E.

ARIZONA DEPARTMENT OF TRANSPORTATION

BRIDGE GROUP

GEOTECHNICAL SERVICES

Infrastructure Delivery and Operations

July 5, 2022

Subject:
Geotechnical Report
I-40 Allentown TI UP Bridge #20246 Replacement
ADOT Project No. 040 AP 351 F0319 01D

This report presents the results of our geotechnical engineering services to support the replacement of the Allentown Road TI UP Bridge (Structure No. 956) over I-40. The project is located over I-40 at milepost (MP) 351.35 within the Navajo Nation in Apache County, Arizona. The project involves removing the existing bridge structure and constructing a replacement bridge (Structure No. 20246) and the associated roadway reconstruction.

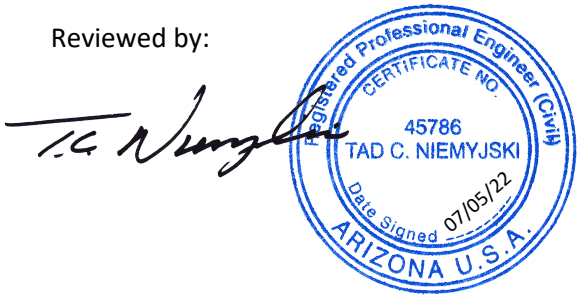
A geotechnical field investigation included advancing three test borings to depths ranging from 70 to 80 feet below the ground surface. The results of the field and laboratory investigation as well as design recommendations for the proposed construction are presented in this report.

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,

James Lemmon, R.G.
Geologist

Reviewed by:



Tad C. Niemyjski, P.E.
Geotechnical Design Team Lead

TABLE OF CONTENTS

FIGURES

TABLES

1.0 INTRODUCTION

This report presents the results of our geotechnical engineering services to support the replacement of the Allentown Road TI UP Bridge (Structure No. 956) on Interstate 40. The project is located over I-40 at milepost (MP) 351.35 in Apache County, Arizona within the Navajo Nation.

1.1 Project Description

The project consists of replacing the existing bridge structure which was constructed in 1967 as a 33-foot wide four-span steel girder bridge with a total length of approximately 250 feet. The bridge abutments are on steel pile foundations and the piers are supported on spread footings.

The planned replacement bridge is designed as a two-span structure, with 9 precast, pre-stressed AASHTO Type Bill-48 Box Beams with a new 8-inch concrete deck. The proposed bridge is planned to span approximately 250 feet in length with a width of 40 feet founded on six drilled shaft cast-in-place foundations.

The work will be completed in a single construction phase with the closure of Allentown Road at the bridge and use of a detour.

1.2 Site Description

The project site for the geotechnical exploration areas is located within the existing ADOT right of way on I-40 between MP 351 and MP 352. The general project area consists of hilly terrain with the outcrops of sedimentary rocks and some locally derived colluvium. The elevation at the bridge surface is approximately 6,135 feet above mean sea level (MSL) and the ground surface at the piers along the I-40 roadway averages approximately 6,110 feet MSL. Vegetation at the site consists of a sparse growth of cactus, native grasses, a few desert bushes, and trees (pinion or juniper). A Site Plan of the project area is presented in the appendix of this report.

Figure 1: Aerial view of the Allentown TI

1.3 Site Geology

The Geologic Map of Arizona (AGS, 2000) indicates that the site is in the Chinle Formation consisting of Late Triassic (210-230 Ma) sedimentary rocks with some conglomerates and sandstones, but predominately mudstones, siltstones and occasional thin lenses of limestone. This formation typically erodes into badlands topography and contains clays that are prone to shrinking and swelling.

2.0 SUBSURFACE INVESTIGATION

2.1 Test Borings

The subsurface investigation included advancing three test borings (see Table 1 for details) to depths ranging from approximately 70 feet below the roadway surface at the northern Abutment 2 location to about 80 feet below the ground surface (bgs) at the proposed bridge center pier location and southern Abutment 2 location. The test borings performed by Geomechanics Southwest, Inc. (GSI) were drilled with a truck mounted CME-85 drill rig utilizing a hollow-stem auger with an 8-inch outside diameter (O.D.) during the week of January 24, 2022. When rock was encountered at 50 below the surface at the north abutment location, drilling changed to 3.5-inch HQ coring system. The subsurface borings were logged and completed by Wood Environment & Infrastructure Solutions, Inc. (Wood).

Figure 2: Drilling activities near the location of Abutment 1

The subsurface soils were then sampled with a split spoon sampler (STP) or with a ring-lined barrel sampler. The sampling was completed at intervals of 5 feet using mostly 2-inch O.D., 1.4-inch inside diameter (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 inch I.D. brass rings.

The SPT and ring samplers were driven 18 and 12 inches, respectively, or to refusal (i.e. 50 blows for less than a 6 inches of sampler penetration) using an automatic hydraulic actuated 140 pound hammer free falling 30 inches. Unless noted otherwise on the boring logs, the sample driving resistance was recorded as number of blows per six inches of penetration. The results of the penetration tests are presented on the borings logs provided in the appendix of this report.

The recovered soil and rock core samples were removed from the sampler, sealed to reduce moisture loss, and submitted to the Wood and ACS Services, LLC (ACS) laboratories. All borings were backfilled in accordance with permit requirements. The upper 6 inches of borings S-01 and S-03 was capped with quick-set concrete to repair the roadway surface. Test Boring logs are presented in the Geotechnical Technical Memorandum provided by Wood which is included at the end of this report in the appendix.

Table 1: Summary of Test Borings

Test Boring No.	Feature	Station, Offset	Ground Elevation (feet)	Bottom Elevation (feet)	Overall Depth of Boring (feet)
S-01	Abutment 1	4+24, 8' L	6,134	6,064	70[1]
S-02	Center Pier	5+54, 20' L	6,113	6,033	80
S-03	Abutment 2	6+93, 8' L	6,137	6,057	80

[1] Boring was terminated at 70 feet after coring 20 feet into bedrock.

2.2 Laboratory Testing

The soil samples obtained during the field investigation were delivered and submitted to the Wood and ACS Services, LLC (ACS) laboratories. Select samples were tested in general conformance with the procedures listed in the following table.

Table 2: Laboratory Test Methods Applied for Representative Soil Samples

Geotechnical Test	Test Procedure	Number of Tests
Sieve Analysis (Grain Size)	ARIZ 201d	9
Atterberg Limits (Plasticity)	AASHTO T 89 and T 90	9
Total Soluble Sulfates	ARIZ 733	3
Total Soluble Chlorides	ARIZ 736	3
Moisture	ASTM D2216	12
Moisture/Density of Soil In-Place	ASTM D2937	9
Direct Shear Test	ASTM D6080	3
Consolidation Test	ASTM D2435	1
Unconfined Compressive Strength of Rock (strength)	ASTM D7012	2
Unconfined Compressive Strength of Rock (density)	ASTM D7012	2

A summary of all laboratory test results is presented in the Geotechnical Technical Memorandum provided by Wood at the end of this report.

3.0 SUBSURFACE CONDITIONS

3.1 Soil Conditions

The subsurface investigation encountered both native and fill soils, in addition to bedrock at one location. The north abutment boring location, S-01, encountered siltstone at a depth 50 feet below the surface. Siltstone layers were not encountered within the explored depths in borings at S-02 and S-03 located near the central pier and the south abutment location.

At the test boring locations, the approaches to the existing bridge are comprised of silty to poorly graded sand fill that was likely placed at the time of the original bridge construction. These fills were encountered at the abutment test borings S-01 and S-03 to depths of 8 and 6 feet below the pavement surface respectively. The pier test boring S-02 was advanced in the median between the westbound and eastbound I-40 lanes. At the location of these test borings,

the subsurface soils below the fill soils were stratified and interbedded layers of sand, silt, and clay. The thickness of each layer was found to vary across the site.

Table 3 below represents a stratigraphic view of the soil profile at the test boring locations in five foot increments with the sand segments shaded in tan and the clay and silt segments shaded in a lighter reddish tan. The siltstone horizons are shaded in a darker tan. The difference in the depths of the borings is generally consistent with the differences in ground elevation at the boring locations.

Table 3: Stratigraphic View of Subsurface Profile

Elevation (ft. MSL)	Abut 1 (S-01)	Pier 1 (S-02)	Abut 2 (S-03)	Elevation (ft. MSL)
	USCS	USCS	USCS	
6,135	Asphaltic Concrete		Asphaltic Concrete	6,135
6,130	SP-SM		SM	6,130
6,125	SC		SM	6,125
6,120	SM		SM	6,120
6,115	SP-SM		CL	6,115
6,110	SM	SP-SM	SM	6,110
6,105	CL	CL	CL	6,105
6,100	CL	CL	CL	6,100
6,095	CL	CL-ML	CL	6,095
6,090	SC	CL-ML	CL-ML	6,090
6,085	SC	CL-ML	CL-ML	6,085
6,080	Siltstone	CL-ML	CL-ML	6,080
6,075	Siltstone	SC	CL	6,075
6,070	Siltstone	SM	CL	6,070
6,065	Siltstone	SC*	SC*	6,065
6,060	Siltstone	SC	CL	6,060
6,055		SC	CL	6,055
6,050		SC	* groundwater at 74' BGS	6,050
6,045		SC		6,045
6,040		SC		6,040
6,035		SC		6,035
6,030		CL		6,030
6,025		* groundwater at 50' BGS		6,025
6,020				6,020
6,015				6,015

3.2 Groundwater Conditions

Groundwater was encountered at two of test boring locations at the time of our investigation. The elevation of the water level surface was approximately 6,050 feet MSL at the pier and at the south abutment.

The observed groundwater level conditions indicated on the logs are as recorded at the time of exploration. These groundwater level 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.

3.3 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 geotechnical investigation blow counts which ranged from 1 to 50, an average blow count of 14 was determined using the soil type/profile values from Table 3.10.3.1-1 of the Load Resistance and Factor Design (LRFD) Bridge Design Specification (AASHTO, 2013). Site Class D was selected since the N-values were between 15 and 50 blows per foot of penetration. The seismic design parameters were derived using the United States Geological Survey (USGS) Seismic Design Maps online tool (USGS 2019) and selecting the 2009 AASHTO option. The USGS application uses the site latitude and longitude to develop seismic design parameters. The results are presented in the table below.

Table 4: Seismic Design Parameters

Seismic Design Parameter	Period (seconds)	Spectral Acceleration Value (g)
Peak Ground Acceleration (PGA)	0.0	0.073
Mapped Short-Period Spectral Acceleration (S_S)	0.2	0.146
Mapped One-Second Spectral Acceleration (S_1)	1.0	0.050
Design Peak Ground Acceleration (A_s)	0.0	0.12
Design Short-Period Spectral Acceleration (S_{DS})	0.2	0.23
Design One-Second Spectral Acceleration (S_{D1})	1.0	0.12
Seismic Design Parameter	Value	
Site Amplification Factor at 0.2 second (F_a)	1.6	
Site Amplification Factor at 1.0 second (F_v)	2.4	
Site Amplification Factor, F_{PGA}	1.6	
Site Latitude	35.28884°	
Site Longitude	-109.15804°	

The site specific 1-second spectral acceleration (S_{D1}) value of 0.12 for this site is less than 0.15 g indicating that the site is classified as a Seismic Zone 1 as identified in Table 3.10.6-1 of AASHTO (2013).

4.0 FOUNDATION RECOMMENDATIONS

4.1 Foundation Types

Deep foundations will be needed for the bridge piers and abutments. Deep foundations typically consist of driven piles or drilled shafts. While driven piles with appropriate driving tips and modern driving equipment can be feasible for the project, the project team has decided to use drilled shaft foundations to support the new bridge structure. Constructions considerations for drilled shafts are discussed in Section 4.4.

4.2 Recommendations for Drilled Shafts

The drilled shaft recommendations for this project are included in Section 4.0 of the Geotechnical Technical Memorandum provided by Wood for this project which is included in the appendix of this report.

4.3 Lateral Earth Pressure on Abutment Walls

The proposed abutment walls with level backfill that are unrestrained and free to displace at least 0.1 percent of the wall height at the top of the wall should be designed for the active earth pressure condition. An equivalent fluid pressure of 35 pounds per square foot per foot (psf/ft) may be applied to the back of the wall to simulate this loading condition.

The displacement of rigid walls is not anticipated to develop active earth pressure conditions and should be designed for the at-rest earth pressure condition. An equivalent fluid pressure of 55 psf/ft may be applied to the back of the wall to simulate this loading condition.

Structure backfill should be in accordance with Section 203 of the ADOT Standard Specifications (2021) and placed in accordance with ADOT Standard Drawings SD 7.01. The lateral earth pressure design values are based on the retained material to be free-draining structural backfill with a compacted moist unit weight of 120 pcf with an effective (drained) angle of internal friction of 33 degrees The surface of the retained backfill is assumed 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 62.4 pcf should be included in the design of the retaining walls. For sloping backfill, the appropriate equivalent fluid pressure distribution as described above should be applied over the full length of a vertical plane extending from the back (heel) of the footing to the point of intersection with the finished grade slope. Surcharge loads, such as traffic loading and temporary construction loads, and hydrostatic pressure, if applicable, should be included with lateral earth pressures as appropriate based on anticipated loading conditions.

4.4 Construction Considerations

All drilled shaft excavation techniques should be in accordance with the Section 609 of 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 Section 609 of ADOT (2021), and the special provisions provided for this project. A detailed quality control report should be submitted for each shaft.

5.0 ROADWAY RECOMMENDATIONS

5.1 Pavement Design Information

The recommended R-values are presented in the table below.

Table 5: Recommended R-Values

Recommended R-Values		
Station	**R-mean**	**R-control**
Entire project	30	30

R-mean should be used to design pavement structure. R-control values should be used to develop the Subgrade Acceptance Chart. Material that is excavated within the project limits and is 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 separate Materials Design Report (MDR) and Pavement Design Summary (PDS) prepared by ADOT Roadway Group - Pavement Design Section.

5.2 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 the purpose of design volume estimation, the recommended Earthwork Factors for this project are provided in following table.

Table 6: Earthwork Factors

Earthwork Factors		
Station	**Ground Compaction**	**Excavation Factor**
Entire project	0.10 feet	10% shrink

5.3 Slopes

The slopes within the construction area should be constructed in conformance to ADOT standard construction drawings C-02.20. The slope within the affected reconstruction area should be constructed in accordance with the standard specifications.

5.4 Water Requirements

Approximately 70 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.

5.5 Excavation

Based on the subsurface information gathered during the field investigation the site soils can be excavated with conventional earthmoving equipment. Bedrock was encountered at the test boring location at Abutment 1 at a depth of approximately 50 feet bgs.

The contractor shall review all available information and provide their own assessment to determine the equipment and technical requirements that will be used to construct this project according to the plans and specifications for this project.

5.6 Borrow Information

There is no Department-furnished source for borrow on this project. 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.

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

6.0 REFERENCES

American Association of State Highway and Transportation Officials (AASHTO), 2013. Interim Revisions to the AASHTO LRFD Bridge Design Specifications, 6th Edition. Washington, D.C.

Arizona Department of Transportation (ADOT), 2021, Standard Specifications for Road and Bridge Construction. Phoenix, AZ.

Arizona Department of Transportation (ADOT), 2021, Geotechnical Project Delivery Manual. Phoenix, AZ.

Arizona Department of Transportation (ADOT), 2017, Pavement Design Manual. Phoenix, AZ

Arizona Department of Transportation (ADOT), 2010, Geotechnical Design Policy DS-3, Analysis of Drilled Shaft Subjected to Lateral Loads Based on Load and Resistance Factor Design. Phoenix, AZ

Arizona Geological Survey (AGS), 2000, Geologic Map of Arizona - Map 35, Tucson, AZ.

APPENDIX

Geotechnical Technical Memorandum provided by Wood Environment & Infrastructure Solutions, Inc.

May 10, 2022
Wood Project No. 1720214058

Wood Environment & Infrastructure Solutions, Inc.
4600 East Washington Street, Suite 600
Phoenix, Arizona 85034
T: (602) 733-6000
F: (602) 733-6100
www.woodplc.com

Arizona Department of Transportation
Bridge Group – Infrastructure Delivery and Operations Division
205 S 17th Avenue
MD 613E
Phoenix, Arizona 85007

Attn: James Lemmon, RG

RE: Contract No.: ADOT 2017-016.01
TRACS No.: 040 AP 351 F0319 01C
Project: Geotechnical Support Services, Allentown TI UP Bridge Rehabilitation

Mr. Lemmon,

Wood Environment & Infrastructure Solutions, Inc. (Wood) representatives have completed the Geotechnical Support Services for the Allentown TI UP Bridge Rehabilitation project. This work was performed in general accordance with Contract Modification No. 11, dated August 21, 2021, under our existing ADOT 2017-016.01 contract. The Geotechnical Technical Memorandum dated May 9, 2022, and prepared by Ethos Engineering, LLC for the above referenced site as requested by Wood and ADOT is attached.

We are committed to providing quality engineering services combined with client satisfaction in order to achieve a continuing relationship with our clients. We appreciate the opportunity to provide these services for you.

If you have any questions regarding this Geotechnical Technical Memorandum, please do not hesitate to contact us.

Respectfully Submitted,

Wood Environment & Infrastructure Solutions, Inc.

Mark Hartig, PE
Arizona Operations Manager

Attachments: Geotechnical Technical Memorandum

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GEOTECHNICAL TECHNICAL MEMORANDUM
ALLENTOWN TI UP BRIDGE REPLACEMENT
MP 351.35 ALONG INTERSTATE 40
ADOT PROJECT NO. 040 AP 351 F0319 01D
WOOD PROJECT NO. 17-2021-4058
PHOENIX, ARIZONA

Prepared for:

Mr. Mark Hartig, PE
Wood Environment & Infrastructure Solutions, Inc.
4600 East Washington Street, Suite 600
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Prepared by:

Ethos Engineering, LLC
9180 South Kyrene Road, Suite 104
Phoenix, Arizona 85284

Ethos Project No. 2022026
May 9, 2022

May 9, 2022
Ethos Project No.: 2022026

Mr. Mark Hartig, PE
Wood Environment & Infrastructure Solutions, Inc.
4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

SUBJECT: Geotechnical Technical Memorandum
Allentown TI UP Bridge Replacement
MP 351.35 along Interstate 40
ADOT Project No. 040AP 351 F0319 01D
Wood Project No. 17-2021-4058
Apache County, Arizona

Dear Mr. Hartig:

Ethos Engineering, LLC is pleased to present the information from the geotechnical exploration for the proposed Allentown TI UP Bridge Replacement located at milepost 351.35 along Interstate 40 (I-40) in Apache County, Arizona. This report provides the results of the geotechnical field investigation, laboratory testing and drilled shaft axial resistance design charts. All other geotechnical engineering analysis and report preparation will be performed by the Arizona Department of Transportation (ADOT).

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

Sincerely,

Ethos Engineering, LLC

Daniel N. Fréchette, PhD, P.E.
Senior Geotechnical Engineer

Reviewed By:

Jesse R. Huston, P.E.
Senior Geotechnical Engineer

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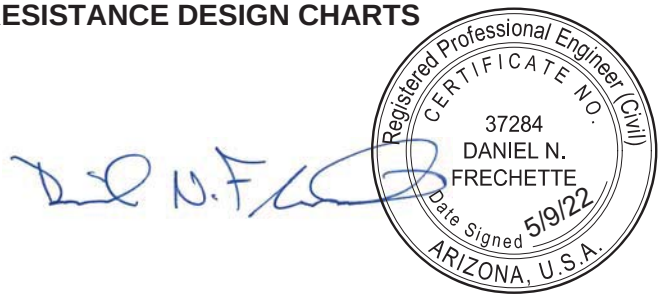
TABLE OF CONTENTS

FIGURES

APPENDICES



1.0 PROJECT DESCRIPTION

Project 040 AP 351 F0319 01C; Federal Aid No. NHPP-040-E(225)T, Allentown TI UP is a Bridge Replacement Project. The project is located on the Allentown Road crossing over I-40 at MP 351.35 in Apache County, within the Navajo Nation in Allentown. The project limits extend from MP 351.0 to 352.0.

Based on information contained in the project assessment (PA), the purpose of the project is to replace the deteriorated bridge. The typical section of the existing bridge consists of two 12-foot-wide lanes with a paved 3-foot-wide shoulder on each side. I-40 within the project limits has two lanes in each direction with an unpaved 84-foot wide median from inside edge of pavement I-40 eastbound (EB), to inside edge of pavement I-40 westbound (WB).

The existing Allentown TI UP, Structure No. 956, was originally constructed in 1967 under project number I-40-5(27)343. The bridge is a four-span continuous steel rolled girder bridge, approximately 250 feet long with zero skew. The bridge top slab is 7 inches thick with 1.5 inches clear cover to the main reinforcement. Both the top slab thickness and clear cover of the existing bridge do not meet the current ADOT Bridge Design Guidelines.

The typical section of the existing Allentown TI UP consists of a 30-foot-wide clear roadway between concrete barriers. The superstructure consists of 4 steel W36x160 rolled girders. The abutments are supported by steel pile foundations and the piers are supported on spread footings.

Ethos understands the existing bridge will be replaced with a new bridge structure that will include a two-lane bridge, one lane in each travel direction. Ethos understands the new bridge will be supported on drilled shaft foundations, and the overall footprint of the new bridge will be widened to both sides of the current bridge locations.

2.0 FIELD EXPLORATION

The Field Exploration was completed by Wood Environment & Infrastructure Solutions, Inc. (Wood). The field investigation consisted of three (3) borings to depths and at locations specified by ADOT. Drilling of the exploratory borings was performed by Geomechanics Southwest, Inc. (GSI) the week of January 24, 2022. The field work was supervised by a field engineer/geologist provided by Wood.

A summary of the field exploration program is provided in Table 2.1. The test boring locations are shown on Figure 1.

Table 2.1 – Field Exploration Program Allentown TI UP Borings

Location ID	Project Element	Allentown Cst CL Station	Drill Method	Depth (feet)
S-01	Abutment 1	4+24, 8'L	Auger/Coring	70[1]
S-02	Pier	5+54, 20'L	Auger	80
S-03	Abutment 2	6+93, 8'L	Auger	80

Note: [1]Boring depth was stopped at 70 feet after coring 20 feet into rock.

The borings were drilled with truck-mounted CME 85 drill-rig advancing 8-inch outside diameter (OD) hollow-stem auger or a 3.5-inch HQ coring system. During the field exploration, the soils and rock encountered were visually classified, logged, and sampled by Wood's field engineer/geologist.

Relatively undisturbed samples of the subsurface soils were obtained using a ring sampler with a 2.42-inch inside diameter (ID) and 3-inch OD. Disturbed samples of soils were obtained using a standard penetration test (SPT) split spoon sampler with a 1.375-inch ID and 2-inch OD. Bulk samples of drill cuttings were also collected at selected near-surface depths from the borings. The SPT and ring samplers were driven 18 and 12 inches, respectively, or to refusal (i.e. 50 blows for less than a 6-inch interval), using an automatic hydraulic actuated 140-pound hammer free falling 30 inches. Unless noted otherwise on the boring logs, the sample driving resistance was recorded as number of blows per six inches of penetration. The penetration results are presented on the borings logs adjacent to each sample.

The recovered soil and rock core samples were removed from the sampler, sealed to reduce moisture loss, and submitted to the Wood and ACS Services, LLC (ACS) laboratories. All borings were backfilled in accordance with permit requirements. The upper 6 inches of Borings S-01 and S-03 were capped with quick-set concrete to repair the roadway surface. The logs of the exploratory borings are presented in Appendix A.

3.0 LABORATORY TESTING

Selected laboratory tests were assigned by Wood and reviewed by ADOT prior to testing. Lab testing was performed on representative samples recovered from the borings to support the field classification and to provide information regarding engineering characteristics and properties of the subsurface soils and rock. The laboratory testing program is listed in Table 3.1. The results of the laboratory tests are presented in Appendix B.

Table 3.1 – Laboratory Testing Program

Laboratory Test	Sample Type	Number of Tests	Purpose of Test
Sieve Analysis (ASTM C136)	Bulk/SPT	9	Soil Classification
Atterberg Limits (ASTM D4318)	Bulk/SPT	9	Soil Classification
Moisture (ASTM D2216)	Bulk/SPT	12	Moisture Conditions
Moisture/Density (ASTM D2937)	Ring	9	In-Situ Density and Moisture Conditions
Consolidation Test (ASTM D2435)	Ring	1	Soil Settlement Characteristics
Direct Shear (ASTM D3080)	Ring	3	Soil Strength Characteristics
Sulfates & Chloride (AZ 733/736)	SPT/Bulk	3	Concrete/Soil Degradation Potential
Unconfined Compressive Strength of Rock (ASTM D7012)	Core	2	Compressive Strength of Rock
Unconfined Compressive Strength of Rock (ASTM D7012)	Core	2	Density of Rock

4.0 ENGINEERING ANALYSES AND RECOMMENDATIONS

4.1 DRILLED SHAFT FOUNDATIONS

The recommended design criteria presented herein are applicable to the bridge foundations and are based on the AASHTO LRFD procedures presented in AASHTO LRFD Bridge Design Specifications (AASHTO 2012). The axial compression resistances of the drilled-shaft foundations were determined using ADOT's Development of Drilled Shaft Axial Resistance Charts for Use by Bridge Engineers Based on LRFD Methodology DS-1 memorandum (ADOT 2010a). The ADOT memorandum outlines the development of drilled shaft axial resistance charts based on methods specified in AASHTO LRFD Bridge Design Specifications (AASHTO 2010). The 6th Edition of the AASHTO LRFD Bridge Design Specifications (AASHTO 2012) was used for this foundation design in accordance with current ADOT policy.

The recommended design criteria presented herein are applicable to drilled, cast-in-place concrete shaft foundations and are based on AASHTO LRFD procedures (AASHTO 2012). The drilled shaft foundations for the project were designed using the methods outlined for very moist or wet cohesive soils (i.e., the alpha method) and cohesionless or drained-cohesive soils (i.e., the beta method), based on the subsurface profile at each bridge element. For the beta method analysis, refusal blow counts were limited to 50 (AASHTO 2012).

A summary of the drilled shaft design charts is presented in Table 4.1. The drilled shaft design charts are presented in Appendix C by foundation element. Development of strength and service limit charts is further discussed in the following sections.

Table 4.1 – Summary of Drilled Shaft Design Charts

Structure	Axial Resistance Design Charts	
	Strength Limit State	Service Limit State
Abutment 1	1	2A through 2D
Pier 1 and 2	3	4A through 4D
Abutment 2	5	6A through 6D

4.2 DRILLED SHAFT AXIAL RESISTANCE

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

The following sections provide design recommendations for strength and service limit states for drilled shaft foundations at the Allentown Bridge TI UP. A minimum drilled-shaft diameter of 4 feet is recommended to facilitate construction of the shafts.

4.2.1 Strength Limit State

Resistance factors used in the determination of the vertical resistance for drilled shafts are a function of the design methodology. The drilled shaft capacities were calculated using a combination of the beta method and alpha method for side resistance and tip resistance. Specifically, the beta method was utilized for the granular soils and the Abutment 1 soils, as they were only slightly moist. The fine-grained very moist to wet soil layers encountered at the Pier and Abutment 2 utilized the alpha method.

Procedures from AASHTO (2012) were also used to calculate tip resistance as presented in Article 10.8.3.5.2. The corresponding resistance factors for geotechnical resistance of drilled shafts are 0.55 and 0.5 for beta method side resistance and end bearing, respectively, and 0.45 and 0.4 for alpha method side resistance and end bearing, respectively, as presented in Table 10.5.5.2.4-1 of AASHTO (2012). These resistance factors assume redundant foundations as defined in Section 10.5.5.2.4 of AASHTO (2012) and Section 10.5.5.2.4 of the ADOT *Bridge Practice Guidelines* (2011).

4.2.2 Service Limit State

The vertical resistance provided by the soil is a function of the relative movement between the drilled shaft and the surrounding soil. Article 10.8.2.2.2 of AASHTO (2012) and ADOT (2010) provide relationships for the development of skin friction and end bearing as a function of settlement normalized to the drilled shaft diameter for various soil types. The vertical resistances for the drilled shafts at several vertical displacement (i.e., settlement) values were calculated using these relationships. It is important to note that the estimated settlement values used to develop the service limit charts considered immediate settlement only. The long-term settlement due to consolidation needs to also be assessed. A consolidation test was performed on a relatively undisturbed sample obtained from near the planned drilled shaft tip elevation at the Pier to characterize the long-term settlement behavior of the saturated clayey soils. Using the applied bearing pressure at the base of the shaft when subjected to the service limit state loads, an estimated strain due to consolidation was determined. The strain was applied over a vertical distance below the shaft tip equal to two times the diameter of the drilled shaft. The results were an additional consolidation (i.e., long-term) settlement of 1.0 to 1.4 inches at the Pier and Abutment 2, respectively. Table 4.2 summarizes the locations evaluated for long-term settlement and includes the total settlement.

Table 4.2 – Summary of Consolidation and Total Settlement in Cohesive Soils

Structure Element	Assumed Diameter (B)	Assumed Service Load (kips)	Assumed Embedment Elevation (feet)	Consolidation Settlement (inches)	Immediate Settlement (inches)	Total Settlement (inches)
Pier	7	990	6051	1.0	0.1	1.1
Abutment 2	6	639	6058	1.4	0.1	1.5

4.2.3 Group Effects - Axial

Design criteria for reductions in axial resistance resulting from group effects are presented in Sections 10.7.3.9 and 10.8.3.6 of the AASHTO (2012) manual. The design charts presented in

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

For cohesionless materials the individual nominal resistance of each shaft in a group should be reduced by a factor, η, presented in Table 10.8.3.6.3-1 of AASHTO (2012) and reproduced in Table 4.3. Based on available design information, drilled shafts at Abutment 1 will be embedded in cohesionless or drained-cohesive materials and should be evaluated for group effects using Table 4.3.

