Preliminary Geotechnical Investigation for Route 19 Bridges at Round Spring

J9P3305
Route 19 Bridges at Round Spring
Shannon County, Missouri

for
Missouri Department of Transportation

June 22, 2022

GeoEngineers
Earth Science + Technology

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File No. 15273-022-01

June 22, 2022

Prepared for:

Missouri Department of Transportation
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Table of Contents

LIST OF FIGURES

APPENDICES

1.0 INTRODUCTION AND PROJECT UNDERSTANDING

GeoEngineers, Inc. (GeoEngineers) has prepared this report for the Missouri Department of Transportation (MoDOT) documenting our preliminary geotechnical investigation for the Route 19 Bridges at Round Spring project. Work to complete this project was conducted in general accordance with MOU No. 2022-02-68210, executed on March 3, 2022. The site location is shown on the attached Vicinity Map, Figure 1.

We completed a preliminary geotechnical investigation for the subject project. The project is located at the Route 19, Spring Valley Bridge in Shannon County, Missouri, approximately 5.5 miles north of Route D on Highway 19. The purpose of the project was to investigate areas identified as anomalies by Collier Geophysics, LLC (a subcontractor to HG Consult) in the geophysical survey performed near the Spring Valley Creek and Round Spring in August, 2021 (Collier, 2021). The Collier geophysics report was included as part of a Karst Review by Olsson (Olsson, 2021), which recommended the geotechnical borings included in this report. We anticipate that additional geotechnical investigation work will be required for bridge foundation engineering and design. The location of the completed borings are shown on the attached Boring Location Map, Figure 2.

2.0 SCOPE OF SERVICES

The purpose of our services was to evaluate the existing subsurface soil, rock, and groundwater conditions by conducting a geotechnical investigation, performing downhole video investigation of the completed boreholes, and monitoring groundwater conditions at Round Spring during drilling operations for Borings B-2 and B-4. The specific scope of services provided by GeoEngineers included the following:

1. Completed site reconnaissance at the site to evaluate boring locations and site access.
2. Conducted a field exploration program by completing a total of 4 borings located at four anomalies identified in a geophysical survey and summarized in the Olsson Karst report (Olsson 2021). The four geotechnical borings were advanced from the ground surface using hollow stem augers and standard penetration testing (SPT) sampling methods using a calibrated automatic hammer on 5' intervals. Below the bedrock contact, rock was cored to depths of up to 75 feet below bedrock contact. (Drilling was completed by our subcontractor Anderson Engineering).
3. Logged the borings, recorded ground water levels at the time of our investigation and obtained samples of the soil and rock encountered during our exploration.
4. Performed SPT and split-barrel sampling in general accordance with ASTM D1586 using an automatic hammer. Gradation samples, moisture samples and pocket penetrometer readings were collected from the SPT samples, as applicable. Bedrock was cored with an NX size core barrel, photographed, and placed in labeled core boxes. Samples were taken from the rock core at approximately 5-foot intervals for unconfined compressive testing.
5. Attempted to obtain video imagery in the bedrock portion of each borehole using downhole video equipment.
6. Monitored water quality parameters (turbidity, pH, specific conductance, dissolved oxygen, oxygen-reduction potential and temperature) at Round Spring during drilling of Borings 2 and 4 which, based

upon the initial geophysical survey interpretation, could potentially have voids with the most direct hydraulic connection to Round Spring.

7. Backfilled the boreholes full-depth using bentonite chips upon completion.
8. Completed a laboratory testing program on samples obtained from the borings to evaluate pertinent engineering properties (testing completed by our subcontractor Anderson Engineering). The tests included the following:
    a. Standard Classification of Soils in general accordance with ASTM D2488.
    b. Standard Classification of Rock in general accordance with ASTM D5878.
    c. Gradation of soils in general accordance with ASTM D422.
    d. Moisture content in general accordance with ASTM D2216.
    e. Unconfined compressive strength for rock in general accordance with ASTM D7012.
9. Prepared gINT logs of the borings using MoDOT templates, to include the following:
    a. N value of blows per foot.
    b. N60 value of blows per foot (corrected for the energy efficiency of the auto- hammer).
    c. Energy efficiency of the auto hammer.
    d. Drilling equipment identification.
    e. Boring locations (Stations and/or Coordinates, and Elevations with datums).
    f. Rock quality designation (RQD), percent recovery.
    g. Index and classification properties of soil and rock.
10. Evaluated pertinent physical and engineering characteristics of the soil and rock based on the results of the field explorations, laboratory testing and our experience.
11. Analyzed data from drilling, laboratory testing, downhole video recording and water quality monitoring.
12. Submitted, by way of this report, the results of the geotechnical investigation and laboratory testing program along with the results of the downhole video analysis and water quality analysis.

3.0 SITE CONDITIONS

3.1. Bedrock Geology

Geologic mapping indicates that Upper Cambrian Age (499 to 488 million years ago) Eminence Dolomite is the predominant bedrock present at the Route 19 Bridges at Round Spring site. The Eminence Dolomite consists primarily of dolomite and chert. The Dolomite is light-gray, massive to thick-bedded, medium to coarse-grained, weathering to bluish gray or medium gray with a pitted surface. The Eminence Dolomite contains variable amounts of light gray and white stringers and nodules of chert throughout. The chert makes up less than 5 percent of the formation. The thickness of the Eminence Dolomite is typically about 150 feet (Orndorff and Weary, 2009).

3.2. Surficial and Site Geology

Surficial geologic mapping indicates Holocene Age (11,700 years ago to present) alluvium and Pleistocene Age (2.6 million to 11,700 year ago) terrace deposits are present at the Route 19 Bridges at Round Spring site, within the stream valley and floodplain of Spring Valley Creek. The alluvium typically consists of silt, sand, clay, and gravel derived from local bedrock. The gravel is angular to subrounded and consists mostly of chert and sandstone. The alluvium forms on floodplains and stream beds. The terrace deposits consist primarily of silt, sand, clay, and gravel. The gravel mostly consists of rounded cobbles of chert and sandstone. The terrace deposits occur within and along the sides of stream valley and typically lie above the alluvium. The thickness of the alluvium and terrace deposits is typically up to 30 feet, overlying the Eminence Dolomite as described above (Orndorff and Weary, 2009).

3.3. Subsurface Conditions

3.3.1. General

We explored the subsurface conditions at the site on April 25 through May 5, 2022 by drilling 4 geotechnical borings at locations previously identified as anomalies on the geophysical survey, and as requested by MoDOT. The borings were drilled to depths of up to approximately 95 feet bgs using a CME-550X ATV-mounted drill.

Our subcontract driller used 4-inch continuous flight augers to advance the boring in soil, and obtained soil samples from the borings using a 1.5-inch inside-diameter (I.D.) split-spoon sampler driven during SPT testing. Rock coring techniques were used to advance the boring through the bedrock and continuous rock core samples were obtained using NQ2 rock coring equipment. A GeoEngineers field geologist logged the borings on a full-time basis. Soil and rock samples collected were visually classified and other pertinent drilling information was documented, as applicable. Our subcontract laboratory completed testing, including moisture content determinations, sieve analyses, Atterberg limits determination, and unconfined compressive strength testing of the rock core for selected samples obtained from the borings. Logs of the borings, laboratory test data, the SPT automatic hammer calibration, and other pertinent information are presented in Appendix A.

While subsurface explorations aid in characterizing the subsurface formations in the areas previously identified as anomalies, subsurface formations can vary over time and between boring locations. Actual subsurface conditions may vary from those encountered within the borings. The types of field exploration methods used indicate subsurface conditions only at the specific locations of the borings where samples were obtained, only at the time they were obtained, and only to the drilled depths of each boring.

3.3.2. Existing Conditions

Native Soils (B-1, B-2, and B-3)

In general, we noted loose to dense (N_{60} blow counts from 5 to 37), native sand and gravelly soils in Borings B-1, B-2 from near the surface to auger refusal on dolomite bedrock at depths of 15 and 19 feet bgs, respectively. Brown silt with sand and gravel was encountered in the top 10 feet in Boring 3 underlain by gravel soils to a depth of 24 feet bgs where dolomite bedrock was noted.

Existing Embankment Fill (B-4)

Boring B-4 was located near the north end of the Spring Valley Bridge, where the highway embankment consists of approximately 40 feet of fill. The fill was generally stiff to hard in consistency (N_{60} blow counts from 8 to 32), lean and fat clay with gravel. A 7" sample of a cobble or boulder was recovered from a core sample taken from approximately 12 feet bgs. What may be native soil was encountered at 40 feet bgs, consisting of lean clay and sandy clay. Dolomite bedrock was encountered at approximately 51 feet bgs.

Dolomite Bedrock

We noted light gray, slightly weathered to fresh dolomite bedrock below the native soils described above in all of the borings. The bedrock was cored to depths of up to 95 feet bgs. Compressive strength testing was completed on 45 samples obtained from the rock core at approximately 5-foot intervals. The compressive strength testing indicates the strength of the bedrock varies from approximately 360 to 2,380 ksf., with an average compressive strength of approximately 1,190 ksf.

The rock-quality designation (RQD) of the rock core ranged from 25 to 100 (Poor to Excellent) with an average RQD of 79 (Good). Boring B-1 exhibited the lowest rock quality, ranging from 25 to 82 (Poor to Good), with an average RQD of 61 (Fair). The remainder of the borings averaged from 86 to 98 (Good to Excellent).

Three voids of approximately 1 foot each were logged in the upper 10 feet of the rock core from Boring B-1. A void of approximately 2 feet was logged in Boring B-2, and a void of approximately 1 foot was logged in Boring B-3. No other voids were noted during drilling.

The top of bedrock elevation varies from approximately 651.8 to 664.8 feet. The surface elevation is generally consistent at Boring B-2, B-3 and B-4, and on the order of 10 feet higher at Boring B-1, where voids were indicated in the top 10 feet.

The depths and elevations of the bedrock surface, groundwater, and voids are summarized in Table 1.

TABLE 1. GEOTECHNICAL BORING SUMMARY

GeoEngineers Boring No.	Depth to Bedrock (ft bgs)	Top of Bedrock Elevation (ft MSL)	Depth to Void (ft bgs)	Top of Void Elevation (ft MSL)	Vertical Extent of Void (ft)	Depth to Groundwater (ft bgs)	Groundwater Elevation (ft MSL)
B-1	15.5	664.8	17.5	662.8	1 foot	10.0	670.3
B-1 (Cont.)	"	"	21.5	658.8	1 foot	"	"
B-1 (Cont.)	"	"	23.5	656.8	1 foot	"	"
B-2	19.0	654.3	83.0	590.3	2 feet	7.0	666.3
B-3	24.0	651.8	37.0	638.8	1 foot	10.0	665.8
B-4	51.0	654.4	N/A			N/A	

3.3.3. Borehole Video

We attempted downhole camera videos after the completion of each boring. The boreholes were allowed to settle following drilling prior to introducing the downhole camera. However, due to excessive suspended sediment, meaningful video recordings were not obtained.

3.3.4. Groundwater Conditions

We encountered groundwater in Borings B-1, B-2 and B-3 during drilling at depths of 10, 7, and 10 feet, respectively. Groundwater was not encountered in Boring B-4. We anticipate the subsurface water level will likely vary with seasonal conditions.

3.3.5. Round Spring Water Quality Measurements

Based upon the geophysical survey report, we interpreted Borings B-2 and B-4 were more likely to encounter voids that could be directly connected to Round Spring. Therefore, we monitored the water quality in Round Spring during the drilling of Borings B-2 and B-4. We recorded temperature, turbidity, specific conductance, pH, oxidation-reduction potential (ORP), and dissolved oxygen with a YSI ProDSS multiparameter meter every five minutes from at least 30 minutes prior to the beginning of drilling each day until at least 30 minutes following the conclusion of drilling. Water quality data for the monitoring period is included in Appendix B and summarized below in Table 1.

Precipitation data is provided from the USGS Stream Gauge 7066000 Jacks Fork at Eminence station located approximately 10 miles south of Round Spring. The precipitation data at that station is recorded every 15 minutes and is included along with the water quality monitoring data in Appendix B.

Flow from Round Spring was generally consistent during the monitoring period, until Thursday, May 5, when we observed the flow to be steadily increasing. This increase in spring flow is likely due to heavy precipitation in the recharge area in the early morning hours.

TABLE 2. SUMMARY OF GROUNDWATER QUALITY MEASUREMENTS

Parameter	Low	High	Mean	Comment
Temperature (°F)	54.7	55.2	54.9	
Specific Conductance (µS/cm)	196.1	223.1	200.7	Higher values were often recorded at the beginning of the monitoring period each day and may reflect the probe still coming to equilibrium with ambient conditions.
pH	6.86	7.30	7.0	
ORP (mV)	108.4	161.2	141.7	
Dissolved Oxygen (DO) (mg/L)	7.36	7.94	7.60	
Turbidity (NTU)	0.16	5.09	0.8	Turbidity over 2 NTUs was recorded on 5/3/22 from 13:30 to 14:25 hours. This period of elevated turbidity was likely due to sediment or algae on the probe as it cleared upon shaking the probe.

Based upon the water quality data observed during drilling, we did not identify impacts to the water quality at Round Spring during the drilling of Borings B-2 and B-4.

4.0 DISCUSSION

The primary purpose of the geotechnical borings described herein was to investigate areas identified as anomalies by Collier Geophysics, LLC, in their geophysical survey performed near the Spring Valley Creek and Round Spring (Collier, 2021). The Collier Geophysics report was included as part of a Karst Review report by Olsson (Olsson, 2021). Olsson recommended four areas for further field investigation with geotechnical borings, representing both anomalies of high resistivity and low resistivity.

Table 3 summarizes how the geotechnical borings installed as part of this investigation relate to anomalies identified in the Collier report and recommended for further evaluation in the Olsson report.

TABLE 3. GEOTECHNICAL BORINGS CORRELATION TO GEOPHYSICAL ANOMALIES

Boring No.	Geophysics Line[1]	Geophysics Anomaly Identifier[1]	Type of Geophysics Anomaly[1]	Anomaly Top Depth (ft bgs)	Anomaly Depth Extent (ft)	Boring Description
B-1	Line 4	V	High resistivity	37	124	Soft to hard dolomite with some vugs and quartz druse
B-2	Line 4	W	Low resistivity	18	40	Medium hard to hard dolomite, slightly weathered with some vugs and clay lenses
B-2	Line 4	V	High resistivity	84	>50	Soft to hard dolomite, slightly weathered with some vugs and quartz druse; void identified 83 to 85 ft bgs.
B-3	Line 4	V	High resistivity	50	>75	Soft to hard dolomite, slightly weathered with some vugs and quartz druse
B-4	Line 3	Q	Low resistivity	13	35	Clay and clay with sand, moist and stiff (fill)

Note 1: From Collier (2021). See Appendix C.

We investigated the high resistivity anomaly identified as “V” by Collier (Collier, 2021) with Borings B-1, B-2, and B-3. All 3 borings identified this anomaly as slightly weathered, soft to hard dolomite with some vugs with quartz druse. The only void identified at or near the Anomaly V was a two-foot void from approximately 83 to 85 feet bgs in Boring B-2, which correlates roughly to the top of this anomaly at this location. In our opinion, it is unlikely that this relatively small void would have produced the large high resistivity anomaly identified as “V” in the Collier geophysics report. Therefore, we interpret this high resistivity anomaly to be attributed to dense bedrock with low moisture content.

We investigated the low resistivity anomaly identified as “W” in the Collier Geophysics report with Boring B-2. This boring was located adjacent to and south of the stream in Spring Valley. The top of bedrock in this

boring was identified at 19 feet bgs, which approximately correlates to the top of this low resistivity geophysical anomaly. The geophysical survey Line 4 included in the Collier Geophysics report appears to indicate a depression in Anomaly V under the stream and above the low resistivity Anomaly W (See Appendix C). No distinct variation appears in the Boring B-2 boring log between the area identified as low resistivity (Anomaly W) and high resistivity (Anomaly V) in this boring.

We investigated the low resistivity anomaly identified as "Q" in the Collier Geophysics report with Boring B-4. The top of bedrock in this boring was identified at 51 feet below ground surface. The Boring B-2 boring log indicates the geology of this low resistivity anomaly to be moist clay and clay with sand fill along the edge of the bridge approach. No voids were encountered in Boring B-4.

5.0 SUMMARY AND CONCLUSIONS

5.1. Summary

We drilled four geotechnical borings in the MoDOT right-of-way along the Spring Valley Bridge on Highway 19 at Round Spring, Missouri between April 25 and May 5, 2022. These borings were drilled to investigate geophysical anomalies identified during a geophysical investigation of the area performed as part of the environmental assessment for bridge replacement.

We advanced the geotechnical borings from the ground surface using hollow stem augers and SPT sampling methods using a calibrated automatic hammer on 5' intervals. Below the bedrock contact, rock was cored to depths of up to 75 feet below bedrock contact. The borings were logged during drilling and samples of the soil and rock encountered during our exploration were sampled for laboratory testing. Upon completion of the borings, video recording of the borings was attempted with a downhole camera.

The geophysical investigation indicated the greatest likelihood of encountering significant voids with a hydrologic connection to Round Spring during Borings 2 and 4. Therefore, we monitored water quality in Round Spring during the drilling of these borings.

5.2. Conclusions

1. We encountered bedrock at depths ranging from 15.5 to 24 feet bgs in Borings B-1 through B-3, and 53 feet in Boring B-4 where approximately 40 feet of embankment fill was noted. Bedrock consisted of light gray, slightly weathered to fresh dolomite.
2. We noted the following five voids in the geotechnical borings:
    a. Boring B-1: Three voids of approximately 1 foot each in the upper 10 feet of the rock core.
    b. Boring B-2: One void of approximately 2 feet from 83 to 85 feet bgs.
    c. Boring B-3: A void of approximately 1 foot was logged at a depth of 37 feet bgs.

    No other voids were noted during geotechnical investigation summarized in this report.
3. Due to excessive suspended sediment in the borings, we were not able to record meaningful downhole video during the geotechnical investigation.
4. Based upon the water quality data observed during drilling, we did not observe impacts to the water quality at Round Spring during the drilling of Borings B-2 and B-4.

5. Based on the results of the borings, the areas identified as anomalies in the Collier report do not appear to represent significant risk for the further development of bridge foundation plans for this project.

6.0 LIMITATIONS

We have prepared this data report for use by MoDOT, their authorized agents, and other approved members of the design team involved with this project. This report is not intended for use by others, and the information contained herein is not applicable to other sites. The data and report may be provided to prospective contractors, but our report, conclusions, and interpretations should not be construed as a warranty of the subsurface conditions.

Variations in subsurface conditions are possible between the explorations. Subsurface conditions may also vary with time. A contingency for unanticipated conditions should be included in the project budget and schedule for such an occurrence. We recommend that sufficient monitoring, testing, and consultation be provided by GeoEngineers during construction to evaluate that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether earthwork, bridge, and MSE wall construction comply with contract plans and specifications.

The scope of our services does not include services related to construction safety precautions. Our recommendations are not intended to direct the contractor's methods, techniques, sequences or procedures, except as specifically described in our report for consideration in design.

Within the limitations of scope, schedule, and budget, our services have been executed in accordance with generally accepted practices in this area at the time the report was prepared. The conclusions, recommendations, and opinions presented in this report are based on our professional knowledge, judgment, and experience. No warranty or other conditions, express, written, or implied, should be understood.

Any electronic form, facsimile, or hard copy of the original document (email, text, table, and/or figure), if provided, and any attachments are only a copy of the original document. The original document is stored by GeoEngineers and will serve as the official document of record.

Please refer to Appendix D, titled “Report Limitations and Guidelines for Use,” for additional information pertaining to use of this report.

7.0 REFERENCES

Collier, 2021. Geophysical Letter Report, Project #21-=145, Round Spring National Park, Eminence, MO. Collier Geophysics.LLC, December 14, 2021, 16 p. + appendices.

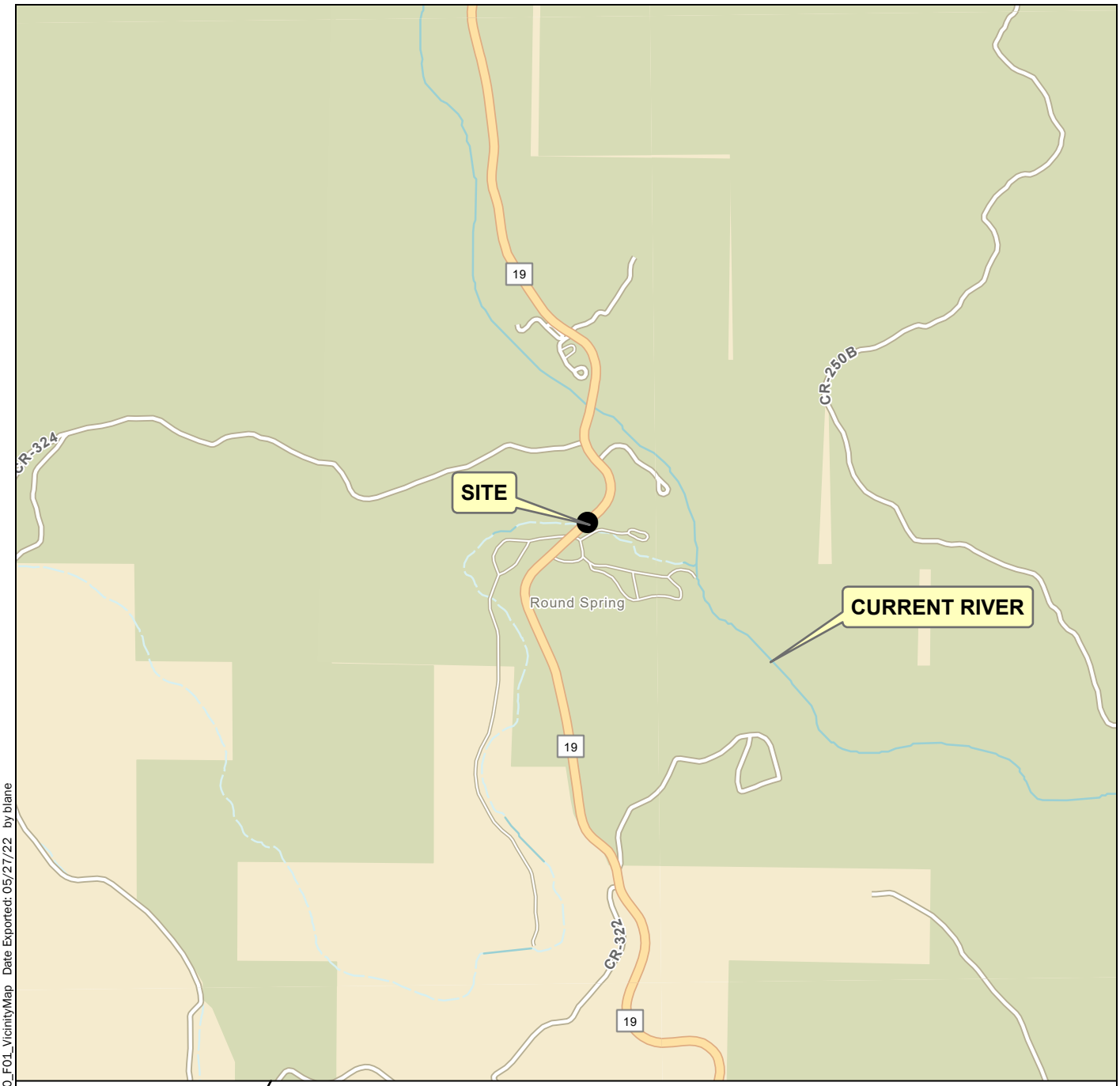
Olsson, 2021. Preliminary Geotechnical Study Route 19 Bridges Karst Review, December 30, 2021. 90 p.

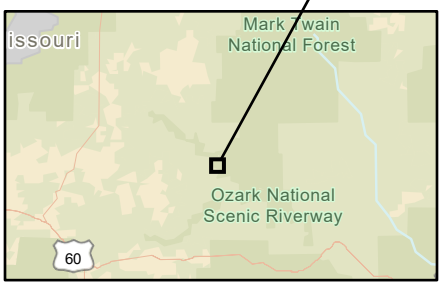
Orndorff, R.C., and Weary, D.J., 2009, Geologic map of the Round Spring quadrangle, Shannon County, Missouri, U.S. Geological Survey, Scientific Investigations Map SIM-3073, Scale 1:24,000.

Regional Geology of North America, 2017, Ozark Plateau Province, gotbooks.miracosta.edu/geology/regions/Ozark_plateau.html, Accessed 4/21/2022.