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

Table 4.3 – Group Reduction Factors for Bearing Resistance in Cohesionless Materials

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

For cohesive materials, the nominal bearing resistance shall be taken as the sum of individual nominal resistances of each pile in the group, or the nominal resistance of an equivalent pier consisting of the piles and block of soil within the area bounded by the piles, whichever is less. An efficiency factor, η, should be multiplied by the individual nominal resistance of each pile if the cap is not in firm contact with the ground and is summarized in Table 4.4. If the soil is stiff or if the cap is in firm contact with the ground, then an efficiency factor reduction should not be applied. Since this site is anticipated to have limited to no fill placed at the project site, if the cap is placed on or within the native soils, it should be designed as if the cap is in contact with the ground. Otherwise, the cap should be designed as if it is not in contact with the ground. Based on available design information, drilled shafts at the Pier and Abutment 2 will be embedded in cohesive material and should be evaluated for group effects using Table 4.4.

Table 4.4 – Group Reduction Factors for Bearing Resistance in Cohesive Materials

η	Drilled Shaft Center-to-Center Spacing
0.65	2.5 diameters
1.0	6.0 diameters

Note:
Linear interpolation is required for intermediate spacings.
Efficiency factors for caps not in firm contact with the ground.

5.0 CLOSURE

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

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

6.0 REFERENCES

American Association of State Highway and Transportation Officials (AASHTO), 2012. *AASHTO LRFD Bridge Design Specifications*. 6th Edition. Washington, DC: American Association of State Highway and Transportation Officials.

American Association of State Highway and Transportation Officials (AASHTO). 2010. *AASHTO LRFD Bridge Design Specifications.* 5th Edition. Washington, DC: American Association of State Highway and Transportation Officials.

Arizona Department of Transportation (ADOT). 2011. *Bridge Practice Guidelines, Section 10: Foundations*, July 28, 2011.

Arizona Department of Transportation (ADOT). 2010. *Development of Drilled Shaft Axial Resistance Charts for Use by Bridge Engineers Based on Load and Resistance Factor Design (LRFD) Methodology DS-1*. Phoenix, Arizona: ADOT. December 1.

FIGURES

Job No.	17-2021-4058
PM:	DNF
Date:	11/9/2021
Scale:	1" = 200 feet

N

Allentown TI UP Bridge Rehabilitation
Allentown, AZ

Site Plan

FIGURE
1

wood.

Path: X:\Projects\2021 Projects\17-2021-4058 Allentown TI UP Bridge Rehab\MXD\Allentown_Figures\Allentown_Figures.aprx

APPENDIX A

Boring Logs

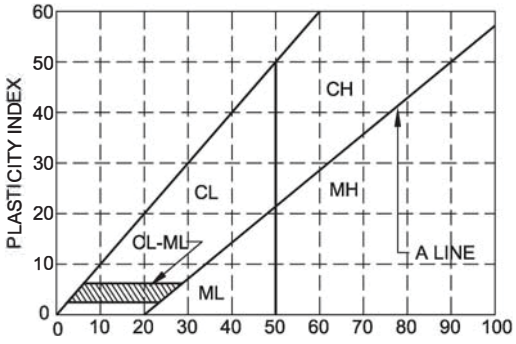
UNIFIED CLASSIFICATION SYSTEM FOR SOILS

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

wood.

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)

EXPLANATION OF CORE LOG PRESENTATION AND TERMINOLOGY FOR THE DESCRIPTION OF ROCK

I. ROCK QUALITY DESIGNATION (RQD). Percentage of rock core per core run which is relatively sound and unfractured and which is longer than 0.33 feet in length. Rock which is soft or weathered, closely jointed, or rock from which the core recovery is low, will have poor to fair RQD.

II. DISCONTINUITIES

A. Spacing of Joints

Code	Spacing of Joints	Descriptive Term
1	Greater than 10 ft.	Very wide
2	3 ft. - 10 ft.	Wide
3	1 ft. - 3 ft.	Moderately close
4	0.2 ft. - 1 ft.	Close
5	Less than 0.2 ft.	Very close

B. Orientation of Joints

Measurements presented represent dip angles from horizontal.

Symbol	Description
Rdm	Random - preferred orientation cannot be determined.

C. Condition of Joints

1. Roughness

Symbol	Descriptive Term	Properties
Smth	Smooth	Appears smooth and is essentially smooth to the touch. May be slickensided.
Srgh	Slightly rough	Asperities on the fracture surfaces are visible and can be distinctly felt.
Mrgh	Medium rough	Asperities are clearly visible and fracture surface feels abrasive.
Rgh	Rough	Large angular asperities can be seen. Some ridge and high side angle steps evident.
VRgh	Very rough	Near-vertical steps and ridges occur on the fracture surface.

2. Presence or Absence of Fracture Filling Material

Symbol	Descriptive Term	Definition
Cln	Clean	No fracture filling material.
Stn	Stained	Coloration of rock only. No recognizable filling material.
Fld	Filled	Fracture filled with recognizable filling material.

III. BEDDING

Symbol	Descriptive Term	Definition
TL	Thinly laminated	Less than 0.01 ft.
L	Laminated	0.01 ft. to 0.04 ft.
ThB	Thinly bedded	0.04 ft. to 0.20 ft.
MB	Medium bedded	0.20 ft. to 2.00 ft.
TkB	Thickly bedded	More than 2.00 ft.

IV. DEGREE OF WEATHERING

Symbol	Descriptive Term	Properties
Dec	Decomposed	, generally soil-like, can be crumbled by hand pressure.
HiW	Highly weathered	, generally rock-like, can be broken easily, but crumbles with difficulty by hand.
MdW	Moderately weathered	, fabric stained rusty brown, can be indented by steel nail, breaks only with difficulty.
SlW	Slightly weathered	, open discontinuities are weathered, coated, but only slight weathering of rock mass, generally not indented by steel nail.
UnW Ex Jts	Unweathered except joints	, weathering limited to the surface of discontinuities; fabric is fresh throughout but most joints show rusty stain and/or soil filling material.
UnW Inc Jts	Unweathered including joints	, rock mass and discontinuities are unweathered; only occasional joints show rusty stain, practically no soil filling.

UnW Unweathered, rock mass unweathered; no staining or infilling.

V. HARDNESS

Descriptive Term	Properties
Very hard	Cannot be scratched with knife or sharp pick. Breaking of hand specimens requires several hard blows of geologist's pick.
Hard	Can be scratched with knife or pick only with difficulty. Hard blow of hammer required to detach hand specimen.
Moderately hard	Can be scratched with knife or pick. Gouges or grooves to 3 inch deep can be excavated by hard blow of point of a geologist's pick. Hand specimens can be detached by moderate blow.
Moderately soft	Can be grooved or gouged 1/16 inch deep by firm pressure on knife or pick point. Can be excavated in small chips to pieces about 1 inch maximum size by hard blows of the point of a geologist's pick.
Soft	Can be gouged or grooved readily with knife or pick point. Can be excavated in chips to pieces several inches in size by moderate blows of a pick point. Small thin pieces can be broken by finger pressure.
Very soft	Can be carved with knife. Can be excavated readily with point of pick. Pieces 1 inch or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail.

VI. MISCELLANEOUS ABBREVIATIONS

Symbol	Description	Symbol	Description
Bkn	Broken	Incl	Inclusions
Brc	Brecciated	Mgd	Medium-Grained
Band	Banded	Mod	Moderately
Qtz	Quartz	Wkly	Weakly
Calc	Calcite	Slicks	Slickensides
Cem	Cemented	Strong	Strongly
Frct	Fractured	SZ	Shear Zone
Fgd	Fine-Grained	Gog	Gouge

wood.

Environment & Infrastructure Solutions, Inc.
4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

BORING LOG I.D.: S-01

PROJECT:	Allentown TI UP Bridge Rehabilitation	**PROJECT LOCATION:**	I-40 MP 351.35
LOGGED BY:	Neundorff, J.	**PROJECT FEATURE:**	Bridge
DRILLER:	Fiesler, C.	**WOOD PROJECT #:**	17-2021-4058
DRILLER FIRM:	GSI	**STATION/OFFSET:**	4+24.08'L
RIG I.D.:	118	**REFERENCE:**	Allentown Road Construction Line
RIG TYPE:	CME-85	**COORDINATES:**	35.28884°N 109.15804°W
BORING TYPE:	HSA **BORING DIA.:** 8"	**COORDINATE SYS:**	Latitude, Longitude
ORIENTATION:	Vertical	**SURFACE ELEV. (FT):**	6134
HAMMER TYPE:	140-lb Automatic	**VERTICAL DATUM:**	NAVD 88
HAMMER CALIBRATION-ENERGY TRANSFER RATIO:	0.95	**COMPLETION DATE:**	01-27-2022 **COMPLETION TIME:** 1806
START DATE:	01-26-2022 **START TIME:** 0909		

Elevation in Feet	Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
6134.0	0										**ASPHALTIC CONCRETE**, 7 inches thick
									GW		**AGGREGATE BASE COURSE**, 4 inches thick
					A				SP-SM	slightly moist medium dense	**FILL - SAND WITH SILT**, rare fine subrounded gravel, predominantly fine to medium subrounded sand, nonplastic, brown
					S	10-10-9					
					U	2-3	100.4	4.6	SM	moist very soft	**FILL - SILTY SAND**, rare fine subrounded gravel, predominantly fine to medium subrounded sand, nonplastic, light brown
6129.0	5				S	1-0-0		10.2	SC	slightly moist very soft	**FILL - CLAYEY SAND**, predominantly fine sand, low plasticity, reddish-brown
									SM	slightly moist loose	**NATIVE - SILTY SAND**, predominantly fine to medium subrounded sand, nonplastic, light brown
6124.0	10				U	6-6	95.8	6.4			
									SP-SM	slightly moist moderately firm	**SAND WITH SILT**, predominantly fine to medium subrounded sand, nonplastic, light brown with red flakes
6119.0	15				S	3-3-6		4.7			
									SM	slightly moist moderately firm	**SILTY SAND**, predominantly fine sand, nonplastic, brown to orangish-brown
6114.0	20				S	4-6-8		7.6			

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽	None		
▼			
▼			
▼			

METHOD Visual

SAMPLE TYPE
A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - Thin Walled Shelby tube sample
NR - No Recovery

(Continued Next Page)

wood.
Environment & Infrastructure Solutions, Inc.
4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

BORING LOG I.D.: S-01

PROJECT:	Allentown TI UP Bridge Rehabilitation	**PROJECT LOCATION:**	I-40 MP 351.35
PROJECT #:	17-2021-4058	**PROJECT FEATURE:**	Bridge

Elevation in Feet	Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
6114.0	20								SM	slightly moist moderately firm	**SILTY SAND**, continued
					U	6-10	100.9	17.7			
6109.0	25								SM	moist moderately firm	**SILTY SAND**, predominantly fine sand, nonplastic, light brown
									CL	moist	**SANDY CLAY**, predominantly fine sand, medium plasticity, dark brown
6104.0	30				S	3-5-8			SM	moist moderately firm	**SILTY SAND**, predominantly fine sand, nonplastic, light brown
									CL	moist firm	**SANDY CLAY**, predominantly fine sand, medium plasticity, dark brown
6099.0	35				S	3-9-7					
									SM	slightly moist to moist firm	**SILTY SAND**, rare fine subrounded gravel, predominantly fine sand, nonplastic, light brown
6094.0	40				U	8-29	106.1	8.6			
									SC	moist hard	**CLAYEY SAND**, rare fine subrounded gravel, predominantly fine to medium subrounded sand, low to medium plasticity, dark brown
6089.0	45				S	13-50/5"		9.2			

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽	None		
▼			
▼			
▼			

METHOD Visual

SAMPLE TYPE
A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - Thin Walled Shelby tube sample
NR - No Recovery

(Continued Next Page)

wood.

Environment & Infrastructure Solutions, Inc.
4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

BORING LOG I.D.: S-01

PROJECT:	Allentown TI UP Bridge Rehabilitation	**PROJECT LOCATION:**	I-40 MP 351.35
PROJECT #:	17-2021-4058	**PROJECT FEATURE:**	Bridge

Elevation in Feet	Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
6089.0	45								SC	moist hard	**CLAYEY SAND WITH GRAVEL**, considerable predominantly fine subrounded gravel, predominantly fine to medium subrounded sand, low to medium plasticity, dark brown
6084.0	50				S	50/2"					note: auger refusal called and swapping to coring at 49.7'
6079.0	55										
6074.0	60										
6069.0	65										
6064.0	70										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽	None		
▼			
▼			
▼			

METHOD Visual

SAMPLE TYPE
A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - Thin Walled Shelby tube sample
NR - No Recovery

wood.

Environment & Infrastructure Solutions, Inc.
4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

BORING LOG I.D.: S-01

PROJECT:	Allentown TI UP Bridge Rehabilitation			**PROJECT LOCATION:**	I-40 MP 351.35
LOGGED BY:	Neundorff, J.			**PROJECT FEATURE:**	Bridge
DRILLER:	Fiesler, C.			**WOOD PROJECT #:**	17-2021-4058
DRILLER FIRM:	GSI			**CONTRACT #:**	
RIG I.D.:	118			**STATION/OFFSET:**	4+24.08'L
RIG TYPE:	CME-85			**REFERENCE:**	Allentown Road Construction Line
BORING TYPE:	HQ Coring	**BORING DIA.:**	3.5	**COORDINATES:**	35.28884N, 109.15804W
ORIENTATION:	Vertical			**COORDINATE SYS:**	Latitude, Longitude
HAMMER TYPE:	140-lb Automatic			**SURFACE ELEV. (FT):**	6134'
HAMMER CALIBRATION-ENERGY TRANSFER RATIO:	0.95			**VERTICAL DATUM:**	NAVD 88
START DATE:	01-26-2022	**START TIME:**	0909	**COMPLETION DATE:**	01-27-2022 **COMPLETION TIME:** 1806

Elevation in Feet	Depth in Feet	Core Run From:	Core Run To:	Sample	Sample Type	Unconfined Compression Test (ksi)	% Core Recovery	% Drilling Fluid Rec.	Rock Quality Designation (RQD)	DISCONTINUITIES Spacing (1 - 5)	DISCONTINUITIES Orientation Horiz - Vert (H 45 V)	Length of Core Recovery (ft.)	Whole Core Length (ft.)	Number of Whole Pieces (#)	Length of Longest Pieces (ft.)	Length of +1 ft. (+0.3m) (ft.)	Length of 4-inch (100mm) (ft.)	Length of Broken Core (ft.)	Length of Rubble Zone (ft.)	Average Hardness (grading) (S1-R6)	Length w/ Hardness <= R2 (ft.)	RMR Hardness Rating (ft.)	Number of Joint Sets (#)	Groundwater Rating (0-15)	Rock Type & Remarks
		49	51		HQ		100	70	20	5		2	2	1	.4	0	.4	1.2	.8	R0	0	16	8	-	**MOENKOPI FORMATION - SILTSTONE**, very fine grained, reddish-brown to brown, crossbeds
6084.0	50																								
		51	56		HQ		100	70	40			5.2	5	4	.6	0	2.1	3.2	0	R1	0	16	12		note: SPT for 26-46-50/5" at 51', mud from drilling not collected between 51-51.8'
										4															
6079.0	55																								
		56	61		HQ		90	70	51	5		4.5	5	3	.7	0	2.3	2.1	.3	R1	0	16	12		note: SPT for 50/5" at 56'
6074.0	60																								
		61	66		HQ		100	70	69			5.5	5	6	.9	0	3.8	1.6	0	R1	0	16	15		
										4															
										5															
6069.0	65																								
		66	71		HQ		100	70	64			5.1	5	6	.8	0	3.3	1.9	0	R1	1.8	16	16		
										4															
										5															**PALEOZOIC SEDIMENTARY ROCKS - LIMESTONE AND SILTSTONE**,

(Continued Next Page)

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽	None		
▼			
▼			
▼			

METHOD Visual

NOTES:

[Sum of Broken Zones] = [Length of Recovered Core] - [Sum of Whole Pieces] - [Sum of Rubble] - [Sum of Length with Hardness <R2].
HSA - Hollow Stem Auger, S - 2" O.D./1.38" I.D. Tube Sample, A - Drill Cuttings.
NR - No Recovery

* Recovery recorded greater than core length

wood.

Environment & Infrastructure Solutions, Inc.
4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

BORING LOG I.D.: S-01

PROJECT:	Allentown TI UP Bridge Rehabilitation	**PROJECT LOCATION:**	I-40 MP 351.35
PROJECT #:	17-2021-4058	**PROJECT FEATURE:**	Bridge

Elevation in Feet	Depth in Feet	Core Run From:	Core Run To:	Sample	Sample Type	Unconfined Compression Test (ksi)	% Core Recovery	% Drilling Fluid Rec.	Rock Quality Designation (RQD)	DISCONTINUITIES Spacing (1 - 5)	DISCONTINUITIES Orientation Horiz - Vert (H 45 V)	Length of Core Recovery (ft.)	Whole Core Length (ft.)	Number of Whole Pieces (#)	Length of Longest Pieces (ft.)	Length of +1 ft. (+0.3m) (ft.)	Length of 4-inch (100mm) (ft.)	Length of Broken Core (ft.)	Length of Rubble Zone (ft.)	Average Hardness (grading) (S1-R6)	Length w/ Hardness <= R2 (ft.)	RMR Hardness Rating (ft.)	Number of Joint Sets (#)	Groundwater Rating (0-15)	Rock Type & Remarks
6064.0	70																								alternating thin beds of **LIMESTONE** and **SILTSTONE** - **LIMESTONE**, is nonclastic, fine to medium grained, no clasts visible, grayish white, **SILTSTONE** very fine grained, reddish-brown to brown, crossbeds
																									Stopped coring at 71 feet Backfilled with cuttings to 20 feet, then with grout to .5 feet, then concrete to the surface.
	75																								
	80																								
	85																								
	90																								

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽	None		
▼			
▼			
▼			

METHOD Visual

NOTES:

[Sum of Broken Zones] = [Length of Recovered Core] - [Sum of Whole Pieces] - [Sum of Rubble] - [Sum of Length with Hardness <R2].
HSA - Hollow Stem Auger, S - 2" O.D./1.38" I.D. Tube Sample, A - Drill Cuttings.
NR - No Recovery

* Recovery recorded greater than core length

wood.

Environment & Infrastructure Solutions, Inc.
4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

BORING LOG I.D.: S-02

PROJECT:	Allentown TI UP Bridge Rehabilitation			**PROJECT LOCATION:**	I-40 MP 351.35
LOGGED BY:	Neundorff, J.			**PROJECT FEATURE:**	Bridge
DRILLER:	Fiesler, C.			**WOOD PROJECT #:**	17-2021-4058
DRILLER FIRM:	GSI			**STATION/OFFSET:**	5+54.20'L
RIG I.D.:	118			**REFERENCE:**	Allentown Road Construction Line
RIG TYPE:	CME-85			**COORDINATES:**	35.28849°N 109.15779°W
BORING TYPE:	HSA	**BORING DIA.:**	8"	**COORDINATE SYS:**	Latitude, Longitude
ORIENTATION:	Vertical			**SURFACE ELEV. (FT):**	6113
HAMMER TYPE:	140-lb Automatic			**VERTICAL DATUM:**	NAVD 88
HAMMER CALIBRATION-ENERGY TRANSFER RATIO:			0.95	**COMPLETION DATE:**	01-24-22 **COMPLETION TIME:** 1635
START DATE:	01-24-2022	**START TIME:**	1010		

Elevation in Feet	Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
6113.0	0				A				SM	moist moderately firm	**FILL - SILTY SAND**, rare fine subrounded gravel, predominantly fine sand, nonplastic, reddish-brown to brown
					U	7-8					
									SP-SM	moist medium dense to loose	**NATIVE - SAND WITH SILT**, predominantly fine sand, nonplastic, light brown
					S	4-7-9		2.9			
6108.0	5				S	4-5-3					
									CL	moist soft	**SANDY CLAY**, predominantly fine sand, medium plasticity, brown
									SC	moist moderately firm	**CLAYEY SAND**, predominantly fine sand, low to medium plasticity, dark brown
					S	5-8-9		5.5			
6103.0	10								SM	moist firm	**SILTY SAND**, predominantly fine sand, nonplastic, light brown
									CL	moist	**SANDY CLAY**, predominantly fine sand, medium plasticity, dark brown
					U	3-12	99.2	24.5			
6098.0	15								SP-SM	moist medium dense	**SAND WITH SILT**, predominantly fine sand, nonplastic, light brown
									CL-ML	moist moderately firm to firm	**SILTY CLAY WITH SAND**, some predominantly fine sand, low plasticity, dark brown
6093.0	20				S	3-4-5					

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽	50.0	1230	01-24-2022
▼			
▼			
▼			

METHOD Visual

SAMPLE TYPE
A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - Thin Walled Shelby tube sample
NR - No Recovery

(Continued Next Page)

wood.
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4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

BORING LOG I.D.: S-02

PROJECT:	Allentown TI UP Bridge Rehabilitation	**PROJECT LOCATION:**	I-40 MP 351.35
PROJECT #:	17-2021-4058	**PROJECT FEATURE:**	Bridge

Elevation in Feet	Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
6093.0	20								CL-ML	moist moderately firm to firm	**SILTY CLAY WITH SAND**, continued
6088.0	25				S	3-9-8		14.3			
6083.0	30				U	9-14	100.7	20.7			note: **SILTY CLAY**, trace fine sand, low plasticity, dark brown at 29'
6078.0	35				S	3-8-8					
									SC	moist firm	**CLAYEY SAND**, predominantly fine sand, low plasticity, dark brown
6073.0	40				S	8-14-12		10.1			
									SM	moist firm	**SILTY SAND**, predominantly fine sand, nonplastic, brown to light brown
									ML	moist firm	**SANDY SILT**, see next page
6068.0	45				U	8-16	102.9	22.7			

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽	50.0	1230	01-24-2022
▼			
▼			
▼			

METHOD Visual

SAMPLE TYPE
A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - Thin Walled Shelby tube sample
NR - No Recovery

(Continued Next Page)

wood.

Environment & Infrastructure Solutions, Inc.
4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

BORING LOG I.D.: S-02

PROJECT:	Allentown TI UP Bridge Rehabilitation	**PROJECT LOCATION:**	I-40 MP 351.35
PROJECT #:	17-2021-4058	**PROJECT FEATURE:**	Bridge

Elevation in Feet	Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
6068.0	45								ML	moist firm	**SANDY SILT**, predominantly fine sand, nonplastic, light brown
									SC	wet very stiff	**CLAYEY SAND**, predominantly fine sand, low plasticity, dark brown with reddish-brown
▽ 6063.0	50				S	5-8-9					
6058.0	55				S	2-4-9				stiff to medium stiff	note: dark brown below 54.5'
6053.0	60				U	3-8	102.5	20.3			
6048.0	65				S	2-5-10					
									SC	wet very stiff to hard	**CLAYEY SAND**, predominantly fine to medium subrounded sand, low to medium plasticity, dark reddish-brown with yellow, white, red, and green
6043.0	70				S	3-11-11					

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽	50.0	1230	01-24-2022
▼			
▼			
▼			

METHOD Visual

SAMPLE TYPE
A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - Thin Walled Shelby tube sample
NR - No Recovery

(Continued Next Page)

wood.

Environment & Infrastructure Solutions, Inc.
4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

BORING LOG I.D.: S-02

PROJECT:	Allentown TI UP Bridge Rehabilitation	**PROJECT LOCATION:**	I-40 MP 351.35
PROJECT #:	17-2021-4058	**PROJECT FEATURE:**	Bridge

Elevation in Feet	Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
6043.0	70								SC	wet very stiff to hard	streaks below **CLAYEY SAND**, continued
6038.0	75				U	25-41					note: occasional fine subrounded gravel, well graded subrounded sand, purplish-reddish-brown with yellow, white, red, green, and black streaks below 74.5'
6033.0	80				S	50/5"			CL	wet hard	**SANDY CLAY**, rare fine angular gravel, predominantly fine sand, moderately cemented, low plasticity, purplish-reddish-brown
											Stopped auger at 79.5 feet Sampler refused at 79.9 feet Backfilled with cuttings to 20 feet, then with grout to .5 feet, then concrete to the surface.
6028.0	85										
6023.0	90										
6018.0	95										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽	50.0	1230	01-24-2022
▼			
▼			
▼			

METHOD Visual

SAMPLE TYPE
A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - Thin Walled Shelby tube sample
NR - No Recovery

wood.
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4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

BORING LOG I.D.: S-03

PROJECT:	Allentown TI UP Bridge Rehabilitation			**PROJECT LOCATION:**	I-40 MP 351.35
LOGGED BY:	Neundorff, J.			**PROJECT FEATURE:**	Bridge
DRILLER:	Fiesler, C.			**WOOD PROJECT #:**	17-2021-4058
DRILLER FIRM:	GSI			**STATION/OFFSET:**	6+93.08'L
RIG I.D.:	118			**REFERENCE:**	Allentown Road Construction Line
RIG TYPE:	CME-85			**COORDINATES:**	35.28818°N 109.15761°W
BORING TYPE:	HSA	**BORING DIA.:**	8"	**COORDINATE SYS:**	Latitude, Longitude
ORIENTATION:	Vertical			**SURFACE ELEV. (FT):**	6137
HAMMER TYPE:	140-lb Automatic			**VERTICAL DATUM:**	NAVD 88
HAMMER CALIBRATION-ENERGY TRANSFER RATIO:			0.95	**COMPLETION DATE:**	01-25-2022 **COMPLETION TIME:** 1540
START DATE:	01-25-2022	**START TIME:**	0912		

Elevation in Feet	Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
6137.0	0										**ASPHALTIC CONCRETE**, 5.5 inches thick
									GW		**AGGREGATE BASE COURSE**, 5.5 inches thick
					A				SM	slightly moist moderately firm to firm	**FILL - SILTY SAND**, predominantly fine to medium subrounded sand, nonplastic, brown
					S	2-4-7					
					S	4-8-9					note: light brown below 2.5'
6132.0	5				U	8-17	106.3	4.2		moist	
									SM		**NATIVE - SILTY SAND**, predominantly fine to medium subrounded sand, nonplastic, brown
6127.0	10				S	2-3-3		3.7		soft to moderately firm	note: predominantly fine sand below 9.5'
6122.0	15				S	4-6-5					
									SM	moist	**NATIVE - SILTY SAND**, predominantly fine sand, nonplastic, brown to light reddish-brown
									SP	moist medium dense	**SAND**, rare fine subrounded gravel, predominantly fine to medium subrounded sand, nonplastic, light brown
6117.0	20				U	6-10	100.6	15.7			

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽	74.0	1330	01-26-2022
▼			
▼			
▼			

METHOD Visual

SAMPLE TYPE
A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - Thin Walled Shelby tube sample
NR - No Recovery

(Continued Next Page)

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4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

BORING LOG I.D.: S-03

PROJECT:	Allentown TI UP Bridge Rehabilitation	**PROJECT LOCATION:**	I-40 MP 351.35
PROJECT #:	17-2021-4058	**PROJECT FEATURE:**	Bridge

Elevation in Feet	Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
6117.0	20								CL	moist firm	**SANDY CLAY**, predominantly fine sand, medium plasticity, dark brown
									SM	moist moderately firm	**SILTY SAND**, predominantly fine sand, nonplastic, dark brown
6112.0	25				S	3-5-5		5.8			
									CL	moist soft	**CLAY**, trace fine sand, medium plasticity, greenish-gray to greenish-gray brown
6107.0	30				S	2-2-4					
											note: dark brown below 32'
6102.0	35				U	3-5	93	29.2			note: grayish dark brown with reddish-brown patches below 34.5'
6097.0	40				S	2-5-9				moderately firm	note: dark brown with reddish-brown patches below 40'
6092.0	45				S	2-5-6					

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽	74.0	1330	01-26-2022
▼			
▼			
▼			

METHOD Visual

SAMPLE TYPE
A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - Thin Walled Shelby tube sample
NR - No Recovery

(Continued Next Page)

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Phoenix, Arizona 85034

BORING LOG I.D.: S-03

PROJECT:	Allentown TI UP Bridge Rehabilitation	**PROJECT LOCATION:**	I-40 MP 351.35
PROJECT #:	17-2021-4058	**PROJECT FEATURE:**	Bridge

Elevation in Feet	Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
6092.0	45								CL-ML	moist moderately firm	**SILTY CLAY WITH SAND**, some predominantly fine to medium subrounded sand, low plasticity, brown to light reddish-brown
6087.0	50				U	3-11	97.3	26.5			note: predominantly fine sand, brown to reddish-brown below 49.5'
6082.0	55				S	3-9-11				firm	note: predominantly fine to medium subrounded sand, dark brown below 54.5'
									CL	moist firm	**SANDY CLAY**, predominantly fine sand, low plasticity, dark brown with reddish brown patches
6077.0	60				S	2-6-10		20.4			
6072.0	65				S	5-8-8					
									SC	moist moderately firm	**CLAYEY SAND**, see next page
6067.0	70				U	5-12					

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽	74.0	1330	01-26-2022
▼			
▼			
▼			

METHOD Visual

SAMPLE TYPE
A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - Thin Walled Shelby tube sample
NR - No Recovery

(Continued Next Page)

wood.
Environment & Infrastructure Solutions, Inc.
4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

BORING LOG I.D.: S-03

PROJECT:	Allentown TI UP Bridge Rehabilitation	**PROJECT LOCATION:**	I-40 MP 351.35
PROJECT #:	17-2021-4058	**PROJECT FEATURE:**	Bridge

Elevation in Feet	Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
6067.0	70								SC	moist moderately firm	**CLAYEY SAND**, predominantly fine sand, low plasticity, dark brown
					S	5-8-9					
6062.0	75								CL	wet very stiff	**SANDY CLAY**, predominantly fine sand, low plasticity, dark brown
					U	8-22					
6057.0	80										Stopped auger at 79.5 feet Stopped Sampler at 80.5 feet Backfilled with cuttings to 20 feet, then with grout to .5 feet, then concrete to the surface.
6052.0	85										
6047.0	90										
6042.0	95										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽	74.0	1330	01-26-2022
▼			
▼			
▼			

METHOD Visual

SAMPLE TYPE
A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - Thin Walled Shelby tube sample
NR - No Recovery

APPENDIX B

Laboratory Test Results

Table B-1: Summary of Laboratory Test Results

Boring Number	Depth (ft)		USCS/Group Symbol (ASTM D2487)	Percent Fines (minus 200) (ASTM C117/C136)	Liquid Limit (ASTM D4318 / AASHTO T-89)	Plasticity Index (ASTM D4318 / AASHTO T-90)	Moisture Content (%) (ASTM D2216 / AASHTO T-255)	In-Place Dry Density (pcf)[1] (ASTM D2937)	Sulfates (ppm)[4] (AZ 733b)	Chloriess (ppm)[4] (AZ 736b)	Consolidation Test Performed (ASTM D2435)	Direct Shear Test Performed (ASTM D3080)	Bulk Density of Rock Cores, Water Disp. Method (pcf)	Unconfined Comp. Strength of Intact Rock Core (ASTM D7012) Method C (pcf)
	Begin	End												
S-01	2.5	3.5					4.6	100.4						
S-01	4.5	6.0					10.2							
S-01	9.5	10.5	SM	19	NV	NP						X		
S-01	14.5	16.0					4.7							
S-01	19.5	21.0	SM	44.4	NV	NP	7.6							
S-01	24.5	25.5					17.7	100.9						
S-01	34.5	36.0							3	14				
S-01	39.5	40.5					8.6	106.1						
S-01	44.5	45.4	SC	23.8	30	12	9.2							
S-01	61.0	61.8											159.8	4,357
S-01	67.0	67.8											161	5,387
S-02	2.5	4.0	SP-SM	9.5	NV	NP	2.9							
S-02	9.5	11.0					5.5							
S-02	14.5	15.5					24.5	99.2						
S-02	19.5	21.0							6	60				
S-02	24.5	26.0					14.3							
S-02	29.5	30.5	CL-ML	89	27	7						X		
S-02	39.5	41.0					10.1							
S-02	44.5	45.5					22.7	102.9						
S-02	59.5	60.5	SC	26	27	11	20.3	102.5			X			
S-03	4.5	5.5					4.2	106.3						
S-03	9.5	11.0	SM	15.6	NV	NP	3.7							
S-03	14.5	16.0							10	44				
S-03	19.5	20.5					15.7	100.6						
S-03	24.5	26.0					5.8							
S-03	34.5	35.5	CL	91	44	25						X		
S-03	49.5	50.5	CL-ML	78.7	25	6	26.5							
S-03	49.5	50.5					26.5	97.3						
S-03	59.5	61.0					20.4							

PROJECT: Allentown TI UP Bridge Rehabilitation
LOCATION: Houck, AZ
MATERIAL: See Boring Logs

JOB NO: 17-2021-4058.05
WORK ORDER NO: 1
DATE ASSIGNED: 2/9/22

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

PERCENT PASSING BY WEIGHT

				Silt or	SAND								GRAVEL									COBBLES	
				Clay	Fine			Medium			Coarse		Fine				Coarse						
Location & Depth	USCS	LL	PI	#200	#100	#50	#40	#30	#16	#10	#8	#4	1/4"	3/8"	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"	3"	6"	Lab #
S-01 (9.5-10.5')	SM	NV	NP	19	43	91	99	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	22-1127-05
S-02 (29.5-30.5')	CL-ML	27	7	89	97	98	99	99	99	99	99	100	100	100	100	100	100	100	100	100	100	100	22-1127-27
S-02 (59.5-60.5')	SC	27	11	26	46	91	98	99	100	100	100	100	100	100	100	100	100	100	100	100	100	100	22-1127-33
S-03 (34.5-35.5')	CL	44	25	91	99	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	22-1127-47

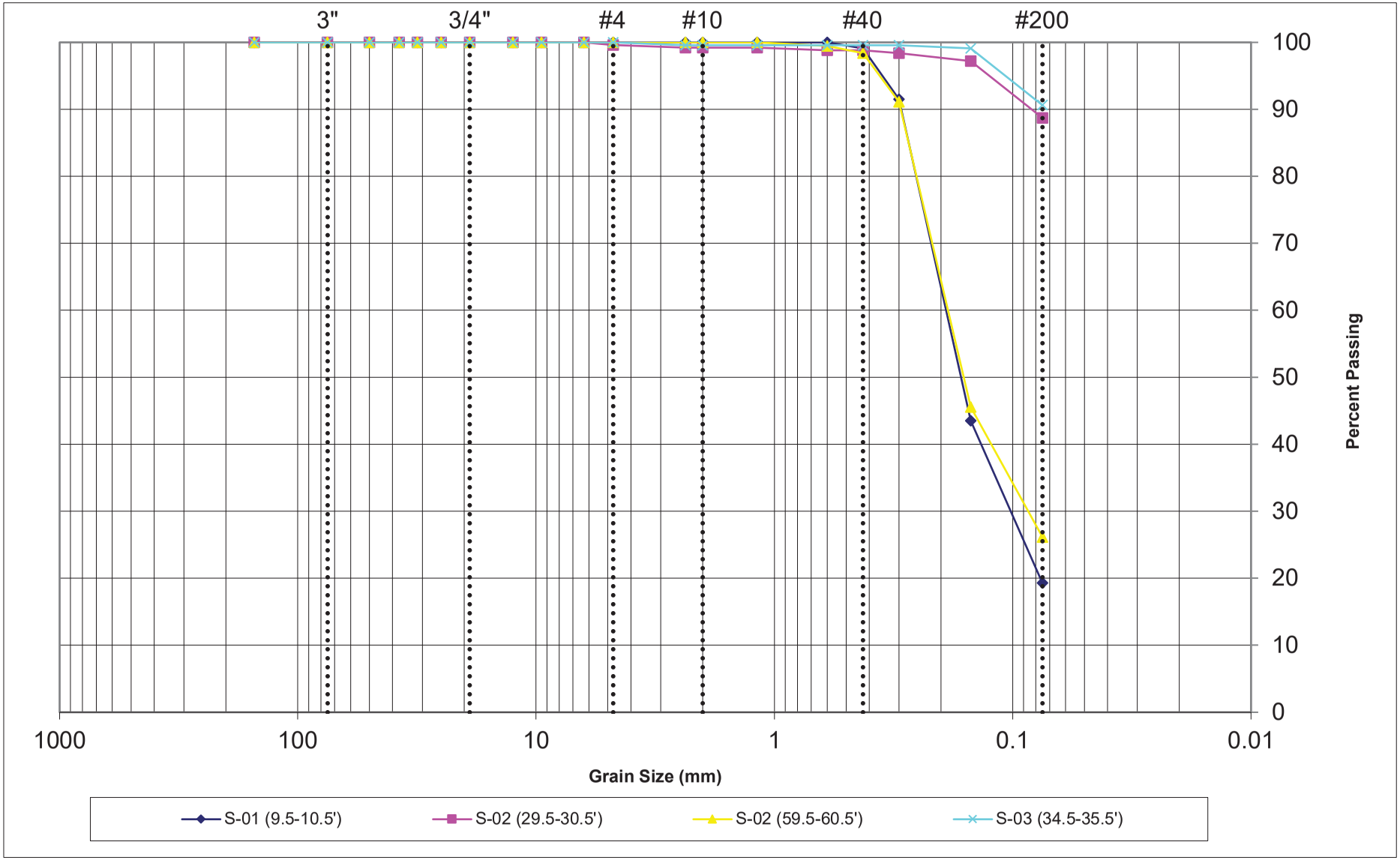
Wood Environment & Infrastructure Solutions, Inc.
3630 E Wier Ave.
Phoenix, AZ 85040

REVIEWED BY Hiram Franco

PROJECT: Allentown TI UP Bridge Rehabilitation
LOCATION: Houck, AZ
MATERIAL: See Boring Logs

JOB NO: 17-2021-4058.05
WORK ORDER NO: 1
DATE ASSIGNED: 2/9/22

MECHANICAL SIEVE ANALYSIS GRAPHS



PROJECT: Allentown TI UP Bridge Rehabilitation
LOCATION: Houck, AZ
MATERIAL: See Boring Logs

JOB NO: 17-2021-4058.05
WORK ORDER NO: 1
DATE ASSIGNED: 2/9/22

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

LAB #	BORING	MOISTURE			NUMBER OF RINGS	WET WEIGHT & RINGS (g)	WEIGHT OF RINGS (g)	DRY DENSITY (pcf)
		WET WT. (g)	DRY WT. (g)	MOISTURE CONTENT				
22-1127-33	S-02 (59.5-60.5')	446.1	370.7	20.3%	3	583.6	136.9	102.5

Wood Environment & Infrastructure Solutions, Inc.
3630 E Wier Ave.
Phoenix, AZ 85040

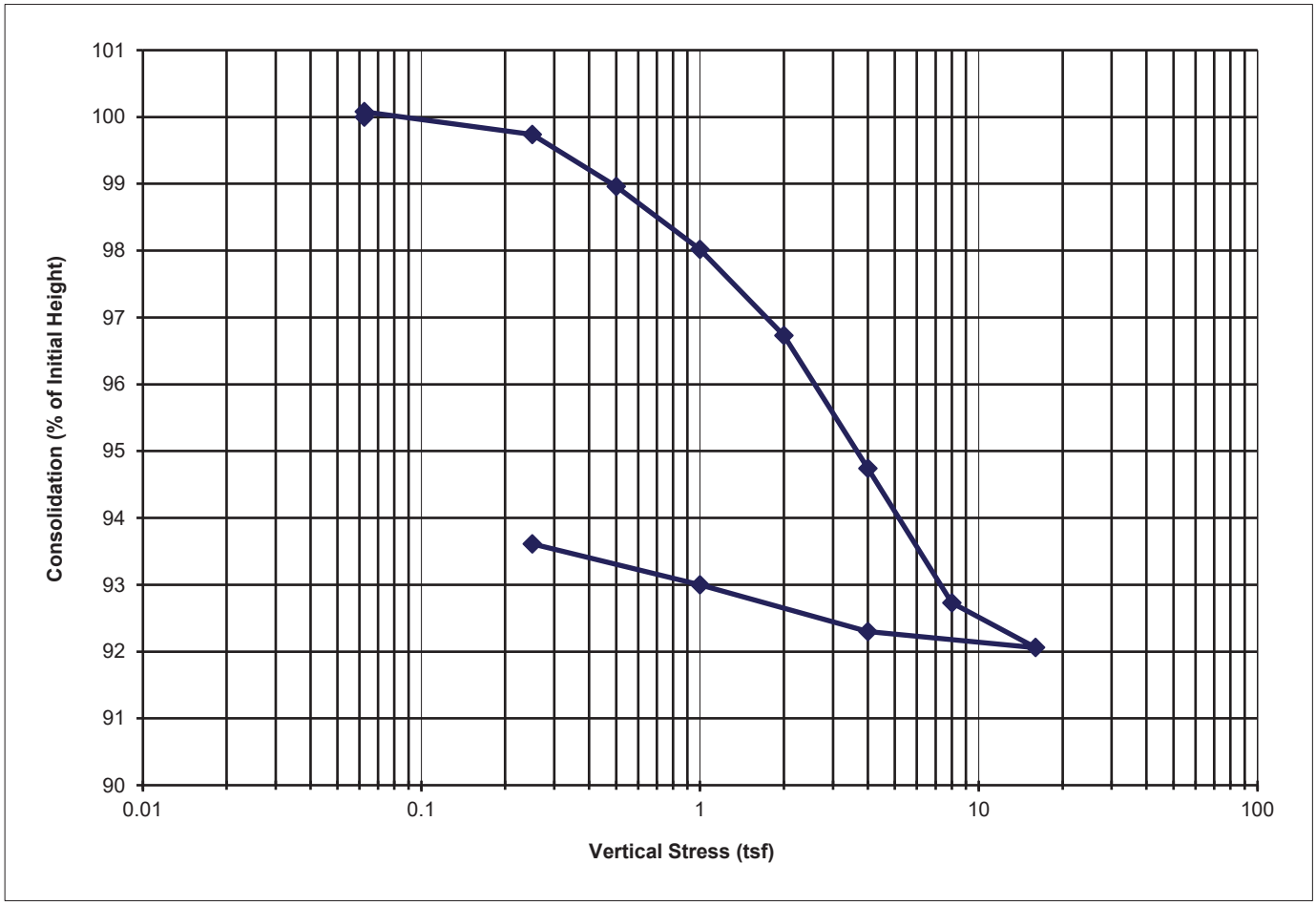
REVIEWED BY Hiram Franco

PROJECT: Allentown TI UP Bridge Rehabilitation
LOCATION: Houck, AZ
MATERIAL: See Boring Logs
SAMPLE SOURCE: S-02 (59.5-60.5')
SAMPLE PREP: In Situ

JOB NO: 17-2021-4058.05
WORK ORDER NO: 1
LAB NO: 22-1127-33
DATE ASSIGNED: 2/9/22

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (ASTM D2435)

INITIAL VOLUME (cu.in):	4.60	FINAL VOLUME (cu.in):	4.24
INITIAL MOISTURE CONTENT:	24.4%	FINAL MOISTURE CONTENT:	21.2%
INITIAL DRY DENSITY(pcf):	98.8	FINAL DRY DENSITY(pcf):	106.8
INITIAL DEGREE OF SATURATION:	93%	FINAL DEGREE OF SATURATION:	99%
INITIAL VOID RATIO:	0.71	FINAL VOID RATIO:	0.58
ESTIMATED SPECIFIC GRAVITY:	2.650	SATURATED AT:	0.0625 tsf



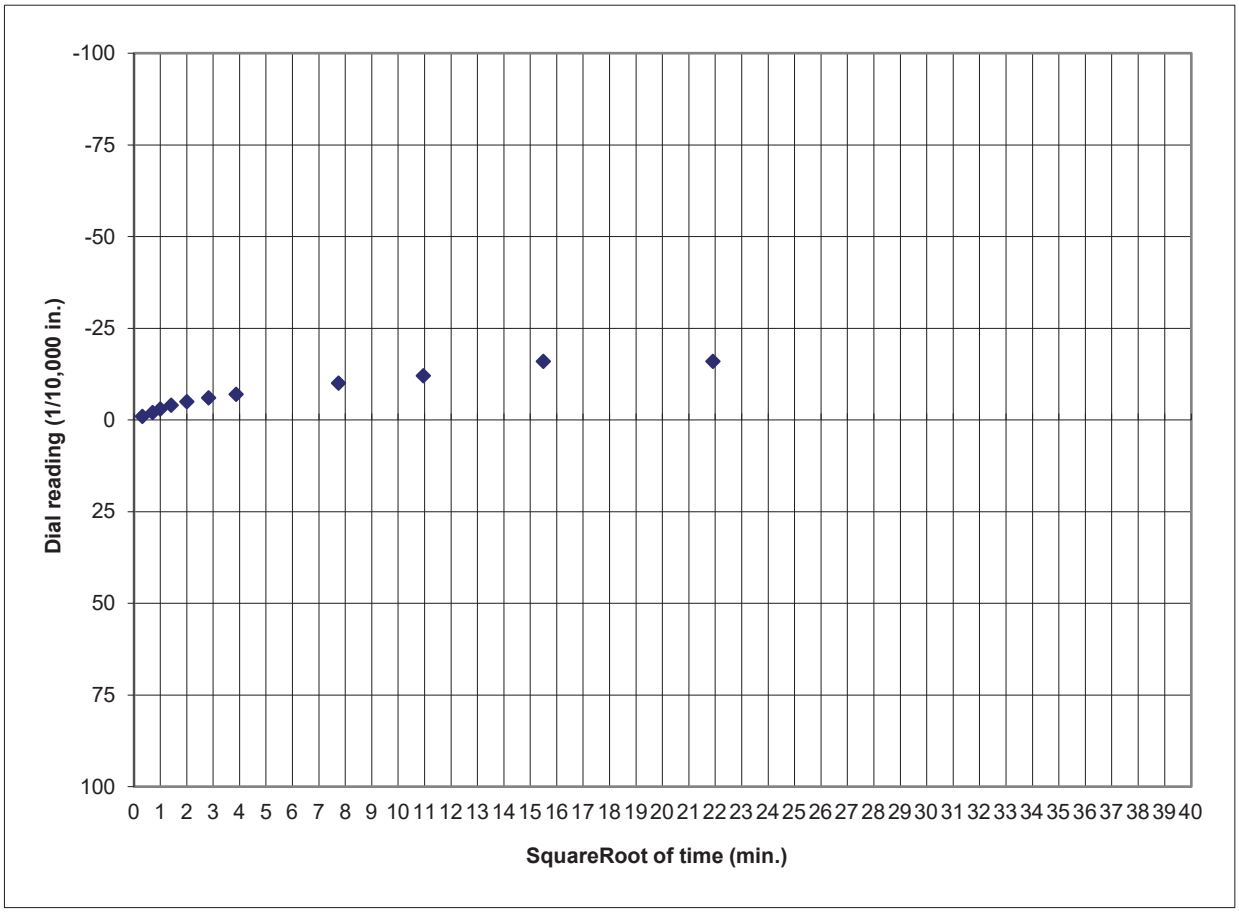
Wood Environment & Infrastructure Solutions, Inc.
3630 E Wier Ave.
Phoenix, AZ 85040

REVIEWED BY Hiram Franco

PROJECT:	Allentown TI UP Bridge Rehabilitation	**JOB NO:**	17-2021-4058.05
LOCATION:	Houck, AZ	**WORK ORDER NO**	1
MATERIAL:	See Boring Logs	**LAB NO:**	22-1127-33
SAMPLE SOURCE:	S-02 (59.5-60.5')	**DATE SAMPLED:**	2/9/22
SAMPLE PREP:	In Situ		

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (ASTM D2435)

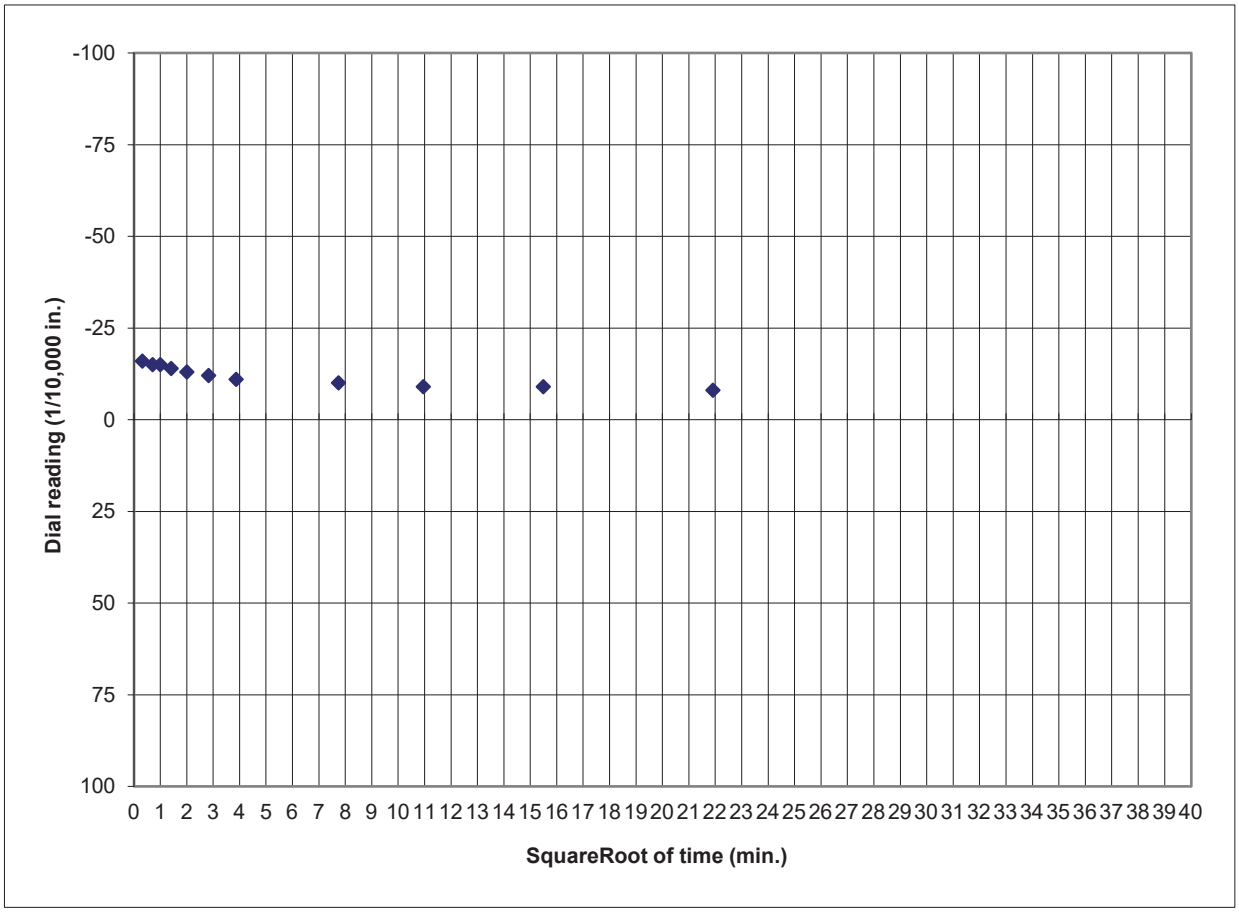
Timed-Load at Increment 0.0625 TSF



PROJECT:	Allentown TI UP Bridge Rehabilitation	**JOB NO:**	17-2021-4058.05
LOCATION:	Houck, AZ	**WORK ORDER NO**	1
MATERIAL:	See Boring Logs	**LAB NO:**	22-1127-33
SAMPLE SOURCE:	S-02 (59.5-60.5')	**DATE SAMPLED:**	2/9/22
SAMPLE PREP:	In Situ		

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (ASTM D2435)

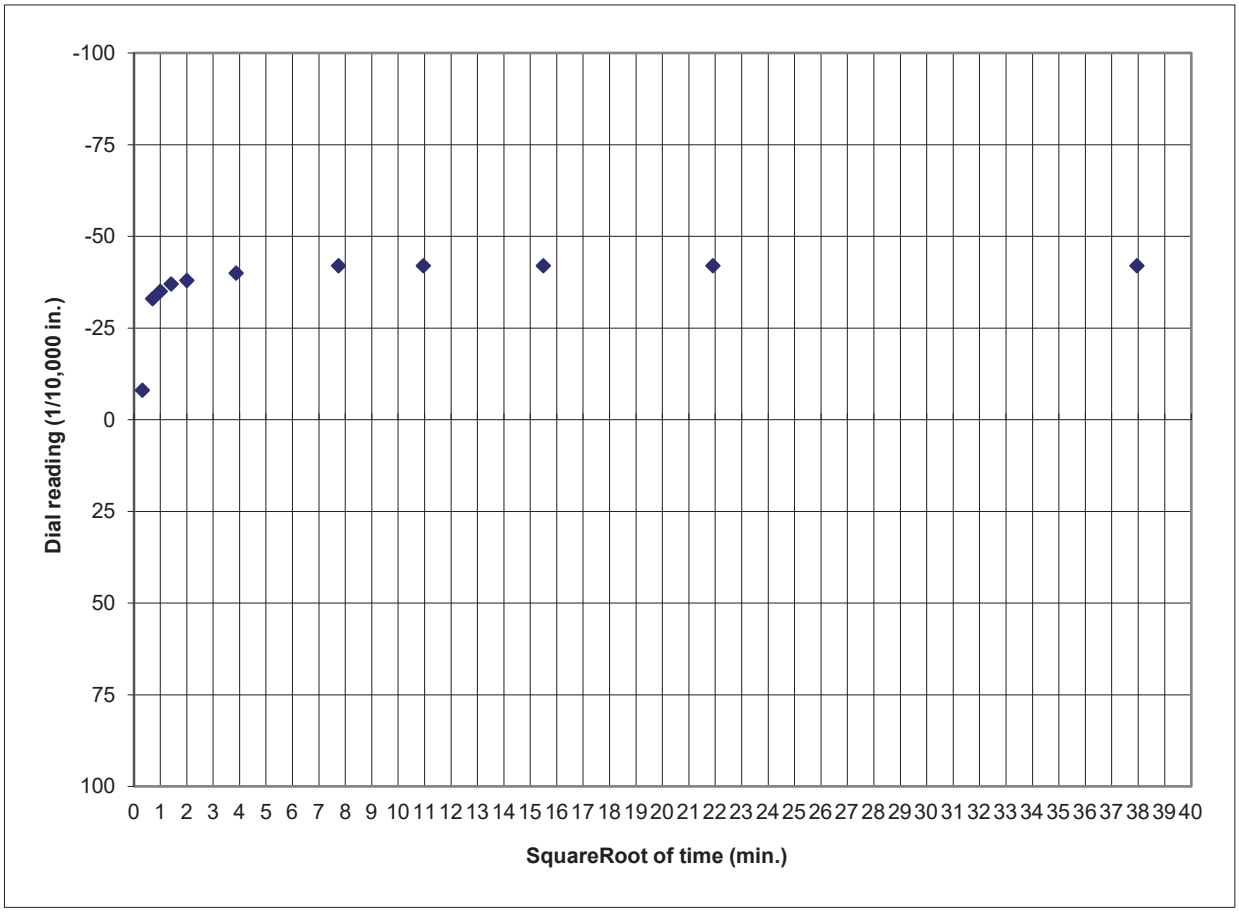
Timed-Load at Increment SATURATED



PROJECT:	Allentown TI UP Bridge Rehabilitation	**JOB NO:**	17-2021-4058.05
LOCATION:	Houck, AZ	**WORK ORDER NO**	1
MATERIAL:	See Boring Logs	**LAB NO:**	22-1127-33
SAMPLE SOURCE:	S-02 (59.5-60.5')	**DATE SAMPLED:**	2/9/22
SAMPLE PREP:	In Situ		

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (ASTM D2435)

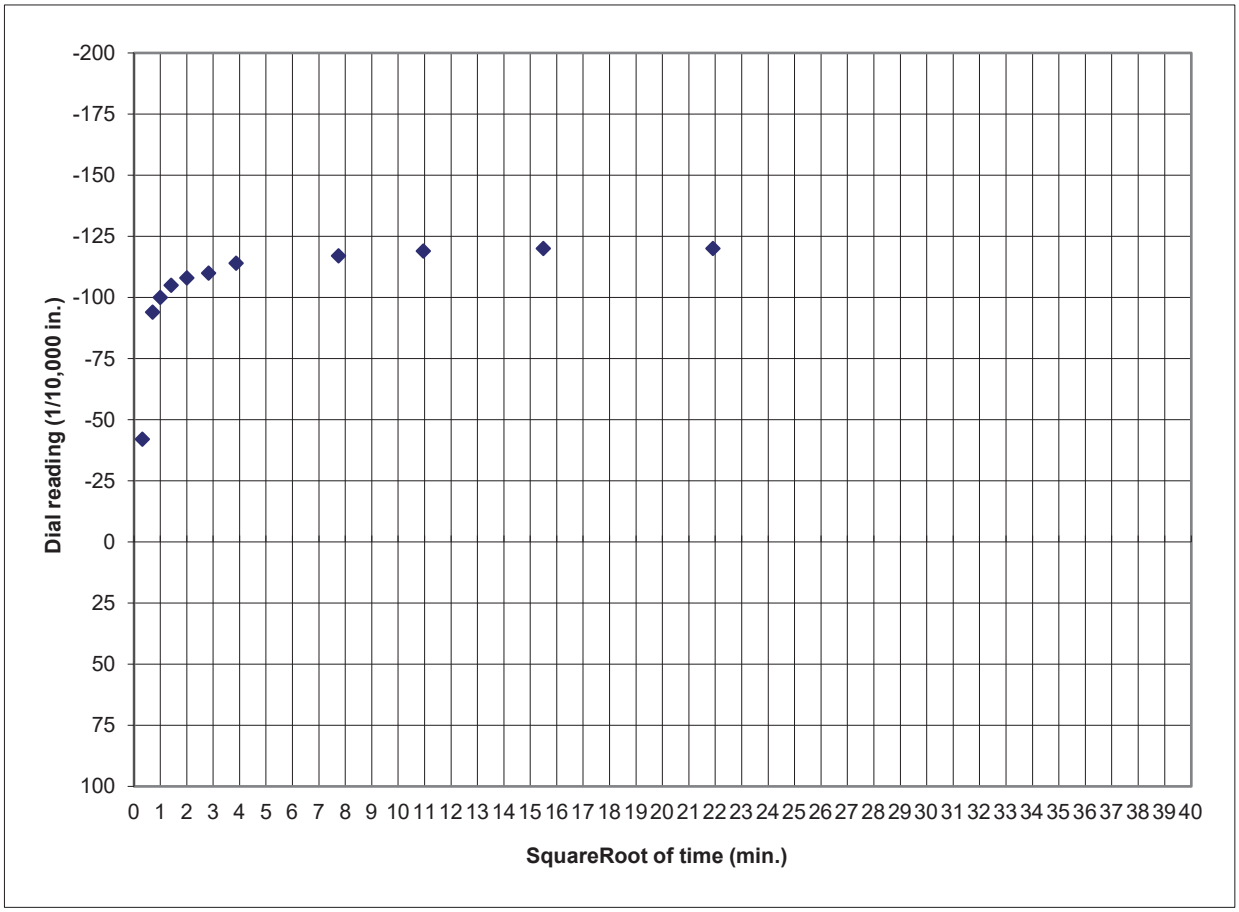
Timed-Load at Increment 0.25 TSF



PROJECT:	Allentown TI UP Bridge Rehabilitation	**JOB NO:**	17-2021-4058.05
LOCATION:	Houck, AZ	**WORK ORDER NO**	1
MATERIAL:	See Boring Logs	**LAB NO:**	22-1127-33
SAMPLE SOURCE:	S-02 (59.5-60.5')	**DATE SAMPLED:**	2/9/22
SAMPLE PREP:	In Situ		

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (ASTM D2435)