FIGURES

GeoEngineers





N
W E
S

2,000 0 2,000

Feet

Vicinity Map

MoDOT
Route 19 Bridges at Round Spring
Shannon County, Missouri

GeoEngineers

Figure 1

Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: ESRI

Projection: NAD 1983 StatePlane Missouri Central FIPS 2402 Feet

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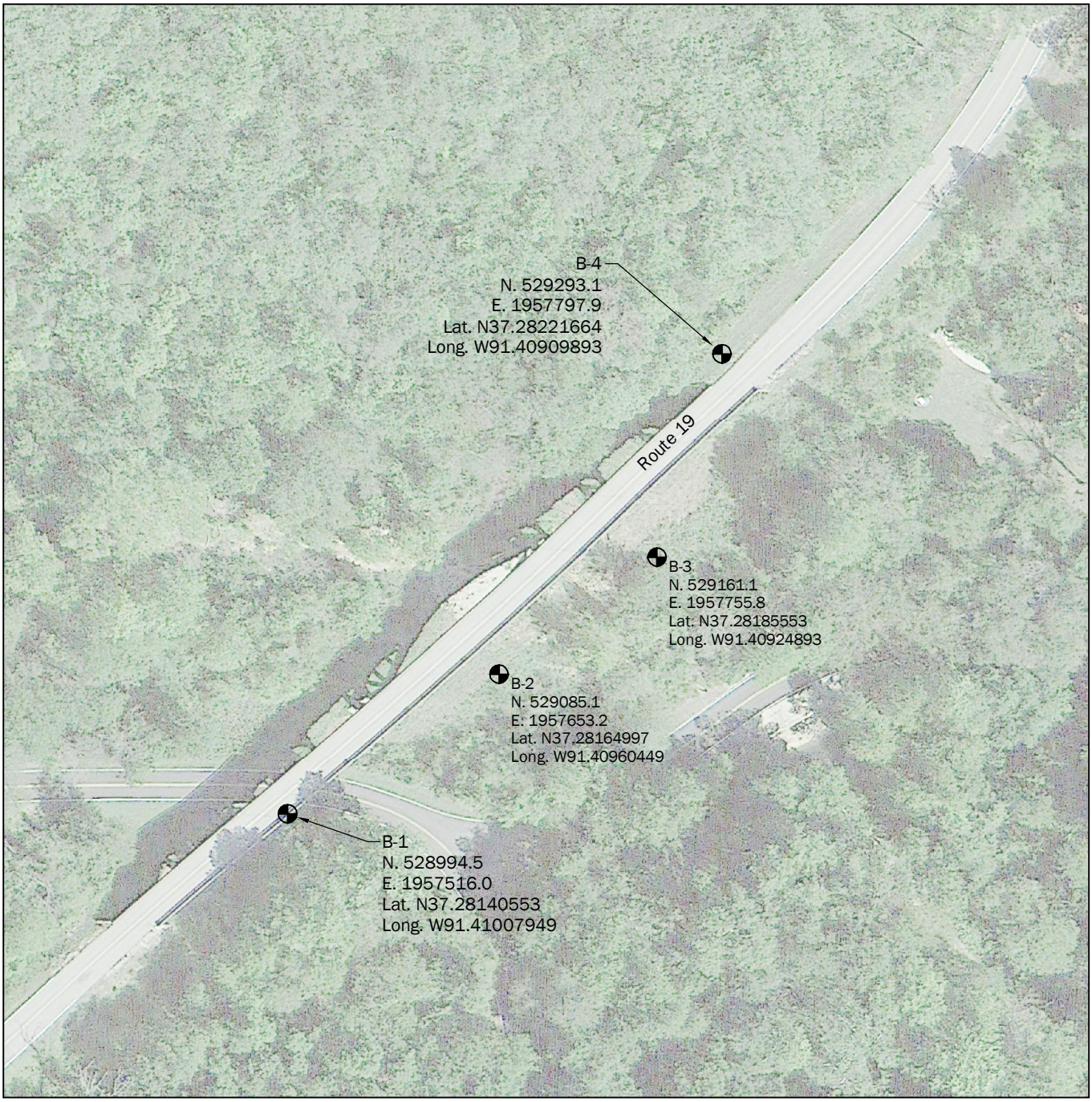


Legend

Boring Location

N
W E
S

100 0 100

Scale In Feet

Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

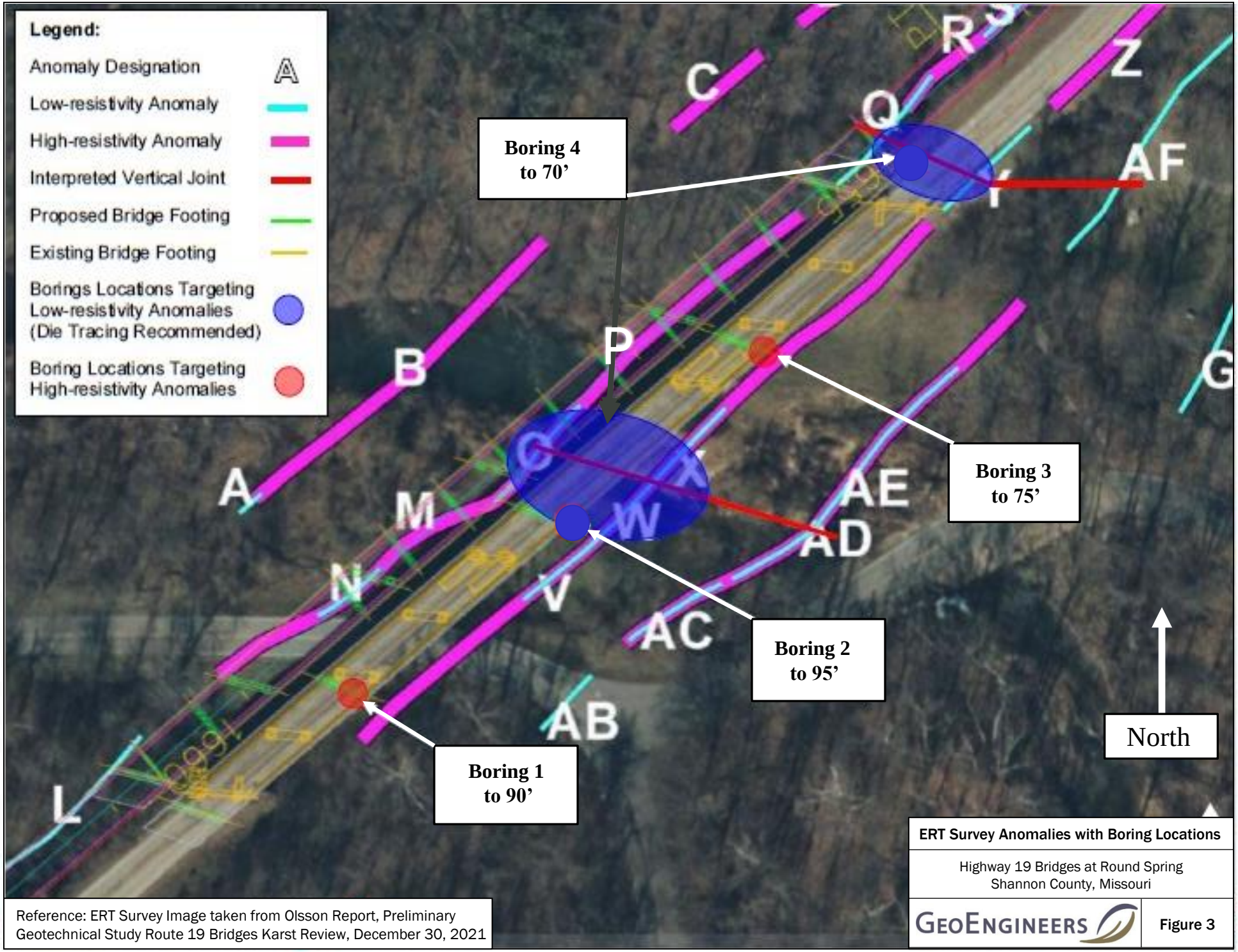
References: Aerial image taken from Google Earth Pro © 2022, licensed to GeoEngineers, Inc., image dated 09/10/12.

Boring Location Map

MoDOT
Route 19 Bridges at Round Spring
Shannon County, Missouri

GeoEngineers

Figure 2



Reference: ERT Survey Image taken from Olsson Report, Preliminary Geotechnical Study Route 19 Bridges Karst Review, December 30, 2021

ERT Survey Anomalies with Boring Locations

Highway 19 Bridges at Round Spring
Shannon County, Missouri

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Figure 3

APPENDICES

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APPENDIX A
Geotechnical Exploration Logs and Laboratory Test Results

APPENDIX A
FIELD EXPLORATIONS AND LABORATORY TESTING

Field Explorations

We explored subsurface conditions at the site on September 15 through September 29, 2020 by drilling four (4) geotechnical borings using a CME-550X ATV-Mounted Drill. The borings were drilled at or near the requested locations in order to characterize the subsurface conditions.

The drilling operations were monitored by GeoEngineers' geotechnical engineer who examined and classified the soil encountered, obtained representative samples, observed groundwater conditions where possible, and prepared a detailed log of each exploration. The soils encountered were classified visually in general accordance with American Society for Testing and Materials International (ASTM) D2488, which is described in Figure A-1. The rock core was classified in general accordance with the Unified Rock Classification System (URCS) in general accordance with ASTM D5878, which is described in Figure A-2. The approximate locations of the drilled explorations are shown on the attached Boring Location Map, Figure 2. The calibration of the drill rig hammer is attached.

In general, coarse-grained soil samples were obtained from the borings using a 1.5-inch inside-diameter (I.D.) split-spoon sampler used during SPT testing. The split-spoon sampler was driven 18 inches using a calibrated automatic hammer with a 140-pound hammer with a 30-inch drop. The number of hammer blows required to drive the sampler 12 inches after the initial 6-inch seating, or "N-value", was recorded on the field logs, and the values for N_{60} Were calculated and added the final logs. Bedrock core was obtained using 2-inch I.D. NQ2 rock coring tools. Upon completion, the borings were backfilled with soil cuttings.

We evaluated the relative density of the SPT samples based on correlations with lab and field observations in general accordance with the values outlined in Table A-1 below.

TABLE A-1 CORRELATION BETWEEN BLOW COUNTS AND RELATIVE DENSITY [1]

Cohesive Soils (Clay/Silt)						
Parameter	Very Soft	Soft	Medium Stiff	Stiff	Very Stiff	Hard
Blows, N	< 2	2 – 4	4 – 8	8 – 16	16 – 32	>32
Cohesionless Soils (Gravel/Sand/Silty Sand) [2]						
	Very Loose	Loose	Medium Dense	Dense	Very Dense	
Blows, N	0 – 4	4 – 10	10 – 30	30 – 50	> 50	

Notes:

[1] After Terzaghi, K and Peck, R.B., "Soil Mechanics in Engineering Practice," John Wiley & Sons, Inc., 1962.

[2] Classification applies to soils containing additional constituents; that is, organic clay, silty or clayey sand, etc.

The exploration logs are attached. The logs are based on our interpretation of the field data obtained from the subsurface explorations and indicate the various types of soil encountered, while indicating the approximate depths at which the subsurface conditions change. Unless noted on the exploration logs, the lines designating the layers between soil units represent approximate boundaries. The transition between materials may be gradual or may occur between recovered samples. Additionally, the logs represent

conditions observed at the time of drilling and has been edited to incorporate results of the laboratory tests performed as appropriate.

Laboratory Testing

General

Representative soil and rock samples obtained from the explorations were tested by Anderson Engineering in their Springfield, Missouri office. Testing included moisture content determinations, sieve analyses, Atterberg limits determination, and unconfined compressive strength testing of the rock core samples. The laboratory testing procedures are discussed in more detail below.

Moisture Content Testing

Moisture content tests were completed for representative soil samples obtained from the explorations in general accordance with ASTM D2216. The results of these tests are presented on the exploration logs at the depths at which the samples were obtained.

Grain Size Distribution

Grain size distribution testing was performed on selected samples in general accordance with ASTM D422/D1140/D6913. The results of the grain size distribution tests were plotted and classified in general accordance with the Unified Soil Classification System (USCS) and are attached. The sieve analysis results are also shown on the boring logs at the respective sample depths.

Unconfined Compressive Strength Testing

Unconfined compressive strength (Q_u) tests were performed on selected rock samples obtained from the borings. The tests were used to evaluate shear strength characteristics of the rock and were completed in general accordance with ASTM D4543. The results of testing are presented on the boring logs at their respective sample depths and are attached in table form.

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% RETAINED ON NO. 200 SIEVE	SAND AND SANDY SOILS	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS
				SP	POORLY-GRADED SANDS, GRAVELLY SAND
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS, ROCK FLOUR, CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% PASSING NO. 200 SIEVE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS AND SILTS OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: Multiple symbols are used to indicate borderline or dual soil classifications

ADDITIONAL MATERIAL SYMBOLS

SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
	AC	Asphalt Concrete
	CC	Cement Concrete
	CR	Crushed Rock/ Quarry Spalls
	SOD	Sod/Forest Duff
	TS	Topsoil

Groundwater Contact

Measured groundwater level in exploration, well, or piezometer

Measured free product in well or piezometer

Graphic Log Contact

Distinct contact between soil strata

Approximate contact between soil strata

Material Description Contact

Contact between geologic units

Contact between soil of the same geologic unit

Sampler Symbol Descriptions

2.4-inch I.D. split barrel / Dames & Moore (D&M)

Standard Penetration Test (SPT)

Shelby tube

Piston

Direct-Push

Bulk or grab

Continuous Coring

Blowcount is recorded for driven samplers as the number of blows required to advance sampler 12 inches (or distance noted). See exploration log for hammer weight and drop.

"P" indicates sampler pushed using the weight of the drill rig.

"WOH" indicates sampler pushed using the weight of the hammer.

Laboratory / Field Tests

%F	Percent fines
%G	Percent gravel
AL	Atterberg limits
CA	Chemical analysis
CP	Laboratory compaction test
CS	Consolidation test
DD	Dry density
DS	Direct shear
HA	Hydrometer analysis
MC	Moisture content
MD	Moisture content and dry density
Mohs	Mohs hardness scale
OC	Organic content
PM	Permeability or hydraulic conductivity
PI	Plasticity index
PL	Point lead test
PP	Pocket penetrometer
SA	Sieve analysis
TX	Triaxial compression
UC	Unconfined compression
UU	Unconsolidated undrained triaxial compression
VS	Vane shear

Sheen Classification

NS	No Visible Sheen
SS	Slight Sheen
MS	Moderate Sheen
HS	Heavy Sheen

NOTE: The reader must refer to the discussion in the report text and the logs of explorations for a proper understanding of subsurface conditions. Descriptions on the logs apply only at the specific exploration locations and at the time the explorations were made; they are not warranted to be representative of subsurface conditions at other locations or times.

Key to Exploration Logs

GeoEngineers

Figure A-1

Explanation of Bedrock Terms

Scale of Relative Rock Weathering[1]

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

Scale of Relative Rock Hardness[1]

Term	Hardness Designation	Field Identification	Approximate Unconfined Compressive Strength
Extremely Soft	R0	Can be indented with difficulty by thumbnail. May be moldable or friable with finger pressure.	< 100 psi
Very Soft	R1	Crumbles under firm blows with point of a geology pick. Can be peeled by a pocket knife. Scratched with fingernail.	100-1000 psi
Soft	R2	Can be peeled by a pocket knife with difficulty. Cannot be scratched with fingernail. Shallow indentation made by firm blow of geology pick.	1000-4000 psi
Medium Hard	R3	Can be scratched by knife or pick. Specimen can be fractured with a single firm blow of hammer/geology pick.	4000-8000 psi
Hard	R4	Can be scratched with knife or pick only with difficulty. Several hard hammer blows required to fracture specimen.	8000-16000 psi
Very Hard	R5	Cannot be scratched by knife or sharp pick. Specimen requires many blows of hammer to fracture or chip. Hammer rebounds after impact.	> 16000 psi

Discontinuity Spacing[1]

Description for Bedding, Foliation, or Flow Banding	Spacing	Description of Joints, Faults, or Other Fractures
Very Thick	>10 ft	Very Widely Spaced
Thick	3 ft – 10 ft	Widely Spaced
Medium	1 ft – 3 ft	Moderately Spaced
Thin	2 in – 1 ft	Closely Spaced
Very Thin	<2 in	Very Closely Spaced

Rock Quality Designation (RQD)[1, 2]

RQD (Percent)	Description of Rock Quality
0 – 25	Very Poor
25 – 50	Poor
50 – 75	Fair
75 – 90	Good
90 – 100	Excellent

Notes:

1. Based on ASCE Manual on Engineering Practice No. 56,1976.
2. RQD is a modified core recovery measurement which expresses the number of hard and sound rock pieces of 4" or more in size as a percentage of the total length of core run.

Explanation of Bedrock Terms

GeoEngineers

Figure A-2

Missouri Department of Transportation
Construction and Materials

Job No.: J9P33.5 **County:** Shannon **Route:** Highway 19
Design: **Skew:** **Location:** 5.5 miles north of Route D
Bent: **Logged By:** Seye Coker [GeoEngineers, Inc.] **Operator:** Carmon Hunter [Anderson]
Station: **Northing:** 528994.5 **Date of Work:** 04/25/22-04/26/22
Offset: **Easting:** 1957516.01 **Depth to Water:** 10.0
Elevation: 680.3 **Requested Northing:** **Depth Hole Open:** 90.5
Requested Station: **Requested Easting:** **Time Change:** At Time of Drilling
Requested Offset: **Equipment:** CME 550X ,Split-Spoon Sampler
Requested Elevation: **Location Note:**
Drill No.: 401073 **Hammer Efficiency:** 92.3% **Drilling Method:** Continuous Flight Auger

Depth (ft)	Graphic	Description	Elevation (ft)	Sample Type	REC % (RQD %)	Blow Counts (N_{60})	Shear Data	Field Tests	Index Tests
0			680						
		0.0-5.0' Brown silty SAND (loose, moist)			67	2-3-3 (9)			
5			675						
		5.0-10.0' Tan fine SAND with chert gravel (medium dense, moist)			22	2-6-9 (23)			Sieve Analysis Sieve # % Passing 3/4" 100.0 3/8" 83.1 #4 68.5 #10 58.9 #40 32.5 #100 4.9 #200 4.0
10		▽	670						
		10.0-15.5' Fine GRAVEL with sand (loose, wet)			39	2-3-3 (9)			
15			665						
		15.5-17.5' Gray DOLOMITE, fresh, hard, medium bedded, slightly vuggy, poor RQD							
		17.5-18.5' VOID							
		18.5-21.5' Gray DOLOMITE, fresh, hard, thick bedded, slightly vuggy with quartz pockets							
20			660		71 (25)	(25)	Qu Test Results UCS = 1450 ksf		
		21.5-22.5' VOID							
		22.5-23.5' Gray DOLOMITE, fresh, hard, thin bedded							
		23.5-24.5' VOID							
25			655						
		24.5-26.0' Gray DOLOMITE, fresh, hard, medium bedded					Qu Test Results UCS = 1460 ksf		
		26.0-30.0' Gray DOLOMITE, moderately weathered, hard, thick bedded, vuggy, sandy, fair RQD							
30									

N_{60} = (Em/60)Nm N_{60} - Corrected N value for standard 60% SPT efficiency; Em - Measured hammer efficiency in percent; Nm - Observed N-value
(1) = Assumed, (2) = Actual

Coordinate System: U.S. State Plane 1983 **Coordinate Zone:** Missouri Central **Coordinate Proj. Factor:** 1.0000772
Coordinate Datum: NAD 83 **Coordinate Units:** U.S. Survey Feet

Missouri Department of Transportation
Construction and Materials

Job No.: J9P33.5 **County:** Shannon **Route:** Highway 19
Design: **Skew:** **Location:** 5.5 miles north of Route D
Bent: **Logged By:** Seye Coker [GeoEngineers, Inc.] **Operator:** Carmon Hunter [Anderson]
Station: **Northing:** 528994.5 **Date of Work:** 04/25/22-04/26/22
Offset: **Easting:** 1957516.01 **Depth to Water:** 10.0
Elevation: 680.3 **Requested Northing:** **Depth Hole Open:** 90.5
Requested Station: **Requested Easting:** **Time Change:** At Time of Drilling
Requested Offset: **Equipment:** CME 550X ,Split-Spoon Sampler
Requested Elevation: **Location Note:**
Drill No.: 401073 **Hammer Efficiency:** 92.3% **Drilling Method:** Continuous Flight Auger

Depth (ft)	Graphic	Description	Elevation (ft)	Sample Type	REC % (RQD %)	Blow Counts (N_{60})	Shear Data	Field Tests	Index Tests
30		30.0-32.5' Gray DOLOMITE, moderately weathered, soft, thick bedded, vuggy, sandy	650		100 (50)		Qu Test Results UCS = 360 ksf		
		32.5-35.5' Gray DOLOMITE, slightly weathered, thick bedded, soft, vuggy, sandy							
35		35.5-39.5' Gray DOLOMITE, slightly weathered, soft, thick bedded, sandy with quartz pockets, poor RQD	645				Qu Test Results UCS = 360 ksf		
40		39.5-45.5' Gray DOLOMITE, slightly weathered, soft, thick bedded, vuggy, sandy	640		100 (42)		Qu Test Results UCS = 500 ksf		
45		45.5-49.5' Gray DOLOMITE, slightly weathered, soft, thick bedded, vuggy, good RQD	635				Qu Test Results UCS = 480 ksf		
50		49.5-50.5' Gray SANDSTONE, fresh, hard, thin bedded	630		100 (82)		Qu Test Results UCS = 1240 ksf		
		50.5-60.5' Gra DOLOMITE, fresh, hard, thick bedded, slightly vuggy with quartz pockets							
55		55.5' Fair RQD	625				Qu Test Results UCS = 2180 ksf		
60									

N_{60} = (Em/60)Nm N_{60} - Corrected N value for standard 60% SPT efficiency; Em - Measured hammer efficiency in percent; Nm - Observed N-value
(1) = Assumed, (2) = Actual

Coordinate System: U.S. State Plane 1983 **Coordinate Zone:** Missouri Central **Coordinate Proj. Factor:** 1.0000772
Coordinate Datum: NAD 83 **Coordinate Units:** U.S. Survey Feet

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Missouri Department of Transportation
Construction and Materials

Job No.: J9P33.5 **County:** Shannon **Route:** Highway 19
Design: **Skew:** **Location:** 5.5 miles north of Route D
Bent: **Logged By:** Seye Coker [GeoEngineers, Inc.] **Operator:** Carmon Hunter [Anderson]
Station: **Northing:** 528994.5 **Date of Work:** 04/25/22-04/26/22
Offset: **Easting:** 1957516.01 **Depth to Water:** 10.0
Elevation: 680.3 **Requested Northing:** **Depth Hole Open:** 90.5
Requested Station: **Requested Easting:** **Time Change:** At Time of Drilling
Requested Offset: **Equipment:** CME 550X ,Split-Spoon Sampler
Requested Elevation: **Location Note:**
Drill No.: 401073 **Hammer Efficiency:** 92.3% **Drilling Method:** Continuous Flight Auger

Depth (ft)	Graphic	Description	Elevation (ft)	Sample Type	REC % (RQD %)	Blow Counts (N_{60})	Shear Data	Field Tests	Index Tests
60			620						
		60.5-65.5' Gray DOLOMITE, slightly weathered, hard, thick bedded, vuggy with green clay lenses			100 (69)		Qu Test Results UCS = 1090 ksf		
65			615						
		65.5-70.0' Gray DOLOMITE, slightly weathered, medium hard, thick bedded, vuggy with quartz pockets, fair RQD					Qu Test Results UCS = 960 ksf		
70			610						
		70.0-85.5' Gray DOLOMITE, slightly weathered, hard, very thick bedded, vuggy with quartz pockets			100 (63)		Qu Test Results UCS = 1240 ksf		
75			605						
		75.5' Good RQD					Qu Test Results UCS = 1620 ksf		
80			600		100 (79)		Qu Test Results UCS = 1420 ksf		
85			595						
		85.5-88.5' Gray DOLOMITE, slightly weathered, medium hard, medium bedded, vuggy, good RQD					Qu Test Results UCS = 1080 ksf		
					100 (75)		Qu Test Results UCS = 530 ksf		
90		88.5-91.5' Gray DOLOMITE, slightly weathered, soft, medium bedded, vuggy							

N_{60} = (Em/60)Nm N_{60} - Corrected N value for standard 60% SPT efficiency; Em - Measured hammer efficiency in percent; Nm - Observed N-value
(1) = Assumed, (2) = Actual

Coordinate System: U.S. State Plane 1983 **Coordinate Zone:** Missouri Central **Coordinate Proj. Factor:** 1.0000772
Coordinate Datum: NAD 83 **Coordinate Units:** U.S. Survey Feet

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Missouri Department of Transportation
Construction and Materials

Job No.: J9P33.5 **County:** Shannon **Route:** Highway 19
Design: **Skew:** **Location:** 5.5 miles north of Route D
Bent: **Logged By:** Seye Coker [GeoEngineers, Inc.] **Operator:** Carmon Hunter [Anderson]
Station: **Northing:** 528994.5 **Date of Work:** 04/25/22-04/26/22
Offset: **Easting:** 1957516.01 **Depth to Water:** 10.0
Elevation: 680.3 **Requested Northing:** **Depth Hole Open:** 90.5
Requested Station: **Requested Easting:** **Time Change:** At Time of Drilling
Requested Offset: **Equipment:** CME 550X ,Split-Spoon Sampler
Requested Elevation: **Location Note:**
Drill No.: 401073 **Hammer Efficiency:** 92.3% **Drilling Method:** Continuous Flight Auger

Depth (ft)	Graphic	Description	Elevation (ft)	Sample Type	REC % (RQD %)	Blow Counts (N_{60})	Shear Data	Field Tests	Index Tests
90		88.5-91.5' Gray DOLOMITE, slightly weathered, soft, medium bedded, vuggy *(continued)*	590						
		Bottom of borehole at 91.5 feet.							