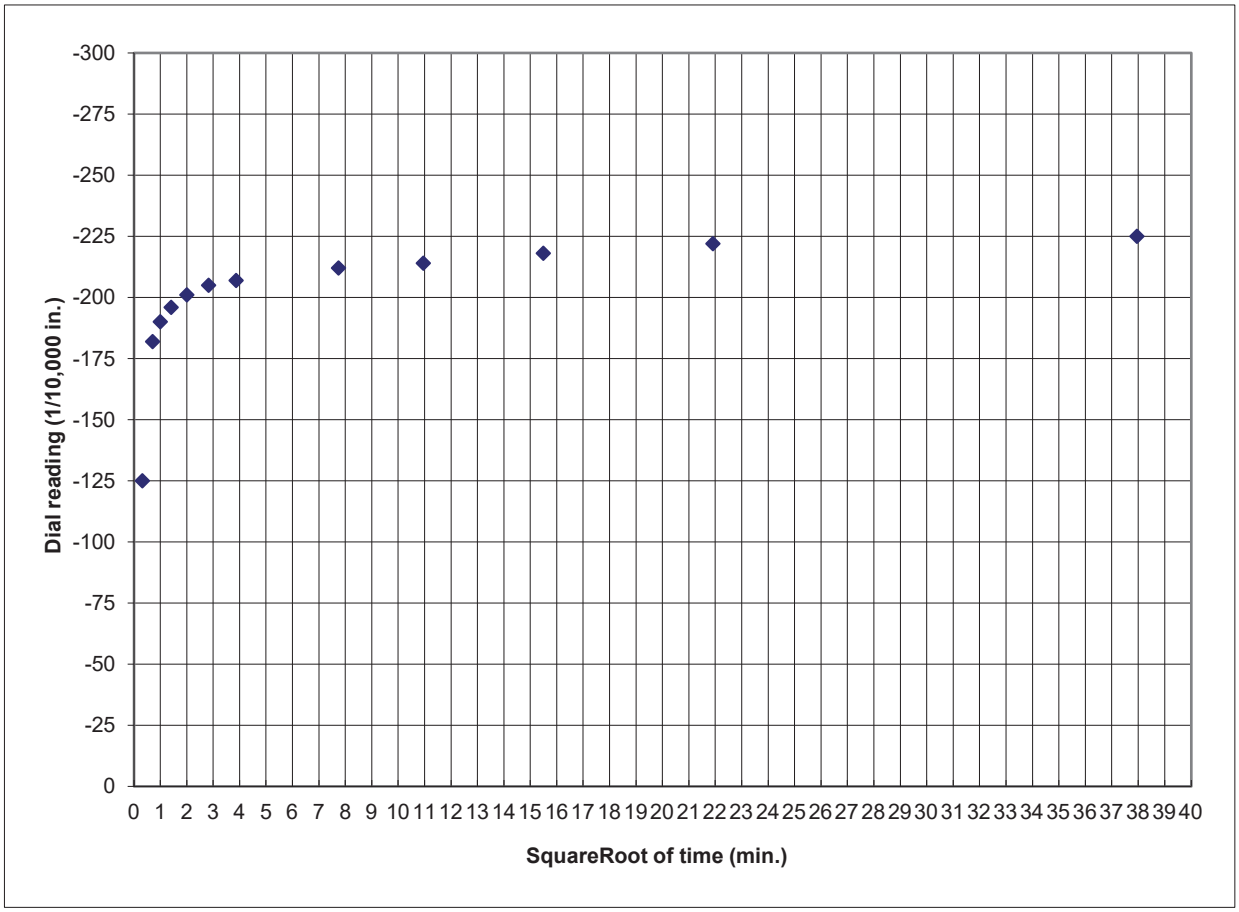
Timed-Load at Increment 0.5 TSF



PROJECT:	Allentown TI UP Bridge Rehabilitation	**JOB NO:**	17-2021-4058.05
LOCATION:	Houck, AZ	**WORK ORDER NO**	1
MATERIAL:	See Boring Logs	**LAB NO:**	22-1127-33
SAMPLE SOURCE:	S-02 (59.5-60.5')	**DATE SAMPLED:**	2/9/22
SAMPLE PREP:	In Situ		

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (ASTM D2435)

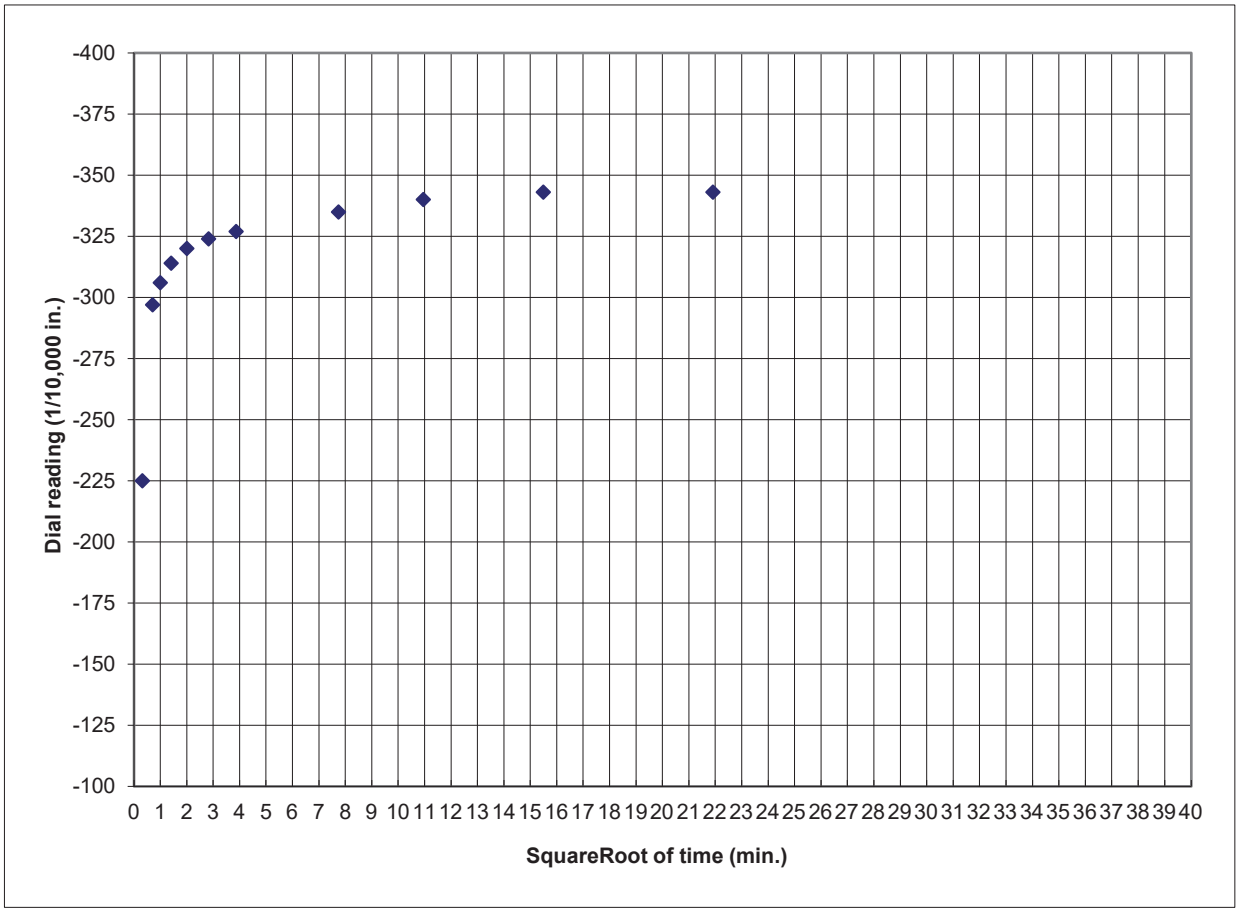
Timed-Load at Increment 1 TSF



PROJECT:	Allentown TI UP Bridge Rehabilitation	**JOB NO:**	17-2021-4058.05
LOCATION:	Houck, AZ	**WORK ORDER NO**	1
MATERIAL:	See Boring Logs	**LAB NO:**	22-1127-33
SAMPLE SOURCE:	S-02 (59.5-60.5')	**DATE SAMPLED:**	2/9/22
SAMPLE PREP:	In Situ		

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (ASTM D2435)

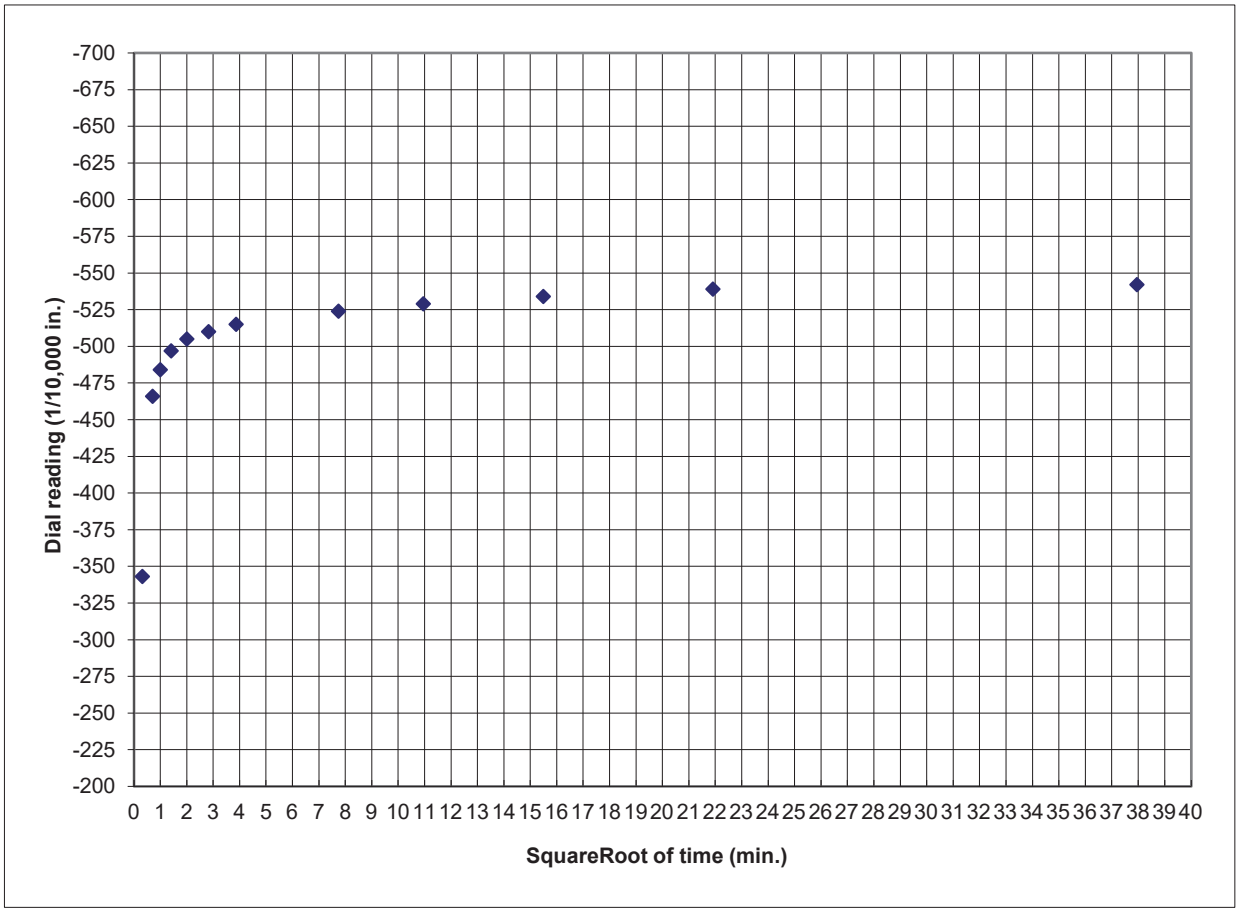
Timed-Load at Increment 2 TSF



PROJECT:	Allentown TI UP Bridge Rehabilitation	**JOB NO:**	17-2021-4058.05
LOCATION:	Houck, AZ	**WORK ORDER NO**	1
MATERIAL:	See Boring Logs	**LAB NO:**	22-1127-33
SAMPLE SOURCE:	S-02 (59.5-60.5')	**DATE SAMPLED:**	2/9/22
SAMPLE PREP:	In Situ		

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (ASTM D2435)

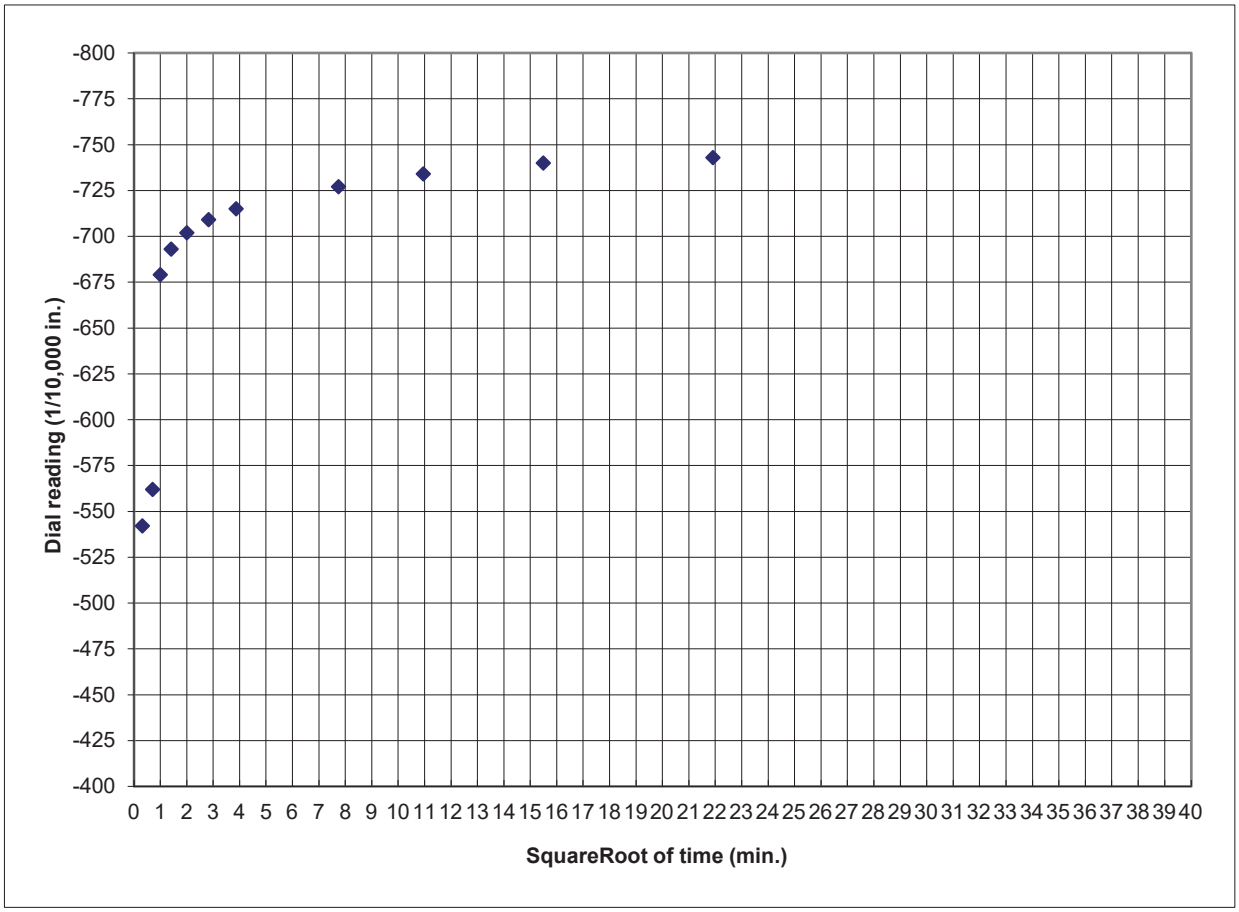
Timed-Load at Increment 4 TSF



PROJECT:	Allentown TI UP Bridge Rehabilitation	**JOB NO:**	17-2021-4058.05
LOCATION:	Houck, AZ	**WORK ORDER NO**	1
MATERIAL:	See Boring Logs	**LAB NO:**	22-1127-33
SAMPLE SOURCE:	S-02 (59.5-60.5')	**DATE SAMPLED:**	2/9/22
SAMPLE PREP:	In Situ		

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (ASTM D2435)

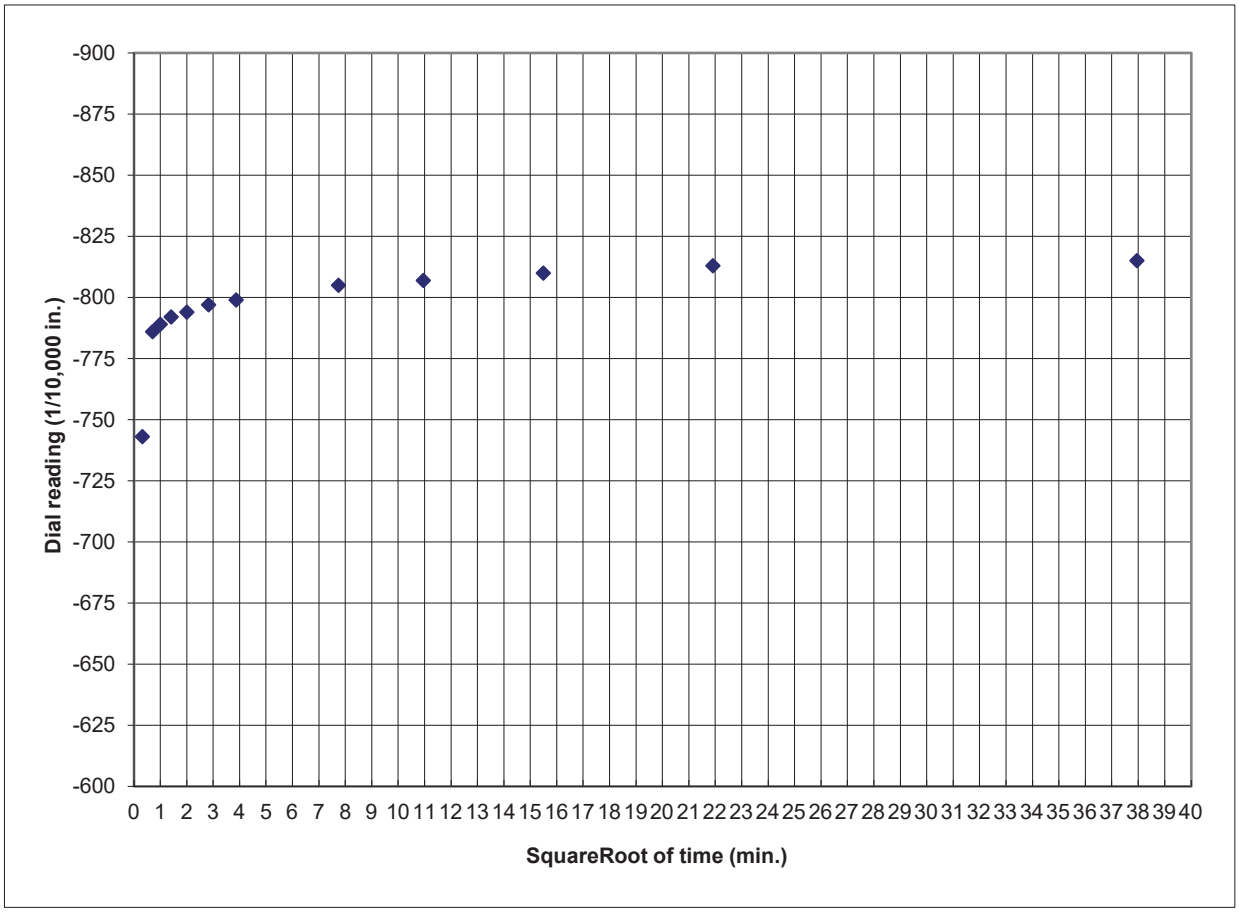
Timed-Load at Increment 8 TSF



PROJECT:	Allentown TI UP Bridge Rehabilitation	**JOB NO:**	17-2021-4058.05
LOCATION:	Houck, AZ	**WORK ORDER NO**	1
MATERIAL:	See Boring Logs	**LAB NO:**	22-1127-33
SAMPLE SOURCE:	S-02 (59.5-60.5')	**DATE SAMPLED:**	2/9/22
SAMPLE PREP:	In Situ		

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (ASTM D2435)

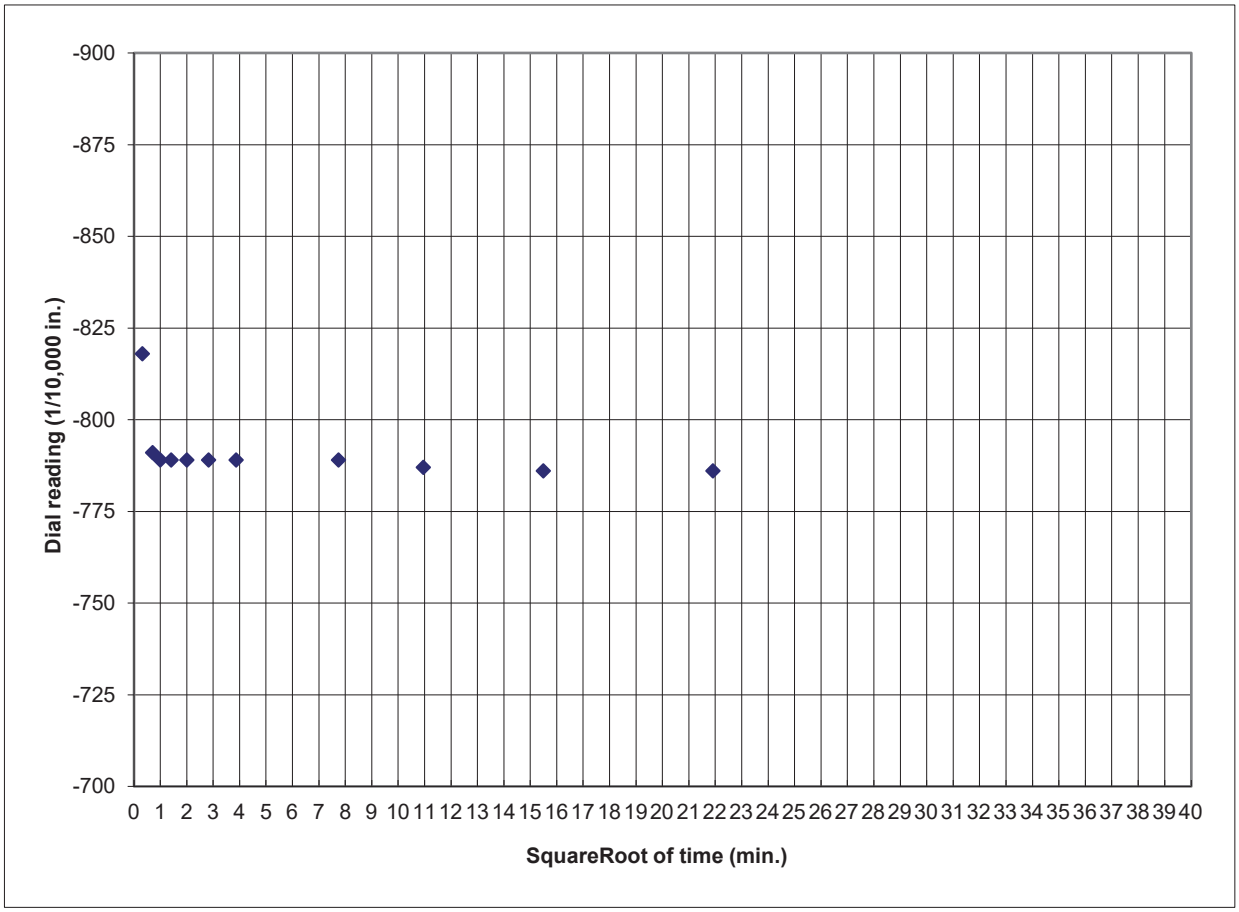
Timed-Load at Increment 16 TSF



PROJECT:	Allentown TI UP Bridge Rehabilitation	**JOB NO:**	17-2021-4058.05
LOCATION:	Houck, AZ	**WORK ORDER NO**	1
MATERIAL:	See Boring Logs	**LAB NO:**	22-1127-33
SAMPLE SOURCE:	S-02 (59.5-60.5')	**DATE SAMPLED:**	2/9/22
SAMPLE PREP:	In Situ		

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (ASTM D2435)

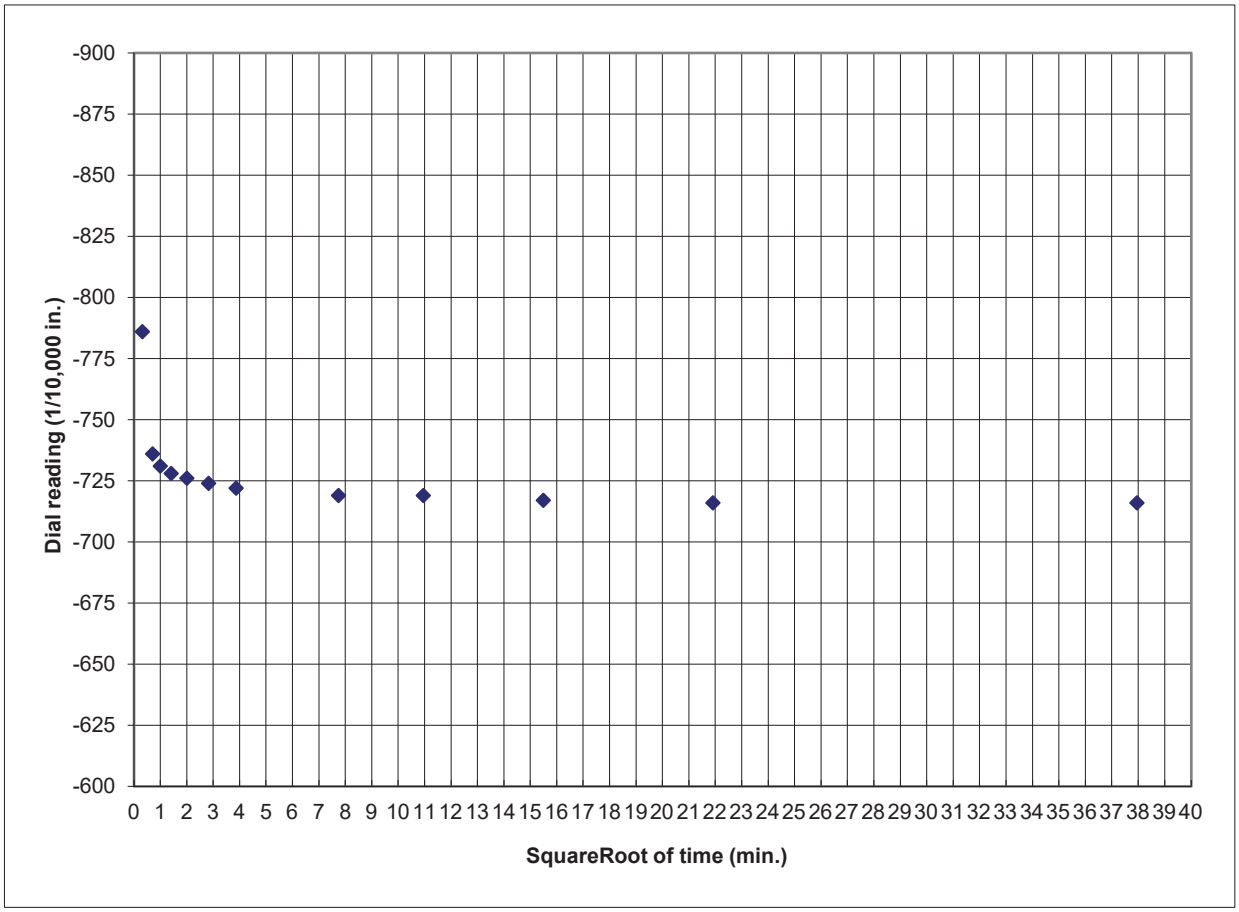
Timed-Load at Increment 4 TSF REBOUND



PROJECT:	Allentown TI UP Bridge Rehabilitation	**JOB NO:**	17-2021-4058.05
LOCATION:	Houck, AZ	**WORK ORDER NO**	1
MATERIAL:	See Boring Logs	**LAB NO:**	22-1127-33
SAMPLE SOURCE:	S-02 (59.5-60.5')	**DATE SAMPLED:**	2/9/22
SAMPLE PREP:	In Situ		

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (ASTM D2435)

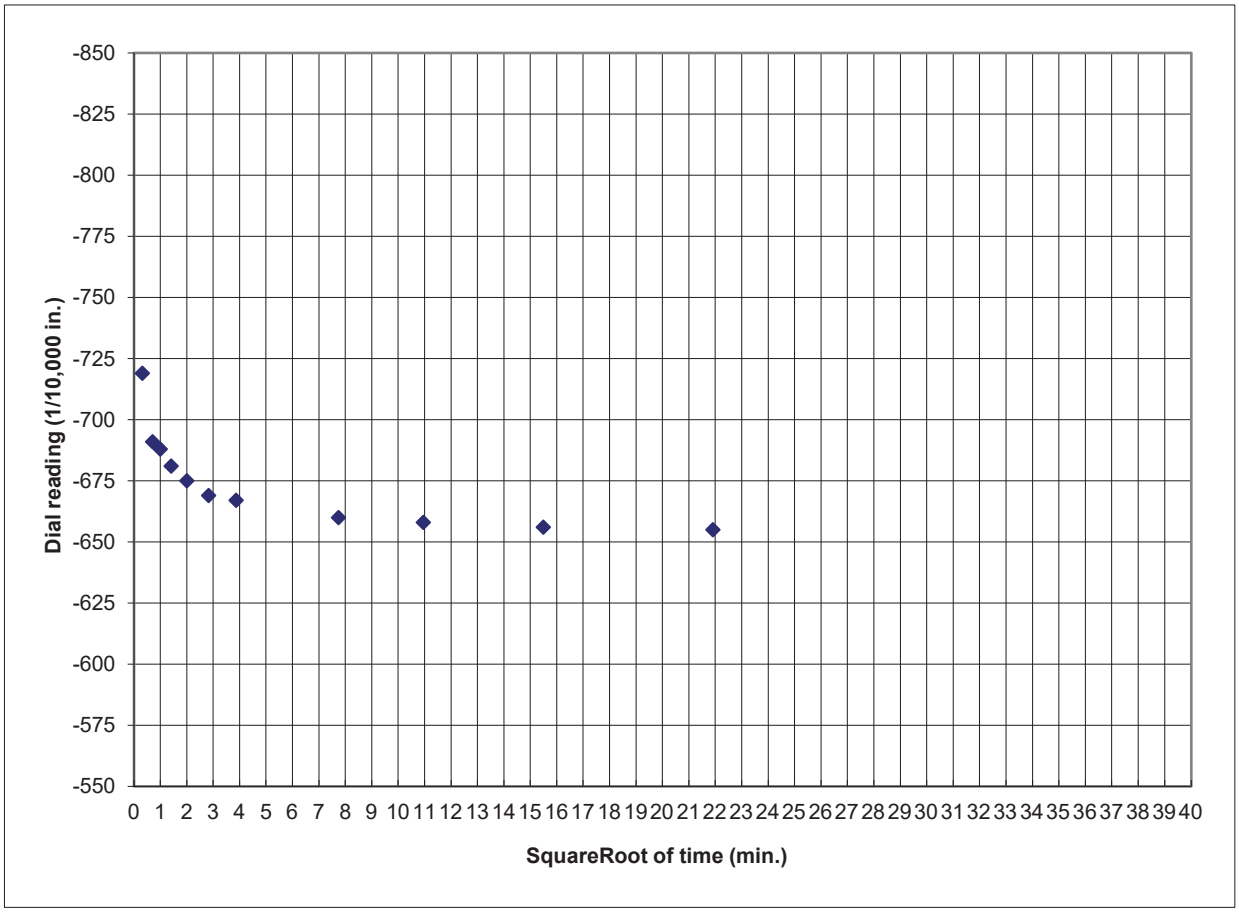
Timed-Load at Increment 1 TSF REBOUND



PROJECT:	Allentown TI UP Bridge Rehabilitation	**JOB NO:**	17-2021-4058.05
LOCATION:	Houck, AZ	**WORK ORDER NO**	1
MATERIAL:	See Boring Logs	**LAB NO:**	22-1127-33
SAMPLE SOURCE:	S-02 (59.5-60.5')	**DATE SAMPLED:**	2/9/22
SAMPLE PREP:	In Situ		

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (ASTM D2435)

Timed-Load at Increment 0.25 TSF REBOUND

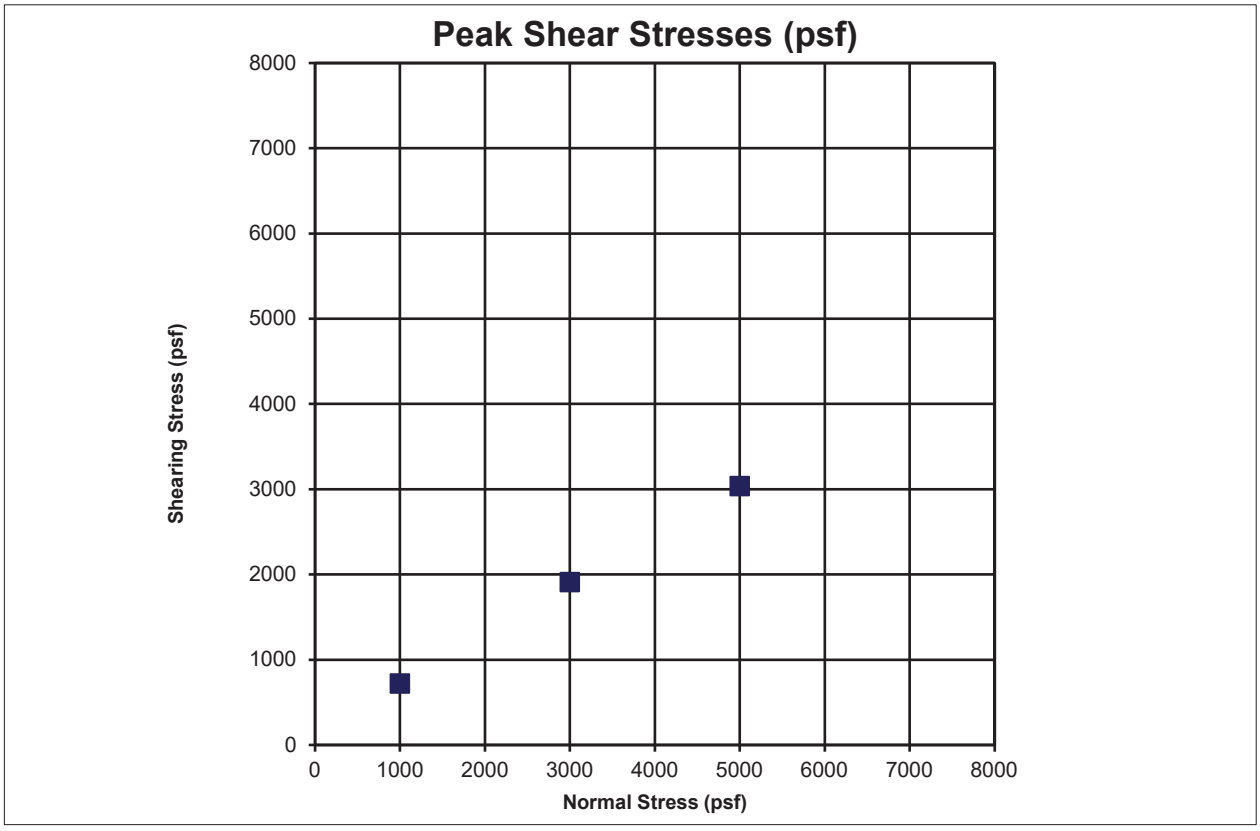


PROJECT: Allentown TI UP Bridge Rehabilitation
LOCATION: Houck, AZ
MATERIAL: See Boring Logs
SAMPLE SOURCE: S-01 (9.5-10.5')
SAMPLE PREPARATION: Saturated - 1, 3, and 5ksf

JOB NO: 17-2021-4058.05
WORK ORDER NO: 1
LAB NO: 22-1127-05
DATE ASSIGNED: 2/9/2022

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

Initial thickness of specimen (in.):	1.00	1.00	1.00
Initial diameter of specimen (in.):	2.42	2.42	2.42
Final thickness before shear (in.):	0.994	0.997	0.993
Shearing device used:	Humboldt Automated Shear Test System by Trautwein Soil Testing Equipment		
Rate of deformation (in/min):	0.01	0.01	0.01
Direct shear point:	1	2	3
Dry mass of specimen (g):	115.5	115.4	115.9
Initial Moisture Content:	5.4%	5.9%	7.9%
Initial Wet Density (pcf):	100.8	101.2	103.6
Initial Dry Density (pcf):	95.7	95.6	96.0
Final Moisture Content:	21.4%	21.8%	19.8%
Final Wet Density (pcf):	116.8	116.8	115.8
Final Dry Density (pcf):	96.2	95.8	96.7
Normal Stress (psf):	1000	3000	5000
Maximum Shearing Stress (psf):	719	1911	3039
Vertical Deformation @ Max Shear (in):	4.752	0.226	0.243
Horizontal Deformation @ Max Shear (in):	0.116	0.483	0.483



Wood Environment & Infrastructure Solutions, Inc.
3630 E Wier Ave.
Phoenix, AZ 85040

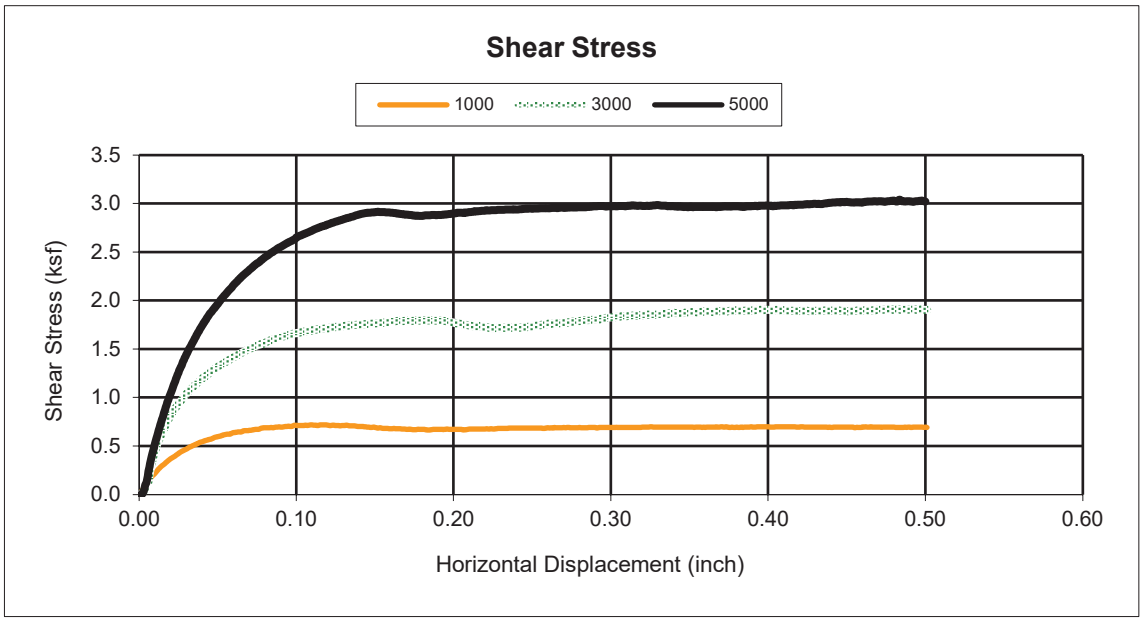
REVIEWED BY Hiram Franco

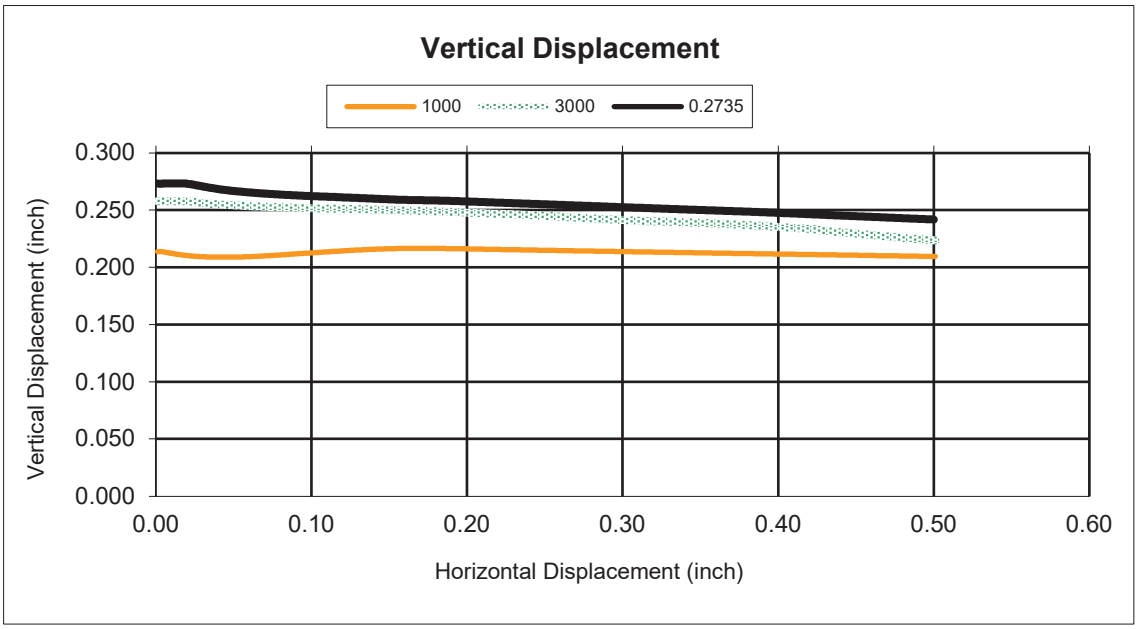
PROJECT: Allentown TI UP Bridge Rehabilitation
LOCATION: Houck, AZ
MATERIAL: See Boring Logs
SAMPLE SOURCE: S-01 (9.5-10.5')
SAMPLE PREPARATION: Saturated - 1, 3, and 5ksf

JOB NO: 17-2021-4058.05
WORK ORDER NO: 1
LAB NO: 22-1127-05
DATE ASSIGNED: 2/9/2022

NORMAL LOADS (psf): 1000 3000 5000

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





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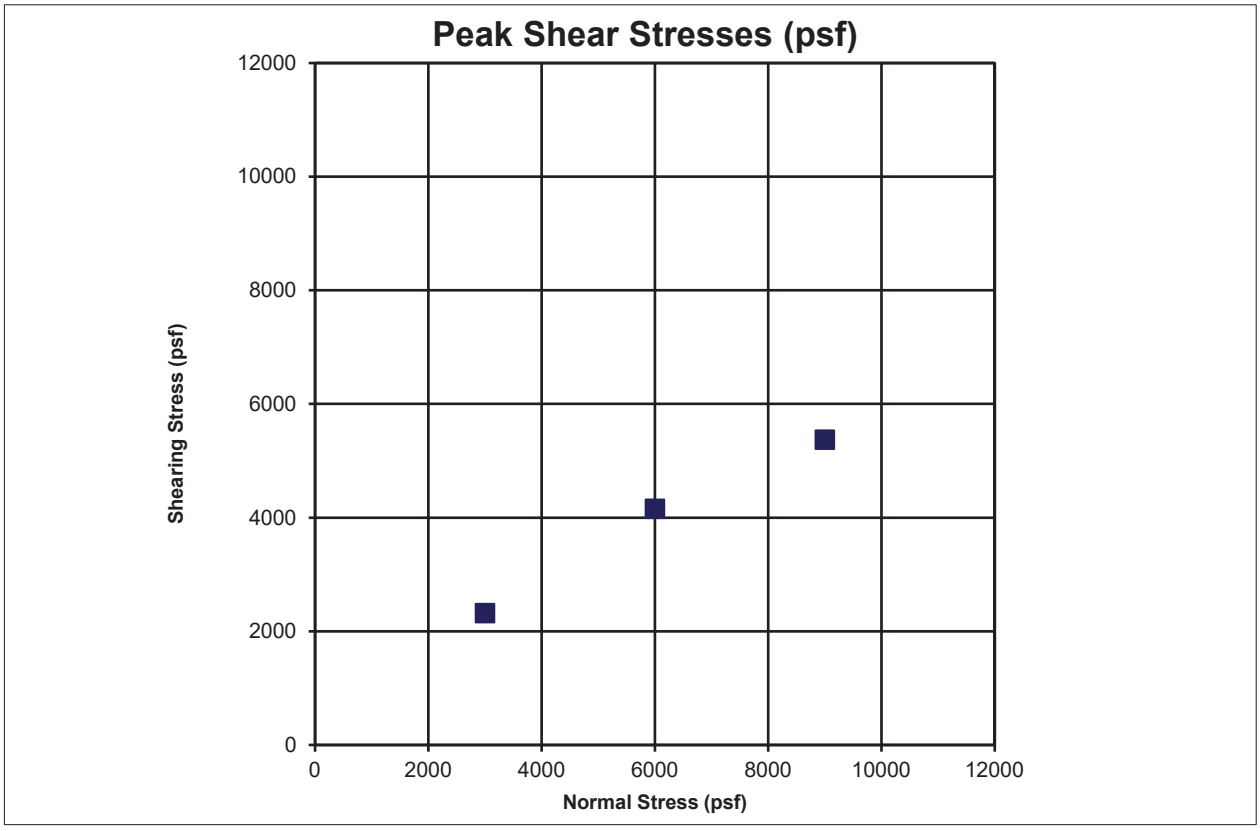
Phoenix, AZ 85040

PROJECT: Allentown TI UP Bridge Rehabilitation
LOCATION: Houck, AZ
MATERIAL: See Boring Logs
SAMPLE SOURCE: S-02 (29.5-30.5')
SAMPLE PREPARATION: Saturated - 3, 6, and 9ksf

JOB NO: 17-2021-4058.05
WORK ORDER NO: 1
LAB NO: 22-1127-27
DATE ASSIGNED: 2/9/2022

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

Initial thickness of specimen (in.):	1.00	1.00	1.00
Initial diameter of specimen (in.):	2.42	2.42	2.42
Final thickness before shear (in.):	0.997	0.995	0.986
Shearing device used:	Humboldt Automated Shear Test System by Trautwein Soil Testing Equipment		
Rate of deformation (in/min):	0.0015	0.0015	0.0015
Direct shear point:	1	2	3
Dry mass of specimen (g):	119.9	123.2	121.7
Initial Moisture Content:	19.4%	19.5%	23.1%
Initial Wet Density (pcf):	118.6	121.9	124.1
Initial Dry Density (pcf):	99.3	102.0	100.8
Final Moisture Content:	23.6%	20.9%	23.4%
Final Wet Density (pcf):	123.1	124.0	126.2
Final Dry Density (pcf):	99.6	102.6	102.3
Normal Stress (psf):	3000	6000	9000
Maximum Shearing Stress (psf):	2318	4154	5374
Vertical Deformation @ Max Shear (in):	0.186	0.248	0.244
Horizontal Deformation @ Max Shear (in):	0.071	0.097	0.185



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3630 E Wier Ave.
Phoenix, AZ 85040

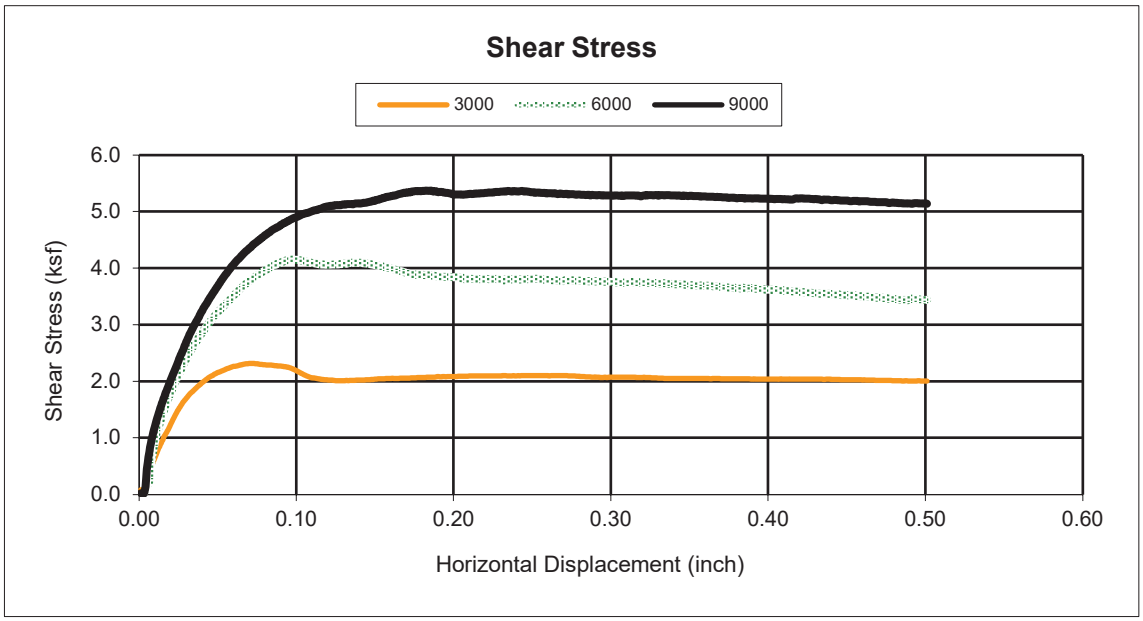
REVIEWED BY Hiram Franco

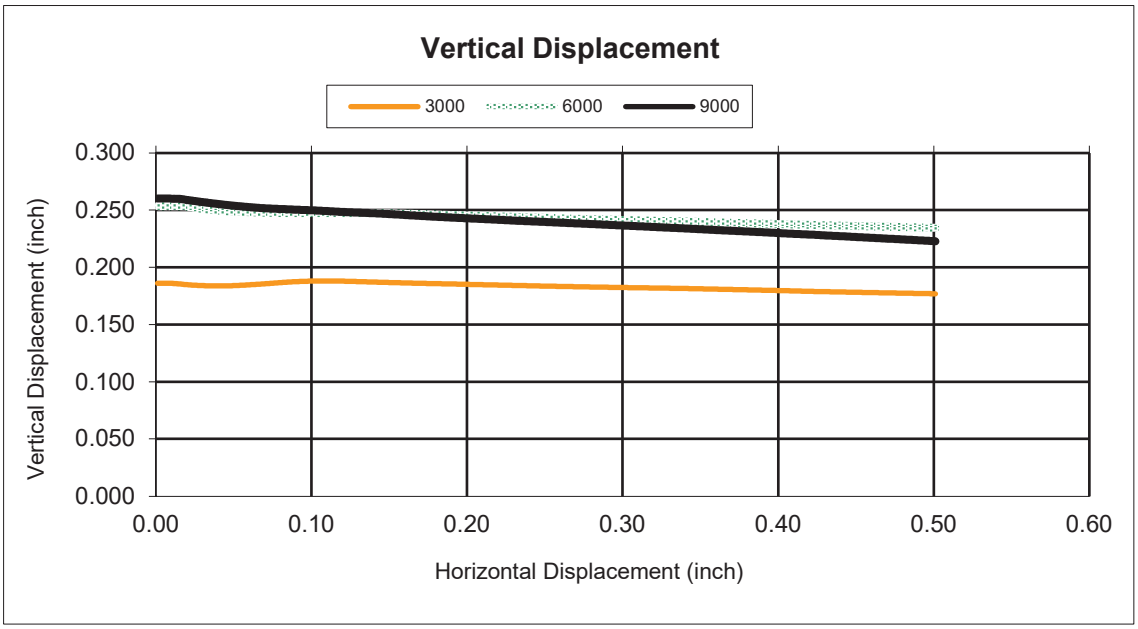
PROJECT: Allentown TI UP Bridge Rehabilitation
LOCATION: Houck, AZ
MATERIAL: See Boring Logs
SAMPLE SOURCE: S-02 (29.5-30.5')
SAMPLE PREPARATION: Saturated - 3, 6, and 9ksf

JOB NO: 17-2021-4058.05
WORK ORDER NO: 1
LAB NO: 22-1127-27
DATE ASSIGNED: 2/9/2022

NORMAL LOADS (psf): 3000 6000 9000

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





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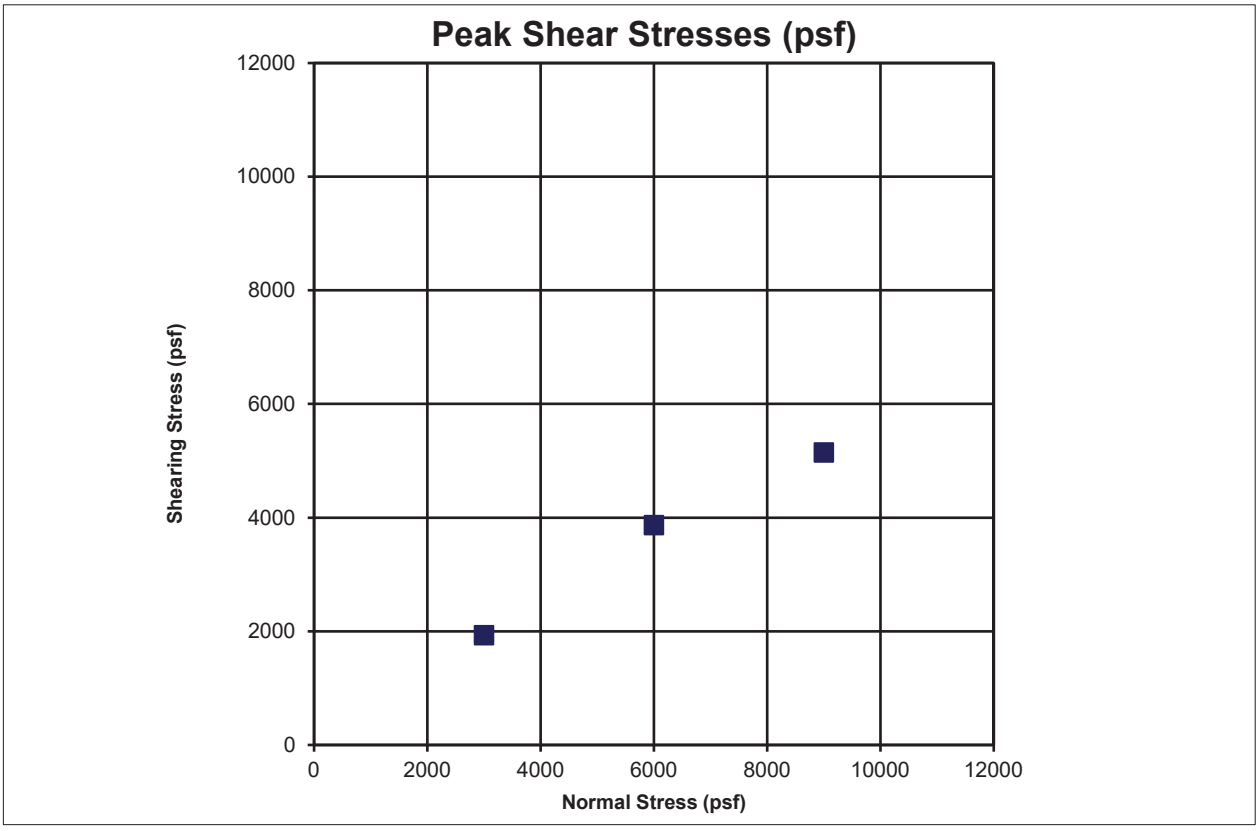
Phoenix, AZ 85040

PROJECT: Allentown TI UP Bridge Rehabilitation
LOCATION: Houck, AZ
MATERIAL: See Boring Logs
SAMPLE SOURCE: S-03 (34.5-35.5')
SAMPLE PREPARATION: Saturated - 3, 6, and 9ksf

JOB NO: 17-2021-4058.05
WORK ORDER NO: 1
LAB NO: 22-1127-47
DATE ASSIGNED: 2/9/2022

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

Initial thickness of specimen (in.):	1.00	1.00	1.00
Initial diameter of specimen (in.):	2.42	2.42	2.42
Final thickness before shear (in.):	0.987	0.973	0.979
Shearing device used:	Humboldt Automated Shear Test System by Trautwein Soil Testing Equipment		
Rate of deformation (in/min):	0.0015	0.0015	0.0015
Direct shear point:	1	2	3
Dry mass of specimen (g):	107.0	113.5	116.4
Initial Moisture Content:	32.0%	29.0%	26.7%
Initial Wet Density (pcf):	116.9	121.3	122.2
Initial Dry Density (pcf):	88.6	94.0	96.4
Final Moisture Content:	31.5%	27.0%	26.0%
Final Wet Density (pcf):	118.1	122.6	124.2
Final Dry Density (pcf):	89.8	96.6	98.5
Normal Stress (psf):	3000	6000	9000
Maximum Shearing Stress (psf):	1931	3870	5144
Vertical Deformation @ Max Shear (in):	0.175	0.204	0.247
Horizontal Deformation @ Max Shear (in):	0.057	0.121	0.211



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3630 E Wier Ave.
Phoenix, AZ 85040

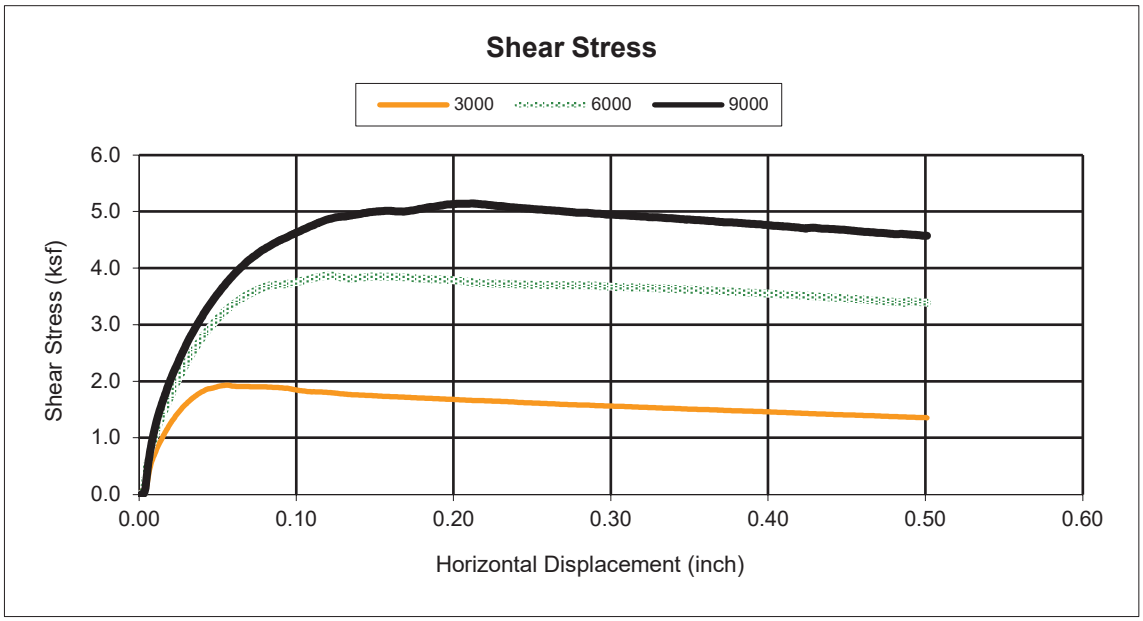
REVIEWED BY Hiram Franco

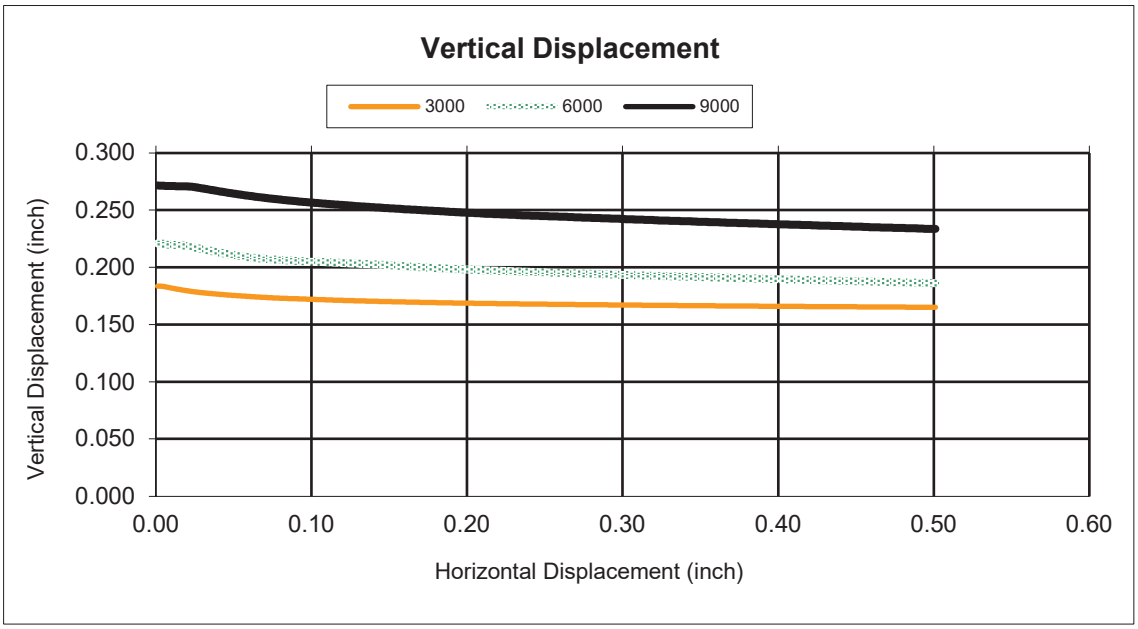
PROJECT: Allentown TI UP Bridge Rehabilitation
LOCATION: Houck, AZ
MATERIAL: See Boring Logs
SAMPLE SOURCE: S-03 (34.5-35.5')
SAMPLE PREPARATION: Saturated - 3, 6, and 9ksf