N_{60} = (Em/60)Nm N_{60} - Corrected N value for standard 60% SPT efficiency; Em - Measured hammer efficiency in percent; Nm - Observed N-value
(1) = Assumed, (2) = Actual

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Coordinate Datum: NAD 83 **Coordinate Units:** U.S. Survey Feet

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Missouri Department of Transportation
Construction and Materials

Job No.: J9P33.5 **County:** Shannon **Route:** Highway 19
Design: **Skew:** **Location:** 5.5 miles north of Route D
Bent: **Logged By:** Seye Coker [GeoEngineers, Inc.] **Operator:** Carmon Hunter (Anderson Engineering)
Station: **Northing:** 529085.1 **Date of Work:** 05/02/22-05/03/22
Offset: **Easting:** 1957653.19 **Depth to Water:** 7.0
Elevation: 673.3 **Requested Northing:** **Depth Hole Open:** 96
Requested Station: **Requested Easting:** **Time Change:** At Time of Drilling
Requested Offset: **Equipment:** CME 550X ,Split-Spoon Sampler
Requested Elevation: **Location Note:**
Drill No.: 401073 **Hammer Efficiency:** 92.3% **Drilling Method:** Continuous Flight Auger

Depth (ft)	Graphic	Description	Elevation (ft)	Sample Type	REC % (RQD %)	Blow Counts (N_{60})	Shear Data	Field Tests	Index Tests
0		0.0-5.0' Gray fine SAND with silt (loose, moist)	670		67	1-2-1 (5)			
5		5.0-19.0' Brown fine GRAVEL with sand (medium dense, moist) ▽	665		50	5-8-11 (29)			
10		10.0' Becomes wet	660		44	4-3-7 (15)			Sieve Analysis Sieve # % Passing 3/4" 100.0 3/8" 73.7 #4 49.2 #10 30.9 #40 17.2 #100 6.7 #200 5.9
15		15.0' Brown fine GRAVEL with sand (dense, wet)	655		39	2-8-16 (37)			
20		19.0-29.0' Gray DOLOMITE, slightly weathered, hard, thick bedded, fractured, vuggy with quartz pockets and clay lenses, good RQD	650		100 (78)		Qu Test Results UCS = 1670 ksf		
25			645						
30							Qu Test Results UCS = 820 ksf		

N_{60} = (Em/60)Nm N_{60} - Corrected N value for standard 60% SPT efficiency; Em - Measured hammer efficiency in percent; Nm - Observed N-value
(1) = Assumed, (2) = Actual

Coordinate System: U.S. State Plane 1983 **Coordinate Zone:** Missouri Central **Coordinate Proj. Factor:** 1.0000772
Coordinate Datum: NAD 83 **Coordinate Units:** U.S. Survey Feet

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Missouri Department of Transportation
Construction and Materials

Job No.: J9P33.5 **County:** Shannon **Route:** Highway 19
Design: **Skew:** **Location:** 5.5 miles north of Route D
Bent: **Logged By:** Seye Coker [GeoEngineers, Inc.] **Operator:** Carmon Hunter (Anderson Engineering)
Station: **Northing:** 529085.1 **Date of Work:** 05/02/22-05/03/22
Offset: **Easting:** 1957653.19 **Depth to Water:** 7.0
Elevation: 673.3 **Requested Northing:** **Depth Hole Open:** 96
Requested Station: **Requested Easting:** **Time Change:** At Time of Drilling
Requested Offset: **Equipment:** CME 550X ,Split-Spoon Sampler
Requested Elevation: **Location Note:**
Drill No.: 401073 **Hammer Efficiency:** 92.3% **Drilling Method:** Continuous Flight Auger

Depth (ft)	Graphic	Description	Elevation (ft)	Sample Type	REC % (RQD %)	Blow Counts (N_{60})	Shear Data	Field Tests	Index Tests
30		29.0-33.5' Gray DOLOMITE, slightly weathered, medium hard, thick bedded, fractured, vuggy with quartz pockets, excellent RQD *(continued)*	640						
35		33.5-39.0' Gray DOLOMITE, slightly weathered, hard, thick bedded, fractured, vuggy	635		100 (90)		Qu Test Results UCS = 1270 ksf		
40		39.0-43.5' Gray DOLOMITE, slightly weathered, medium hard, thick bedded, fractured, vuggy, excellent RQD	630				Qu Test Results UCS = 870 ksf		
45		43.5-49.0' Gray DOLOMITE, slightly weathered, hard, thick bedded, slightly fractured, vuggy	625		100 (93)		Qu Test Results UCS = 1180 ksf		
50		49.0-53.5' Gray DOLOMITE, slightly weathered, soft, thick bedded, fractured, vuggy, good RQD	620				Qu Test Results UCS = 530 ksf		
55		53.5-69.0' Gray DOLOMITE, slightly weathered, hard, very thick bedded, vuggy	615		100 (88)		Qu Test Results UCS = 1350 ksf		
60		59.0' Excellent RQD					Qu Test Results UCS = 1250 ksf		

N_{60} = (Em/60)Nm N_{60} - Corrected N value for standard 60% SPT efficiency; Em - Measured hammer efficiency in percent; Nm - Observed N-value
(1) = Assumed, (2) = Actual

Coordinate System: U.S. State Plane 1983 **Coordinate Zone:** Missouri Central **Coordinate Proj. Factor:** 1.0000772
Coordinate Datum: NAD 83 **Coordinate Units:** U.S. Survey Feet

Missouri Department of Transportation
Construction and Materials

Job No.: J9P33.5 **County:** Shannon **Route:** Highway 19
Design: **Skew:** **Location:** 5.5 miles north of Route D
Bent: **Logged By:** Seye Coker [GeoEngineers, Inc.] **Operator:** Carmon Hunter (Anderson Engineering)
Station: **Northing:** 529085.1 **Date of Work:** 05/02/22-05/03/22
Offset: **Easting:** 1957653.19 **Depth to Water:** 7.0
Elevation: 673.3 **Requested Northing:** **Depth Hole Open:** 96
Requested Station: **Requested Easting:** **Time Change:** At Time of Drilling
Requested Offset: **Equipment:** CME 550X ,Split-Spoon Sampler
Requested Elevation: **Location Note:**
Drill No.: 401073 **Hammer Efficiency:** 92.3% **Drilling Method:** Continuous Flight Auger

Depth (ft)	Graphic	Description	Elevation (ft)	Sample Type	REC % (RQD %)	Blow Counts (N_{60})	Shear Data	Field Tests	Index Tests
60		53.5-69.0' Gray DOLOMITE, slightly weathered, hard, very thick bedded, vuggy *(continued)*	610		100 (100)		Qu Test Results UCS = 1270 ksf		
65			605						
70		69.0-73.5' Gray DOLOMITE, slightly weathered, medium hard, thick bedded, fractured, vuggy, good RQD	600				Qu Test Results UCS = 880 ksf		
75		73.5-79.0' Gray DOLOMITE, slightly weathered, hard, thick bedded, fractured, vuggy	595		100 (75)		Qu Test Results UCS = 2120 ksf		
80		79.0-82.0' Gray DOLOMITE, slightly weathered, medium hard, thick bedded, fractured, vuggy, good RQD					Qu Test Results UCS = 740 ksf		
		82.0-83.0' Gray DOLOMITE, slightly weathered, hard, thin bedded, fractured, vuggy	590						
85		83.0-85.0' VOID			100 (88)		Qu Test Results UCS = 1630 ksf		
		85.0-91.5' Gray DOLOMITE, slightly weathered, hard, thick bedded, vuggy with quartz pockets, sandy	585						
90							Qu Test Results UCS = 1330 ksf		

N_{60} = (Em/60)Nm N_{60} - Corrected N value for standard 60% SPT efficiency; Em - Measured hammer efficiency in percent; Nm - Observed N-value
(1) = Assumed, (2) = Actual

Coordinate System: U.S. State Plane 1983 **Coordinate Zone:** Missouri Central **Coordinate Proj. Factor:** 1.0000772
Coordinate Datum: NAD 83 **Coordinate Units:** U.S. Survey Feet

Missouri Department of Transportation
Construction and Materials

Job No.: J9P33.5 **County:** Shannon **Route:** Highway 19
Design: **Skew:** **Location:** 5.5 miles north of Route D
Bent: **Logged By:** Seye Coker [GeoEngineers, Inc.] **Operator:** Carmon Hunter (Anderson Engineering)
Station: **Northing:** 529085.1 **Date of Work:** 05/02/22-05/03/22
Offset: **Easting:** 1957653.19 **Depth to Water:** 7.0
Elevation: 673.3 **Requested Northing:** **Depth Hole Open:** 96
Requested Station: **Requested Easting:** **Time Change:** At Time of Drilling
Requested Offset: **Equipment:** CME 550X ,Split-Spoon Sampler
Requested Elevation: **Location Note:**
Drill No.: 401073 **Hammer Efficiency:** 92.3% **Drilling Method:** Continuous Flight Auger

Depth (ft)	Graphic	Description	Elevation (ft)	Sample Type	REC % (RQD %)	Blow Counts (N_{60})	Shear Data	Field Tests	Index Tests
90		89.5' Excellent RQD							
		91.5-94.0' Gray DOLOMITE, slightly weathered, soft, medium bedded, vuggy, sandy	580		93 (93)		Qu Test Results UCS = 560 ksf		
95		94.0-94.5' Clay filled VOID							
		94.5-96.0' Gray DOLOMITE, fresh, soft, medium bedded, sandy							
		Refusal at 19.0 feet. Bottom of borehole at 96.0 feet.							

N_{60} = (Em/60)Nm N_{60} - Corrected N value for standard 60% SPT efficiency; Em - Measured hammer efficiency in percent; Nm - Observed N-value
(1) = Assumed, (2) = Actual

Coordinate System: U.S. State Plane 1983 **Coordinate Zone:** Missouri Central **Coordinate Proj. Factor:** 1.0000772
Coordinate Datum: NAD 83 **Coordinate Units:** U.S. Survey Feet

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Missouri Department of Transportation
Construction and Materials

Job No.: J9P33.5 **County:** Shannon **Route:** Highway 19

Design: **Skew:** **Location:** 5.5 miles north of Route D

Bent: **Logged By:** Seye Coker [GeoEngineers, Inc.] **Operator:** Carmon Hunter (Anderson Engineering)

Station: **Northing:** 529161.14 **Date of Work:** 04/26/22-04/27/22

Offset: **Easting:** 1957755.78 **Depth to Water:** 10.0

Elevation: 675.8 **Requested Northing:** **Depth Hole Open:** 76.5

Requested Station: **Requested Easting:** **Time Change:** At Time of Drilling

Requested Offset: **Equipment:** CME 550X ,Split-Spoon Sampler

Requested Elevation: **Location Note:**

Drill No.: 401073 **Hammer Efficiency:** 92.3% **Drilling Method:** Continuous Flight Auger

Depth (ft)	Graphic	Description	Elevation (ft)	Sample Type	REC % (RQD %)	Blow Counts (N_{60})	Shear Data	Field Tests	Index Tests
0		0.0-5.0' Brown SILT with sand and trace gravel (medium stiff, dry)	675		67	2-1-2 (5)			MC = 19.0%
5		5.0-10.0' Brown SILT with sand and gravel (stiff, moist)	670		22	3-5-4 (14)			MC = 16.6%
10		10.0-15.0' Brown GRAVEL with sand and silt (loose, wet)	665		39	0-1-3 (6)			
15		15.0-15.5' Coarse SAND (wet) 15.5-20.0' Fine GRAVEL with sand (medium dense, wet)	660		50	3-7-9 (25)			Sieve Analysis Sieve # % Passing 3/4" 100.0 3/8" 89.2 #4 74.3 #10 51.8 #40 13.4 #100 3.7 #200 3.0
20		20.0-23.0' Fine GRAVEL with sand (dense, wet)	655		44	5-12-10 (34)			
25		23.0-24.0' Fine GRAVEL 24.0-33.0' Gray DOLOMITE, slightly weathered, medium hard, thick bedded, vuggy, sandy, good RQD	650		100 (84)		Qu Test Results UCS = 1040 ksf		
30									

N_{60} = (Em/60)Nm N_{60} - Corrected N value for standard 60% SPT efficiency; Em - Measured hammer efficiency in percent; Nm - Observed N-value
(1) = Assumed, (2) = Actual

Coordinate System: U.S. State Plane 1983 **Coordinate Zone:** Missouri Central **Coordinate Proj. Factor:** 1.0000772

Coordinate Datum: NAD 83 **Coordinate Units:** U.S. Survey Feet

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Missouri Department of Transportation
Construction and Materials

Job No.: J9P33.5 **County:** Shannon **Route:** Highway 19
Design: **Skew:** **Location:** 5.5 miles north of Route D
Bent: **Logged By:** Seye Coker [GeoEngineers, Inc.] **Operator:** Carmon Hunter (Anderson Engineering)
Station: **Northing:** 529161.14 **Date of Work:** 04/26/22-04/27/22
Offset: **Easting:** 1957755.78 **Depth to Water:** 10.0
Elevation: 675.8 **Requested Northing:** **Depth Hole Open:** 76.5
Requested Station: **Requested Easting:** **Time Change:** At Time of Drilling
Requested Offset: **Equipment:** CME 550X ,Split-Spoon Sampler
Requested Elevation: **Location Note:**
Drill No.: 401073 **Hammer Efficiency:** 92.3% **Drilling Method:** Continuous Flight Auger

Depth (ft)	Graphic	Description	Elevation (ft)	Sample Type	REC % (RQD %)	Blow Counts (N_{60})	Shear Data	Field Tests	Index Tests
30		24.0-33.0' Gray DOLOMITE, slightly weathered, medium hard, thick bedded, vuggy, sandy, good RQD *(continued)*	645						
		33.0-37.0' Gray DOLOMITE, slightly weathered, hard, thick bedded, vuggy with quartz pockets, excellent RQD					Qu Test Results UCS = 1600 ksf		
35			640						
		37.0-38.0' VOID							
		38.0-44.0' Gray DOLOMITE, slightly weathered, hard, thick bedded, vuggy			98 (98)		Qu Test Results UCS = 1750 ksf		
40			635						
		43.0' Good RQD					Qu Test Results UCS = 1190 ksf		
45		44.0-53.0' Gray DOLOMITE, slightly weathered, hard, thick bedded, vuggy with quartz pockets	630		100 (92)		Qu Test Results UCS = 1960 ksf		
50			625						
		53.0-57.0' Gray DOLOMITE, slightly weathered, soft, thick bedded, vuggy, fair RQD					Qu Test Results UCS = 440 ksf		
55			620						
		57.0-67.5' Gray DOLOMITE, slightly weathered, medium hard, thick bedded, vuggy			100 (64)		Qu Test Results UCS = 1140 ksf		
60									

N_{60} = (Em/60)Nm N_{60} - Corrected N value for standard 60% SPT efficiency; Em - Measured hammer efficiency in percent; Nm - Observed N-value
(1) = Assumed, (2) = Actual

Coordinate System: U.S. State Plane 1983 **Coordinate Zone:** Missouri Central **Coordinate Proj. Factor:** 1.0000772
Coordinate Datum: NAD 83 **Coordinate Units:** U.S. Survey Feet

Missouri Department of Transportation
Construction and Materials

Job No.: J9P33.5 **County:** Shannon **Route:** Highway 19
Design: **Skew:** **Location:** 5.5 miles north of Route D
Bent: **Logged By:** Seye Coker [GeoEngineers, Inc.] **Operator:** Carmon Hunter (Anderson Engineering)
Station: **Northing:** 529161.14 **Date of Work:** 04/26/22-04/27/22
Offset: **Easting:** 1957755.78 **Depth to Water:** 10.0
Elevation: 675.8 **Requested Northing:** **Depth Hole Open:** 76.5
Requested Station: **Requested Easting:** **Time Change:** At Time of Drilling
Requested Offset: **Equipment:** CME 550X ,Split-Spoon Sampler
Requested Elevation: **Location Note:**
Drill No.: 401073 **Hammer Efficiency:** 92.3% **Drilling Method:** Continuous Flight Auger

Depth (ft)	Graphic	Description	Elevation (ft)	Sample Type	REC % (RQD %)	Blow Counts (N_{60})	Shear Data	Field Tests	Index Tests
60		57.0-67.5' Gray DOLOMITE, slightly weathered, medium hard, thick bedded, vuggy *(continued)*	615						
		63.0' Good RQD					Qu Test Results UCS = 790 ksf		
65			610						
		67.5-76.5' Gray DOLOMITE, slightly weathered, hard, thick bedded, vuggy with quartz pockets			100 (80)		Qu Test Results UCS = 1550 ksf		
70			605				Qu Test Results UCS = 1510 ksf		
		73.0' Excellent RQD							
75			600		100 (100)		Qu Test Results UCS = 1440 ksf		
		Refusal at 23.0 feet. Bottom of borehole at 76.5 feet.							

N_{60} = (Em/60)Nm N_{60} - Corrected N value for standard 60% SPT efficiency; Em - Measured hammer efficiency in percent; Nm - Observed N-value
(1) = Assumed, (2) = Actual

Coordinate System: U.S. State Plane 1983 **Coordinate Zone:** Missouri Central **Coordinate Proj. Factor:** 1.0000772
Coordinate Datum: NAD 83 **Coordinate Units:** U.S. Survey Feet

Missouri Department of Transportation
Construction and Materials

Job No.: J9P33.5 **County:** Shannon **Route:** Highway 19
Design: **Skew:** **Location:** 5.5 miles north of Route D
Bent: **Logged By:** Seye Coker [GeoEngineers, Inc.] **Operator:** Carmon Hunter (Anderson Engineering)
Station: **Northing:** 529293.12 **Date of Work:** 05/04/22-05/04/22
Offset: **Easting:** 1957797.9 **Depth to Water:**
Elevation: 705.4 **Requested Northing:** **Depth Hole Open:**
Requested Station: **Requested Easting:** **Time Change:**
Requested Offset: **Equipment:** CME 550X ,Split-Spoon Sampler
Requested Elevation: **Location Note:**
Drill No.: 401073 **Hammer Efficiency:** 92.3% **Drilling Method:** Continuous Flight Auger

Depth (ft)	Graphic	Description	Elevation (ft)	Sample Type	REC % (RQD %)	Blow Counts (N_{60})	Shear Data	Field Tests	Index Tests
0			705						
		0.0-5.0' Red fat CLAY with gravel (stiff, moist) (fill)		X	67	2-3-2 (8)			
5		5.0-10.0' Red and gray CLAY with chert gravel and sand (stiff, moist) (fill)	700	X	67	2-2-4 (9)			
10		10.0-12.0' Red and gray clayey SAND with gravel (hard, moist) (fill)	695	X	44	3-3-18 (32)			Sieve Analysis Sieve # % Passing 1" 100.0 3/4" 89.6 3/8" 80.8 #4 67.5 #10 59.4 #40 50.1 #100 37.0 #200 34.2
		12.0-30.0' Red CLAY with 7" dolomite boulder (fill)							
15			690		12				
		18.5' Red CLAY with sand, gravel and chert (stiff, moist) (fill)		X	67	3-6-4 (15)			
20			685						
25		25.0' Red and gray CLAY with wood and trace gravel (stiff, moist) (fill)	680	X	67	4-4-6 (15)			
30									

N_{60} = (Em/60)Nm N_{60} - Corrected N value for standard 60% SPT efficiency; Em - Measured hammer efficiency in percent; Nm - Observed N-value
(1) = Assumed, (2) = Actual

Coordinate System: U.S. State Plane 1983 **Coordinate Zone:** Missouri Central **Coordinate Proj. Factor:** 1.0000772
Coordinate Datum: NAD 83 **Coordinate Units:** U.S. Survey Feet

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Missouri Department of Transportation
Construction and Materials

Job No.: J9P33.5 **County:** Shannon **Route:** Highway 19
Design: **Skew:** **Location:** 5.5 miles north of Route D
Bent: **Logged By:** Seye Coker [GeoEngineers, Inc.] **Operator:** Carmon Hunter (Anderson Engineering)
Station: **Northing:** 529293.12 **Date of Work:** 05/04/22-05/04/22
Offset: **Easting:** 1957797.9 **Depth to Water:**
Elevation: 705.4 **Requested Northing:** **Depth Hole Open:**
Requested Station: **Requested Easting:** **Time Change:**
Requested Offset: **Equipment:** CME 550X ,Split-Spoon Sampler
Requested Elevation: **Location Note:**
Drill No.: 401073 **Hammer Efficiency:** 92.3% **Drilling Method:** Continuous Flight Auger

Depth (ft)	Graphic	Description	Elevation (ft)	Sample Type	REC % (RQD %)	Blow Counts (N_{60})	Shear Data	Field Tests	Index Tests
30									
		30.0-40.0' Tan and red fat CLAY with trace gravel (stiff, moist) (fill)	675	X	67	3-5-6 (17)			
35		35.0' Tan and red fat CLAY with sand (stiff, moist) (fill)	670	X	67	6-5-5 (15)			
40		40.0-51.0' Tan and red sandy CLAY (stiff, wet)	665	X	67	3-2-2 (6)			
45		45.0' Tan and red fat CLAY (medium stiff, wet)	660	X	67	3-3-3 (9)			
50		50.0' Tan and red CLAY with bedrock at tip (very soft, wet)	655	X	56	1-1-50 (78)			
		51.0-63.0' Gray DOLOMITE, slightly weathered, medium hard, thick bedded, vuggy with clay lenses 53.0' Excellent RQD							
55			650		100 (100)		Qu Test Results UCS = 1140 ksf		
60									

N_{60} = (Em/60)Nm N_{60} - Corrected N value for standard 60% SPT efficiency; Em - Measured hammer efficiency in percent; Nm - Observed N-value
(1) = Assumed, (2) = Actual

Coordinate System: U.S. State Plane 1983 **Coordinate Zone:** Missouri Central **Coordinate Proj. Factor:** 1.0000772
Coordinate Datum: NAD 83 **Coordinate Units:** U.S. Survey Feet

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LETTER BOREHOLE - MODOT 20150728.GDT - 6/20/22 10:39 - P:\15\15273022\GINT\1527302201.GPJ

Missouri Department of Transportation
Construction and Materials

Job No.: J9P33.5 **County:** Shannon **Route:** Highway 19
Design: **Skew:** **Location:** 5.5 miles north of Route D
Bent: **Logged By:** Seye Coker [GeoEngineers, Inc.] **Operator:** Carmon Hunter (Anderson Engineering)
Station: **Northing:** 529293.12 **Date of Work:** 05/04/22-05/04/22
Offset: **Easting:** 1957797.9 **Depth to Water:**
Elevation: 705.4 **Requested Northing:** **Depth Hole Open:**
Requested Station: **Requested Easting:** **Time Change:**
Requested Offset: **Equipment:** CME 550X ,Split-Spoon Sampler
Requested Elevation: **Location Note:**
Drill No.: 401073 **Hammer Efficiency:** 92.3% **Drilling Method:** Continuous Flight Auger

Depth (ft)	Graphic	Description	Elevation (ft)	Sample Type	REC % (RQD %)	Blow Counts (N_{60})	Shear Data	Field Tests	Index Tests
60		51.0-63.0' Gray DOLOMITE, slightly weathered, medium hard, thick bedded, vuggy with clay lenses *(continued)* 60.5' Excellent RQD	645				Qu Test Results UCS = 990 ksf		
65		63.0-66.0' Bluish gray DOLOMITE, slightly weathered, hard, thick bedded, vuggy with clay pockets and fractures	640		100 (96)		Qu Test Results UCS = 2380 ksf		
70		66.0-70.0' Light gray DOLOMITE, slightly weathered, very hard, thick bedded, slightly vuggy with fractures					Qu Test Results UCS = 1050 ksf		
		Refusal at 53.0 feet. Bottom of borehole at 70.0 feet.							

N_{60} = (Em/60)Nm N_{60} - Corrected N value for standard 60% SPT efficiency; Em - Measured hammer efficiency in percent; Nm - Observed N-value
(1) = Assumed, (2) = Actual

Coordinate System: U.S. State Plane 1983 **Coordinate Zone:** Missouri Central **Coordinate Proj. Factor:** 1.0000772
Coordinate Datum: NAD 83 **Coordinate Units:** U.S. Survey Feet

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Anderson Engineering Laboratory Test Results and Summaries

ROCK CORE COMPRESSION REPORT (ASTM D 4543-19)

Client: GeoEngineers / MoDot - GEO # 15273-022-01 Project #: 22SP30077

Project: Highway 19 Bridge

Boring	Depth, ft	Core Diameter (in.)	Weight (LBS)	Sawed Length (in.)	Length w/ Cap (in.)	L/D Ratio	Date Tested	Max Load (LBS)	Area of Cores (in.2)	L/D Correction	Compressive strength (PSI)	Type Break
B-1	18.75	1.97	1.38	4.54	4.81	2.4	05/03/22	30,730	3.05	1.00	10,082	5
B-1	20.66	1.97	1.20	4.05	4.15	2.1	05/03/22	30,980	3.05	1.00	10,164	2
B-1	27.75	1.96	0.84	3.82	3.93	2.0	05/03/22	7,460	3.02	1.00	2,473	3
B-1	32.25	1.97	0.86	3.66	3.87	2.0	05/03/22	7,700	3.05	1.00	2,526	3
B-1	36.25	1.97	1.02	3.43	3.62	1.8	05/03/22	10,670	3.05	1.00	3,501	3
B-1	43.00	1.97	0.84	2.84	3.12	1.4	05/03/22	10,150	3.05	1.00	3,330	3
B-1	46.50	1.98	1.38	4.74	4.91	2.4	05/03/22	26,580	3.08	1.00	8,632	3
B-1	52.25	1.96	1.54	5.10	5.31	2.6	05/03/22	45,790	3.02	1.00	15,176	5
B-1	58.25	1.98	1.36	4.51	4.67	2.3	05/03/22	23,230	3.08	1.00	7,544	3
B-1	64.50	1.97	1.44	4.81	4.94	2.4	05/03/22	20,300	3.05	1.00	6,660	2
B-1	70.20	1.97	1.24	4.06	4.27	2.1	05/03/22	3,774	3.05	1.00	1,238	2
B-1	73.75	1.97	1.48	4.86	5.03	2.5	05/03/22	34,300	3.05	1.00	11,253	2
B-1	76.50	1.95	1.50	4.95	5.16	2.5	05/03/22	29,360	2.99	1.00	9,831	2

Report Date: 5/3/2022

Signed: John T. Smith, P.E.

with Anderson Engineering

2 - Columnar, cone break
3 - Columnar break
5 - Side fracture, top or bottom

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ROCK CORE COMPRESSION REPORT (ASTM D 4543-19)

Client: GeoEngineers / MoDot - GEO # 15273-022-01 Project #: 22SP30077

Project: Highway 19 Bridge

	Boring	Depth, ft	Core Diameter (in.)	Weight (LBS)	Sawed Length (in.)	Length w/ Cap (in.)	L/D Ratio	Date Tested	Max Load (LBS)	Area of Cores (in.2)	L/D Correction	Compressive strength (PSI)	Type Break
A	B-2	21.66	1.97	1.20	3.95	4.15	2.0	05/06/22	35,370	3.05	1.00	11,604	3
B	B-2	28.20	1.97	1.40	4.04	4.19	2.1	05/06/22	17,310	3.05	1.00	5,679	3
C	B-2	33.20	1.96	1.28	4.25	4.48	2.2	05/06/22	26,640	3.02	1.00	8,829	3
D	B-2	38.33	1.98	1.24	4.08	4.37	2.1	05/06/22	18,660	3.08	1.00	6,060	3
E	B-2	43.00	1.97	1.26	4.12	4.30	2.1	05/06/22	25,020	3.05	1.00	8,209	3
F	B-2	45.20	1.97	1.22	4.11	4.36	2.1	05/06/22	11,290	3.05	1.00	3,704	3
G	B-2	50.25	1.98	1.20	3.94	4.14	2.0	05/06/22	28,890	3.08	1.00	9,383	4
H	B-2	58.66	1.98	1.24	4.03	4.23	2.0	05/06/22	26,750	3.08	1.00	8,688	3
I	B-2	65.00	1.97	1.26	4.04	4.25	2.1	05/06/22	26,800	3.05	1.00	8,793	3
J	B-2	68.50	1.97	1.18	3.98	4.19	2.0	05/06/22	18,580	3.05	1.00	6,096	3
K	B-2	69.33	1.97	1.24	4.02	4.26	2.0	05/06/22	44,780	3.05	1.00	14,691	3
L	B-2	78.60	1.97	1.24	4.07	4.29	2.1	05/06/22	15,760	3.05	1.00	5,171	4
M	B-2	80.25	1.98	1.22	4.13	4.27	2.1	05/06/22	34,950	3.08	1.00	11,351	3
N	B-2	88.33	1.97	1.22	4.05	4.28	2.1	05/06/22	28,090	3.05	1.00	9,216	3
O	B-2	93.80	1.98	1.16	3.95	4.09	2.0	05/06/22	11,920	3.08	1.00	3,871	3

Report Date: 5/6/2022

Signed: John T. Smith, P.E.

with Anderson Engineering

3 - Columnar break
4 - Diagonal fracture

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ROCK CORE COMPRESSION REPORT (ASTM D 4543-19)

Client: GeoEngineers / MoDot - GEO # 15273-022-01 Project #: 22SP30077

Project: Highway 19 Bridge

Boring	Depth, ft	Core Diameter (in.)	Weight (LBS)	Sawed Length (in.)	Length w/ Cap (in.)	L/D Ratio	Date Tested	Max Load (LBS)	Area of Cores (in.2)	L/D Correction	Compressive strength (PSI)	Type Break
B-3	25.33	1.97	1.46	5.10	5.10	2.6	05/03/22	22,090	3.05	1.00	7,247	3
B-3	30.33	1.97	1.30	4.30	4.30	2.2	05/03/22	33,930	3.05	1.00	11,132	3
B-3	38.00	1.97	1.20	3.88	3.88	2.0	05/03/22	36,970	3.05	1.00	12,129	3
B-3	40.20	1.97	1.62	5.24	5.24	2.7	05/03/22	25,260	3.05	1.00	8,287	2
B-3	47.75	1.97	1.68	5.52	5.52	2.8	05/03/22	41,550	3.05	1.00	13,632	3
B-3	49.66	1.97	1.44	4.84	4.84	2.5	05/03/22	9,330	3.05	1.00	3,061	3
B-3	56.00	1.97	1.26	4.31	4.31	2.2	05/03/22	24,190	3.05	1.00	7,936	3
B-3	61.75	1.98	1.58	5.31	5.31	2.7	05/03/22	16,950	3.08	1.00	5,505	2
B-3	63.66	1.97	1.42	4.61	4.61	2.3	05/03/22	32,890	3.05	1.00	10,790	3
B-3	72.50	1.98	1.18	3.96	3.96	2.0	05/03/22	32,270	3.08	1.00	10,480	3
B-3	75.50	1.97	1.44	4.63	4.63	2.4	05/03/22	30,510	3.05	1.00	10,010	3
B-1	82.50	1.97	0.98	3.30	3.30	1.7	05/03/22	22,780	3.05	1.00	7,474	2
B-1	86.00	1.94	1.06	3.86	3.86	2.0	05/03/22	10,880	2.96	1.00	3,681	2

Report Date: 5/3/2022

Signed: John T. Snider P.E.

with Anderson Engineering

2 - Columnar, cone break
3 - Columnar break
5 - Side fracture, top or bottom

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ROCK CORE COMPRESSION REPORT (ASTM D 4543-19)

Client: GeoEngineers / MoDot - GEO # 15273-022-01 Project #: 22SP30077

Project: Highway 19 Bridge

	Boring	Depth, ft	Core Diameter (in.)	Weight (LBS)	Sawed Length (in.)	Length w/ Cap (in.)	L/D Ratio	Date Tested	Max Load (LBS)	Area of Cores (in.2)	L/D Correction	Compressive strength (PSI)	Type Break
A	B-4	54.75	1.85	1.08	4.40	4.18	2.4	05/10/22	21,210	2.69	1.00	7,891	3
B	B-4	61.50	1.85	1.06	3.97	4.10	2.1	05/10/22	18,550	2.69	1.00	6,901	3
C	B-4	65.42	1.85	1.06	3.90	4.07	2.1	05/10/22	44,410	2.69	1.00	16,521	3
D	B-4	68.25	1.85	1.08	3.95	4.10	2.1	05/10/22	19,570	2.69	1.00	7,280	3
E													
F													
G													
H													
I													
J													
K													
L													
M													
N													
O													

Report Date: 5/10/2022

Signed: John T. Snider, PE

with Anderson Engineering

3 - Columnar break

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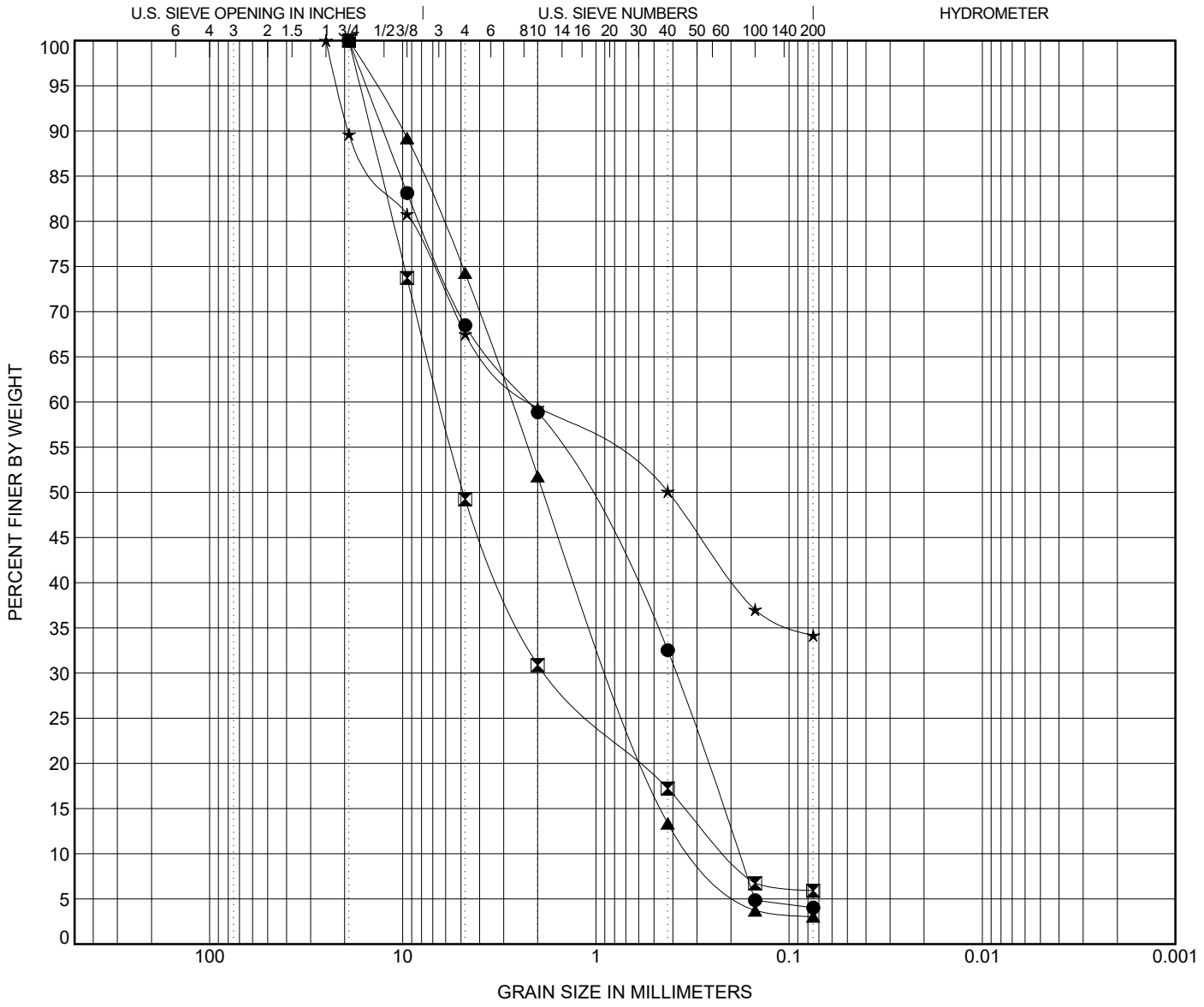
ANDERSON ENGINEERING
EMPLOYEE OWNED
Anderson Engineering Inc
3213 S. West Bypass
Springfield, MO 65807
Telephone: 417-866-2741
Fax: 417-866-2778

GRAIN SIZE DISTRIBUTION

CLIENT GEOENGINEERS - GEO # 15273-022-01 **PROJECT NAME** HIGHWAY 19 BRIDGE

PROJECT NUMBER 22SP30077 **PROJECT LOCATION** SHANNON COUNTY, MO

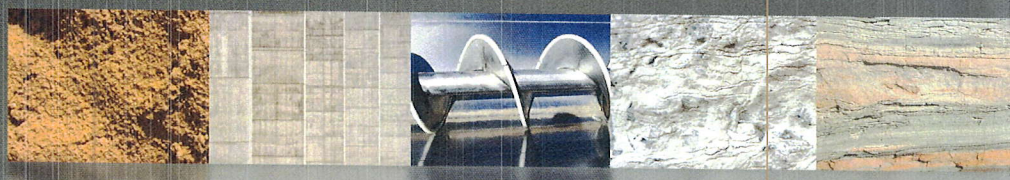


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	B-1	5.0	POORLY GRADED SAND with GRAVEL(SP)				0.37	12.16
⊠	B-2	10.0					2.44	31.02
▲	B-3	15.0	POORLY GRADED SAND with GRAVEL(SP)				0.85	9.28
★	B-4	10.0						

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-1	5.0	19	2.213	0.386	0.182	31.5	64.5	4.0	
⊠	B-2	10.0	19	6.441	1.808	0.208	50.8	43.3	5.9	
▲	B-3	15.0	19	2.743	0.831	0.296	25.7	71.3	3.0	
★	B-4	10.0	25	2.141			32.5	33.3	34.2	

Anderson Engineering Drill Calibration



FOUNDATION TESTING & CONSULTING, LLC
Knowledge To Build On®

16500 Lucille St. Overland Park, KS 66221
phone 913-626-8499
fax 913-439-1703

September 16, 2020

Mr. Gary White
Anderson Engineering, Inc.
3213 S. West Bypass
Springfield, Missouri 65807

Subject: SPT Hammer Calibration for Drill Rigs
FTC Project Number 075-2020

Dear Mr. White,

Foundation Testing and Consulting, LLC (FTC) is pleased to submit the results of our SPT hammer calibration to you. The field work associated with the hammer calibrations was performed September 10, 2020 at your drill yard in Springfield, Missouri. The energy efficiency rating for the hammers on 3 of your drill rigs was determined by us.

Hammer blow rates, average maximum compressive forces, average maximum velocities, average energy transfer and average transfer ratio were computed for each sample interval from data collected using a PAX 8 model pile driving analyzer (PDA) unit manufactured by Pile Dynamics Incorporated with upgraded software to comply with ASTM D4633. The PDA unit was connected to an instrumented AWJ rod. The primary objective of the calibration testing was to determine the average energy transfer efficiency for each hammer system. The testing procedure and detailed test results are presented below.

Procedure

SPT sample depths ranged from surface to 16.5 feet below ground surface.

Energy measurements were taken over the full 18 inches of sample drive for each sample interval. The drill rig was equipped with an auto-hammer. A total of 3 or more data sets were collected for each rig and we elected to use selected representative intervals in our analysis for each rig.

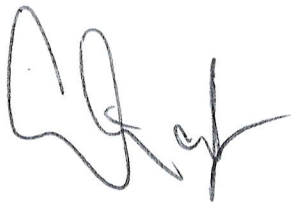
Rig Type	Serial Number	Average Efficiency (%)	Energy Correction Factor
CME 75	249037	80.5	1.34
CME 550X	295993	86.3	1.44
CME 550X	401073	92.3	1.54

These calibration results are presented graphically in the attached plots for the SPT data sets collected in the borings.

Please note that per ASTM D4633, hammer energy measurements (calibrations) should be performed at least annually and following major repair or refurbishment of the hammer system components.

It was our pleasure to provide these calibration services to you. Please contact me with any questions or future needs.

Sincerely,



William C. Jones, P.E*, P.G.** – Technical Director, FTC

*Professional Engineer in Kansas, Missouri, Iowa, Illinois, Tennessee, Arkansas, Texas, Nevada and Oklahoma
**Professional Geologist in Kansas and Missouri

Enclosure: Tables and Data Plots

Table 1
Anderson Engineering, Inc., CME75 Rig, (Serial Number 249037) Auto Hammer
Hammer Calibration Performed September 10, 2020

Rod Length (feet)	Beginning Depth (feet)	Final Depth (feet)	Blows per 6-inch interval	**N**	**N_{60}**	BPM	Avg. Max. Compressive Force (kips)	Avg. Max. Velocity (ft/sec)	Avg. Transferred Energy (lb-ft)	**Average Transfer Ratio (%)**
13.5	10.0	11.5	7-9-11	**20**	**27**	54	24	15	284	**81**
18.6	15.0	16.5	3-2-50+	**50+**	**50+**	59	34	18	280	**80**
Overall Average						56.5	29.0	16.5	282.0	80.5
Standard Deviation						2.5	5.0	1.5	2.0	0.5

Overall Calibration Factor for N_{60} = 80.5.0/60 = 1.34
To compute N_{60} values for this rig multiply recorded N-value by 1.34*

* Calibration factor should be recomputed annually or sooner if changes are made to rig and/or hammer

Table 2
Anderson Engineering, Inc. CME550X Rig, (Serial Number 295993) Auto Hammer
Hammer Calibration Performed September 10, 2020

Rod Length (feet)	Beginning Depth (feet)	Final Depth (ft)	Blows per 6-inch interval	**N**	**N_{60}**	BPM	Avg. Max. Compressive Force (kips)	Avg. Max. Velocity (ft/sec)	Avg. Transferred Energy (lb-ft)	**Average Transfer Ratio (%)**
3.3	0	1.5	12-19-13	**32**	**46**	58	30	18	326	**93**
8.7	5.0	6.5	4-9-9	**18**	**26**	58	27	17	294	**84**
13.5	10.0	11.5	5-6-5	**11**	**16**	57	27	17	287	**82**
Overall Average						57.7	28.0	17.3	302.3	86.3
Standard Deviation						0.5	1.4	0.5	17.0	4.8

Overall Calibration Factor for N_{60} = 86.3/60 = 1.44
To compute N_{60} values for this rig multiply recorded N-value by 1.44*

* Calibration factor should be recomputed annually or sooner if changes are made to rig and/or hammer

Table 3
Anderson Engineering, Inc., CME 550X Rig (Serial Number 295993) Auto Hammer
Hammer Calibration Performed September 10, 2020

Rod Length (feet)	Beginning Depth (feet)	Final Depth (ft)	Blows per 6-inch interval	**N**	**N_{60}**	BPM	Avg. Max. Compressive Force (kips)	Avg. Max. Velocity (ft/sec)	Avg. Transferred Energy (lb-ft)	**Average Transfer Ratio (%)**
3.3	5.0	6.5	7-14-8	**22**	**34**	56	32	21	322	**92**
8.7	10.0	11.5	2-4-9	**13**	**20**	55	31	22	319	**91**
13.5	15.0	16.5	7-50+	**50+**	**50+**	55	34	21	329	**94**
Overall Average						55.3	32.3	21.3	323.3	92.3
Standard Deviation						0.5	1.2	0.5	4.2	1.2

Overall Calibration Factor for N_{60} = 92.3/60 = 1.54
To compute N_{60} values for this rig multiply recorded N-value by 1.54*

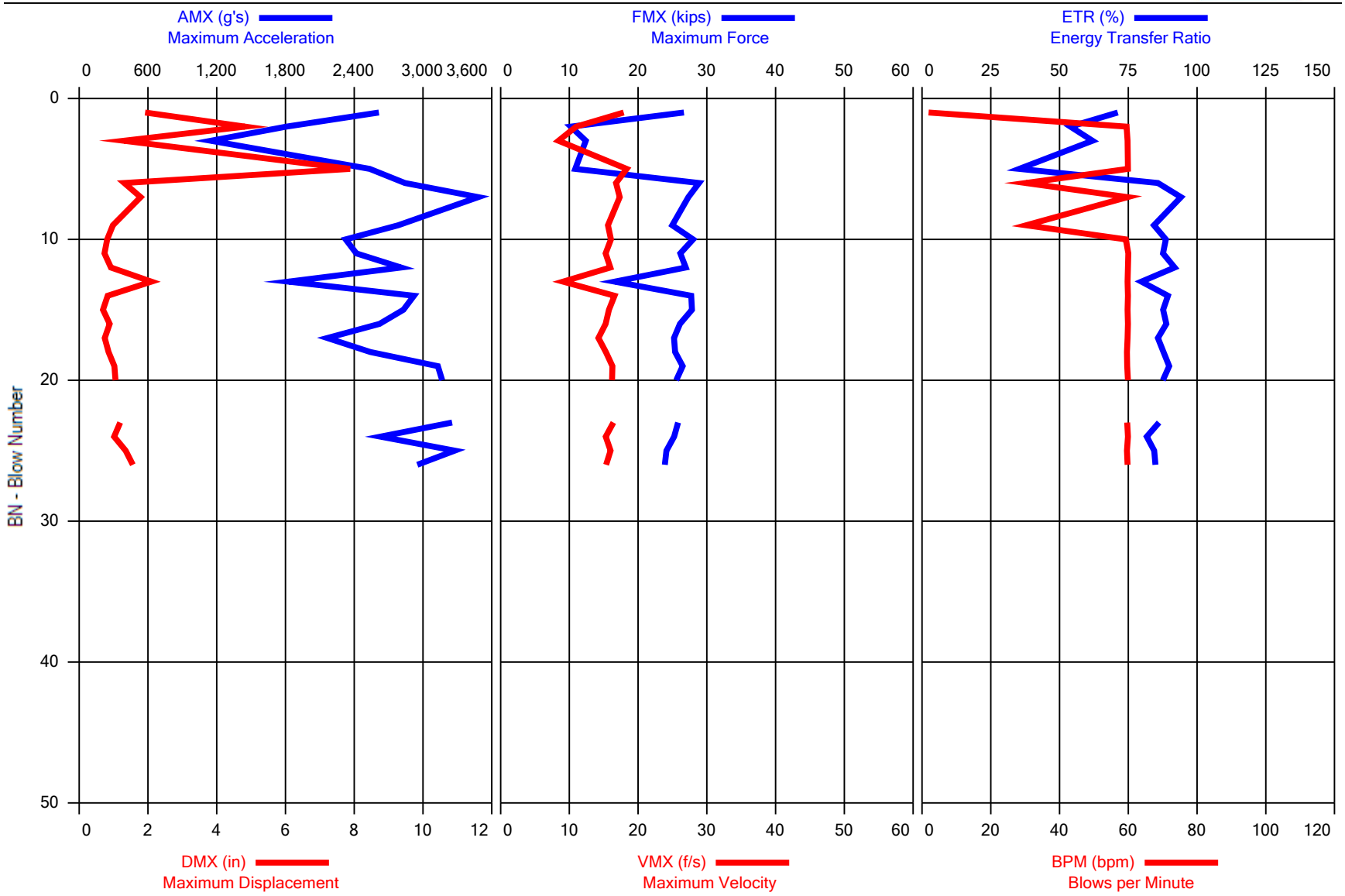
* Calibration factor should be recomputed annually or sooner if changes are made to rig and/or hammer

Foundation Testing & Consulting LLC - PDIPLOT2 Ver 2017.2.58.3 - Case Method & iCAP® Results

Printed: 15-September-2020

Test started: 10-September-2020

ANDERSON ENG, INC. - 249037.3



ANDERSON ENG, INC. - 249037.3 CME
OP: CMH Date: 10-September-2020

AR: 1.19 in² SP: 0.492 k/ft³
LE: 13.54 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 0.00

AMX: Maximum Acceleration
DMX: Maximum Displacement
FMX: Maximum Force
VMX: Maximum Velocity
ETR: Energy Transfer Ratio
BPM: Blows per Minute
CSX: Max Measured Compr. Stress
EMX: Max Transferred Energy
CSI: Max F1 or F2 Compr. Stress

BL#	Depth ft	BLC **	AMX g's	DMX in	FMX kips	VMX f/s	ETR (%)	BPM bpm	CSX ksi	EMX k-ft	CSI ksi
1	10.00	0	2,615	2	27	18	71	2	22.4	0.2	22.8
2	10.00	0	1,808	5	10	11	54	60	8.6	0.2	8.6
3	10.00	0	1,150	1	12	8	62	60	10.4	0.2	10.6
5	10.00	0	2,535	8	11	18	35	60	9.1	0.1	9.2
6	10.00	0	2,842	1	29	17	86	30	24.3	0.3	24.4
7	10.00	0	3,483	2	27	17	94	60	22.9	0.3	23.3
9	10.00	0	2,784	1	25	16	84	30	21.0	0.3	21.1
10	10.00	0	2,325	1	28	16	89	59	23.5	0.3	23.7
11	10.00	0	2,418	1	26	15	88	60	22.0	0.3	22.0
12	10.00	0	2,809	1	27	16	92	60	22.6	0.3	23.2
13	10.00	0	1,827	2	17	9	80	60	14.0	0.3	14.0
14	10.00	0	2,922	1	28	17	89	60	23.3	0.3	23.8
15	10.00	0	2,830	1	28	16	88	60	23.4	0.3	23.8
16	10.00	0	2,621	1	26	15	89	60	21.9	0.3	22.3
17	10.00	0	2,165	1	25	14	86	60	21.2	0.3	21.4
18	10.00	0	2,541	1	25	15	88	60	21.3	0.3	21.3
19	10.00	0	3,130	1	26	16	90	60	22.3	0.3	22.5
20	10.00	0	3,168	1	26	16	88	60	21.5	0.3	21.7
23	10.00	0	3,255	1	26	16	86	60	21.7	0.3	22.2
24	10.00	0	2,629	1	25	15	82	60	21.2	0.3	21.3
25	10.00	0	3,277	1	24	16	84	60	20.3	0.3	20.3
26	10.00	0	2,951	2	24	15	85	60	20.1	0.3	20.1
		Average	2,640	2	24	15	81	54	19.9	0.3	20.2

Total number of blows analyzed: 22

BL# Sensors

1-26 F3: [AWJ-1-2015] 214.3 (1.00); F4: [AWJ-2-2015] 213.7 (1.00); A3: [K10511] 360.0 (1.00); A4: [K10514] 354.0 (1.00)

Time Summary

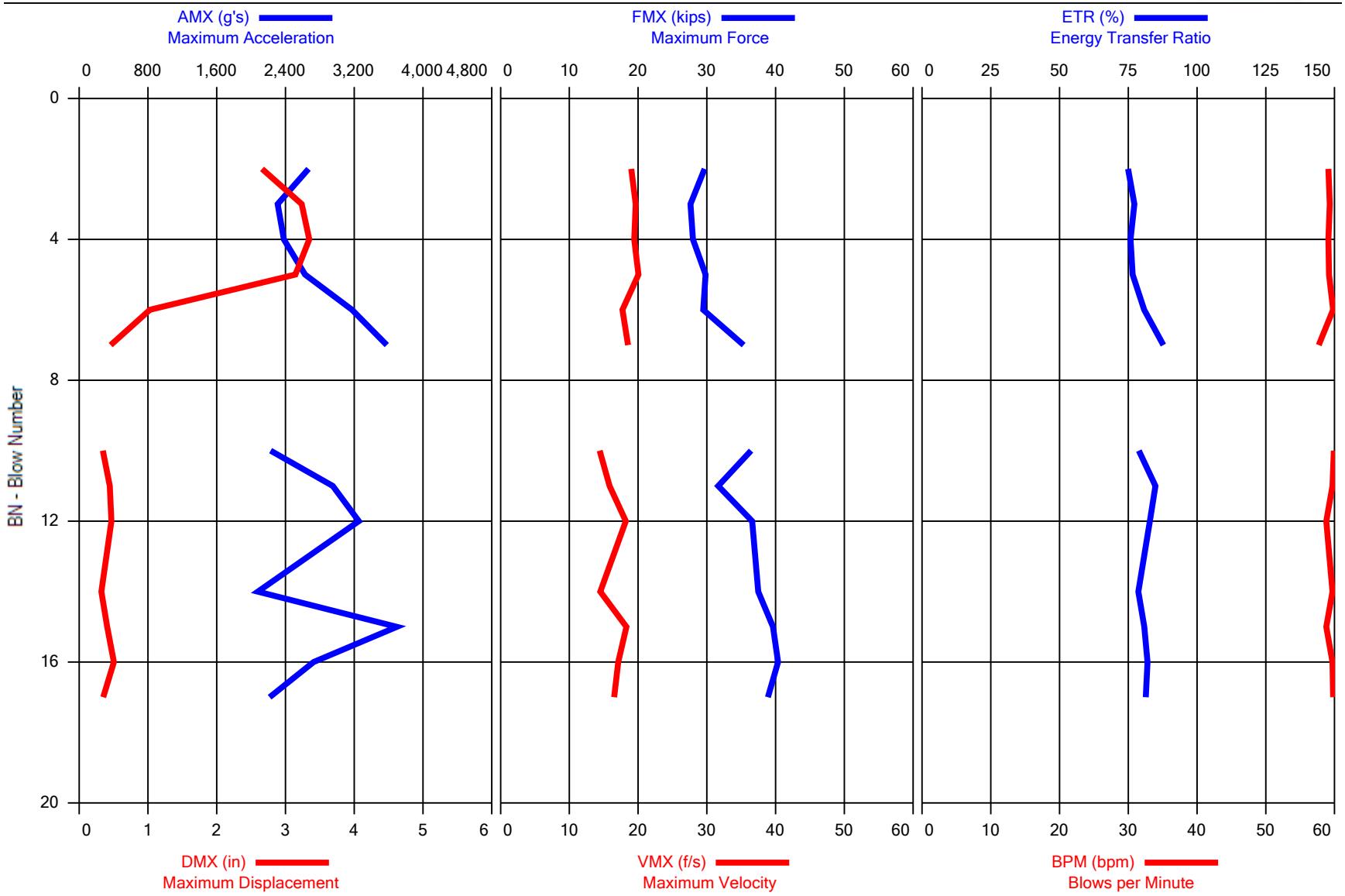
Drive 27 seconds 1:04 PM - 1:04 PM BN 1 - 26