JOB NO: 17-2021-4058.05
WORK ORDER NO: 1
LAB NO: 22-1127-47
DATE ASSIGNED: 2/9/2022

NORMAL LOADS (psf): 3000 6000 9000

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





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Phoenix, AZ 85040

PROJECT: Allentown TI UP Bridge Rehabilitation
LOCATION: Houck, AZ
MATERIAL: See Boring Logs
SAMPLE SOURCE: See Below

JOB NO: 17-2021-4058
WORK ORDER NO: 1
LAB NO: See Below
DATE SAMPLED: 2/9/22

BULK DENSITY OF ROCK CORES
USING WATER DISPLACEMENT METHOD

LAB#	SAMPLE SOURCE	SSD WEIGHT (g)	IMMERSED WEIGHT (g)	DRY WEIGHT (g)	SPECIFIC GRAVITY	DENSITY (pcf)
22-1127-16	S-01 (61.0-61.8')	930.2	570.5	921.2	2.561	159.8
22-1127-17	S-01 (67.0-67.8')	1,035.7	637.9	1,029.1	2.587	161.4

REVIEWED BY Hiram Franco

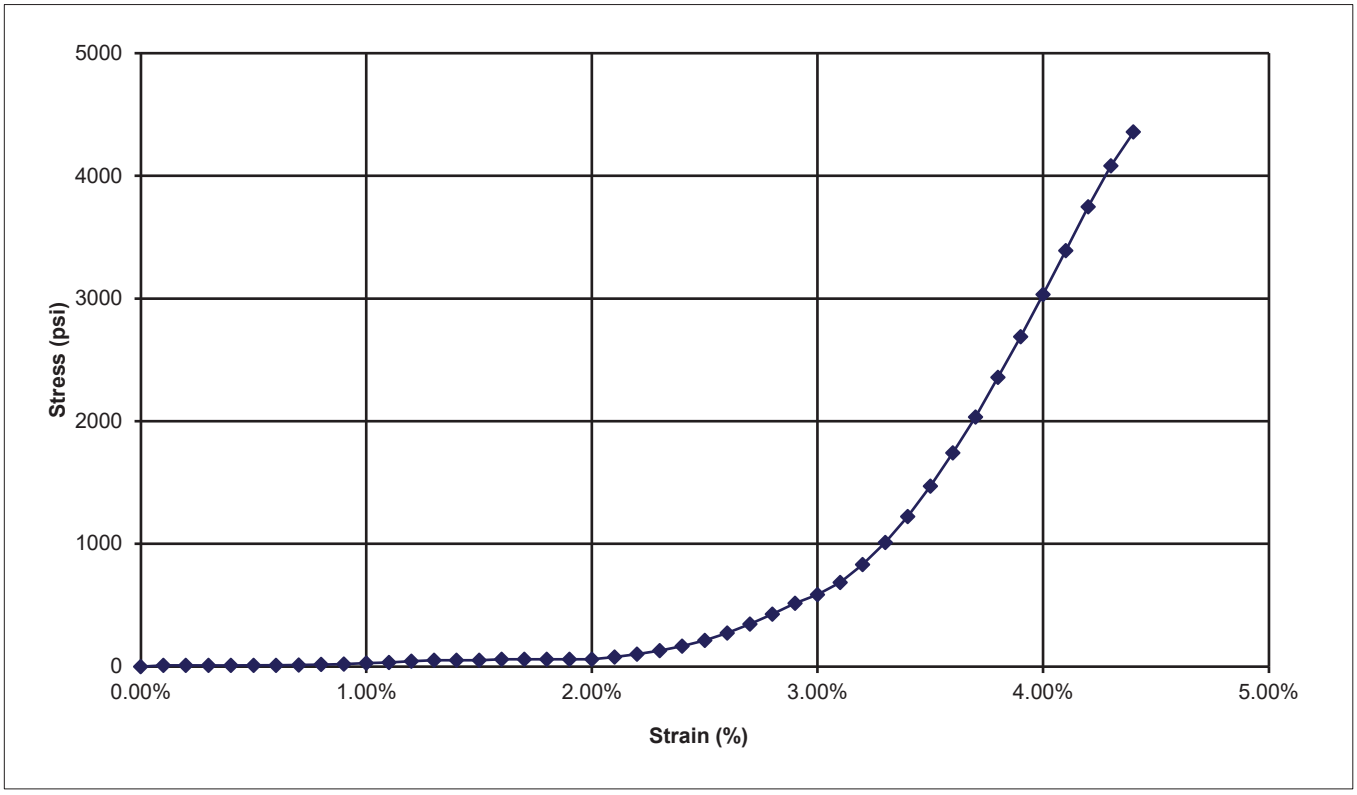
PROJECT: Allentown TI UP Bridge Rehabilitation
LOCATION: Houck, AZ
MATERIAL: See Boring Logs
SAMPLE SOURCE: S-01 (61.0-61.8')
SAMPLE PREP: INSITU

JOB NO: 17-2021-4058.05
WORK ORDER NO: 1
LAB NO: 22-1127-16
DATE ASSIGNED: 02/09/22

UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE SPECIMENS (ASTM D7012) METHOD C

DIAMETER (IN):	2.37	STRAIN RATE (IN/MIN):	0.020
LENGTH (IN):	5.00	TOTAL STRAIN:	4.40%
L/D (2.0-2.5 REQ.):	2.11		
DRY DENSITY (PCF):	159.0	**UNCONFINED COMPRESSIVE STRENGTH (PSI):**	**4,357**
MOISTURE CONTENT:	0.7%		

SPECIMEN AIR DRIED UNTIL TIME OF TEST



Note: Test specimens were not prepared in accordance with ASTM D4543. Results may differ from results obtained from a test specimen that meets the requirements of ASTM D4543.

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3630 E Wier Ave.
Phoenix, AZ 85040

REVIEWED BY Hiram Franco

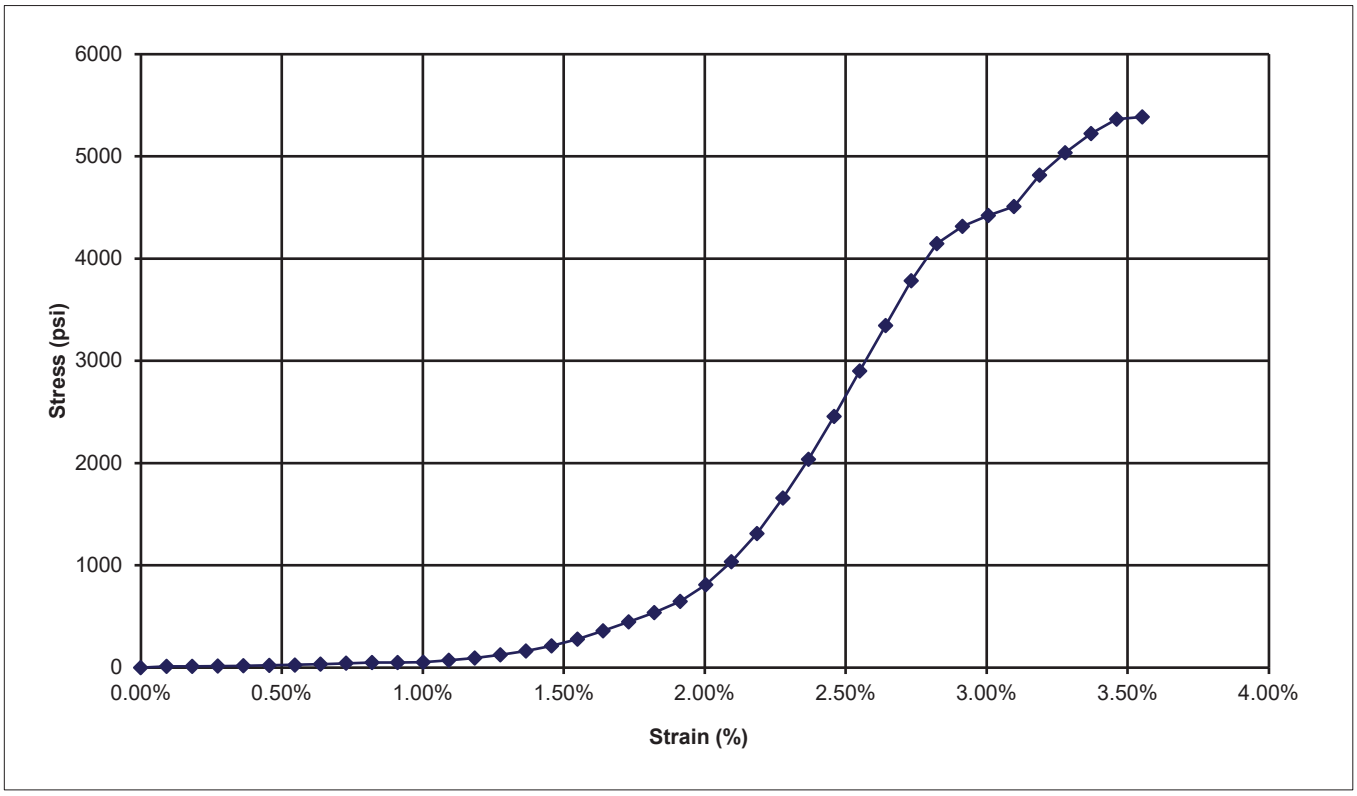
PROJECT: Allentown TI UP Bridge Rehabilitation
LOCATION: Houck, AZ
MATERIAL: See Boring Logs
SAMPLE SOURCE: S-01 (67.0-67.8')
SAMPLE PREP: INSITU

JOB NO: 17-2021-4058.05
WORK ORDER NO: 1
LAB NO: 22-1127-17
DATE ASSIGNED: 02/09/22

UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE SPECIMENS (ASTM D7012) METHOD C

DIAMETER (IN):	2.37	STRAIN RATE (IN/MIN):	0.020
LENGTH (IN):	5.49	TOTAL STRAIN:	3.55%
L/D (2.0-2.5 REQ.):	2.32		
DRY DENSITY (PCF):	161.8	**UNCONFINED COMPRESSIVE STRENGTH (PSI):**	**5,387**
MOISTURE CONTENT:	0.4%		

SPECIMEN AIR DRIED UNTIL TIME OF TEST



Note: Test specimens were not prepared in accordance with ASTM D4543. Results may differ from results obtained from a test specimen that meets the requirements of ASTM D4543.

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Phoenix, AZ 85040

REVIEWED BY Hiram Franco

MOTZZ LABORATORY, INC.

Laboratory Analysis Report

Wood
Franco Escalante
4600 E. Washington Street Suite 600
Phoenix, Arizona 85034

Project: 17-2021-4058.05 WO1
Date Received: 2/11/2022
Date Reported: 2/15/2022

PO Number: 172021405805

Lab Number: 940575-1 **22-1127-10 S-01 (34.5-36.0')**

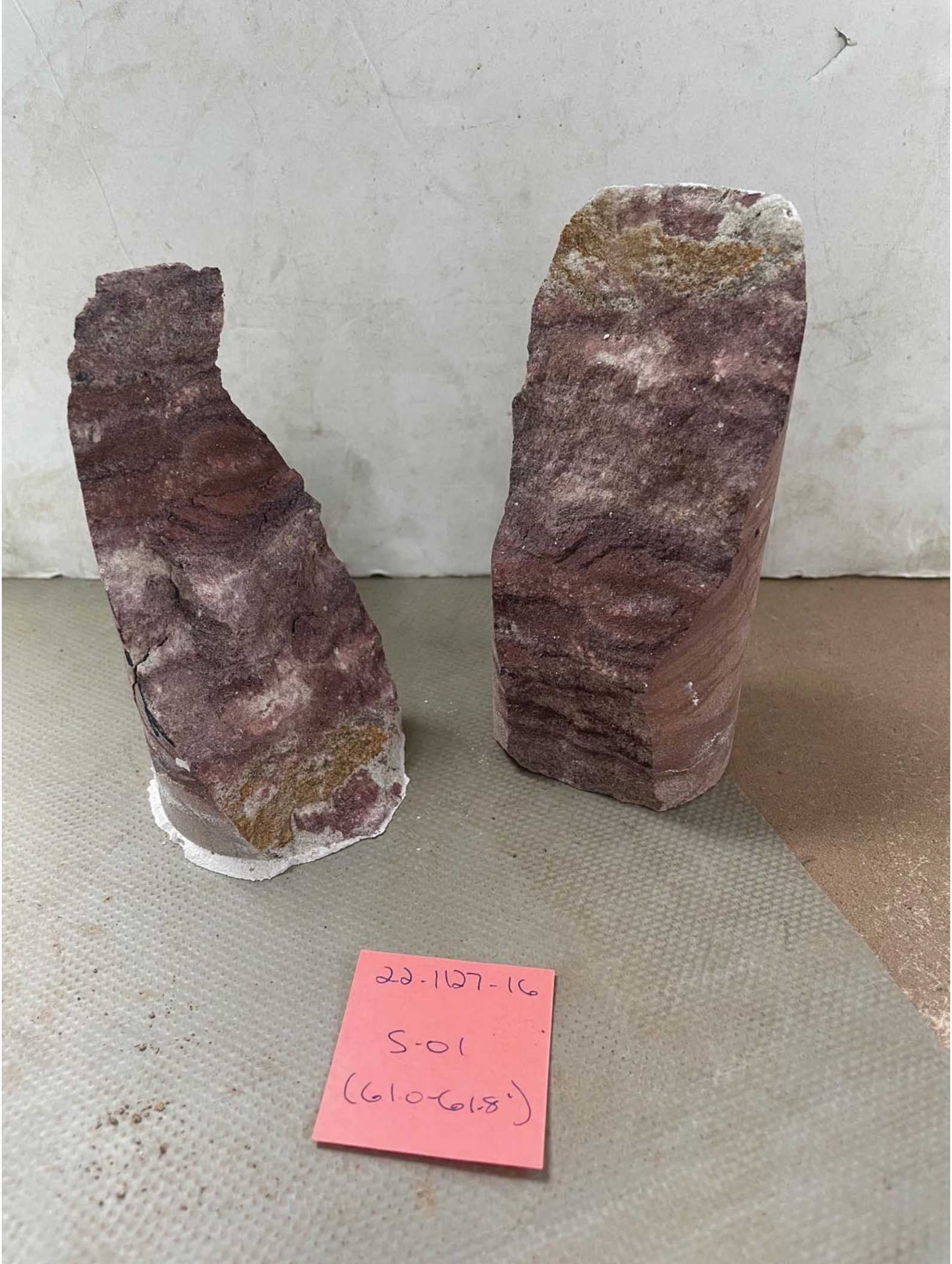
Test Parameter	Method	Result	Units	Levels
Sulfate	ARIZ 733b	3	ppm	
Chloride	ARIZ 736b	14	ppm	

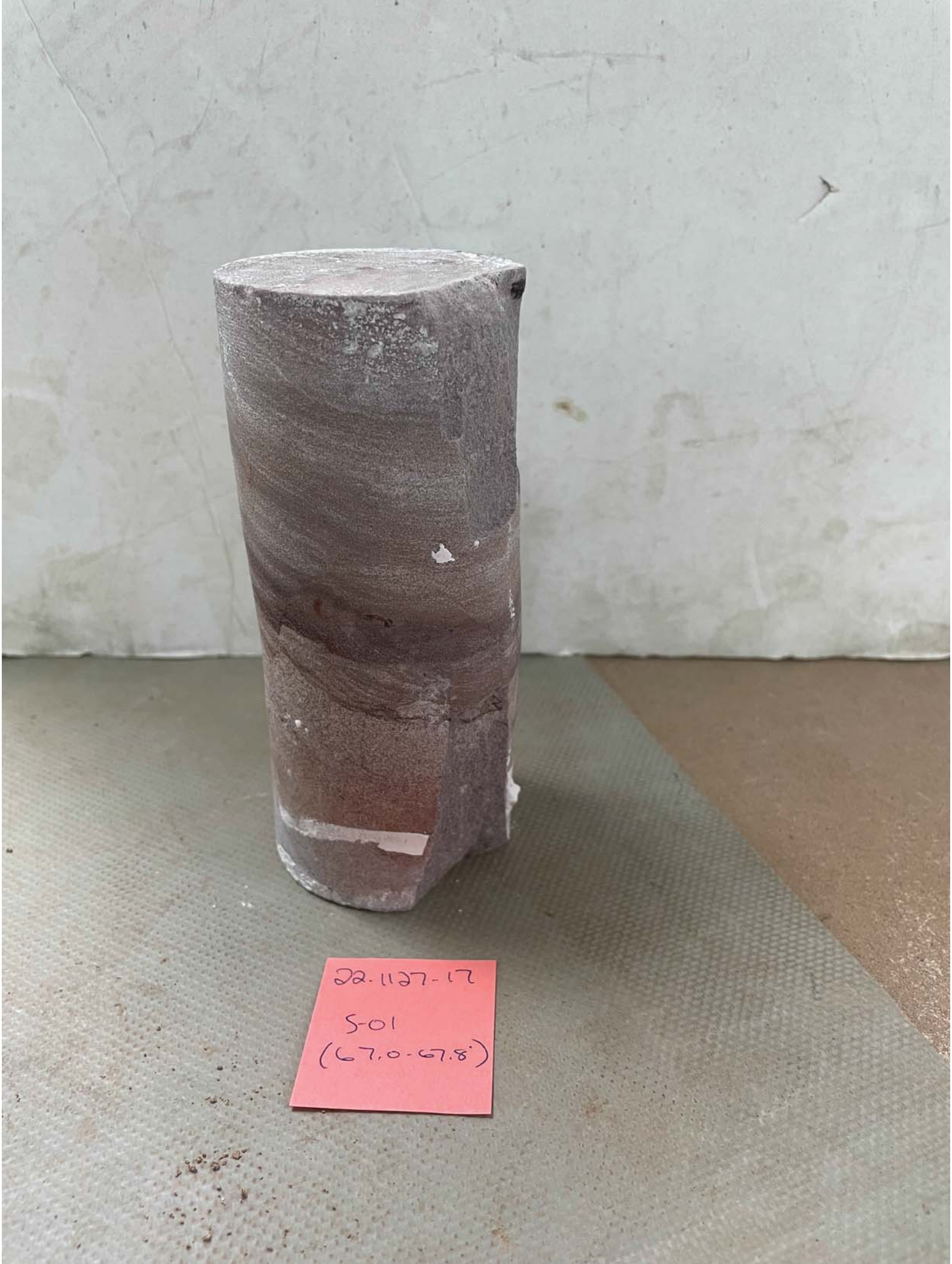
Lab Number: 940575-2 **22-1127-25 S-02 (19.5-21.0')**

Test Parameter	Method	Result	Units	Levels
Sulfate	ARIZ 733b	6	ppm	
Chloride	ARIZ 736b	60	ppm	

Lab Number: 940575-3 **22-1127-43 S-03 (14.5-16.0')**

Test Parameter	Method	Result	Units	Levels
Sulfate	ARIZ 733b	10	ppm	
Chloride	ARIZ 736b	44	ppm	


22-1127-16
S-01
(61.0-61.8')


22.1127-17
S-01
(67.0-67.8')

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2201139	Material Type:	Native
ACS Lab #	22-1399-4	Supplier:	-
Client:	Wood	Sample Date:	-
Project Name:	Allentown TI UP Bridge Rehabilitation	Sampled By:	Wood
Project Address:	3630 East Wier Avenue	Test Date:	2/14/2022
Project City	Phoenix	Tested By:	Brian Karl
Sample Location:	S-01 @ 19.5 - 21.0'	Reviewed By:	Dylan Ward

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

Sieve Size	% Retained	% Passed	Specs
6"	0	100	
3"	0	100	
2 1/2"	0	100	
2"	0	100	
1 1/2"	0	100	
1"	0	100	
3/4"	0	100	
1/2"	0	100	
3/8"	0	100	
1/4"	0	100	
#4	0	100	
#8	0	100	
#10	0	100	
#16	0	100	
#30	0	100	
#40	0	100	
#50	1	99	
#100	26	72	
#200	28	44.4	

Liquid Limit (AASHTO T-89)	
Plastic Limit (AASHTO T-90)	
Plasticity Index (AASHTO T-90)	NP
Moisture Content (AASHTO T-255)	7.6
USCS Soil Classification	SM

Group Name (ASTM D2487)
Silty SAND

*Testing sizes reduced from standard minimums due to lack of material

Dylan Ward
Laboratory Manager

Dylan Ward
Signature

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2201139	Material Type:	Native
ACS Lab #	22-1399-7	Supplier:	-
Client:	Wood	Sample Date:	-
Project Name:	Allentown TI UP Bridge Rehabilitation	Sampled By:	Wood
Project Address:	3630 East Wier Avenue	Test Date:	2/14/2022
Project City	Phoenix	Tested By:	Brian Karl
Sample Location:	S-01 @ 44.5 - 45.4'	Reviewed By:	Dylan Ward

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

Sieve Size	% Retained	% Passed	Specs
6"	0	100	
3"	0	100	
2 1/2"	0	100	
2"	0	100	
1 1/2"	0	100	
1"	0	100	
3/4"	3	97	
1/2"	7	90	
3/8"	6	84	
1/4"	8	76	
#4	5	71	
#8	9	62	
#10	2	60	
#16	5	55	
#30	10	45	
#40	5	40	
#50	4	36	
#100	6	30	
#200	6	23.8	

Liquid Limit (AASHTO T-89)	30
Plastic Limit (AASHTO T-90)	18
Plasticity Index (AASHTO T-90)	12
Moisture Content (AASHTO T-255)	9.2
USCS Soil Classification	SC

Group Name (ASTM D2487)
Clayey SAND with gravel

*Testing sizes reduced from standard minimums due to lack of material

Dylan Ward
Laboratory Manager

Dylan Ward
Signature

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2201139	Material Type:	Native
ACS Lab #	22-1399-8	Supplier:	-
Client:	Wood	Sample Date:	-
Project Name:	Allentown TI UP Bridge Rehabilitation	Sampled By:	Wood
Project Address:	3630 East Wier Avenue	Test Date:	2/14/2022
Project City	Phoenix	Tested By:	Brian Karl
Sample Location:	S-02 @ 2.5 - 4.0'	Reviewed By:	Dylan Ward

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

Sieve Size	% Retained	% Passed	Specs
6"	0	100	
3"	0	100	
2 1/2"	0	100	
2"	0	100	
1 1/2"	0	100	
1"	0	100	
3/4"	0	100	
1/2"	0	100	
3/8"	0	100	
1/4"	0	100	
#4	0	100	
#8	0	100	
#10	0	100	
#16	0	100	
#30	2	98	
#40	6	92	
#50	19	73	
#100	45	28	
#200	19	9.5	

Liquid Limit (AASHTO T-89)	
Plastic Limit (AASHTO T-90)	
Plasticity Index (AASHTO T-90)	NP
Moisture Content (AASHTO T-255)	2.9
USCS Soil Classification	SP-SM

Group Name (ASTM D2487)
Poorly graded SAND with silt

*Testing sizes reduced from standard minimums due to lack of material

Dylan Ward
Laboratory Manager

Dylan Ward
Signature

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2201139	Material Type:	Native
ACS Lab #	22-1399-15	Supplier:	-
Client:	Wood	Sample Date:	-
Project Name:	Allentown TI UP Bridge Rehabilitation	Sampled By:	Wood
Project Address:	3630 East Wier Avenue	Test Date:	2/14/2022
Project City	Phoenix	Tested By:	Fernando Montero
Sample Location:	S-03 @ 9.5 - 11.0'	Reviewed By:	Dylan Ward

Sieve Analysis (ASTM C-136 / AASHTO T-27 / ARIZ 201)			
Sieve Size	**% Retained**	**% Passed**	**Specs**
6"	0	100	
3"	0	100	
2 1/2"	0	100	
2"	0	100	
1 1/2"	0	100	
1"	0	100	
3/4"	0	100	
1/2"	0	100	
3/8"	0	100	
1/4"	0	100	
#4	0	100	
#8	0	100	
#10	0	100	
#16	0	100	
#30	1	99	
#40	2	97	
#50	6	91	
#100	53	38	
#200	22	15.6	

Liquid Limit (AASHTO T-89)	
Plastic Limit (AASHTO T-90)	
Plasticity Index (AASHTO T-90)	NP
Moisture Content (AASHTO T-255)	3.7
USCS Soil Classification	SM

Group Name (ASTM D2487)
Silty SAND

*Testing sizes reduced from standard minimums due to lack of material

Dylan Ward
Laboratory Manager

Dylan Ward
Signature

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2201139	Material Type:	Native
ACS Lab #	22-1399-18	Supplier:	-
Client:	Wood	Sample Date:	-
Project Name:	Allentown TI UP Bridge Rehabilitation	Sampled By:	Wood
Project Address:	3630 East Wier Avenue	Test Date:	2/14/2022
Project City	Phoenix	Tested By:	Brian Karl
Sample Location:	S-03 @ 49.5 - 50.5'	Reviewed By:	Dylan Ward

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

Sieve Size	% Retained	% Passed	Specs
6"	0	100	
3"	0	100	
2 1/2"	0	100	
2"	0	100	
1 1/2"	0	100	
1"	0	100	
3/4"	0	100	
1/2"	0	100	
3/8"	0	100	
1/4"	0	100	
#4	0	100	
#8	0	100	
#10	0	100	
#16	0	100	
#30	0	100	
#40	0	100	
#50	0	100	
#100	2	98	
#200	19	78.7	

Liquid Limit (AASHTO T-89)	25
Plastic Limit (AASHTO T-90)	19
Plasticity Index (AASHTO T-90)	6
Moisture Content (AASHTO T-255)	26.5
USCS Soil Classification	CL-ML

Group Name (ASTM D2487)
SILTY CLAY with sand

*Testing sizes reduced from standard minimums due to lack of material

Dylan Ward
Laboratory Manager

Dylan Ward
Signature

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2201139	Material Type:	Native
ACS Lab #	22-1399-2	Supplier:	-
Client:	Wood	Sample Date:	-
Project Name:	Allentown TI UP Bridge Rehabilitation	Sampled By:	Wood
Project Address:	3630 East Wier Avenue	Test Date:	2/14/2022
Project City	Phoenix	Tested By:	Brian Karl
Sample Location:	S-01 @ 4.5 - 6.0'	Reviewed By:	Dylan Ward

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

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

Liquid Limit (AASHTO T-89)	
Plastic Limit (AASHTO T-90)	
Plasticity Index (AASHTO T-90)	
Moisture Content (AASHTO T-255)	10.2
USCS Soil Classification	

Group Name (ASTM D2487)

Dylan Ward
Laboratory Manager

Dylan Ward
Signature

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2201139	Material Type:	Native
ACS Lab #	22-1399-3	Supplier:	-
Client:	Wood	Sample Date:	-
Project Name:	Allentown TI UP Bridge Rehabilitation	Sampled By:	Wood
Project Address:	3630 East Wier Avenue	Test Date:	2/14/2022
Project City	Phoenix	Tested By:	Brian Karl
Sample Location:	S-01 @ 14.5 - 16.0'	Reviewed By:	Dylan Ward

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

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

Liquid Limit (AASHTO T-89)	
Plastic Limit (AASHTO T-90)	
Plasticity Index (AASHTO T-90)	
Moisture Content (AASHTO T-255)	4.7
USCS Soil Classification	

Group Name (ASTM D2487)

Dylan Ward
Laboratory Manager

Dylan Ward
Signature

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2201139	Material Type:	Native
ACS Lab #	22-1399-9	Supplier:	-
Client:	Wood	Sample Date:	-
Project Name:	Allentown TI UP Bridge Rehabilitation	Sampled By:	Wood
Project Address:	3630 East Wier Avenue	Test Date:	2/14/2022
Project City	Phoenix	Tested By:	Brian Karl
Sample Location:	S-02 @ 9.5 - 11.0'	Reviewed By:	Dylan Ward