Foundation Testing & Consulting LLC - PDIPLOT2 Ver 2017.2.58.3 - Case Method & iCAP® Results

Printed: 15-September-2020

Test started: 10-September-2020

ANDERSON ENG, INC. - 249037.4



ANDERSON ENG, INC. - 249037.4 CME
OP: CMH Date: 10-September-2020

AR: 1.19 in² SP: 0.492 k/ft³
LE: 18.67 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 0.00

AMX: Maximum Acceleration
DMX: Maximum Displacement
FMX: Maximum Force
VMX: Maximum Velocity
ETR: Energy Transfer Ratio
BPM: Blows per Minute
CSX: Max Measured Compr. Stress
EMX: Max Transferred Energy
CSI: Max F1 or F2 Compr. Stress

BL#	Depth ft	BLC **	AMX g's	DMX in	FMX kips	VMX f/s	ETR (%)	BPM bpm	CSX ksi	EMX k-ft	CSI ksi
2	15.00	0	2,668	3	30	19	75	59	24.9	0.3	25.1
3	15.00	0	2,309	3	28	20	77	59	23.2	0.3	23.2
4	15.00	0	2,382	3	28	19	76	59	23.5	0.3	23.6
5	15.00	0	2,629	3	30	20	77	59	25.1	0.3	25.1
6	15.00	0	3,174	1	29	18	81	60	24.8	0.3	24.8
7	15.00	0	3,580	0	35	19	88	58	29.7	0.3	29.7
10	15.00	0	2,227	0	36	14	79	60	30.6	0.3	30.7
11	15.00	0	2,950	0	32	16	85	60	26.6	0.3	26.7
12	15.00	0	3,254	0	37	18	83	59	30.7	0.3	30.8
14	15.00	0	2,079	0	37	15	79	60	31.5	0.3	31.5
15	15.00	0	3,697	0	40	18	81	59	33.3	0.3	33.4
16	15.00	0	2,727	1	40	17	82	60	33.9	0.3	33.9
17	15.00	0	2,215	0	39	17	81	60	32.7	0.3	32.7
		Average	2,761	1	34	18	80	59	28.5	0.3	28.6

Total number of blows analyzed: 13

BL# Sensors

2-17 F3: [AWJ-1-2015] 214.3 (1.00); F4: [AWJ-2-2015] 213.7 (1.00); A3: [K10511] 360.0 (1.00); A4: [K10514] 354.0 (1.00)

Time Summary

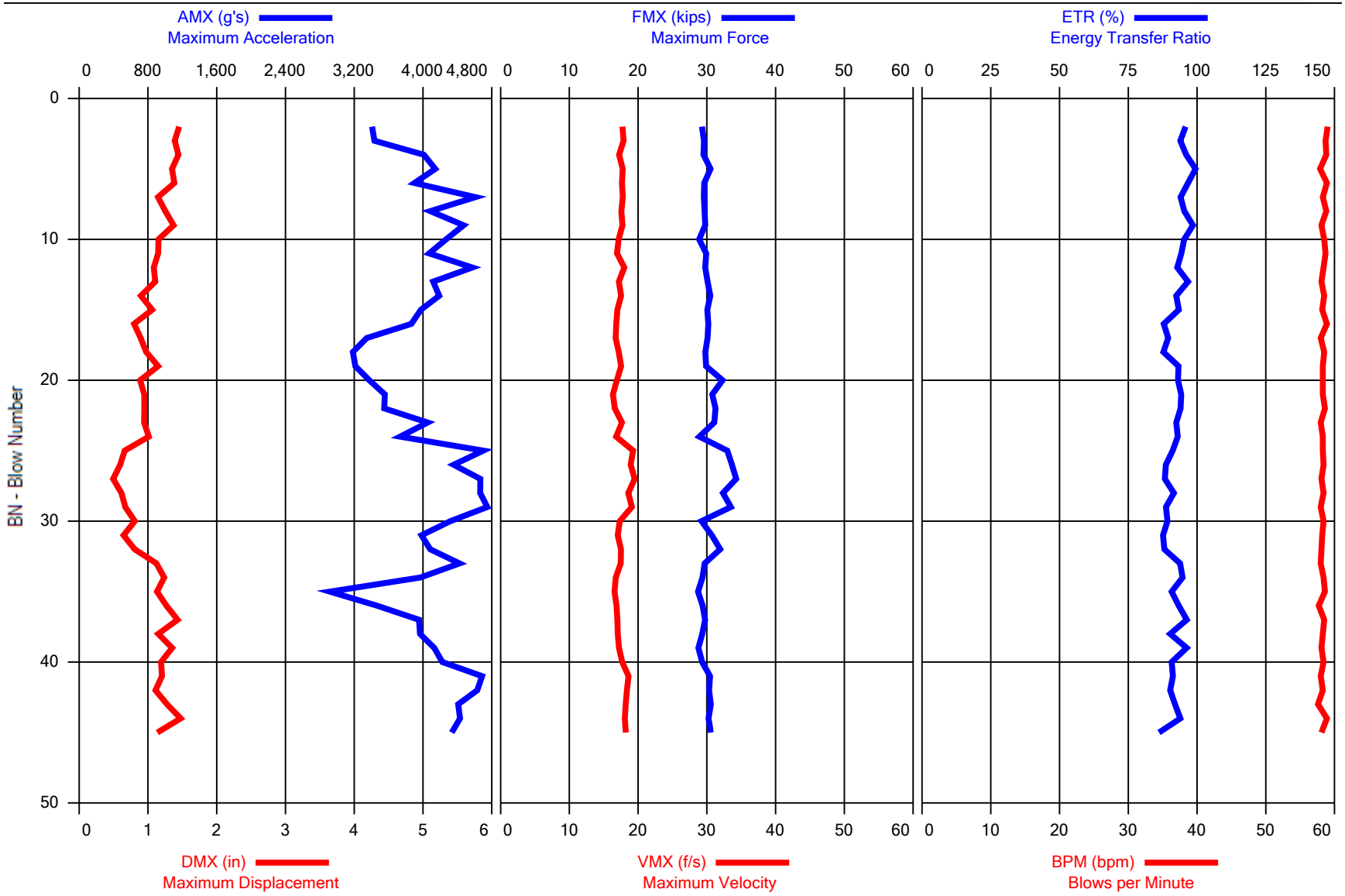
Drive 19 seconds 1:15 PM - 1:15 PM BN 1 - 17

Foundation Testing & Consulting LLC - PDIPLOT2 Ver 2017.2.58.3 - Case Method & iCAP® Results

Printed: 15-September-2020

Test started: 10-September-2020

ANDERSON ENG, INC. - 295993



ANDERSON ENG, INC. - 295993 CME
OP: CMH Date: 10-September-2020

AR: 1.19 in² SP: 0.492 k/ft³
LE: 3.33 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 0.00

AMX: Maximum Acceleration
DMX: Maximum Displacement
FMX: Maximum Force
VMX: Maximum Velocity
ETR: Energy Transfer Ratio
BPM: Blows per Minute
CSX: Max Measured Compr. Stress
EMX: Max Transferred Energy
CSI: Max F1 or F2 Compr. Stress

BL#	Depth	BLC	AMX	DMX	FMX	VMX	ETR	BPM	CSX	EMX	CSI
	ft	**	g's	in	kips	f/s	(%)	bpm	ksi	k-ft	ksi
2	0.00	0	3,407	1	29	18	96	59	24.6	0.3	24.7
3	0.00	0	3,436	1	30	18	94	59	24.9	0.3	25.0
4	0.00	0	4,010	1	30	17	96	59	24.8	0.3	24.9
5	0.00	0	4,143	1	31	18	99	58	25.7	0.3	25.8
6	0.00	0	3,900	1	30	18	97	59	24.9	0.3	25.1
7	0.00	0	4,610	1	30	18	94	58	24.8	0.3	25.2
8	0.00	0	4,085	1	30	18	95	59	24.9	0.3	25.2
9	0.00	0	4,474	1	30	18	99	58	25.0	0.3	25.4
10	0.00	0	4,269	1	29	17	95	59	24.3	0.3	24.4
11	0.00	0	4,073	1	30	17	94	59	25.1	0.3	25.3
12	0.00	0	4,575	1	30	18	93	58	25.0	0.3	25.3
13	0.00	0	4,119	1	30	17	97	58	25.3	0.3	25.6
14	0.00	0	4,190	1	31	18	92	59	25.6	0.3	25.9
15	0.00	0	3,976	1	30	17	93	58	25.3	0.3	25.5
16	0.00	0	3,865	1	30	17	88	59	25.4	0.3	25.5
17	0.00	0	3,346	1	30	17	90	58	25.3	0.3	25.4
18	0.00	0	3,184	1	30	17	88	59	25.0	0.3	25.2
19	0.00	0	3,213	1	30	18	93	58	25.1	0.3	25.2
20	0.00	0	3,376	1	32	17	93	58	27.1	0.3	27.1
21	0.00	0	3,556	1	31	16	94	58	25.9	0.3	26.1
22	0.00	0	3,549	1	31	17	94	59	26.3	0.3	26.5
23	0.00	0	4,055	1	31	18	92	58	26.1	0.3	26.2
24	0.00	0	3,734	1	29	17	93	58	24.3	0.3	24.4
25	0.00	0	4,702	1	33	19	91	58	27.7	0.3	27.8
26	0.00	0	4,357	1	34	19	89	58	28.3	0.3	28.4
27	0.00	0	4,668	0	34	20	88	58	28.8	0.3	28.9
28	0.00	0	4,667	1	32	19	92	58	27.2	0.3	27.5
29	0.00	0	4,749	1	33	19	89	58	28.1	0.3	28.3
30	0.00	0	4,319	1	29	17	89	58	24.6	0.3	24.7
31	0.00	0	3,983	1	31	17	88	58	25.8	0.3	25.9
32	0.00	0	4,085	1	32	18	88	58	26.8	0.3	27.0
33	0.00	0	4,426	1	30	17	94	58	24.9	0.3	25.0
34	0.00	0	3,969	1	29	17	95	58	24.7	0.3	24.8
35	0.00	0	2,918	1	29	17	91	59	24.1	0.3	24.3
36	0.00	0	3,464	1	29	17	93	58	24.7	0.3	24.8
37	0.00	0	3,955	1	30	17	96	59	25.0	0.3	25.1
38	0.00	0	3,965	1	29	17	90	58	24.6	0.3	24.9
39	0.00	0	4,132	1	29	17	96	58	24.2	0.3	24.3
40	0.00	0	4,225	1	29	18	91	58	24.6	0.3	24.7
41	0.00	0	4,689	1	30	19	91	58	25.6	0.3	25.8
42	0.00	0	4,632	1	30	18	90	58	25.5	0.3	25.7
43	0.00	0	4,410	1	31	18	92	58	25.7	0.3	25.8
44	0.00	0	4,432	1	30	18	94	59	25.4	0.3	25.5
45	0.00	0	4,336	1	31	18	86	58	25.7	0.3	25.9
		Average	4,051	1	30	18	93	58	25.5	0.3	25.7

ANDERSON ENG, INC. - 295993 CME
OP: CMH Date: 10-September-2020

BL#	Depth	BLC	AMX	DMX	FMX	VMX	ETR	BPM	CSX	EMX	CSI
	ft	**	g's	in	kips	f/s	(%)	bpm	ksi	k-ft	ksi

Total number of blows analyzed: 44

BL#	Sensors
2-45	F3: [AWJ-1-2015] 214.3 (1.00); F4: [AWJ-2-2015] 213.7 (1.00); A3: [K10511] 360.0 (1.00); A4: [K10514] 354.0 (1.00)

Time Summary

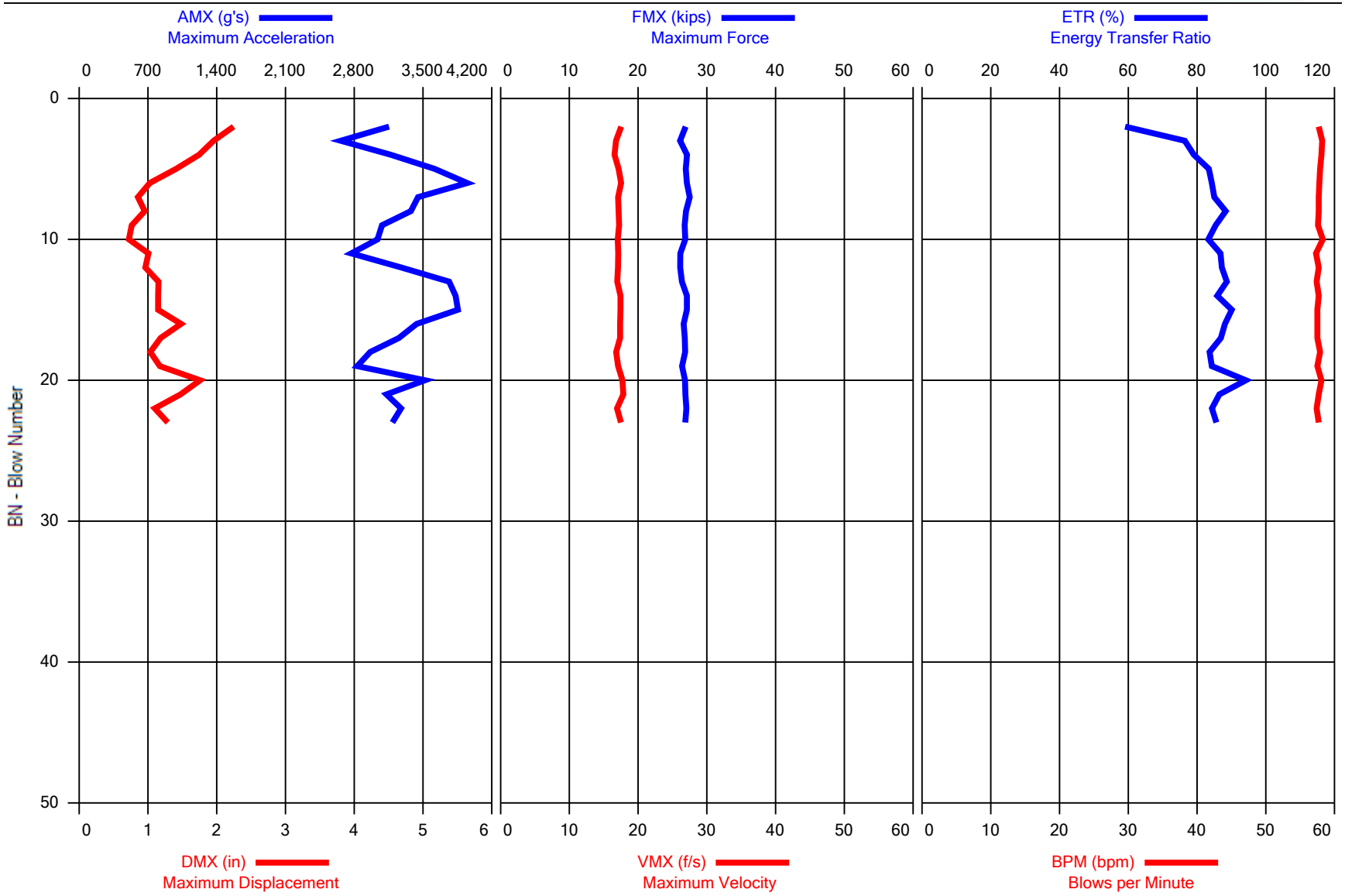
Drive 45 seconds 1:37 PM - 1:38 PM BN 1 - 45

Foundation Testing & Consulting LLC - PDIPLOT2 Ver 2017.2.58.3 - Case Method & iCAP® Results

Printed: 15-September-2020

Test started: 10-September-2020

ANDERSON ENG, INC. - 295993-2



ANDERSON ENG, INC. - 295993-2
CME
OP: CMH
Date: 10-September-2020

AR: 1.19 in²
SP: 0.492 k/ft³
LE: 8.67 ft
EM: 30,000 ksi
WS: 16,807.9 f/s
JC: 0.00

AMX: Maximum Acceleration
DMX: Maximum Displacement
FMX: Maximum Force
VMX: Maximum Velocity
ETR: Energy Transfer Ratio
BPM: Blows per Minute
CSX: Max Measured Compr. Stress
EMX: Max Transferred Energy
CSI: Max F1 or F2 Compr. Stress

BL#	Depth ft	BLC **	AMX g's	DMX in	FMX kips	VMX f/s	ETR (%)	BPM bpm	CSX ksi	EMX k-ft	CSI ksi
2	5.00	0	3,155	2	27	18	59	58	22.6	0.2	22.6
3	5.00	0	2,663	2	26	17	76	58	21.9	0.3	22.1
4	5.00	0	3,173	2	27	17	79	58	22.8	0.3	22.8
5	5.00	0	3,619	1	27	17	83	58	22.6	0.3	22.7
6	5.00	0	3,951	1	27	18	84	58	22.8	0.3	22.9
7	5.00	0	3,450	1	28	17	85	58	23.1	0.3	23.2
8	5.00	0	3,377	1	27	17	88	58	22.7	0.3	22.7
9	5.00	0	3,083	1	27	17	85	58	22.5	0.3	22.6
10	5.00	0	3,038	1	27	17	83	58	22.6	0.3	22.7
11	5.00	0	2,770	1	26	17	87	57	22.0	0.3	22.3
12	5.00	0	3,279	1	26	17	87	58	22.0	0.3	22.1
13	5.00	0	3,766	1	26	17	89	57	22.2	0.3	22.2
14	5.00	0	3,832	1	27	17	86	58	22.8	0.3	22.8
15	5.00	0	3,856	1	27	17	90	58	22.8	0.3	22.9
16	5.00	0	3,436	1	27	17	88	58	22.4	0.3	22.5
17	5.00	0	3,255	1	27	17	87	58	22.5	0.3	22.6
18	5.00	0	2,963	1	27	17	84	58	22.6	0.3	22.7
19	5.00	0	2,831	1	26	17	84	58	22.2	0.3	22.2
20	5.00	0	3,521	2	27	18	94	58	22.5	0.3	22.7
21	5.00	0	3,129	1	27	18	87	58	22.6	0.3	22.7
22	5.00	0	3,277	1	27	17	84	57	22.7	0.3	22.9
23	5.00	0	3,189	1	27	18	86	58	22.6	0.3	22.7
		Average	3,301	1	27	17	84	58	22.5	0.3	22.6

Total number of blows analyzed: 22

BL# Sensors

2-23 F3: [AWJ-1-2015] 214.3 (1.00); F4: [AWJ-2-2015] 213.7 (1.00); A3: [K10511] 360.0 (1.00); A4: [K10514] 354.0 (1.00)

Time Summary

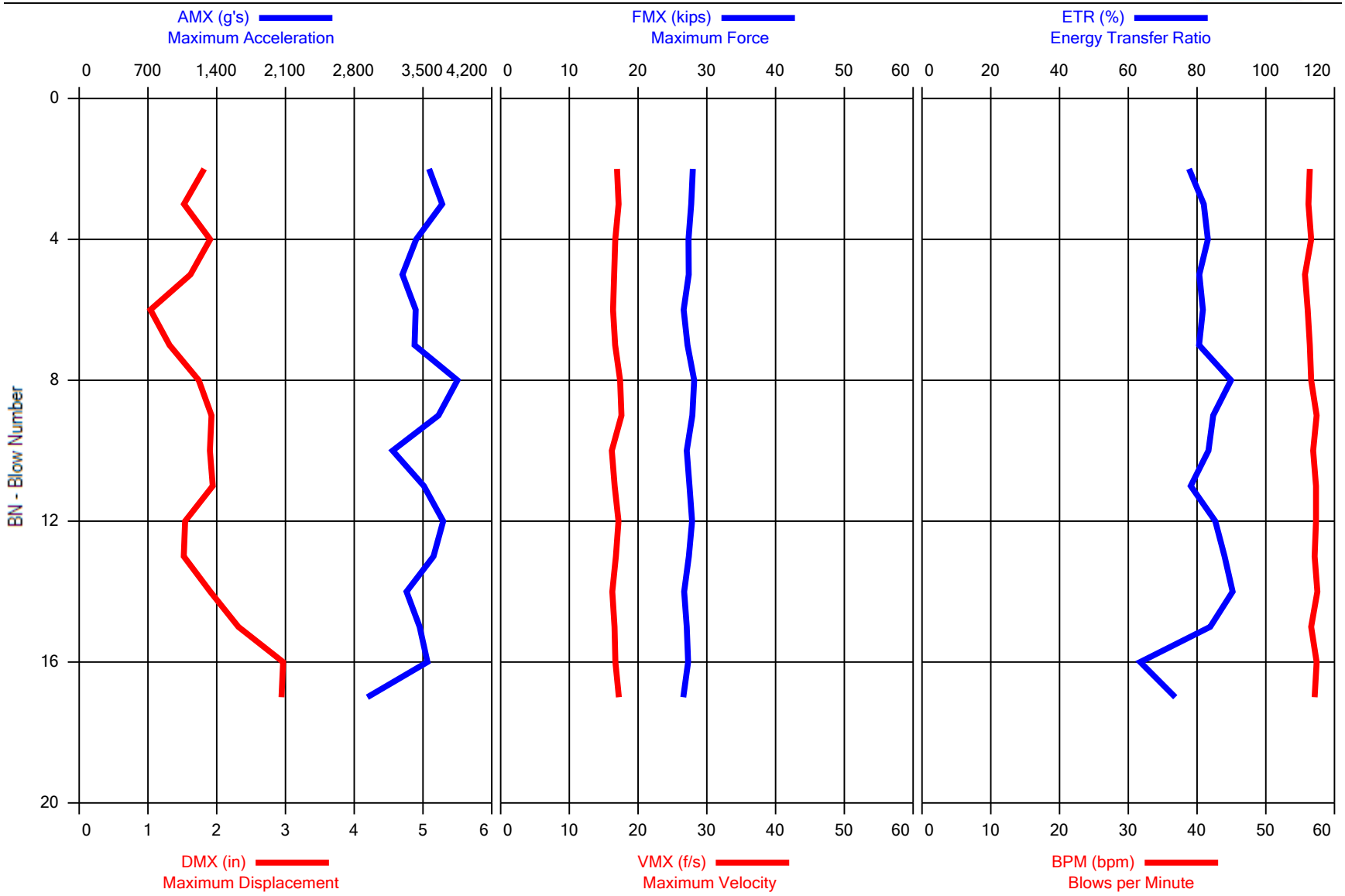
Drive 22 seconds 1:45 PM - 1:45 PM BN 1 - 23

Foundation Testing & Consulting LLC - PDIPLOT2 Ver 2017.2.58.3 - Case Method & iCAP® Results

Printed: 15-September-2020

Test started: 10-September-2020

ANDERSON ENG, INC. - 295993-3



ANDERSON ENG, INC. - 295993-3 CME
OP: CMH Date: 10-September-2020

AR: 1.19 in² SP: 0.492 k/ft³
LE: 13.46 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 0.00

AMX: Maximum Acceleration
DMX: Maximum Displacement
FMX: Maximum Force
VMX: Maximum Velocity
ETR: Energy Transfer Ratio
BPM: Blows per Minute
CSX: Max Measured Compr. Stress
EMX: Max Transferred Energy
CSI: Max F1 or F2 Compr. Stress

BL#	Depth ft	BLC **	AMX g's	DMX in	FMX kips	VMX f/s	ETR (%)	BPM bpm	CSX ksi	EMX k-ft	CSI ksi
2	10.00	0	3,563	2	28	17	78	56	23.5	0.3	23.7
3	10.00	0	3,696	2	28	17	82	56	23.3	0.3	23.5
4	10.00	0	3,431	2	27	17	83	57	23.0	0.3	23.1
5	10.00	0	3,292	2	27	17	81	56	23.0	0.3	23.1
6	10.00	0	3,426	1	27	16	82	56	22.4	0.3	22.7
7	10.00	0	3,415	1	27	17	81	56	22.8	0.3	23.0
8	10.00	0	3,852	2	28	17	90	57	23.7	0.3	23.9
9	10.00	0	3,658	2	28	18	85	57	23.4	0.3	23.6
10	10.00	0	3,191	2	27	16	83	57	22.8	0.3	22.8
11	10.00	0	3,510	2	27	17	78	57	23.1	0.3	23.2
12	10.00	0	3,705	2	28	17	85	57	23.4	0.3	23.6
13	10.00	0	3,608	2	27	17	88	57	23.0	0.3	23.1
14	10.00	0	3,333	2	27	16	90	58	22.4	0.3	22.5
15	10.00	0	3,467	2	27	17	84	57	22.8	0.3	23.0
16	10.00	0	3,546	3	27	17	63	57	22.9	0.2	23.2
17	10.00	0	2,934	3	27	17	74	57	22.3	0.3	22.5
		Average	3,477	2	27	17	82	57	23.0	0.3	23.2

Total number of blows analyzed: 16

BL# Sensors

2-17 F3: [AWJ-1-2015] 214.3 (1.00); F4: [AWJ-2-2015] 213.7 (1.00); A3: [K10511] 360.0 (1.00); A4: [K10514] 354.0 (1.00)