Sieve Analysis (ASTM C-136 / AASHTO T-27 / ARIZ 201)			
Sieve Size	**% Retained**	**% Passed**	**Specs**
6"			
3"			
2 1/2"			
2"			
1 1/2"			
1"			
3/4"			
1/2"			
3/8"			
1/4"			
#4			
#8			
#10			
#16			
#30			
#40			
#50			
#100			
#200			

Liquid Limit (AASHTO T-89)	
Plastic Limit (AASHTO T-90)	
Plasticity Index (AASHTO T-90)	
Moisture Content (AASHTO T-255)	5.5
USCS Soil Classification	

Group Name (ASTM D2487)

Dylan Ward
Laboratory Manager

Dylan Ward
Signature

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2201139	Material Type:	Native
ACS Lab #	22-1399-11	Supplier:	-
Client:	Wood	Sample Date:	-
Project Name:	Allentown TI UP Bridge Rehabilitation	Sampled By:	Wood
Project Address:	3630 East Wier Avenue	Test Date:	2/14/2022
Project City	Phoenix	Tested By:	Brian Karl
Sample Location:	S-02 @ 24.5 - 26.0'	Reviewed By:	Dylan Ward

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

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

Liquid Limit (AASHTO T-89)	
Plastic Limit (AASHTO T-90)	
Plasticity Index (AASHTO T-90)	
Moisture Content (AASHTO T-255)	14.3
USCS Soil Classification	

Group Name (ASTM D2487)

Dylan Ward
Laboratory Manager

Dylan Ward
Signature

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2201139	Material Type:	Native
ACS Lab #	22-1399-12	Supplier:	-
Client:	Wood	Sample Date:	-
Project Name:	Allentown TI UP Bridge Rehabilitation	Sampled By:	Wood
Project Address:	3630 East Wier Avenue	Test Date:	2/14/2022
Project City	Phoenix	Tested By:	Brian Karl
Sample Location:	S-02 @ 39.5 - 41.0'	Reviewed By:	Dylan Ward

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

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

Liquid Limit (AASHTO T-89)	
Plastic Limit (AASHTO T-90)	
Plasticity Index (AASHTO T-90)	
Moisture Content (AASHTO T-255)	10.1
USCS Soil Classification	

Group Name (ASTM D2487)

Dylan Ward
Laboratory Manager

Dylan Ward
Signature

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2201139	Material Type:	Native
ACS Lab #	22-1399-17	Supplier:	-
Client:	Wood	Sample Date:	-
Project Name:	Allentown TI UP Bridge Rehabilitation	Sampled By:	Wood
Project Address:	3630 East Wier Avenue	Test Date:	2/14/2022
Project City	Phoenix	Tested By:	Brian Karl
Sample Location:	S-03 @ 24.5 - 26.0'	Reviewed By:	Dylan Ward

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

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

Liquid Limit (AASHTO T-89)	
Plastic Limit (AASHTO T-90)	
Plasticity Index (AASHTO T-90)	
Moisture Content (AASHTO T-255)	5.8
USCS Soil Classification	

Group Name (ASTM D2487)

Dylan Ward
Laboratory Manager

Dylan Ward
Signature

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2201139	Material Type:	Native
ACS Lab #	22-1399-19	Supplier:	-
Client:	Wood	Sample Date:	-
Project Name:	Allentown TI UP Bridge Rehabilitation	Sampled By:	Wood
Project Address:	3630 East Wier Avenue	Test Date:	2/14/2022
Project City	Phoenix	Tested By:	Brian Karl
Sample Location:	S-03 @ 59.5 - 61.0'	Reviewed By:	Dylan Ward

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

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

Liquid Limit (AASHTO T-89)	
Plastic Limit (AASHTO T-90)	
Plasticity Index (AASHTO T-90)	
Moisture Content (AASHTO T-255)	20.4
USCS Soil Classification	

Group Name (ASTM D2487)

Dylan Ward
Laboratory Manager

Dylan Ward
Signature

ACS Services LLC

Job #	2201139	Material Type:	Native
Lab #	22-1399	Extraction Date:	-
Client:	Wood	Extracted By:	Client
Project Name:	Allentown TI UP Bridge Rehabilitation	Laboratory Test Date	2/14/2022
Project Address:	3630 East Wier Avenue	Laboratory Tested By:	Fernando Montero
Project City:	Phoenix	Reviewed By:	Dylan Ward
Material Source:	-		

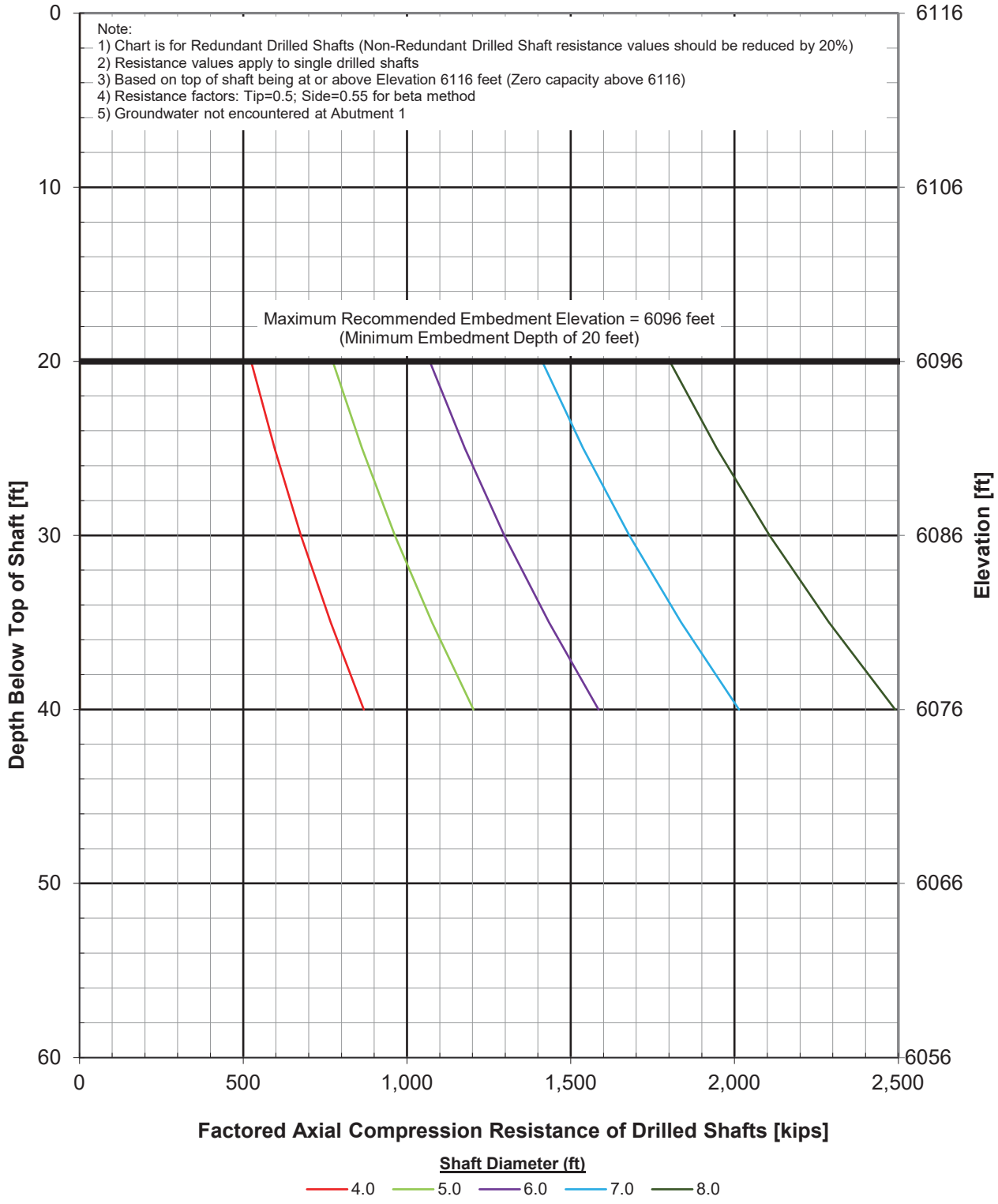
Density of Soil in Place by the Drive-Cylinder Method (ASTM D2937)

ID #	Sample Location	Wet Wt. (g)	Moisture Dry Wt. (g)	**Moist Content**	# Of Rings	Wet Wt'+Rings (g)	Wt. of Rings (g)	**Dry Density (pcf)**
22-1399-1	S-01 @ 2.3 - 3.5'	507.7	485.2	4.6%	4	686.9	179.2	100.4
22-1399-5	S-01 @ 24.5 - 25.5'	573.4	487.2	17.7%	4	751.5	178.1	100.9
22-1399-6	S-01 @ 39.5 - 40.5'	695.8	640.7	8.6%	5	916.5	220.7	106.1
22-1399-10	S-02 @ 14.5 - 15.5'	596.7	479.4	24.5%	4	767	170.3	99.2
22-1399-13	S-02 @ 44.5 - 45.5'	610	497.3	22.7%	4	788.2	178.2	102.9
22-1399-14	S-03 @ 4.5 - 5.5'	802.2	770.2	4.2%	6	1073.1	270.9	106.3
22-1399-16	S-03 @ 19.5 - 20.5'	843.1	728.9	15.7%	6	1103.9	260.8	100.6
22-1399-18	S-03 @ 49.5 - 50.5	594.6	469.9	26.5%	4	772.1	177.5	97.3

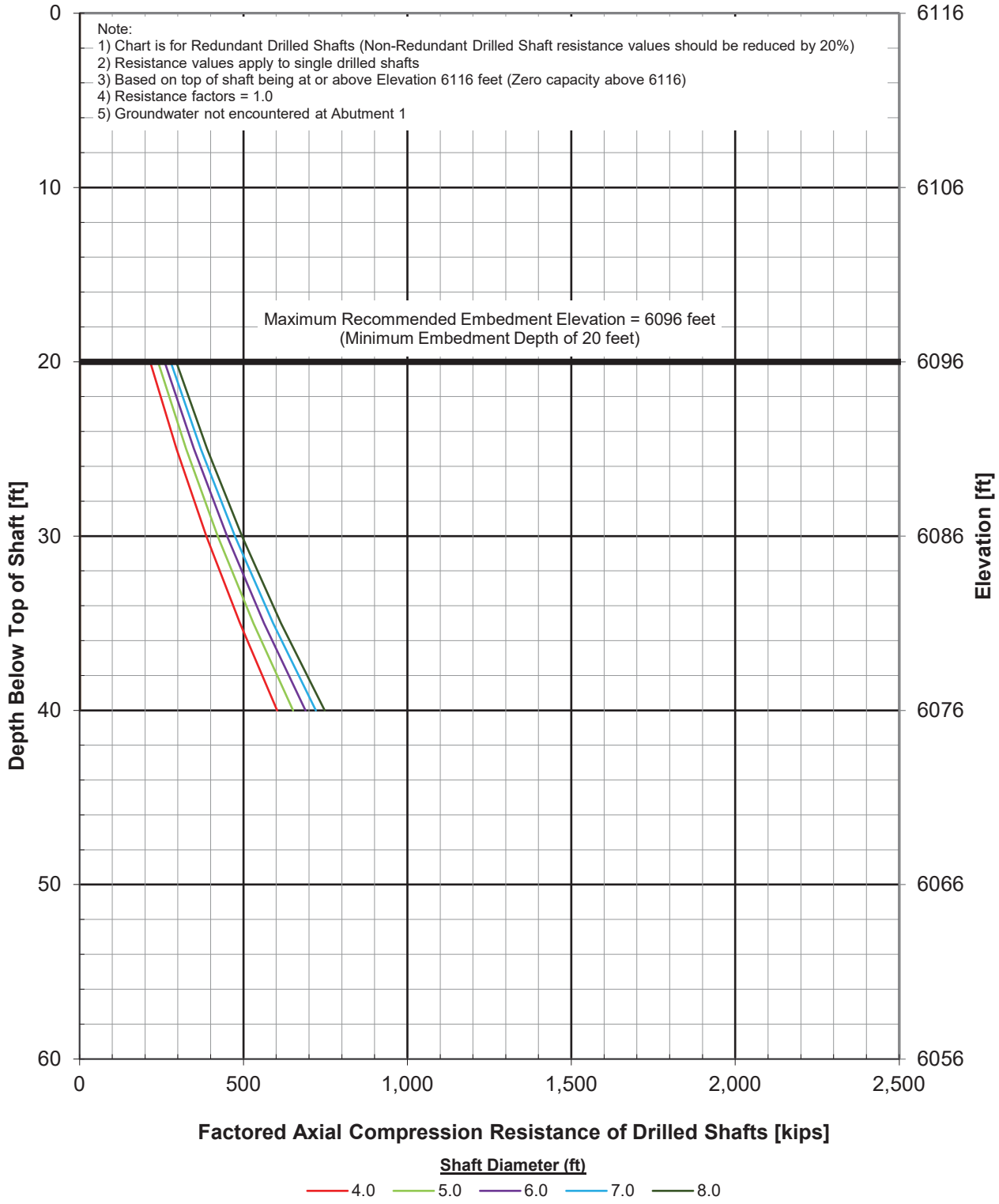
APPENDIX C

Drilled Shaft Axial Resistance Design Charts

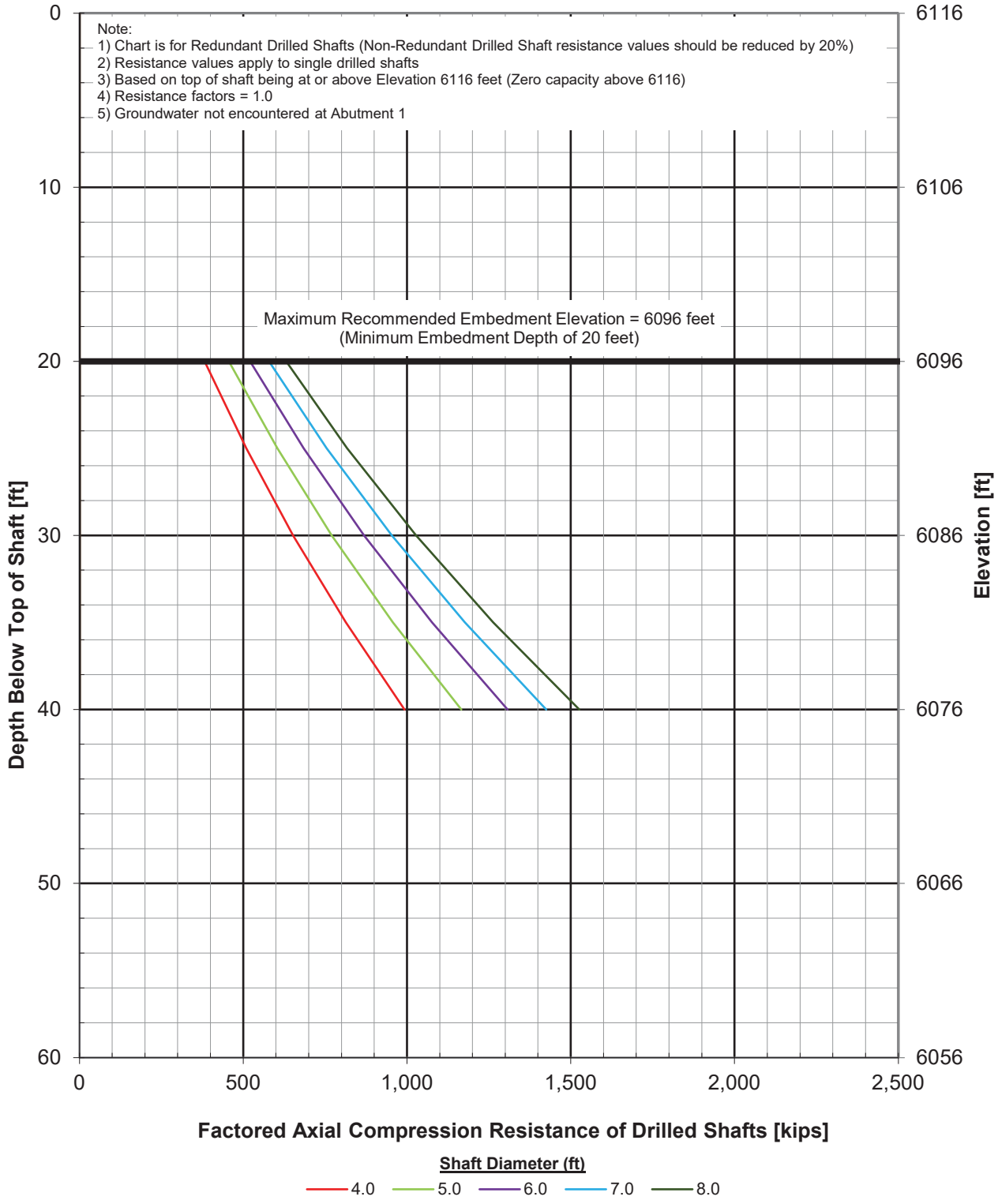
Design Chart 1 - STRENGTH LIMIT
Allentown Bridge over I-40
Abutment 1



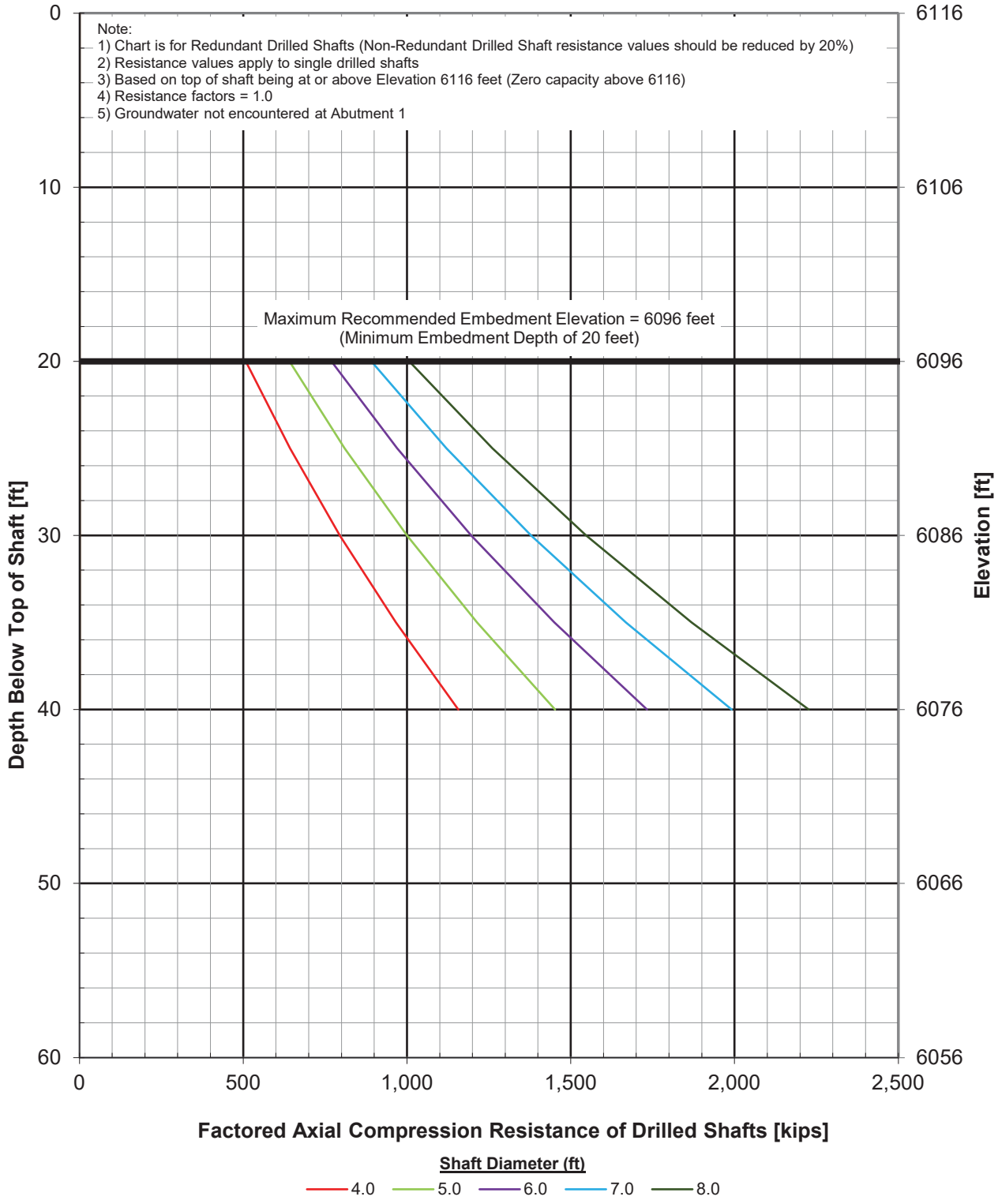
Design Chart 2A - SERVICE LIMIT AT 0.10 INCHES
Allentown Bridge over I-40
Abutment 1



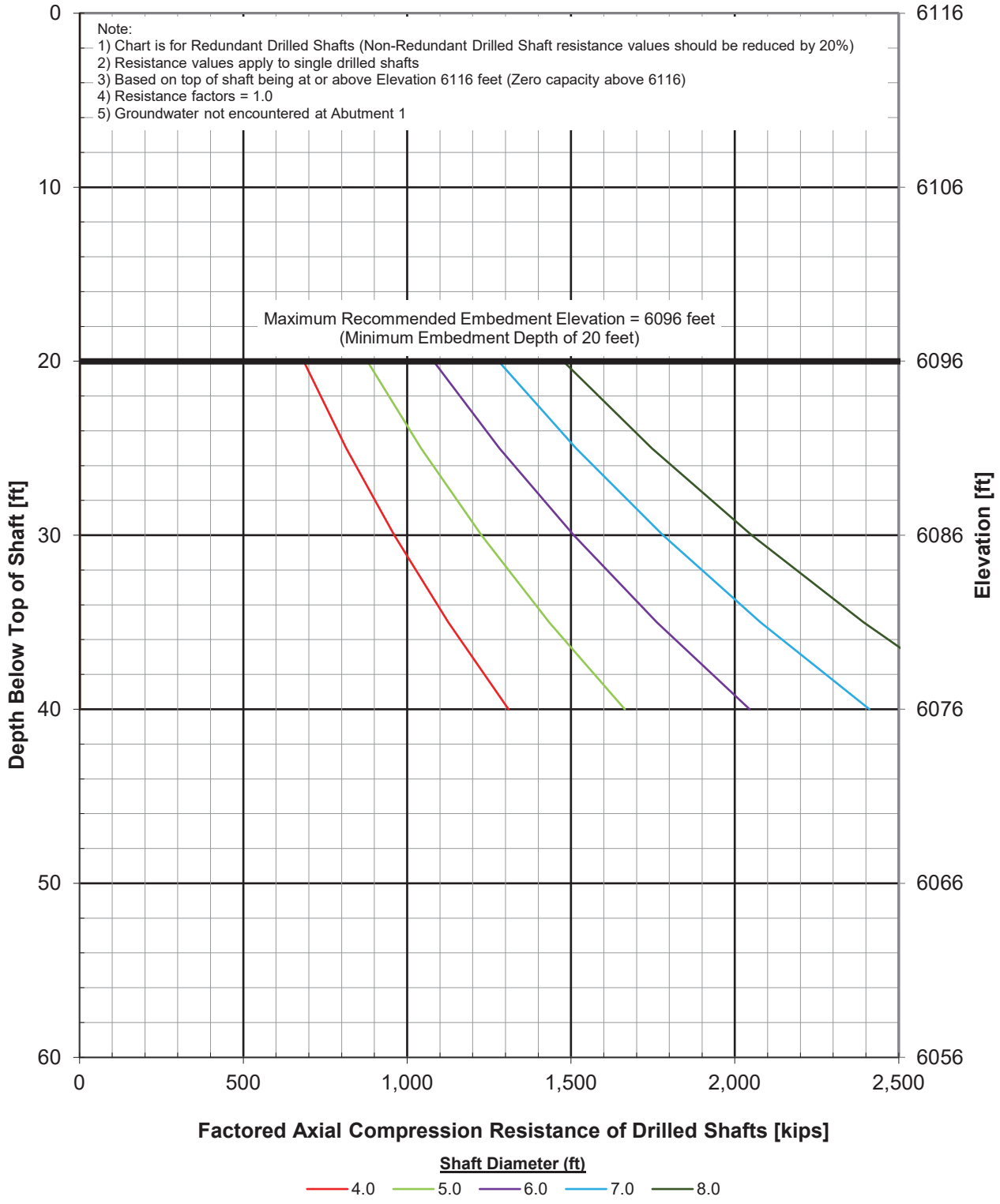
Design Chart 2B - SERVICE LIMIT AT 0.25 INCHES
Allentown Bridge over I-40
Abutment 1



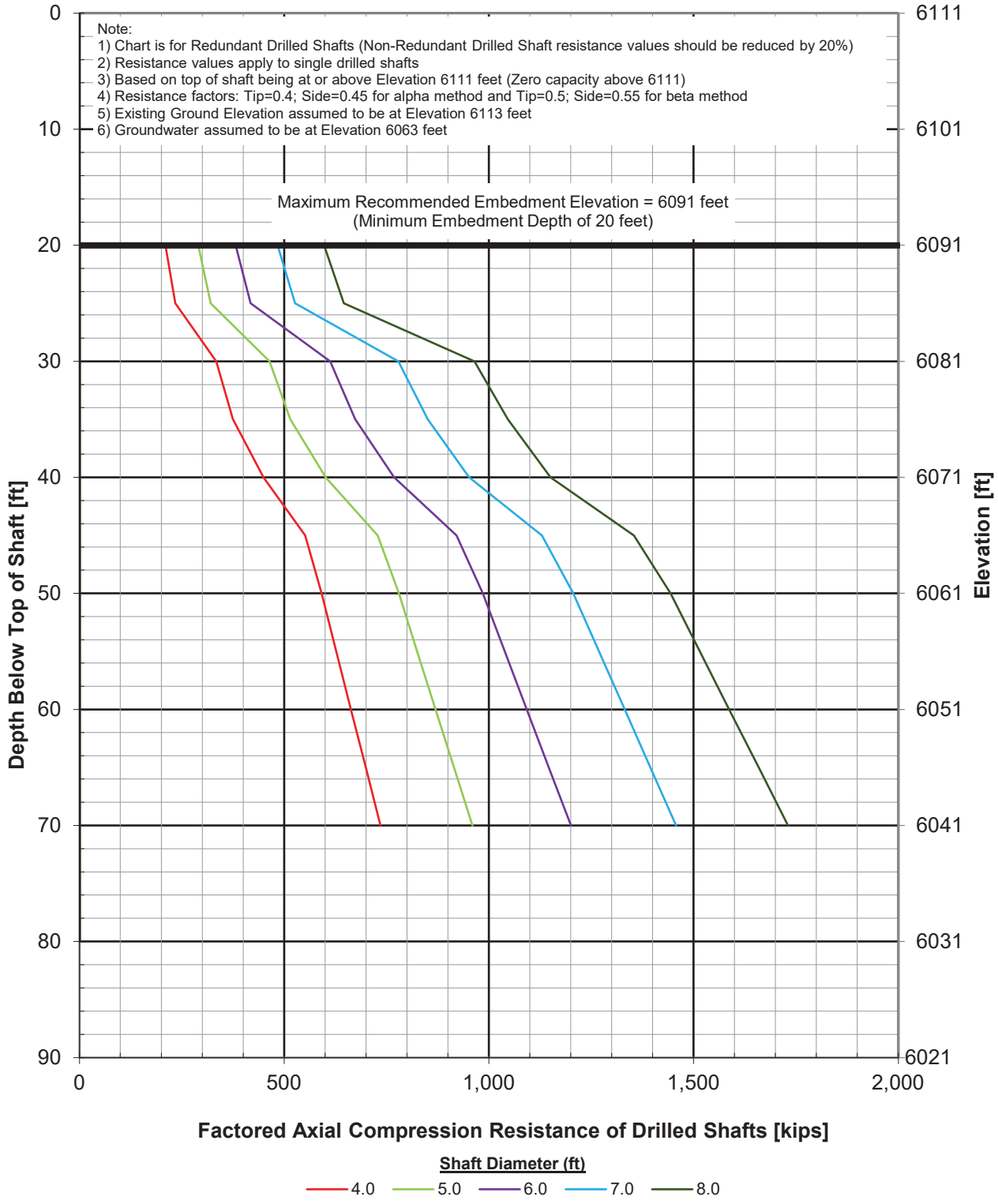
Design Chart 2C - SERVICE LIMIT AT 0.50 INCHES
Allentown Bridge over I-40
Abutment 1