Time Summary

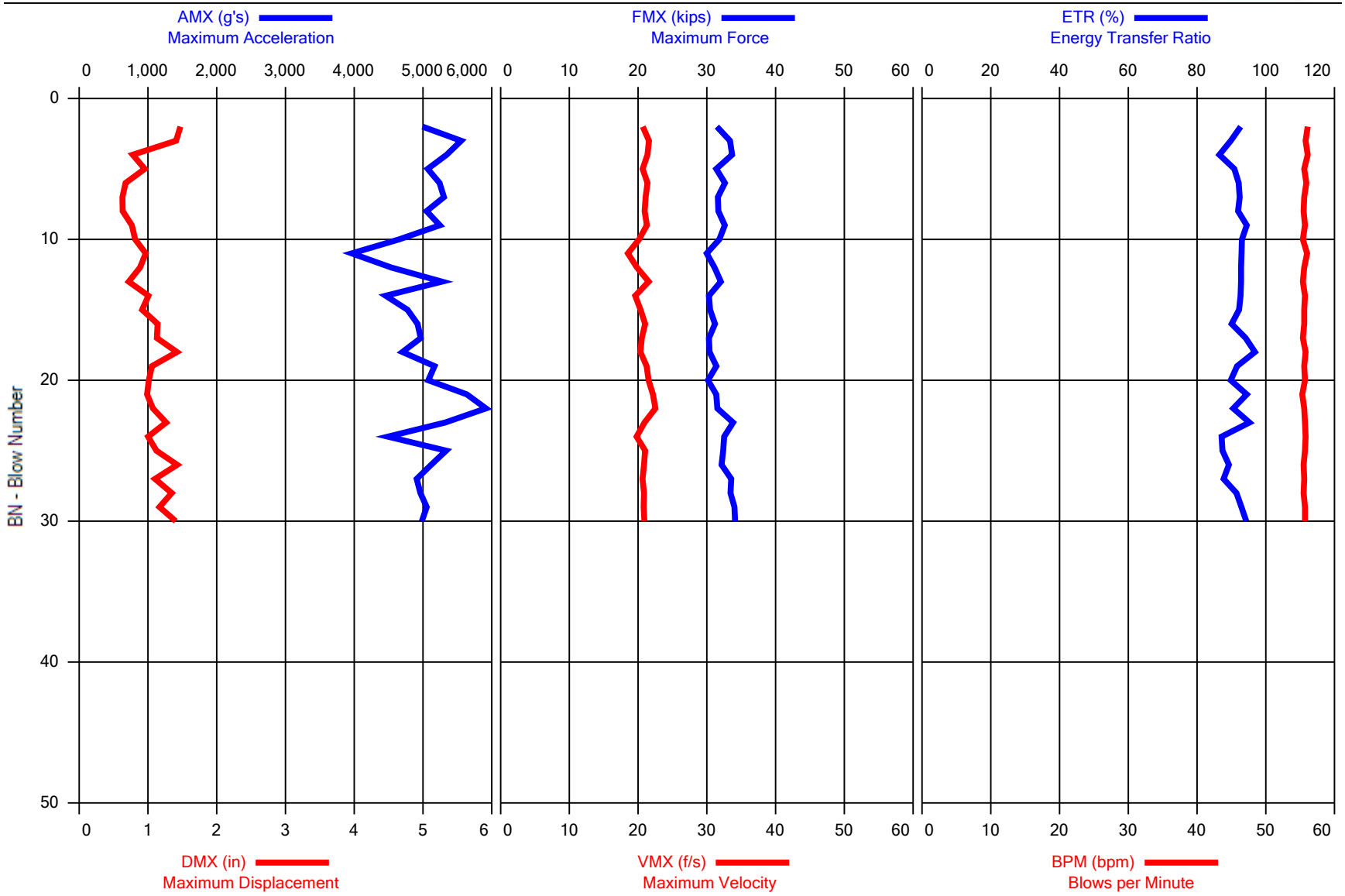
Drive 16 seconds 1:54 PM - 1:55 PM BN 1 - 17

Foundation Testing & Consulting LLC - PDIPLOT2 Ver 2017.2.58.3 - Case Method & iCAP® Results

Printed: 15-September-2020

Test started: 10-September-2020

ANDERSON ENG, INC. - 401073-2



ANDERSON ENG, INC. - 401073-2
OP: CMH
GEOPROBE
Date: 10-September-2020

AR: 1.19 in²
LE: 8.71 ft
WS: 16,807.9 f/s
SP: 0.492 k/ft³
EM: 30,000 ksi
JC: 0.00

AMX: Maximum Acceleration
DMX: Maximum Displacement
FMX: Maximum Force
VMX: Maximum Velocity
ETR: Energy Transfer Ratio
BPM: Blows per Minute
CSX: Max Measured Compr. Stress
EMX: Max Transferred Energy
CSI: Max F1 or F2 Compr. Stress

BL#	Depth ft	BLC **	AMX g's	DMX in	FMX kips	VMX f/s	ETR (%)	BPM bpm	CSX ksi	EMX k-ft	CSI ksi
2	5.00	0	4,993	1	31	21	93	56	26.4	0.3	26.9
3	5.00	0	5,555	1	33	22	90	56	28.0	0.3	28.2
4	5.00	0	5,346	1	34	21	87	56	28.3	0.3	28.4
5	5.00	0	5,069	1	31	21	91	56	26.4	0.3	26.6
6	5.00	0	5,242	1	33	21	92	56	27.4	0.3	27.6
7	5.00	0	5,306	1	32	21	92	56	26.6	0.3	26.9
8	5.00	0	5,053	1	32	21	92	56	26.6	0.3	26.8
9	5.00	0	5,247	1	33	21	94	56	27.4	0.3	27.6
10	5.00	0	4,652	1	32	20	93	55	26.7	0.3	26.9
11	5.00	0	3,964	1	30	19	93	56	25.2	0.3	25.3
12	5.00	0	4,539	1	31	20	93	56	26.2	0.3	26.4
13	5.00	0	5,277	1	32	22	93	55	26.9	0.3	27.0
14	5.00	0	4,458	1	30	20	93	56	25.5	0.3	25.8
15	5.00	0	4,775	1	30	20	92	56	25.6	0.3	26.0
16	5.00	0	4,921	1	31	21	90	56	26.2	0.3	26.3
17	5.00	0	4,967	1	30	21	94	55	25.5	0.3	25.6
18	5.00	0	4,702	1	30	20	97	56	25.5	0.3	25.7
19	5.00	0	5,168	1	31	21	92	56	26.4	0.3	26.6
20	5.00	0	5,078	1	30	22	90	56	25.3	0.3	25.5
21	5.00	0	5,639	1	31	22	94	55	26.4	0.3	26.5
22	5.00	0	5,917	1	32	23	91	56	26.5	0.3	26.6
23	5.00	0	5,324	1	34	21	95	56	28.4	0.3	28.6
24	5.00	0	4,491	1	33	20	87	56	27.3	0.3	27.3
25	5.00	0	5,337	1	32	21	87	56	27.2	0.3	27.3
26	5.00	0	5,121	1	32	21	89	56	27.0	0.3	27.3
27	5.00	0	4,908	1	34	21	88	56	28.2	0.3	28.4
28	5.00	0	4,963	1	33	21	91	56	28.1	0.3	28.2
29	5.00	0	5,055	1	34	21	93	56	28.6	0.3	28.6
30	5.00	0	4,984	1	34	21	94	56	28.7	0.3	28.7
		Average	5,036	1	32	21	92	56	26.8	0.3	27.0

Total number of blows analyzed: 29

BL# Sensors

2-30 F3: [AWJ-1-2015] 214.3 (1.00); F4: [AWJ-2-2015] 213.7 (1.00); A3: [K10511] 360.0 (1.00); A4: [K10514] 354.0 (1.00)

Time Summary

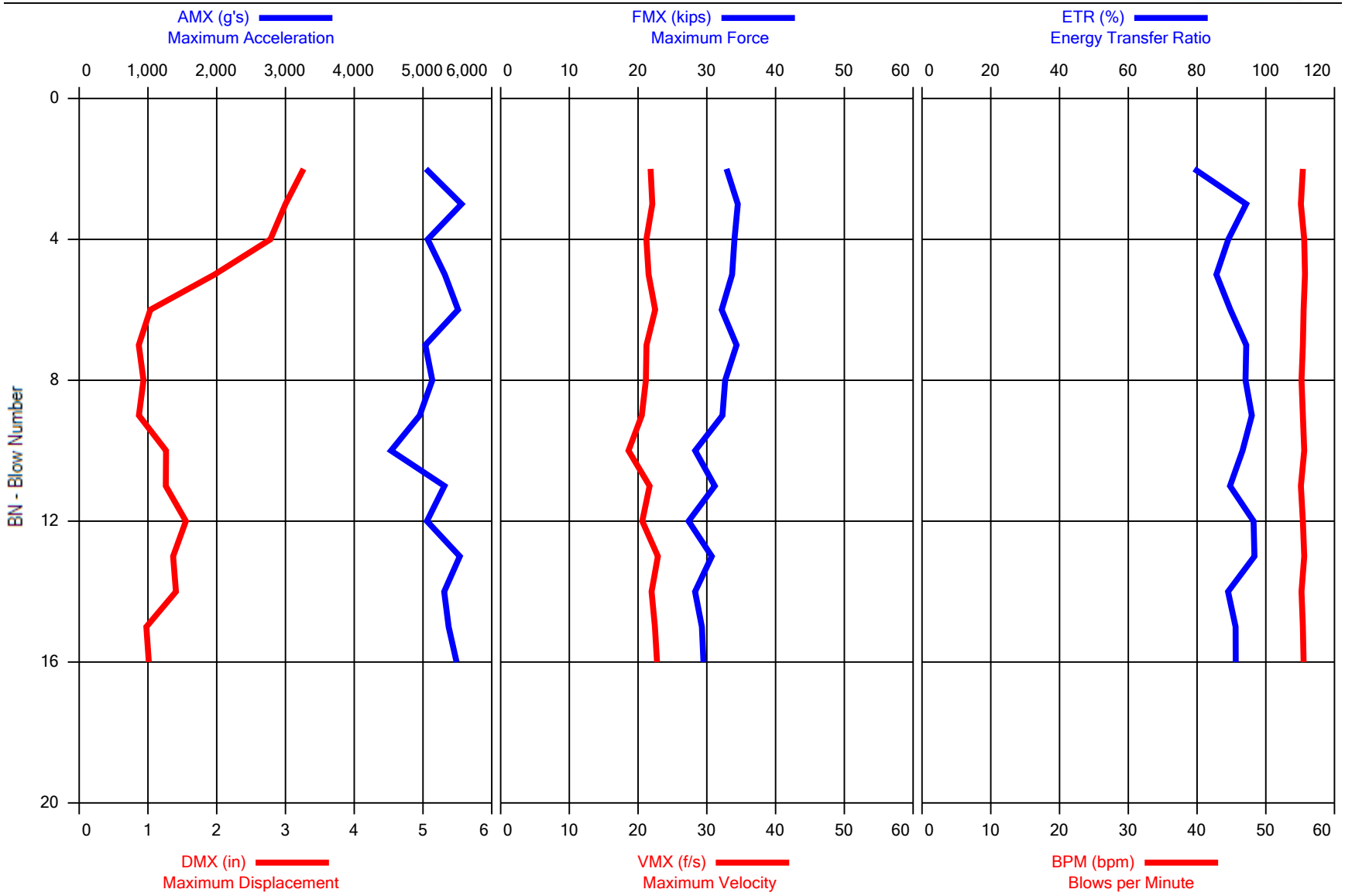
Drive 31 seconds 11:04 AM - 11:04 AM BN 1 - 30

Foundation Testing & Consulting LLC - PDIPLOT2 Ver 2017.2.58.3 - Case Method & iCAP® Results

Printed: 15-September-2020

Test started: 10-September-2020

ANDERSON ENG, INC. - 401073-3



ANDERSON ENG, INC. - 401073-3
OP: CMH
GEOPROBE
Date: 10-September-2020

AR: 1.19 in²
LE: 13.46 ft
WS: 16,807.9 f/s
SP: 0.492 k/ft³
EM: 30,000 ksi
JC: 0.00

AMX: Maximum Acceleration
DMX: Maximum Displacement
FMX: Maximum Force
VMX: Maximum Velocity
ETR: Energy Transfer Ratio
BPM: Blows per Minute
CSX: Max Measured Compr. Stress
EMX: Max Transferred Energy
CSI: Max F1 or F2 Compr. Stress

BL#	Depth ft	BLC **	AMX g's	DMX in	FMX kips	VMX f/s	ETR (%)	BPM bpm	CSX ksi	EMX k-ft	CSI ksi
2	10.00	0	5,045	3	33	22	79	55	27.6	0.3	27.7
3	10.00	0	5,561	3	34	22	94	55	29.0	0.3	29.3
4	10.00	0	5,069	3	34	21	89	56	28.6	0.3	28.7
5	10.00	0	5,319	2	34	22	86	56	28.3	0.3	28.6
6	10.00	0	5,511	1	32	22	90	56	27.0	0.3	27.1
7	10.00	0	5,036	1	34	21	94	55	28.8	0.3	29.1
8	10.00	0	5,136	1	33	21	94	55	27.4	0.3	27.7
9	10.00	0	4,951	1	32	21	96	55	27.1	0.3	27.4
10	10.00	0	4,536	1	28	19	93	56	23.8	0.3	24.2
11	10.00	0	5,313	1	31	22	90	55	26.2	0.3	26.2
12	10.00	0	5,059	2	27	21	96	55	23.0	0.3	23.2
13	10.00	0	5,537	1	31	23	97	56	25.8	0.3	26.0
14	10.00	0	5,309	1	28	22	89	55	23.8	0.3	24.1
15	10.00	0	5,374	1	29	22	91	55	24.6	0.3	25.1
16	10.00	0	5,489	1	30	23	91	56	24.8	0.3	25.1
		Average	5,216	2	31	22	91	55	26.4	0.3	26.6

Total number of blows analyzed: 15

BL# Sensors

2-16 F3: [AWJ-1-2015] 214.3 (1.00); F4: [AWJ-2-2015] 213.7 (1.00); A3: [K10511] 360.0 (1.00); A4: [K10514] 354.0 (1.00)

Time Summary

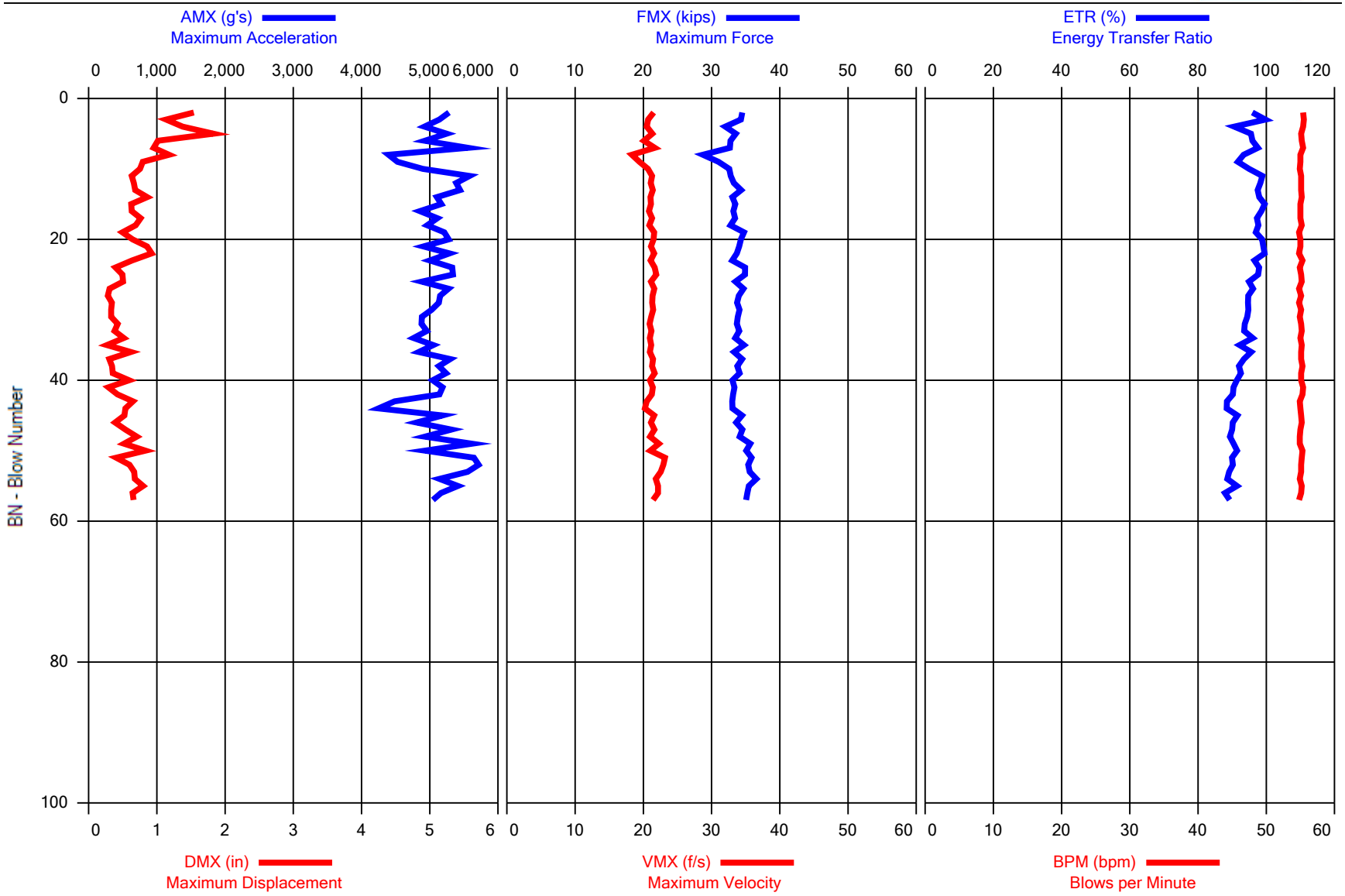
Drive 16 seconds 11:11 AM - 11:11 AM BN 1 - 16

Foundation Testing & Consulting LLC - PDIPLOT2 Ver 2017.2.58.3 - Case Method & iCAP® Results

Printed: 15-September-2020

Test started: 10-September-2020

ANDERSON ENG, INC. - 401073-4



ANDERSON ENG, INC. - 401073-4
OP: CMH
GEOPROBE
Date: 10-September-2020

AR: 1.19 in²
LE: 18.42 ft
WS: 16,807.9 f/s
SP: 0.492 k/ft³
EM: 30,000 ksi
JC: 0.00

AMX: Maximum Acceleration
DMX: Maximum Displacement
FMX: Maximum Force
VMX: Maximum Velocity
ETR: Energy Transfer Ratio
BPM: Blows per Minute
CSX: Max Measured Compr. Stress
EMX: Max Transferred Energy
CSI: Max F1 or F2 Compr. Stress

BL#	Depth	BLC	AMX	DMX	FMX	VMX	ETR	BPM	CSX	EMX	CSI
	ft	**	g's	in	kips	f/s	(%)	bpm	ksi	k-ft	ksi
2	15.00	0	5,283	2	34	22	96	55	29.0	0.3	29.2
3	15.00	0	5,140	1	34	21	100	56	28.8	0.3	29.0
4	15.00	0	4,922	1	32	20	91	55	26.9	0.3	27.1
5	15.00	0	5,248	2	34	21	96	55	28.2	0.3	28.4
6	15.00	0	4,927	1	33	20	96	55	27.5	0.3	27.7
7	15.00	0	5,560	1	33	22	98	55	27.5	0.3	27.6
8	15.00	0	4,395	1	29	18	93	55	24.1	0.3	24.3
9	15.00	0	4,526	1	31	19	92	55	26.1	0.3	26.3
10	15.00	0	4,899	1	33	21	95	55	27.4	0.3	27.7
11	15.00	0	5,584	1	33	21	99	55	27.6	0.3	27.7
12	15.00	0	5,388	1	33	21	98	55	27.9	0.3	28.1
13	15.00	0	5,443	1	34	21	97	55	28.8	0.3	29.1
14	15.00	0	5,103	1	33	21	98	55	27.8	0.3	27.9
15	15.00	0	5,169	1	33	21	100	55	28.1	0.3	28.4
16	15.00	0	4,854	1	33	21	99	55	27.9	0.3	27.9
17	15.00	0	5,111	1	33	21	97	55	28.1	0.3	28.3
18	15.00	0	4,962	1	33	21	98	55	27.5	0.3	27.6
19	15.00	0	5,213	0	35	22	97	55	29.2	0.3	29.4
20	15.00	0	5,277	1	34	21	99	55	28.8	0.3	29.1
21	15.00	0	4,909	1	34	21	99	55	28.6	0.3	28.8
22	15.00	0	5,289	1	34	22	99	55	28.3	0.3	28.6
23	15.00	0	5,000	1	33	21	97	55	27.7	0.3	28.0
24	15.00	0	5,329	0	35	22	98	55	29.3	0.3	29.7
25	15.00	0	5,340	0	35	22	98	55	29.3	0.3	29.7
26	15.00	0	4,885	1	33	21	95	55	28.1	0.3	28.3
27	15.00	0	5,275	0	35	22	96	55	29.1	0.3	29.5
28	15.00	0	5,150	0	34	21	95	55	28.6	0.3	28.8
29	15.00	0	5,132	0	34	21	95	55	28.3	0.3	28.6
30	15.00	0	5,028	0	34	21	95	55	28.7	0.3	29.0
31	15.00	0	4,884	0	34	21	94	55	28.4	0.3	28.8
32	15.00	0	4,878	0	34	21	94	55	28.3	0.3	28.4
33	15.00	0	4,957	0	34	21	93	55	28.6	0.3	28.7
34	15.00	0	4,762	1	33	21	96	55	28.1	0.3	28.2
35	15.00	0	5,052	0	35	21	92	55	29.2	0.3	29.4
36	15.00	0	4,838	1	33	21	96	55	28.0	0.3	28.1
37	15.00	0	5,301	0	34	21	93	55	29.0	0.3	29.3
38	15.00	0	5,133	0	34	21	92	55	28.4	0.3	28.6
39	15.00	0	5,239	0	34	22	93	55	28.7	0.3	29.0
40	15.00	0	5,043	1	33	21	91	55	27.8	0.3	28.1
41	15.00	0	5,187	0	33	21	90	55	28.0	0.3	28.4
42	15.00	0	5,142	0	33	21	90	55	27.9	0.3	28.1
43	15.00	0	4,484	1	33	21	88	55	27.8	0.3	28.0
44	15.00	0	4,249	1	33	20	88	55	27.8	0.3	27.9
45	15.00	0	5,186	1	34	22	92	55	29.0	0.3	29.3
46	15.00	0	4,809	0	34	21	90	55	28.2	0.3	28.5

ANDERSON ENG, INC. - 401073-4
GEOPROBE
OP: CMH
Date: 10-September-2020

BL#	Depth	BLC	AMX	DMX	FMX	VMX	ETR	BPM	CSX	EMX	CSI
	ft	**	g's	in	kips	f/s	(%)	bpm	ksi	k-ft	ksi
47	15.00	0	5,316	1	35	22	90	55	29.0	0.3	29.1
48	15.00	0	4,929	1	34	21	89	55	28.7	0.3	28.8
49	15.00	0	5,618	1	36	22	90	55	30.0	0.3	30.2
50	15.00	0	4,932	1	35	21	91	55	29.5	0.3	29.5
51	15.00	0	5,646	0	36	23	90	55	30.1	0.3	30.3
52	15.00	0	5,717	1	35	23	90	55	29.7	0.3	29.9
53	15.00	0	5,555	1	36	23	89	55	29.9	0.3	29.9
54	15.00	0	5,143	1	37	22	89	55	30.7	0.3	30.8
55	15.00	0	5,413	1	35	22	91	55	29.8	0.3	29.9
56	15.00	0	5,164	1	35	22	88	55	29.6	0.3	29.8
57	15.00	0	5,046	1	35	21	89	55	29.5	0.3	29.5
		Average	5,107	1	34	21	94	55	28.4	0.3	28.6

Total number of blows analyzed: 56

BL# Sensors

2-57 F3: [AWJ-1-2015] 214.3 (1.00); F4: [AWJ-2-2015] 213.7 (1.00); A3: [K10511] 360.0 (1.00); A4: [K10514] 354.0 (1.00)