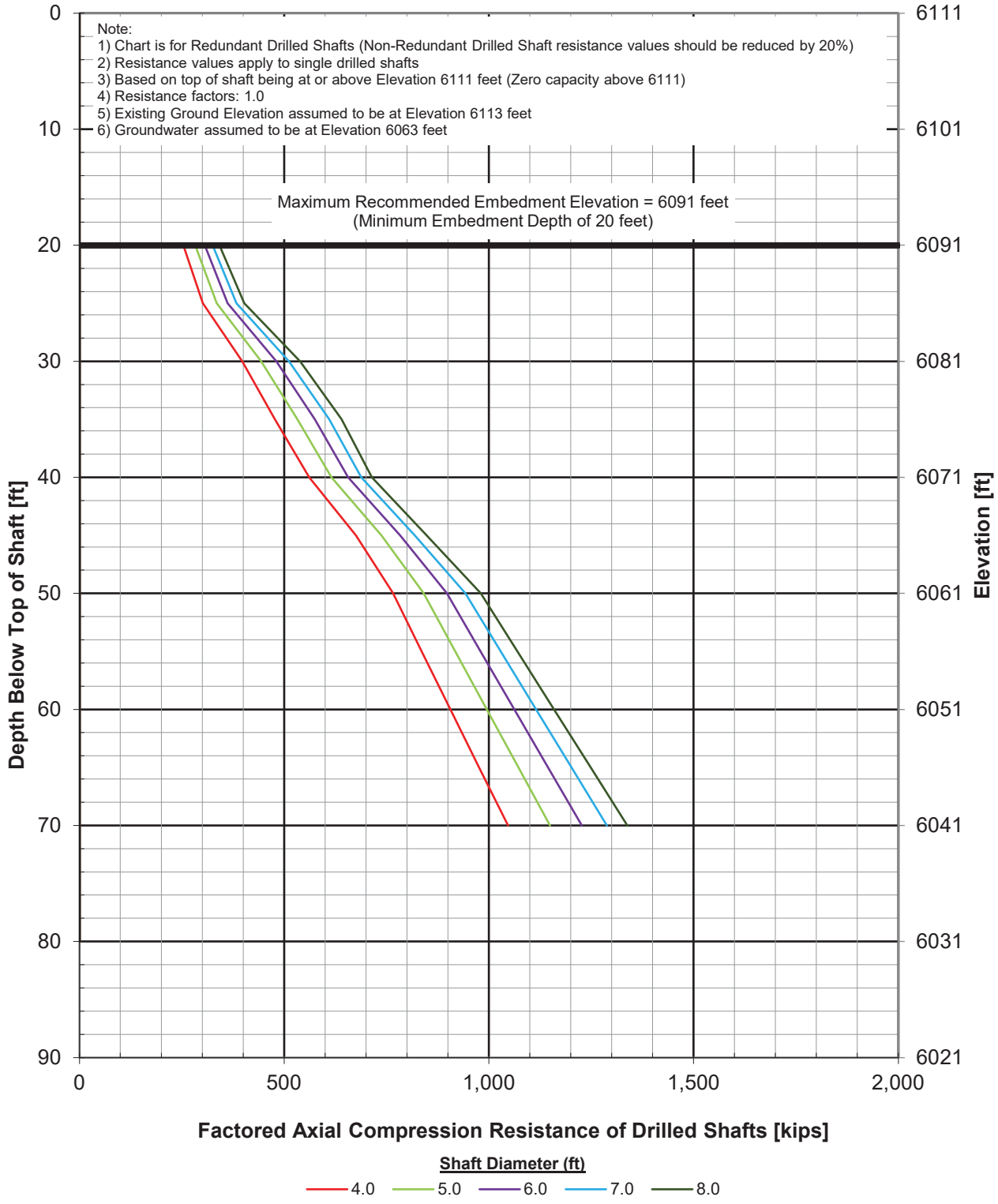
Design Chart 2D - SERVICE LIMIT AT 1.0 INCH
Allentown Bridge over I-40
Abutment 1



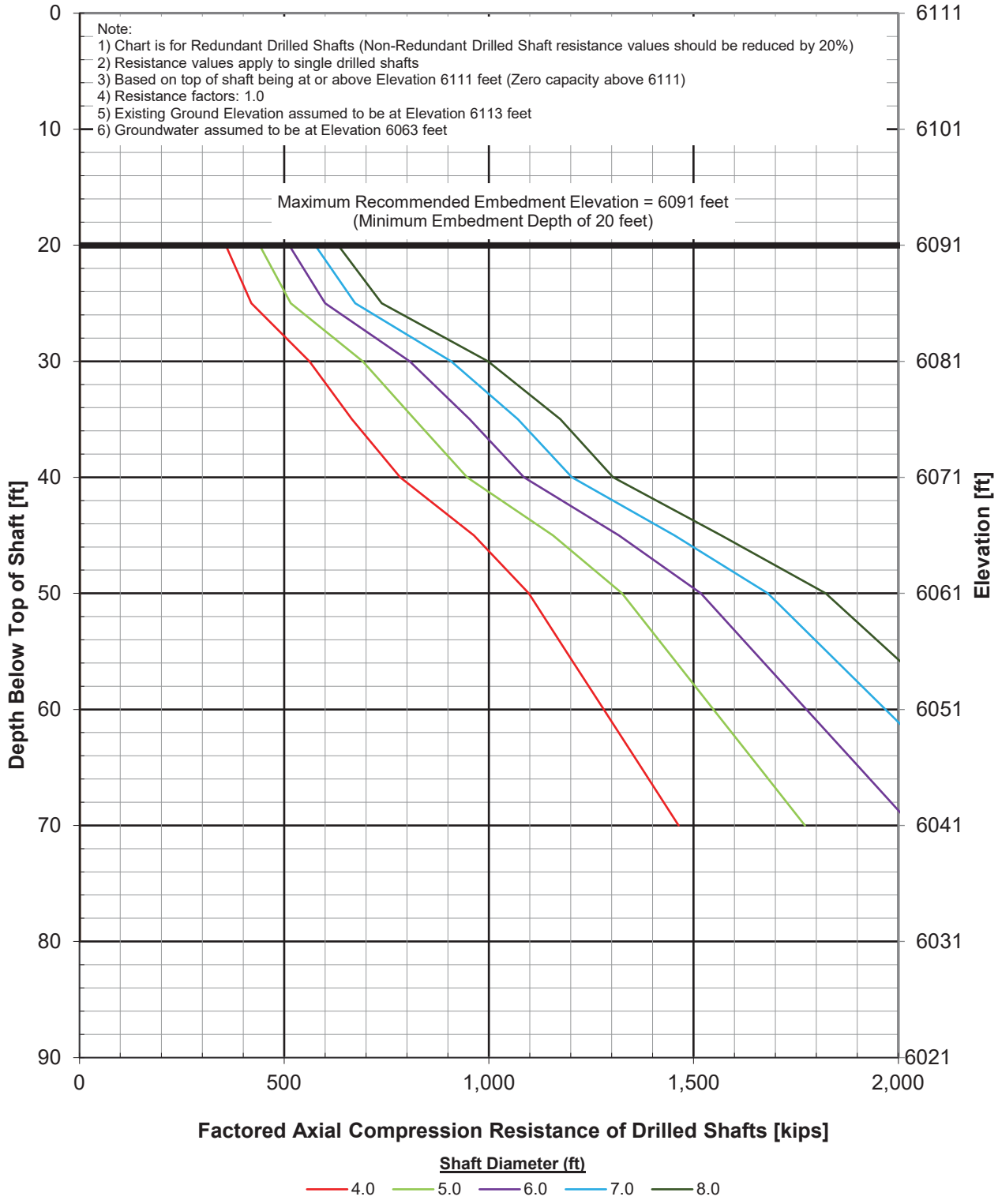
Design Chart 3 - STRENGTH LIMIT
Allentown Bridge over I-40
Pier



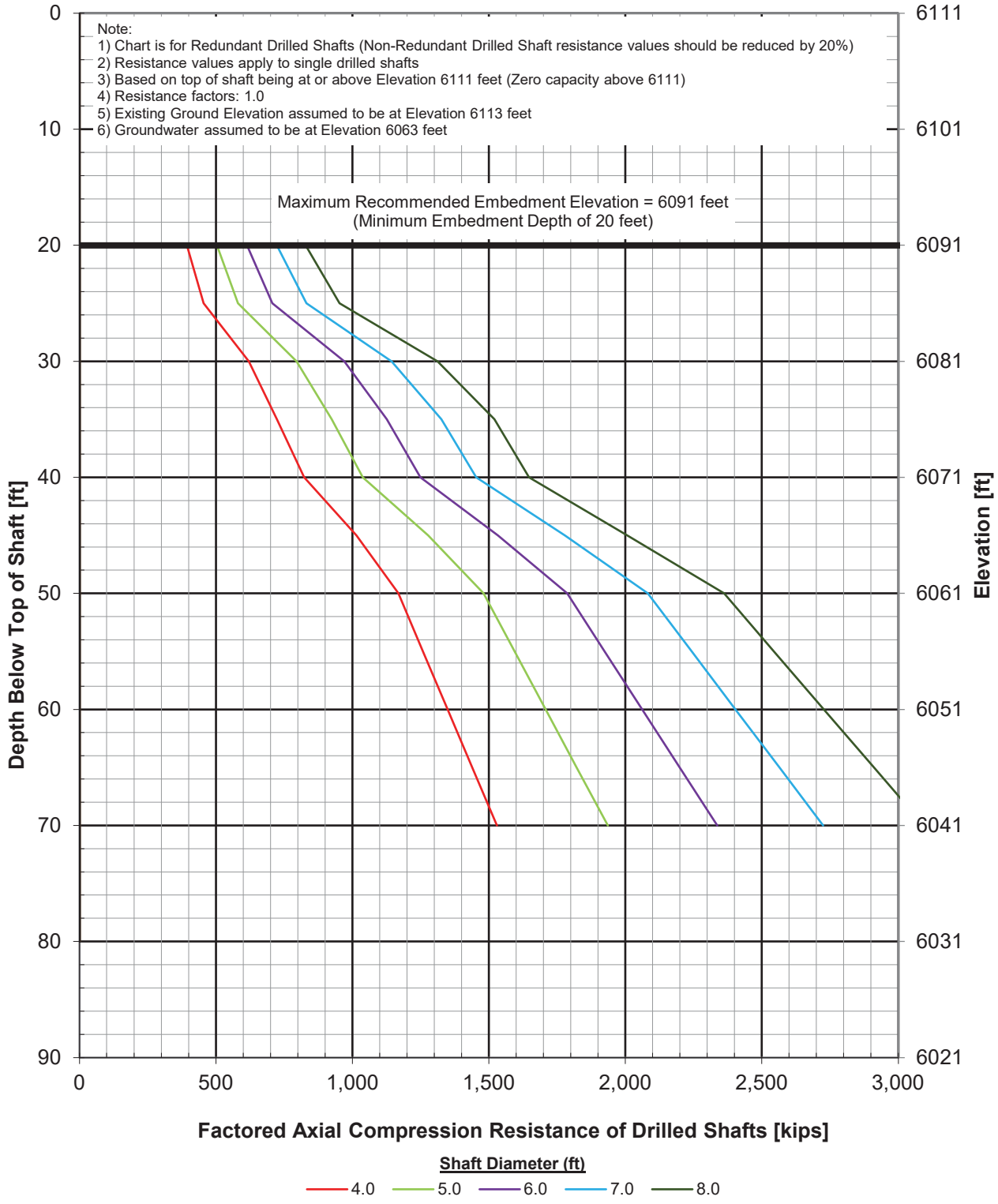
Design Chart 4A - SERVICE LIMIT AT 0.10 INCHES
Allentown Bridge over I-40
Pier



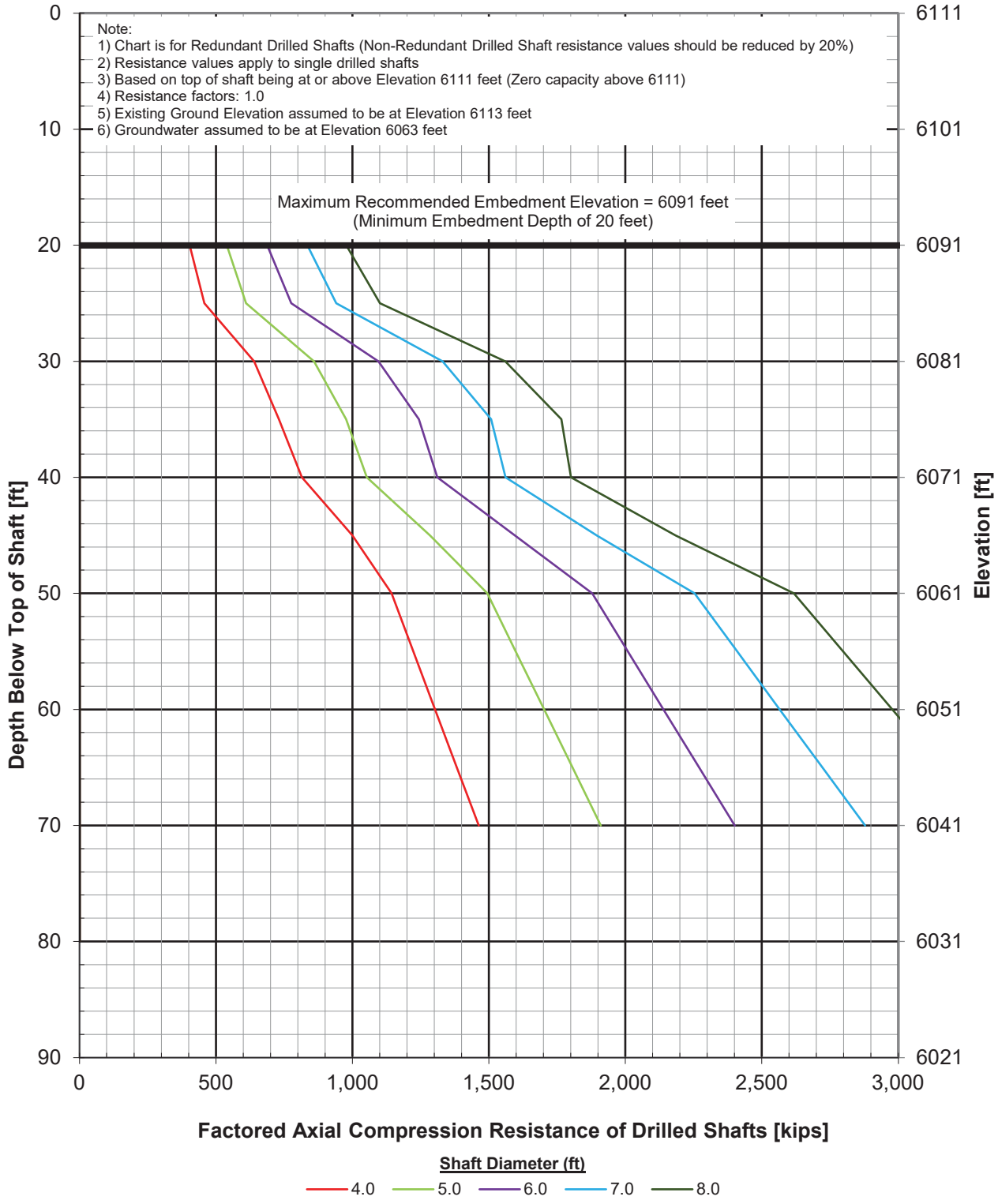
Design Chart 4B - SERVICE LIMIT AT 0.25 INCHES
Allentown Bridge over I-40
Pier



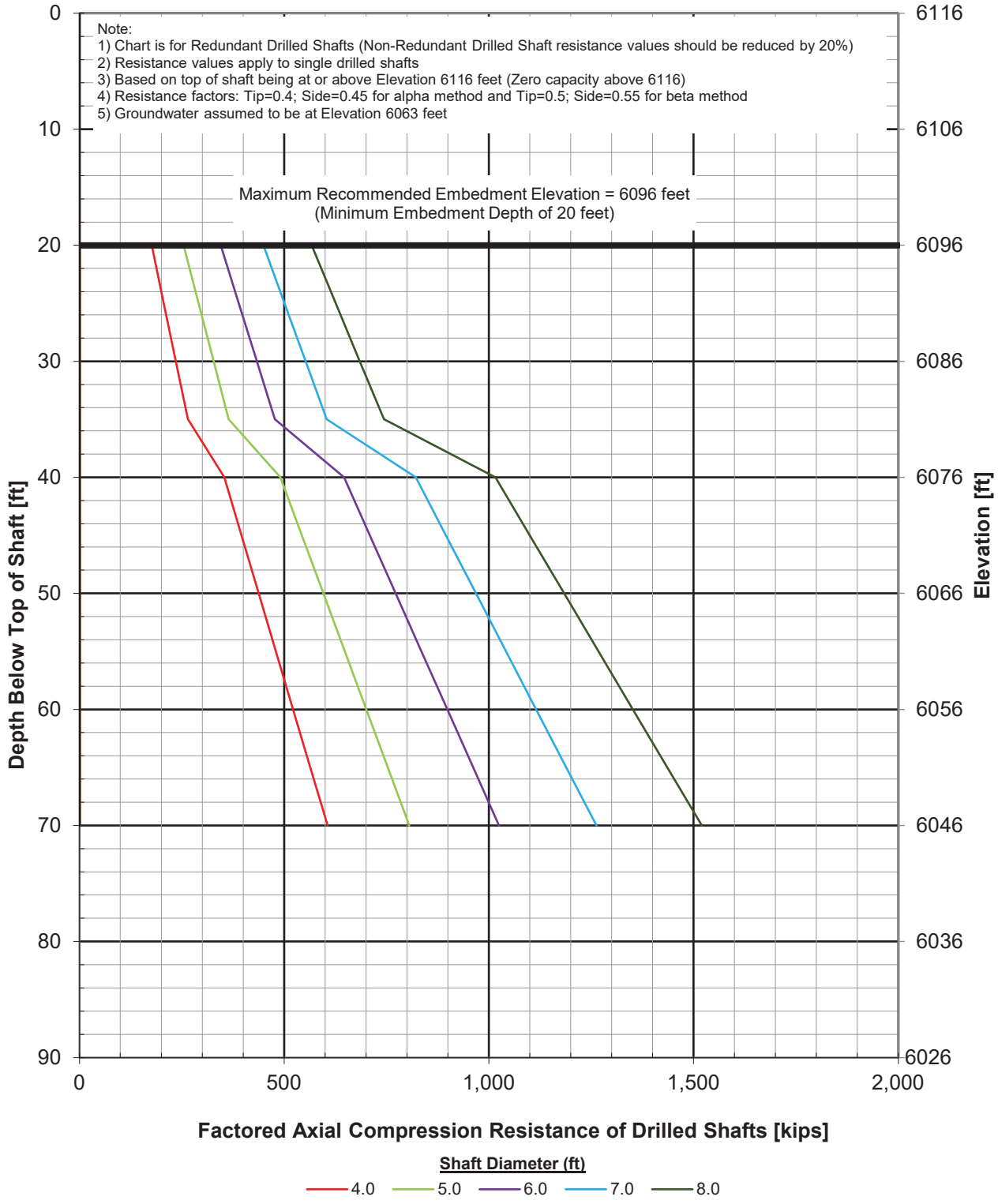
Design Chart 4C - SERVICE LIMIT AT 0.50 INCHES
Allentown Bridge over I-40
Pier



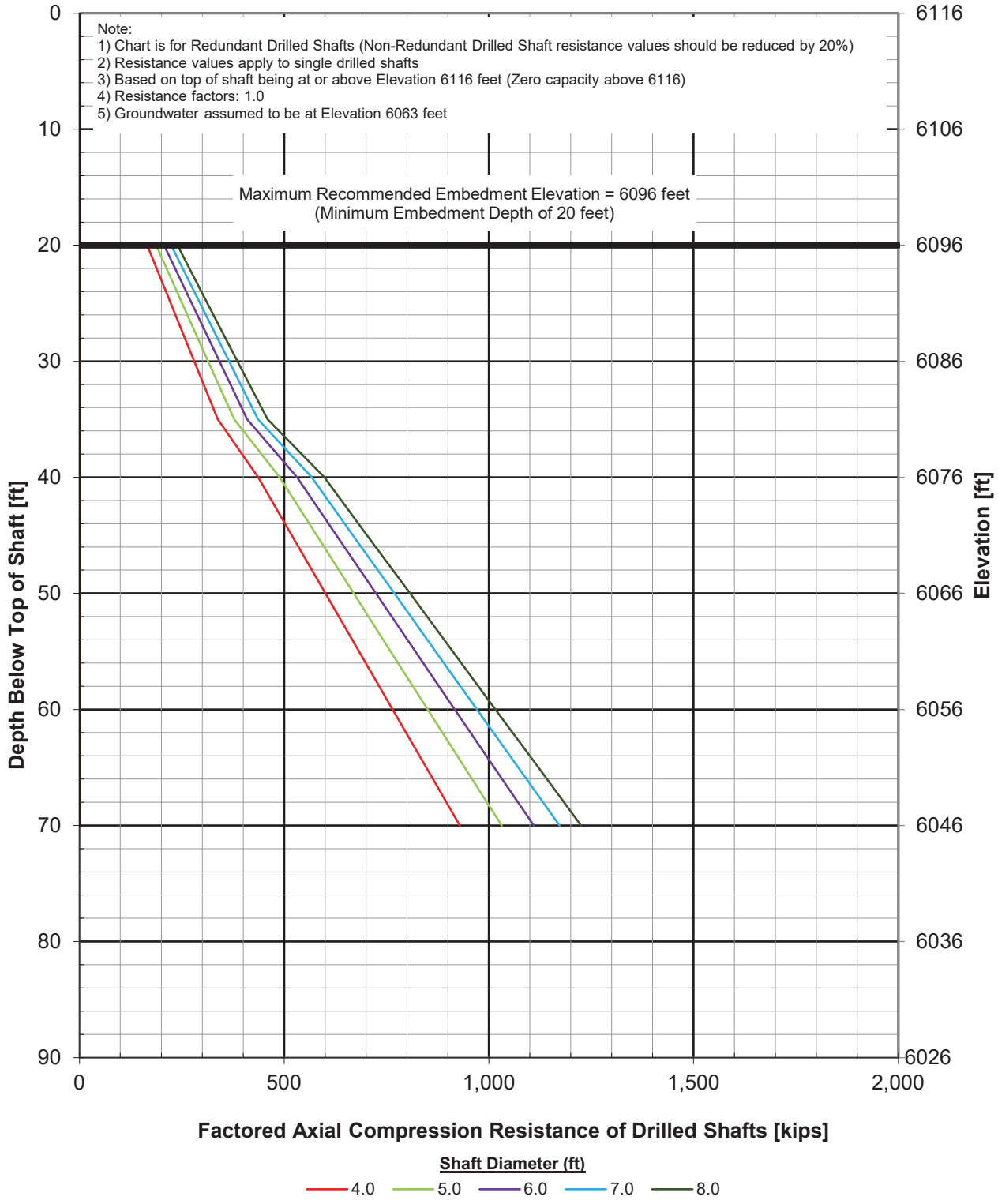
Design Chart 4D - SERVICE LIMIT AT 1.0 INCH
Allentown Bridge over I-40
Pier



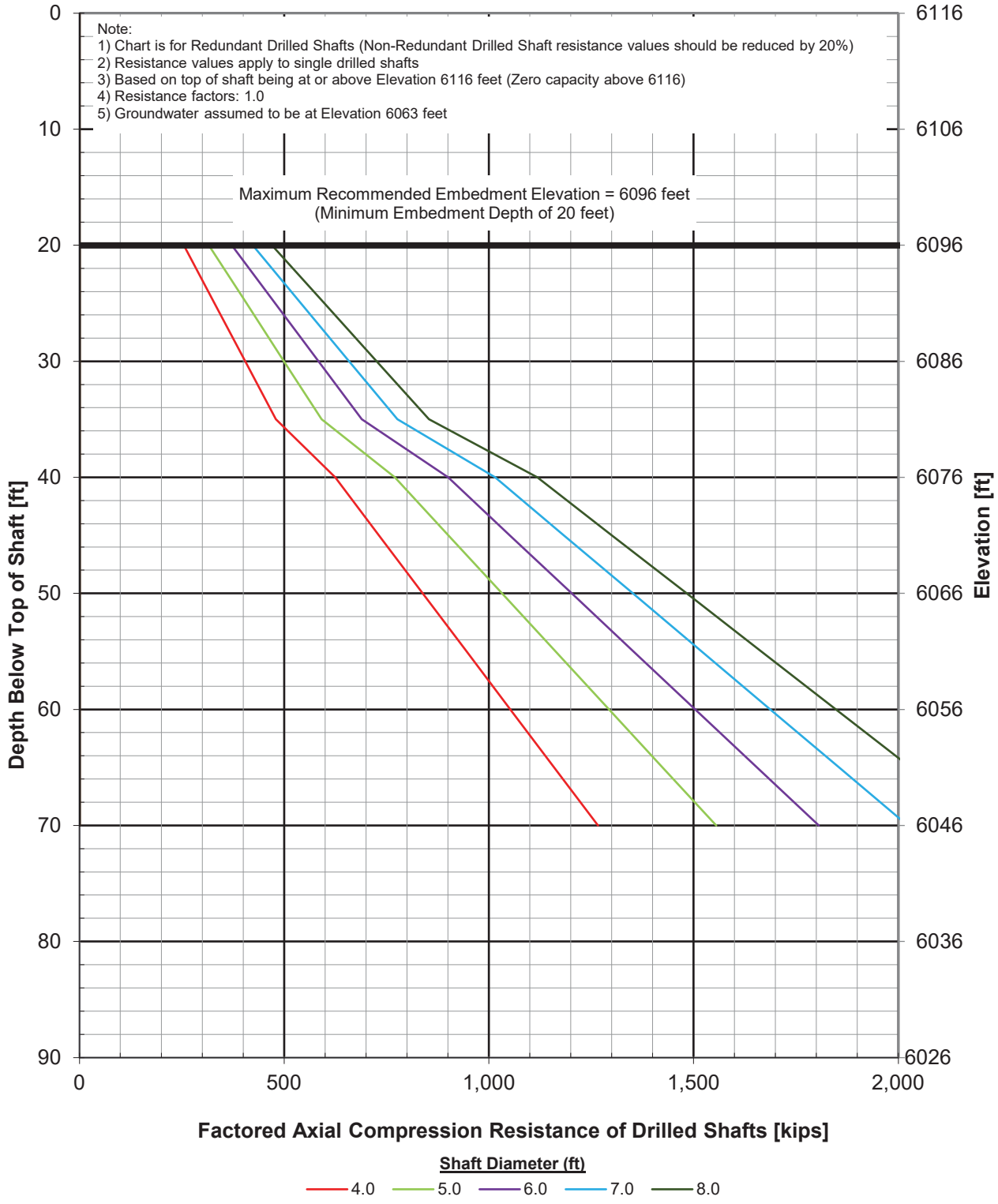
Design Chart 5 - STRENGTH LIMIT
Allentown Bridge over I-40
Abutment 2



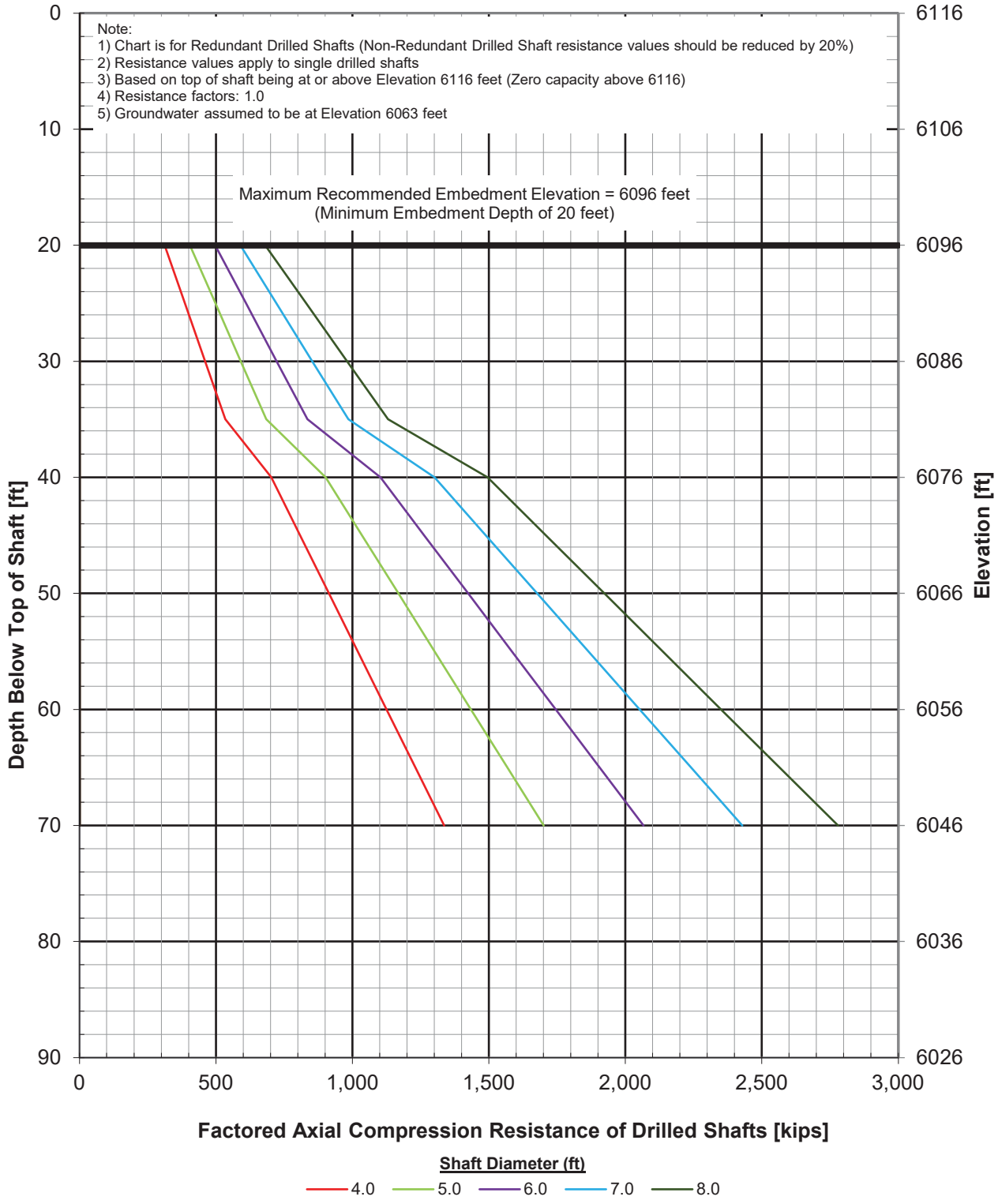
Design Chart 6A - SERVICE LIMIT AT 0.10 INCHES
Allentown Bridge over I-40
Abutment 2



Design Chart 6B - SERVICE LIMIT AT 0.25 INCHES
Allentown Bridge over I-40
Abutment 2



Design Chart 6C - SERVICE LIMIT AT 0.50 INCHES
Allentown Bridge over I-40
Abutment 2



Design Chart 6D - SERVICE LIMIT AT 1.0 INCH
Allentown Bridge over I-40
Abutment 2