Time Summary

Drive 1 minute 0 second 11:20 AM - 11:21 AM BN 1 - 57

APPENDIX B
Round Spring Water Quality Monitoring Data

Round Spring Water Quality Data
Spring Valley GeoTechnical Investigation

DATE	TIME	Temp (°F)	Sp Cond (µS/cm)	pH	ORP (mV)	ODO (mg/L)	Turbidity (NTU)	Precipitation (in) NOTE 1
5/2/2022	7:00:26 AM	54.7	213.2	7.16	134.8	7.64	0.23	0.00
5/2/2022	7:05:26 AM	54.7	211.3	7.11	145.3	7.46	0.82	
5/2/2022	7:10:26 AM	54.7	210.1	7.07	148.9	7.44	0.35	
5/2/2022	7:15:26 AM	54.7	209.2	7.06	150.1	7.45	0.30	0.00
5/2/2022	7:20:26 AM	54.7	208.5	7.05	150.4	7.45	0.27	
5/2/2022	7:25:26 AM	54.7	207.8	7.02	150.9	7.46	0.30	
5/2/2022	7:30:26 AM	54.7	207.2	7.01	151.0	7.46	0.27	0.00
5/2/2022	7:35:26 AM	54.7	206.7	6.98	151.2	7.47	0.32	
5/2/2022	7:40:26 AM	54.7	206.4	6.97	150.8	7.47	0.27	
5/2/2022	7:45:26 AM	54.7	205.8	6.96	150.5	7.47	0.20	0.00
5/2/2022	7:50:25 AM	54.7	205.4	6.94	150.1	7.47	0.23	
5/2/2022	7:55:25 AM	54.7	205.1	6.93	149.5	7.48	0.24	
5/2/2022	8:00:25 AM	54.8	204.8	6.92	149.0	7.48	0.25	0.00
5/2/2022	8:05:25 AM	54.8	204.4	6.91	148.5	7.48	0.30	
5/2/2022	8:10:25 AM	54.8	204.0	6.91	147.8	7.48	0.25	
5/2/2022	8:15:25 AM	54.8	203.8	6.90	146.9	7.49	0.27	0.00
5/2/2022	**8:15:00 AM**	**Boring B-2: Begin drilling.**						
5/2/2022	8:20:25 AM	54.8	203.5	6.90	145.6	7.51	0.25	
5/2/2022	8:25:25 AM	54.8	203.3	6.90	144.1	7.53	0.22	
5/2/2022	8:30:25 AM	54.8	203.0	6.90	142.3	7.56	0.24	0.00
5/2/2022	8:35:25 AM	54.8	202.9	6.90	140.5	7.58	0.26	
5/2/2022	8:40:25 AM	54.8	202.6	6.91	138.6	7.60	0.22	
5/2/2022	8:45:25 AM	54.8	202.4	6.91	136.7	7.61	0.20	0.00
5/2/2022	8:50:25 AM	54.8	202.2	6.91	134.8	7.63	0.32	
5/2/2022	8:55:25 AM	54.8	202.0	6.92	133.0	7.64	0.24	
5/2/2022	9:00:25 AM	54.8	201.8	6.92	131.2	7.65	0.24	0.00
5/2/2022	**9:00:00 AM**	**Boring B-2: Encountered bedrock at 19 feet below ground surface (bgs).**						
5/2/2022	9:05:25 AM	54.8	201.7	6.93	129.3	7.67	0.26	
5/2/2022	9:10:25 AM	54.8	201.6	6.94	127.4	7.71	0.24	
5/2/2022	9:15:25 AM	54.8	201.4	6.94	125.4	7.74	0.27	0.00
5/2/2022	9:20:25 AM	54.8	201.2	6.95	123.8	7.74	0.29	
5/2/2022	9:25:25 AM	54.8	201.1	6.96	122.6	7.75	0.25	
5/2/2022	9:30:25 AM	54.8	200.9	6.96	121.9	7.72	0.32	0.00
5/2/2022	9:35:25 AM	54.8	200.8	6.97	121.6	7.70	0.26	
5/2/2022	9:40:25 AM	54.8	200.7	6.97	121.1	7.68	0.31	
5/2/2022	9:45:25 AM	54.8	200.6	6.98	120.5	7.69	0.28	0.00
5/2/2022	9:50:25 AM	54.8	200.6	6.98	119.6	7.70	0.29	
5/2/2022	9:55:25 AM	54.8	200.3	6.99	118.6	7.71	0.30	
5/2/2022	10:00:25 AM	54.9	200.3	7.00	117.3	7.74	0.31	0.00
5/2/2022	10:05:25 AM	54.9	200.2	7.00	116.2	7.78	0.25	
5/2/2022	10:10:25 AM	54.9	200.1	7.01	115.7	7.77	0.23	
5/2/2022	10:15:25 AM	54.9	199.9	7.01	115.7	7.75	0.28	0.00
5/2/2022	10:20:25 AM	54.8	199.8	7.02	115.9	7.74	0.21	
5/2/2022	10:25:25 AM	54.8	199.6	7.02	116.2	7.72	0.81	
5/2/2022	10:30:25 AM	54.8	199.6	7.02	116.4	7.70	0.31	0.00
5/2/2022	10:35:25 AM	54.8	199.5	7.02	116.9	7.69	0.23	

Round Spring Water Quality Data
Spring Valley GeoTechnical Investigation

DATE	TIME	Temp (°F)	Sp Cond (µS/cm)	pH	ORP (mV)	ODO (mg/L)	Turbidity (NTU)	Precipitation (in) NOTE 1
5/2/2022	10:40:25 AM	54.8	199.4	7.03	117.8	7.66	0.28	
5/2/2022	10:45:25 AM	54.8	199.4	7.03	119.0	7.63	0.26	0.00
5/2/2022	10:50:25 AM	54.8	199.2	7.03	120.3	7.59	0.27	
5/2/2022	10:55:25 AM	54.8	199.1	7.03	121.5	7.58	0.16	
5/2/2022	11:00:25 AM	54.8	199.2	7.03	122.7	7.56	0.26	0.00
5/2/2022	11:05:25 AM	54.8	199.1	7.03	124.0	7.54	0.26	
5/2/2022	11:10:25 AM	54.8	199.0	7.04	125.0	7.52	0.23	
5/2/2022	11:15:25 AM	54.8	199.0	7.04	126.2	7.51	0.22	0.00
5/2/2022	11:20:25 AM	54.8	198.7	7.05	127.4	7.48	0.25	
5/2/2022	11:25:25 AM	54.8	198.7	7.05	128.3	7.48	0.20	
5/2/2022	11:30:25 AM	54.8	198.6	7.05	129.2	7.48	0.33	0.00
5/2/2022	11:35:25 AM	54.8	198.6	7.05	130.0	7.48	0.31	
5/2/2022	11:40:25 AM	54.8	198.4	7.05	130.7	7.47	0.30	
5/2/2022	11:45:24 AM	54.8	198.4	7.05	131.3	7.47	0.28	0.03
5/2/2022	11:50:24 AM	54.8	198.3	7.06	131.5	7.47	0.26	
5/2/2022	11:55:24 AM	54.8	198.2	7.06	131.8	7.47	0.25	
5/2/2022	12:00:24 PM	54.8	198.1	7.06	131.8	7.49	0.21	0.04
5/2/2022	12:05:24 PM	54.8	198.1	7.06	131.1	7.52	0.25	
5/2/2022	12:10:24 PM	54.8	198.1	7.06	130.4	7.54	0.18	
5/2/2022	12:15:24 PM	54.8	198.1	7.07	129.6	7.55	0.23	0.02
5/2/2022	12:20:24 PM	54.8	198.0	7.07	128.9	7.56	0.28	
5/2/2022	12:25:24 PM	54.8	197.9	7.07	128.3	7.57	0.22	
5/2/2022	12:30:24 PM	54.8	197.8	7.07	127.6	7.58	0.33	0.01
5/2/2022	12:35:24 PM	54.8	197.8	7.07	127.4	7.57	0.16	
5/2/2022	12:40:24 PM	54.8	197.8	7.07	127.2	7.56	0.19	
5/2/2022	12:45:24 PM	54.8	197.7	7.07	127.2	7.56	0.23	0.01
5/2/2022	12:50:24 PM	54.8	197.7	7.07	126.7	7.56	0.25	
5/2/2022	12:55:24 PM	54.8	197.7	7.07	126.5	7.58	0.19	
5/2/2022	1:00:24 PM	54.8	197.6	7.07	126.4	7.57	0.21	0.00
5/2/2022	1:05:24 PM	54.8	197.6	7.07	126.7	7.57	0.21	
5/2/2022	1:10:24 PM	54.8	197.5	7.07	126.9	7.55	0.22	
5/2/2022	1:15:24 PM	54.8	197.4	7.07	126.9	7.56	0.23	0.00
5/2/2022	1:20:24 PM	54.8	197.4	7.07	127.2	7.56	0.22	
5/2/2022	1:25:24 PM	54.8	197.3	7.07	127.9	7.53	0.24	
5/2/2022	1:30:24 PM	54.8	197.3	7.07	128.5	7.52	0.22	0.01
5/2/2022	1:35:24 PM	54.8	197.2	7.07	129.0	7.51	0.30	
5/2/2022	1:40:24 PM	54.8	197.1	7.07	129.5	7.51	0.25	
5/2/2022	1:45:24 PM	54.8	197.0	7.07	129.9	7.51	0.25	0.03
5/2/2022	1:50:24 PM	54.8	197.1	7.07	129.8	7.53	0.24	
5/2/2022	1:55:24 PM	54.8	197.1	7.08	129.6	7.54	0.24	
5/2/2022	2:00:24 PM	54.8	196.9	7.07	129.5	7.55	0.28	0.02
5/2/2022	2:05:24 PM	54.8	197.0	7.07	128.6	7.57	0.29	
5/2/2022	2:10:24 PM	54.8	197.1	7.08	127.6	7.60	0.28	
5/2/2022	2:15:24 PM	54.8	197.0	7.08	126.6	7.63	0.22	0.01
5/2/2022	2:20:24 PM	54.8	197.0	7.08	126.2	7.61	0.23	
5/2/2022	2:25:24 PM	54.8	196.9	7.08	125.7	7.62	0.39	

Round Spring Water Quality Data
Spring Valley GeoTechnical Investigation

DATE	TIME	Temp (°F)	Sp Cond (µS/cm)	pH	ORP (mV)	ODO (mg/L)	Turbidity (NTU)	Precipitation (in) NOTE 1
5/2/2022	2:30:24 PM	54.8	196.9	7.08	125.4	7.62	0.37	0.01
5/2/2022	2:35:24 PM	54.8	196.8	7.08	124.9	7.63	0.39	
5/2/2022	2:40:24 PM	54.8	197.0	7.08	123.3	7.67	0.34	
5/2/2022	2:45:24 PM	54.8	196.9	7.09	121.4	7.70	0.41	0.00
5/2/2022	2:50:24 PM	54.8	197.0	7.08	122.2	7.64	0.32	
5/2/2022	2:55:24 PM	54.8	196.8	7.08	122.7	7.60	0.33	
5/2/2022	3:00:24 PM	54.8	196.8	7.08	123.0	7.61	0.33	0.00
5/2/2022	3:05:24 PM	54.8	196.7	7.08	123.1	7.62	0.36	
5/2/2022	3:10:24 PM	54.8	196.7	7.08	123.6	7.59	0.42	
5/2/2022	3:15:24 PM	54.8	196.6	7.08	124.5	7.57	0.30	0.00
5/2/2022	3:20:24 PM	54.8	196.7	7.08	125.2	7.56	0.36	
5/2/2022	3:25:24 PM	54.8	196.6	7.08	125.0	7.58	0.35	
5/2/2022	3:30:24 PM	54.8	196.6	7.08	125.4	7.59	0.42	0.00
5/2/2022	3:35:24 PM	54.8	196.6	7.08	125.2	7.60	0.30	
5/2/2022	3:40:24 PM	54.8	196.5	7.08	125.1	7.62	0.36	
5/2/2022	3:45:24 PM	54.8	196.5	7.08	125.0	7.62	0.33	0.00
5/2/2022	3:50:23 PM	54.8	196.5	7.08	124.8	7.63	0.30	
5/2/2022	3:55:23 PM	54.8	196.6	7.09	124.0	7.66	0.32	
5/2/2022	4:00:23 PM	54.8	196.4	7.09	124.2	7.65	0.31	0.01
5/2/2022	4:05:23 PM	54.8	196.4	7.08	125.0	7.61	0.40	
5/2/2022	4:10:23 PM	54.8	196.4	7.08	125.3	7.60	0.39	
5/2/2022	4:15:23 PM	54.8	196.4	7.08	125.5	7.61	0.34	0.01
5/2/2022	**4:20:00 PM**	**Boring B-2: End drilling for the day at 79 feet bgs.**						
5/2/2022	4:20:23 PM	54.8	196.3	7.08	125.9	7.59	0.36	
5/2/2022	4:25:23 PM	54.8	196.2	7.08	126.5	7.57	0.28	
5/2/2022	4:30:23 PM	54.8	196.3	7.08	126.9	7.56	0.26	0.00
5/2/2022	4:35:23 PM	54.8	196.3	7.08	127.6	7.53	0.34	
5/2/2022	4:40:23 PM	54.8	196.2	7.07	129.0	7.50	0.37	
5/2/2022	4:45:23 PM	54.8	196.2	7.07	130.4	7.46	0.33	0.00
5/2/2022	4:50:23 PM	54.8	196.2	7.07	131.4	7.46	0.38	
5/2/2022	4:55:23 PM	54.8	196.2	7.07	132.3	7.45	0.38	
5/2/2022	5:00:23 PM	54.8	196.1	7.07	133.6	7.43	0.37	0.00
5/2/2022: Precipitation through midnight: 0.08 inches. 5/3/2022: Precipitation midnight through 07:15 AM: 0.10 inches.								
5/3/2022	7:25:03 AM	54.8	219.7	7.15	144.3	7.43	0.98	
5/3/2022	7:30:03 AM	54.8	215.9	7.05	152.6	7.41	0.99	0.00
5/3/2022	7:35:03 AM	54.8	213.0	6.99	156.7	7.41	1.03	
5/3/2022	7:40:03 AM	54.8	211.6	6.94	158.8	7.40	0.92	
5/3/2022	7:45:03 AM	54.8	209.9	6.92	159.7	7.39	0.96	0.00
5/3/2022	7:50:03 AM	54.8	208.5	6.90	160.0	7.40	1.01	
5/3/2022	7:55:03 AM	54.8	207.0	6.88	160.3	7.40	0.95	
5/3/2022	8:00:03 AM	54.8	205.5	6.87	160.5	7.38	0.96	0.00
5/3/2022	**8:00:00 AM**	**Boring B-2: Begin drilling at 79 feet bgs.**						
5/3/2022	8:05:03 AM	54.8	204.7	6.87	160.4	7.38	0.98	
5/3/2022	8:10:03 AM	54.8	204.0	6.86	159.9	7.39	0.94	
5/3/2022	8:15:03 AM	54.8	203.3	6.86	159.4	7.41	1.03	0.00

Round Spring Water Quality Data
Spring Valley GeoTechnical Investigation

DATE	TIME	Temp (°F)	Sp Cond (µS/cm)	pH	ORP (mV)	ODO (mg/L)	Turbidity (NTU)	Precipitation (in) NOTE 1
5/3/2022	8:20:03 AM	54.8	202.8	6.86	158.8	7.42	0.96	
5/3/2022	8:25:03 AM	54.8	202.3	6.86	158.6	7.41	1.00	
5/3/2022	8:30:03 AM	54.8	201.9	6.86	158.4	7.40	1.05	0.00
5/3/2022	8:35:03 AM	54.8	201.5	6.86	157.6	7.42	0.99	
5/3/2022	8:40:03 AM	54.8	201.2	6.87	156.7	7.44	1.00	
5/3/2022	8:45:03 AM	54.8	200.9	6.87	155.9	7.44	0.97	0.00
5/3/2022	8:50:02 AM	54.8	200.6	6.88	155.5	7.43	0.99	
5/3/2022	8:55:02 AM	54.8	200.3	6.88	155.0	7.42	1.01	
5/3/2022	9:00:02 AM	54.8	200.1	6.88	154.5	7.43	1.07	0.00
5/3/2022	9:05:02 AM	54.8	199.9	6.89	153.6	7.45	1.01	
5/3/2022	9:10:02 AM	54.8	199.7	6.89	152.6	7.48	1.01	
5/3/2022	9:15:02 AM	54.8	199.5	6.90	151.1	7.50	0.96	0.00
5/3/2022	9:20:02 AM	54.9	199.4	6.90	148.8	7.56	1.00	
5/3/2022	9:25:02 AM	54.9	199.3	6.91	147.0	7.58	1.10	
5/3/2022	9:30:02 AM	54.9	199.2	6.92	144.7	7.61	0.99	0.00
5/3/2022	9:35:02 AM	54.9	199.1	6.92	142.1	7.65	0.92	
5/3/2022	9:40:02 AM	54.9	199.0	6.93	139.9	7.67	0.96	
5/3/2022	9:45:02 AM	54.9	198.9	6.94	139.0	7.66	0.93	0.00
5/3/2022	9:50:02 AM	54.9	198.7	6.94	139.8	7.58	1.02	
5/3/2022	9:55:02 AM	54.9	198.7	6.94	139.6	7.53	0.96	
5/3/2022	10:00:02 AM	54.9	198.6	6.95	137.4	7.61	1.06	0.00
5/3/2022	10:05:02 AM	55.0	198.5	6.96	134.6	7.71	1.15	
5/3/2022	10:10:02 AM	54.9	198.5	6.96	133.2	7.73	0.98	
5/3/2022	10:15:02 AM	54.9	198.3	6.97	131.9	7.72	0.97	0.00
5/3/2022	10:20:02 AM	54.9	198.3	6.97	130.9	7.71	0.97	
5/3/2022	10:25:02 AM	55.0	198.2	6.97	129.2	7.74	1.03	
5/3/2022	10:30:02 AM	55.0	198.2	6.98	127.4	7.77	1.04	0.00
5/3/2022	10:35:02 AM	55.0	198.1	6.99	125.7	7.81	0.98	
5/3/2022	10:40:02 AM	55.0	198.1	6.99	125.9	7.77	0.95	
5/3/2022	10:45:02 AM	55.0	198.0	6.99	125.5	7.75	1.20	0.00
5/3/2022	10:50:02 AM	55.0	197.9	7.00	125.3	7.78	0.96	
5/3/2022	10:55:02 AM	54.9	197.9	6.99	127.1	7.66	1.00	
5/3/2022	11:00:02 AM	54.9	197.8	6.99	128.3	7.64	1.02	0.00
5/3/2022	11:05:02 AM	54.9	197.7	6.99	129.2	7.61	0.98	
5/3/2022	**11:10:00 AM**	**Boring B-2: Drilling ended at total depth of 95 feet bgs.**						
5/3/2022	11:10:02 AM	54.9	197.7	7.00	130.4	7.58	1.05	
5/3/2022	11:15:02 AM	54.9	197.7	7.00	131.7	7.55	1.03	0.00
5/3/2022	11:20:02 AM	54.9	197.6	7.00	132.5	7.56	0.97	
5/3/2022	11:25:02 AM	54.9	197.6	7.00	132.9	7.56	0.92	
5/3/2022	11:30:02 AM	54.9	197.5	7.00	132.2	7.60	0.97	0.00
5/3/2022	11:35:02 AM	54.9	197.5	7.01	130.3	7.68	1.07	
5/3/2022	11:40:02 AM	54.9	197.4	7.01	130.1	7.66	1.02	
5/3/2022	11:45:02 AM	55.0	197.5	7.01	127.7	7.73	0.94	0.00
5/3/2022	11:50:02 AM	54.9	197.4	7.02	126.5	7.75	0.95	
5/3/2022	11:55:02 AM	54.9	197.4	7.02	126.4	7.72	1.02	
5/3/2022	12:00:02 PM	54.9	197.3	7.02	126.8	7.69	1.01	0.00

Round Spring Water Quality Data
Spring Valley GeoTechnical Investigation

DATE	TIME	Temp (°F)	Sp Cond (µS/cm)	pH	ORP (mV)	ODO (mg/L)	Turbidity (NTU)	Precipitation (in) NOTE 1
5/3/2022	12:05:02 PM	54.9	197.3	7.02	126.9	7.67	1.05	
5/3/2022	12:10:02 PM	55.0	197.3	7.02	124.1	7.77	1.00	
5/3/2022	12:15:02 PM	55.0	197.3	7.03	121.7	7.82	0.97	0.00
5/3/2022	12:20:02 PM	55.0	197.2	7.03	121.4	7.80	0.99	
5/3/2022	12:25:02 PM	55.0	197.2	7.03	120.9	7.79	1.03	
5/3/2022	12:30:02 PM	55.0	197.2	7.03	120.8	7.77	0.99	0.00
5/3/2022	12:35:02 PM	55.0	197.2	7.03	120.5	7.78	1.73	
5/3/2022	12:40:02 PM	55.0	197.2	7.03	118.4	7.80	0.96	
5/3/2022	12:45:02 PM	55.0	197.2	7.03	118.0	7.77	2.32	0.00
5/3/2022	12:50:02 PM	55.0	197.1	7.03	116.5	7.83	1.71	
5/3/2022	12:55:02 PM	55.0	197.1	7.04	116.2	7.83	1.70	
5/3/2022	1:00:02 PM	55.0	197.1	7.03	115.7	7.82	1.75	0.00
5/3/2022	1:05:01 PM	55.0	197.1	7.03	115.4	7.80	0.95	
5/3/2022	1:10:01 PM	55.0	197.1	7.04	114.2	7.84	0.99	
5/3/2022	1:15:01 PM	55.0	197.0	7.04	115.2	7.78	0.96	0.00
5/3/2022	1:20:01 PM	55.0	197.0	7.04	116.2	7.75	0.98	
5/3/2022	1:25:01 PM	55.0	197.0	7.04	116.8	7.74	1.03	
5/3/2022	1:30:01 PM	55.0	197.0	7.03	115.5	7.79	3.34	0.00
5/3/2022	1:35:01 PM	55.1	197.1	7.04	113.5	7.89	4.97	
5/3/2022	1:40:01 PM	55.1	197.1	7.04	112.0	7.93	2.64	
5/3/2022	1:45:01 PM	55.1	197.1	7.05	111.2	7.94	4.11	0.00
5/3/2022	1:50:01 PM	55.1	197.1	7.05	110.8	7.94	3.60	
5/3/2022	1:55:01 PM	55.1	197.0	7.05	110.3	7.93	4.05	
5/3/2022	2:00:01 PM	55.2	197.0	7.05	110.0	7.94	3.88	0.00
5/3/2022	2:05:01 PM	55.1	197.0	7.04	110.0	7.90	4.21	
5/3/2022	2:10:01 PM	55.2	197.0	7.05	109.3	7.93	4.22	
5/3/2022	2:15:01 PM	55.1	197.0	7.05	108.9	7.92	5.09	0.00
5/3/2022	2:20:01 PM	55.1	197.0	7.05	108.4	7.91	4.27	
5/3/2022	2:25:01 PM	55.1	197.0	7.04	108.6	7.87	4.51	
5/3/2022	2:30:01 PM	55.0	197.1	7.04	110.1	7.81	1.08	0.00
5/3/2022: Precipitation through midnight: 0.00 inches. 5/4/2022: Precipitation midnight through 07:15 AM: 0.00 inches.								
5/4/2022	7:25:02 AM	54.8	223.1	7.30	130.4	7.45	1.44	
5/4/2022	7:30:02 AM	54.8	220.1	7.13	144.6	7.41	0.49	0.00
5/4/2022	7:35:02 AM	54.8	217.6	7.08	149.4	7.42	0.54	
5/4/2022	7:40:02 AM	54.8	215.4	7.05	151.7	7.42	0.57	
5/4/2022	7:45:02 AM	54.8	213.5	7.04	152.9	7.42	0.49	0.00
5/4/2022	7:50:02 AM	54.8	211.8	7.02	154.0	7.43	0.45	
5/4/2022	7:55:02 AM	54.8	210.3	7.01	154.7	7.44	0.39	
5/4/2022	8:00:02 AM	54.8	209.1	6.99	155.3	7.44	0.41	0.00
5/4/2022	8:05:02 AM	54.8	207.9	6.98	155.7	7.44	0.38	
5/4/2022	8:10:02 AM	54.8	206.9	6.97	156.1	7.46	0.39	
5/4/2022	8:15:02 AM	54.8	206.1	6.96	156.5	7.46	0.48	0.00
5/4/2022	8:20:02 AM	54.8	205.4	6.96	156.8	7.46	0.39	
5/4/2022	8:25:02 AM	54.8	204.7	6.95	156.9	7.48	0.38	
5/4/2022	8:30:02 AM	54.8	204.2	6.95	157.0	7.50	0.41	0.00

Round Spring Water Quality Data
Spring Valley GeoTechnical Investigation

DATE	TIME	Temp (°F)	Sp Cond (µS/cm)	pH	ORP (mV)	ODO (mg/L)	Turbidity (NTU)	Precipitation (in) NOTE 1
5/4/2022	8:35:02 AM	54.8	203.7	6.94	157.2	7.51	0.40	
5/4/2022	**8:40:00 AM**	**Boring B-4: Begin drilling.**						
5/4/2022	8:40:02 AM	54.8	203.3	6.94	157.3	7.51	0.39	
5/4/2022	8:45:02 AM	54.8	202.9	6.93	157.5	7.52	0.34	0.00
5/4/2022	8:50:02 AM	54.8	202.5	6.93	157.5	7.52	0.45	
5/4/2022	8:55:02 AM	54.8	202.2	6.93	157.5	7.53	0.36	
5/4/2022	9:00:02 AM	54.8	201.9	6.93	157.4	7.55	0.36	0.00
5/4/2022	9:05:02 AM	54.9	201.7	6.93	157.3	7.56	0.33	
5/4/2022	9:10:02 AM	54.9	201.5	6.93	157.0	7.60	0.33	
5/4/2022	9:15:02 AM	54.9	201.3	6.93	156.9	7.60	0.39	0.00
5/4/2022	9:20:02 AM	54.9	201.1	6.93	156.6	7.61	0.43	
5/4/2022	9:25:02 AM	54.9	200.9	6.93	156.4	7.61	0.39	
5/4/2022	9:30:02 AM	54.9	200.7	6.93	156.2	7.62	0.31	0.00
5/4/2022	9:35:02 AM	54.9	200.6	6.94	155.8	7.64	0.40	
5/4/2022	9:40:02 AM	54.9	200.5	6.94	155.6	7.65	0.35	
5/4/2022	9:45:02 AM	54.9	200.3	6.94	155.2	7.65	0.41	0.00
5/4/2022	9:50:02 AM	54.9	200.2	6.95	154.8	7.66	0.37	
5/4/2022	9:55:02 AM	54.9	200.1	6.95	154.6	7.66	0.35	
5/4/2022	10:00:02 AM	54.9	200.0	6.95	154.3	7.67	0.38	0.00
5/4/2022	10:05:02 AM	54.9	199.9	6.96	153.9	7.70	0.35	
5/4/2022	10:10:02 AM	54.9	199.8	6.96	153.4	7.72	0.37	
5/4/2022	10:15:02 AM	54.9	199.7	6.96	153.2	7.70	0.34	0.00
5/4/2022	10:20:02 AM	54.9	199.6	6.97	153.1	7.70	0.33	
5/4/2022	10:25:02 AM	54.9	199.5	6.97	152.9	7.72	0.35	
5/4/2022	10:30:02 AM	54.9	199.5	6.98	152.6	7.72	0.33	0.00
5/4/2022	10:35:01 AM	54.9	199.4	6.98	152.3	7.75	0.32	
5/4/2022	10:40:01 AM	55.0	199.4	6.99	151.9	7.79	0.39	
5/4/2022	10:45:01 AM	55.0	199.3	6.99	151.5	7.79	0.33	0.00
5/4/2022	10:50:01 AM	55.0	199.3	7.00	151.0	7.81	0.35	
5/4/2022	10:55:01 AM	55.0	199.2	7.00	150.3	7.85	0.35	
5/4/2022	11:00:01 AM	55.0	199.2	7.00	149.8	7.86	0.32	0.00
5/4/2022	11:05:01 AM	55.0	199.2	7.01	149.2	7.88	0.29	
5/4/2022	11:10:01 AM	55.0	199.1	7.01	148.7	7.87	0.38	
5/4/2022	11:15:01 AM	55.0	199.0	7.01	148.5	7.86	0.32	0.00
5/4/2022	11:20:01 AM	55.0	199.0	7.02	148.2	7.86	0.35	
5/4/2022	11:25:01 AM	55.0	198.9	7.02	148.2	7.84	0.38	
5/4/2022	11:30:01 AM	55.0	198.9	7.02	148.0	7.84	0.33	0.00
5/4/2022	11:35:01 AM	55.0	198.9	7.02	147.8	7.85	0.32	
5/4/2022	11:40:01 AM	55.0	198.8	7.03	147.6	7.85	0.37	
5/4/2022	11:45:01 AM	55.0	198.7	7.03	147.6	7.82	0.30	0.00
5/4/2022	11:50:01 AM	55.0	198.7	7.03	147.6	7.82	0.32	
5/4/2022	11:55:01 AM	55.0	198.7	7.03	147.7	7.82	0.31	
5/4/2022	12:00:01 PM	55.0	198.6	7.04	147.6	7.81	0.35	0.00
5/4/2022	12:05:01 PM	55.0	198.6	7.04	147.6	7.82	0.30	
5/4/2022	12:10:01 PM	55.0	198.6	7.04	147.9	7.82	0.33	
5/4/2022	12:15:01 PM	55.0	198.5	7.04	148.1	7.79	0.33	0.00

Round Spring Water Quality Data
Spring Valley GeoTechnical Investigation

DATE	TIME	Temp (°F)	Sp Cond (µS/cm)	pH	ORP (mV)	ODO (mg/L)	Turbidity (NTU)	Precipitation (in) NOTE 1
5/4/2022	12:20:01 PM	55.0	198.5	7.04	148.3	7.78	0.33	
5/4/2022	12:25:01 PM	55.0	198.4	7.04	148.3	7.77	0.37	
5/4/2022	12:30:01 PM	54.9	198.4	7.04	148.6	7.75	0.33	0.00
5/4/2022	12:35:01 PM	54.9	198.3	7.04	148.9	7.74	0.44	
5/4/2022	12:40:01 PM	54.9	198.3	7.04	149.3	7.71	0.36	
5/4/2022	12:45:01 PM	54.9	198.3	7.04	149.8	7.67	0.35	0.00
5/4/2022	12:50:01 PM	54.9	198.3	7.04	150.3	7.62	0.41	
5/4/2022	12:55:01 PM	54.9	198.3	7.04	150.8	7.59	0.35	
5/4/2022	1:00:01 PM	54.9	198.2	7.04	151.1	7.58	0.32	0.00
5/4/2022	1:05:01 PM	54.9	198.2	7.04	151.6	7.58	0.27	
5/4/2022	1:10:01 PM	54.9	198.2	7.04	151.8	7.59	0.39	
5/4/2022	1:15:01 PM	54.9	198.1	7.05	151.9	7.62	0.36	0.00
5/4/2022	**1:15:00 PM**	**Boring B-4: End drilling for the day at top of bedrock (53 feet bgs).**						
5/4/2022	1:20:01 PM	54.9	198.1	7.05	152.1	7.62	0.36	
5/4/2022	1:25:01 PM	54.9	198.1	7.05	152.5	7.59	0.32	
5/4/2022	1:30:01 PM	54.9	198.1	7.05	152.7	7.60	0.33	0.00
5/4/2022	1:35:01 PM	54.9	198.1	7.05	153.0	7.57	0.30	
5/4/2022	1:40:01 PM	54.9	198.1	7.05	153.3	7.56	0.34	
5/4/2022	1:45:01 PM	54.9	198.0	7.05	153.2	7.60	0.37	0.00
5/4/2022	1:50:01 PM	54.9	198.0	7.05	153.1	7.64	0.30	
5/4/2022	1:55:01 PM	54.9	198.0	7.05	153.4	7.62	0.29	
5/4/2022	2:00:01 PM	54.9	198.0	7.05	153.8	7.58	0.36	0.00
5/4/2022	2:05:01 PM	54.9	198.0	7.05	154.1	7.54	0.42	
5/4/2022	2:10:01 PM	54.9	198.0	7.05	154.4	7.53	0.32	
5/4/2022	2:15:01 PM	54.9	198.0	7.05	154.6	7.53	0.37	0.00
5/4/2022	2:20:01 PM	54.9	198.0	7.06	154.3	7.57	0.35	
5/4/2022	2:25:01 PM	54.9	197.9	7.06	154.3	7.57	0.34	
5/4/2022	2:30:01 PM	54.9	197.9	7.06	154.6	7.55	0.41	0.00
5/4/2022	2:35:01 PM	54.9	197.9	7.06	154.8	7.54	0.37	
5/4/2022	2:40:01 PM	54.9	197.9	7.06	155.1	7.52	0.36	
5/4/2022	2:45:00 PM	54.9	197.9	7.06	155.5	7.50	0.30	0.00
5/4/2022	2:50:00 PM	54.9	197.9	7.06	155.5	7.49	0.38	
5/4/2022	2:55:00 PM	54.9	197.9	7.06	156.0	7.47	0.32	
5/4/2022	3:00:00 PM	54.8	197.9	7.05	156.6	7.40	0.42	0.00
5/4/2022	3:05:00 PM	54.8	197.9	7.05	157.1	7.39	0.38	
5/4/2022	3:10:00 PM	54.8	197.9	7.05	157.5	7.38	0.43	
5/4/2022	3:15:00 PM	54.8	197.8	7.05	157.8	7.37	0.47	0.00
5/4/2022	3:20:00 PM	54.8	197.5	7.05	158.1	7.38	0.67	
5/4/2022	3:25:00 PM	54.8	197.5	7.06	158.5	7.39	0.55	
5/4/2022	3:30:00 PM	54.8	197.6	7.06	158.9	7.38	0.48	0.11
5/4/2022	3:35:00 PM	54.8	197.7	7.05	159.2	7.39	0.47	
5/4/2022	3:40:00 PM	54.8	197.7	7.05	159.5	7.38	0.32	
5/4/2022	3:45:00 PM	54.8	197.7	7.06	159.7	7.37	0.38	0.09
5/4/2022	3:50:00 PM	54.8	197.7	7.06	160.0	7.36	0.35	
5/4/2022	3:55:00 PM	54.8	197.6	7.06	160.3	7.36	0.35	
5/4/2022	4:00:00 PM	54.8	197.6	7.06	160.4	7.36	0.37	0.06

Round Spring Water Quality Data
Spring Valley GeoTechnical Investigation

DATE	TIME	Temp (°F)	Sp Cond (µS/cm)	pH	ORP (mV)	ODO (mg/L)	Turbidity (NTU)	Precipitation (in) NOTE 1
5/4/2022: Precipitation through midnight: 0.02 inches.								
5/5/2022: Precipitation from midnight through 09:45 AM: 2.3 inches.								
5/5/2022	9:55:03 AM	54.9	218.2	7.28	138.8	7.60	1.37	
5/5/2022	10:00:03 AM	54.9	213.4	7.09	150.8	7.55	1.26	0.00
5/5/2022	10:05:03 AM	54.9	211.1	7.06	153.6	7.55	1.27	
5/5/2022	10:10:03 AM	54.9	209.6	7.04	155.1	7.57	1.44	
5/5/2022	10:15:03 AM	54.9	208.5	7.01	155.9	7.56	1.35	0.00
5/5/2022	10:20:03 AM	54.9	207.8	6.99	156.3	7.56	1.34	
5/5/2022	10:25:03 AM	54.9	207.2	6.98	156.8	7.54	1.42	
5/5/2022	10:30:03 AM	54.9	206.8	6.96	157.4	7.51	1.36	0.00
5/5/2022	10:35:03 AM	54.9	206.4	6.94	157.9	7.51	1.34	
5/5/2022	10:40:03 AM	54.9	206.1	6.93	158.5	7.49	1.41	
5/5/2022	10:45:03 AM	54.9	205.8	6.92	158.9	7.48	1.47	0.00
5/5/2022	10:50:03 AM	54.9	205.6	6.91	159.1	7.47	1.39	
5/5/2022	10:55:03 AM	54.9	205.3	6.90	159.6	7.46	1.34	
5/5/2022	11:00:03 AM	54.9	205.1	6.89	159.9	7.46	1.45	0.00
5/5/2022	11:05:03 AM	54.9	205.0	6.89	160.2	7.45	1.37	
5/5/2022	11:10:03 AM	54.9	204.8	6.89	160.2	7.46	1.39	
5/5/2022	11:15:03 AM	54.9	204.6	6.88	160.4	7.48	1.37	0.00
5/5/2022	11:20:03 AM	54.9	204.5	6.88	160.2	7.49	1.43	
5/5/2022	11:25:03 AM	54.9	204.4	6.88	160.3	7.48	1.47	
5/5/2022	11:30:03 AM	54.9	204.3	6.88	160.5	7.46	1.48	0.00
5/5/2022	11:35:03 AM	54.9	204.1	6.88	160.7	7.45	1.54	
5/5/2022	11:40:03 AM	54.9	204.0	6.87	161.0	7.44	1.51	
5/5/2022	11:45:03 AM	54.9	203.9	6.88	161.1	7.44	1.43	0.00
5/5/2022	11:50:03 AM	54.9	203.8	6.88	161.2	7.44	1.47	
5/5/2022	11:55:03 AM	54.9	203.7	6.88	161.1	7.46	1.40	
5/5/2022	12:00:03 PM	54.9	203.6	6.88	160.9	7.46	1.51	0.00
5/5/2022	12:05:03 PM	54.9	203.5	6.88	160.8	7.47	1.46	
5/5/2022	12:10:03 PM	54.9	203.5	6.88	160.7	7.47	1.56	
5/5/2022	12:15:03 PM	54.9	203.3	6.89	160.5	7.48	1.41	0.00
5/5/2022	12:20:03 PM	54.9	203.2	6.89	160.4	7.48	1.61	
5/5/2022	12:25:03 PM	54.9	203.1	6.90	160.2	7.47	1.50	
5/5/2022	12:30:03 PM	54.9	203.1	6.90	160.0	7.47	1.57	0.00
5/5/2022	12:35:03 PM	54.9	203.0	6.90	159.9	7.46	1.52	
5/5/2022	**12:40:00 PM**	**Boring B-4: Begin drilling at 53 feet bgs.**						
5/5/2022	12:40:03 PM	54.9	202.9	6.91	159.7	7.47	1.54	
5/5/2022	12:45:03 PM	54.9	202.8	6.91	159.4	7.47	1.56	0.00
5/5/2022	12:50:03 PM	54.9	202.8	6.92	159.1	7.49	1.58	
5/5/2022	12:55:03 PM	54.9	202.7	6.92	158.6	7.50	1.58	
5/5/2022	1:00:03 PM	54.9	202.7	6.93	158.1	7.51	1.58	0.00
5/5/2022	1:05:03 PM	54.9	202.6	6.93	157.5	7.53	1.54	
5/5/2022	1:10:03 PM	54.9	202.6	6.94	157.1	7.53	1.58	
5/5/2022	1:15:02 PM	54.9	202.6	6.94	156.9	7.52	1.65	0.00
5/5/2022	1:20:02 PM	54.9	202.5	6.94	156.5	7.52	1.63	
5/5/2022	1:25:02 PM	54.9	202.5	6.95	156.0	7.54	1.55	

Round Spring Water Quality Data
Spring Valley GeoTechnical Investigation

DATE	TIME	Temp (°F)	Sp Cond (µS/cm)	pH	ORP (mV)	ODO (mg/L)	Turbidity (NTU)	Precipitation (in) NOTE 1
5/5/2022	1:30:02 PM	54.9	202.4	6.95	155.9	7.54	1.61	0.00
5/5/2022	1:35:02 PM	54.9	202.4	6.96	155.4	7.54	1.62	
5/5/2022	1:40:02 PM	54.9	202.3	6.96	155.2	7.54	1.82	
5/5/2022	1:45:02 PM	54.9	202.3	6.96	154.9	7.53	1.68	0.00
5/5/2022	1:50:02 PM	54.9	202.3	6.97	154.6	7.53	1.76	
5/5/2022	1:55:02 PM	55.0	202.2	6.97	154.2	7.56	1.72	
5/5/2022	2:00:02 PM	55.0	202.2	6.98	153.5	7.57	1.82	0.00
5/5/2022	**2:00:00 PM**	**Boring B-4: Drilling ended at total depth of 70 feet bgs.**						
5/5/2022	2:05:02 PM	55.0	202.2	6.98	152.4	7.59	1.72	
5/5/2022	2:10:02 PM	55.0	202.2	6.98	152.2	7.57	1.67	
5/5/2022	2:15:02 PM	54.9	202.1	6.99	152.5	7.54	1.73	0.00
5/5/2022	2:20:02 PM	54.9	202.1	6.99	152.6	7.53	1.75	
5/5/2022	2:25:02 PM	55.0	202.1	6.99	152.1	7.55	1.78	
5/5/2022	2:30:02 PM	55.0	202.0	6.99	152.1	7.55	1.76	0.00
5/5/2022	2:35:02 PM	54.9	202.0	7.00	152.1	7.54	1.71	
5/5/2022	2:40:02 PM	54.9	202.0	7.00	152.4	7.53	1.74	
5/5/2022	2:45:02 PM	54.9	201.9	7.00	152.5	7.52	1.84	0.00
5/5/2022	2:50:02 PM	54.9	201.9	7.00	152.5	7.53	1.95	
5/5/2022	2:55:02 PM	54.9	201.9	7.00	152.3	7.53	1.82	
5/5/2022	3:00:02 PM	55.0	201.9	7.01	152.1	7.54	1.85	0.00
5/5/2022	3:05:02 PM	54.9	201.8	7.01	152.3	7.53	1.85	
5/5/2022	3:10:02 PM	54.9	201.8	7.01	152.4	7.52	1.81	
5/5/2022	3:15:02 PM	54.9	201.8	7.01	152.7	7.52	1.85	0.00
5/5/2022	3:20:02 PM	54.9	201.8	7.01	152.6	7.52	1.71	
5/5/2022	3:25:02 PM	54.9	201.7	7.02	152.7	7.52	1.85	
5/5/2022	3:30:02 PM	55.0	201.7	7.02	152.4	7.53	1.88	0.00
5/5/2022	3:35:02 PM	54.9	201.7	7.02	153.0	7.51	1.84	0.00

Note: 1. Precipitation from USGS stream gauge 7066000 Jacks Fork at Eminence, located approximately 10 miles south of Round Sprin

APPENDIX C
Collier Geophysics Survey Lines 3 and 4
From: Collier (2021)

SW

NE

Road

Stream

L

N

O

P

Q

S

T

U

M

R

?

100

1000

10000

Elevation (ft)

750
700
650
600
550

50 100 150 200 250 300 350 400 450 500 550 600 650 700 750 800 850 900 950 1000 1050 1100 1150

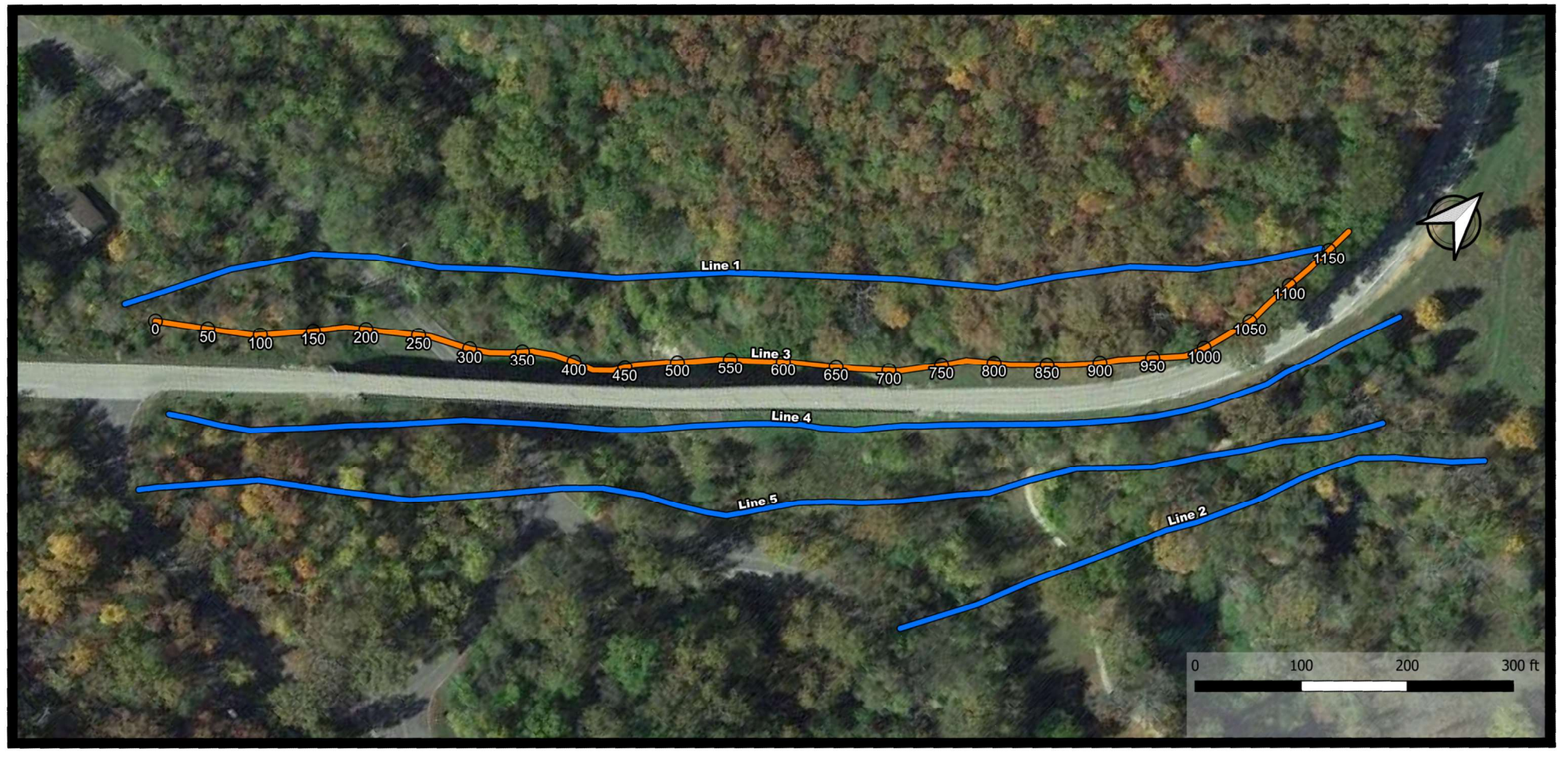
Distance (ft)

Resistivity (ohm-m)

5 10 20 50 100 200 500 1000 2000 5000 10000

Line 3
ERT

1.5x Vertical Exaggeration



Legend

A — Anomaly Designation

High resistivity anomaly in bedrock
Potential air-filled void

Low resistivity anomaly in bedrock
Potential dissolution feature or residuum

Interpreted Bedrock
Top of Wx (Dashed)
Competent (Ticked)

Resistivity Results - Line 3
Round Spring Nat'l Park
Eminence, MO

COLLIER GEOPHYSICS

HG Consult Inc.

Project #: 21-146 | **Figure A-3**

Drafted by: T. Ensele | Checked by: N. Pendrigh | **December 2021**

SW

NE

Road

Stream

2500

100

10000

1000

X

W

V

Y

Z

Elevation (ft)

750
700
650
600
550

50 100 150 200 250 300 350 400 450 500 550 600 650 700 750 800 850 900 950 1000 1050 1100 1150

Distance (ft)

Line 4
ERT

1.5x Vertical Exaggeration

Resistivity (ohm-m)

5 10 20 50 100 200 500 1000 2000 5000 10000

Legend

A
Anomaly Designation

2500 — Seismic P-wave Velocity (ft/s) From SRT

High resistivity anomaly in bedrock
Potential air-filled void

Low resistivity anomaly in bedrock
Potential dissolution feature or residuum

Interpreted Bedrock
Top of Wx (Dashed)
Competent (Ticked)

Resistivity Results - Line 4
Round Spring Nat'l Park
Eminence, MO

COLLIER GEOPHYSICS

HG Consult Inc.

Project #: 21-146 | **Figure A-4**

Drafted by: T. Ensele | Checked by: N. Pendrigh | **December 2021**

APPENDIX D
Report Limitations and Guidelines for Use

APPENDIX D
REPORT LIMITATIONS AND GUIDELINES FOR USE[1]

This appendix provides information to help you manage your risks with respect to the use of this report.

Geotechnical and Environmental Services Are Performed for Specific Purposes, Persons and Projects

This report has been prepared for the exclusive use of MoDOT, and their authorized agents. This report is not intended for use by others, and the information contained herein is not applicable to other sites.

GeoEngineers structures our services to meet the specific needs of our clients. For example, a geotechnical or geologic study conducted for a civil engineer or architect may not fulfill the needs of a construction contractor or even another civil engineer or architect that are involved in the same project. Similarly, an environmental assessment study conducted for a property owner may not fulfill the needs of a prospective purchaser of the same property. Because each study is unique, each report is unique, prepared solely for the specific client and project site. Our report is prepared for the exclusive use of our Client. No other party may rely on the product of our services unless we agree in advance to such reliance in writing. This is to provide our firm with reasonable protection against open-ended liability claims by third parties with whom there would otherwise be no contractual limits to their actions. Within the limitations of scope, schedule and budget, our services have been executed in accordance with our Agreement with the Client and generally accepted geotechnical practices in this area at the time this report was prepared. This report should not be applied for any purpose or project except the one originally contemplated.

A Geotechnical Engineering or Environmental Report Is Based on a Unique Set of Project-Specific Factors

This report has been prepared for the Missouri Department of Transportation Route 19 Bridges at Round Spring Project, located in Shannon County, Missouri. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, do not rely on this report if it was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

[1] Developed based on material provided by ASFE/The Best People on Earth, Professional Firms Practicing in the Geosciences; www.asfe.org.

For example, changes that can affect the applicability of this report include those that affect:

- the function of the proposed structures;
- elevation, configuration, location, orientation or weight of the proposed structures;
- composition of the design team; or
- project ownership.

If important changes are made after the date of this report, GeoEngineers should be given the opportunity to review our interpretations and recommendations and provide written modifications or confirmation, as appropriate.

Subsurface Conditions Can Change

This report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by manmade events such as construction on or adjacent to the site, by new releases of hazardous substances, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. Always contact GeoEngineers before applying a report to determine if it remains applicable.

Top Soil

For the purposes of this report, we consider topsoil to consist of generally fine-grained soil with an appreciable amount of organic matter, based on visual examination, and to be unsuitable for direct support of the proposed improvements. However, the organic content and other mineralogical and gradational characteristics used to evaluate the suitability of soil for use in landscaping and agricultural purposes were not determined, nor were they considered in our analyses. Therefore, the information and recommendations in this report, and our logs and descriptions, should not be used as a basis for estimating the volume of topsoil available for such purposes.

Most Geotechnical and Environmental Findings Are Professional Opinions

Our interpretations of subsurface conditions are based on field observations and laboratory test results from widely spaced sampling locations at the site. Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoEngineers reviewed field and laboratory data and then applied our professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ, sometimes significantly, from those indicated in this report. Our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions.

Geotechnical Engineering Report Recommendations Are Not Final

Do not over-rely on the preliminary construction recommendations included in this report. These recommendations are not final, because they were developed principally from GeoEngineers' professional judgment and opinion. GeoEngineers' recommendations can be finalized only by observing actual subsurface conditions revealed during construction. GeoEngineers cannot assume responsibility or liability for this report's recommendations if we do not perform construction observation.

Sufficient monitoring and consultation by GeoEngineers should be provided during construction to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide

recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether or not construction activities are completed in accordance with our recommendations. Retaining GeoEngineers for construction observation for this project is the most effective method of managing the risks associated with unanticipated conditions.

A Geotechnical Engineering or Geologic Report Could Be Subject to Misinterpretation

Misinterpretation of this report by other design team members can result in costly problems. You could lower that risk by having GeoEngineers confer with appropriate members of the design team after submitting the report. Also, retain GeoEngineers to review pertinent elements of the design team's plans and specifications. If important changes are made after the date of this report, GeoEngineers should be given the opportunity to review our interpretations and recommendations and provide written modifications or confirmation, as appropriate. Contractors can also misinterpret a geotechnical engineering or geologic report. Reduce that risk by having GeoEngineers participate in pre-bid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Exploration Logs

Geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering or geologic report should never be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, but recognize that separating logs from the report can elevate risk.

Give Contractors a Complete Report and Guidance

Some owners and design professionals believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering or geologic report, but preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with GeoEngineers and/or to conduct additional study to obtain the specific types of information they need or prefer. A pre-bid conference can also be valuable. Be sure contractors have sufficient time to perform additional study. Only then might an owner be in a position to give contractors the best information available, while requiring them to at least share the financial responsibilities stemming from unanticipated conditions. Further, a contingency for unanticipated conditions should be included in your project budget and schedule.

Contractors Are Responsible for Site Safety on Their Own Construction Projects

Our geotechnical recommendations are not intended to direct the contractor's procedures, methods, schedule or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and to adjacent properties.

Read These Provisions Closely

Some clients, design professionals and contractors may not recognize that the geoscience practices (geotechnical engineering or geology) are far less exact than other engineering and natural science disciplines. This lack of understanding can create unrealistic expectations that could lead to disappointments, claims and disputes. GeoEngineers includes these explanatory "limitations" provisions in our reports to help reduce such risks. Please confer with GeoEngineers if you are unclear how these "Report Limitations and Guidelines for Use" apply to your project or site.

Geotechnical, Geologic and Environmental Reports Should Not Be Interchanged

The equipment, techniques and personnel used to perform an environmental study differ significantly from those used to perform a geotechnical or geologic study and vice versa. For that reason, a geotechnical engineering or geologic report does not usually relate any environmental findings, conclusions or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. Similarly, environmental reports are not used to address geotechnical or geologic concerns regarding a specific project.

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