BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

1403 South 70th East Avenue
Tulsa, OK 74112
Ph: (918) 439-9005
www.BuildingAndEarth.com

July 25, 2018

Mr. Dwain Garner, P.E.
CGA Engineers, Inc.
8179 East 41st Street
Tulsa, Oklahoma 74145

Subject: Report of Subsurface Exploration
Substation Roadway
Cherokee Springs Plaza
Tahlequah, Oklahoma
Building & Earth Project OK180167

Dear Mr. Garner:

Building & Earth Sciences, Inc., completed the authorized subsurface exploration for the substation roadway at Cherokee Springs Plaza in Tahlequah, Oklahoma. Our services were performed in accordance with our proposal numbered OK20257 (Revision 1), dated July 16, 2018. CGA authorized our services by returning our signed proposal document on the same day.

The purpose of our exploration was to determine the general subsurface conditions within the proposed roadway.

The authorized exploration was performed on July 18, 2018. The subsurface exploration consisted of five (5) test borings near the locations shown on the attached Boring Location Plan sheet. The boring locations were marked in the field by Building & Earth based on information provided by CGA.

The borings were advanced with a truck-mounted CME-75 drill rig equipped with hollow stem augers and an automatic hammer. A Building & Earth field geologist observed the drilling operations and logged the borings in the field.

Soil samples were retrieved at standard sampling intervals by driving a split-tube sampler. The borehole was first advanced to the sample depth by augering, and the sampling tools were placed in the open hole. The sampler was then driven into the ground 18 inches by blows from a 140-pound hammer falling 30 inches. The number of blows required to drive the sampler each 6-inch increment was recorded. The initial increment is considered the "seating" blows, where the sampler penetrates any loose or disturbed soil in the bottom of the borehole. The blows required to penetrate the final two increments are added together and referred to as the Standard Penetration Test (SPT) N-Value.

Automatic hammers deliver higher energy efficiency (80 to 85 percent) than the manual hammer (safety hammer, 60 percent efficient). Therefore, an energy correction factor should be taken into consideration with regard to the recorded field N-values. The N-values discussed or mentioned in this letter and shown on the boring logs are recorded field values. The N-Value, when properly evaluated, gives an indication of the soil's strength and ability to support structural loads. Many factors can affect the SPT N-Value, so this result should not be used exclusively to evaluate soil conditions.

The disturbed soil samples retrieved from the boring locations were visually examined by our engineer and soil descriptions were provided. The project engineer prepared Boring Logs summarizing the subsurface conditions at the boring locations (see attached).

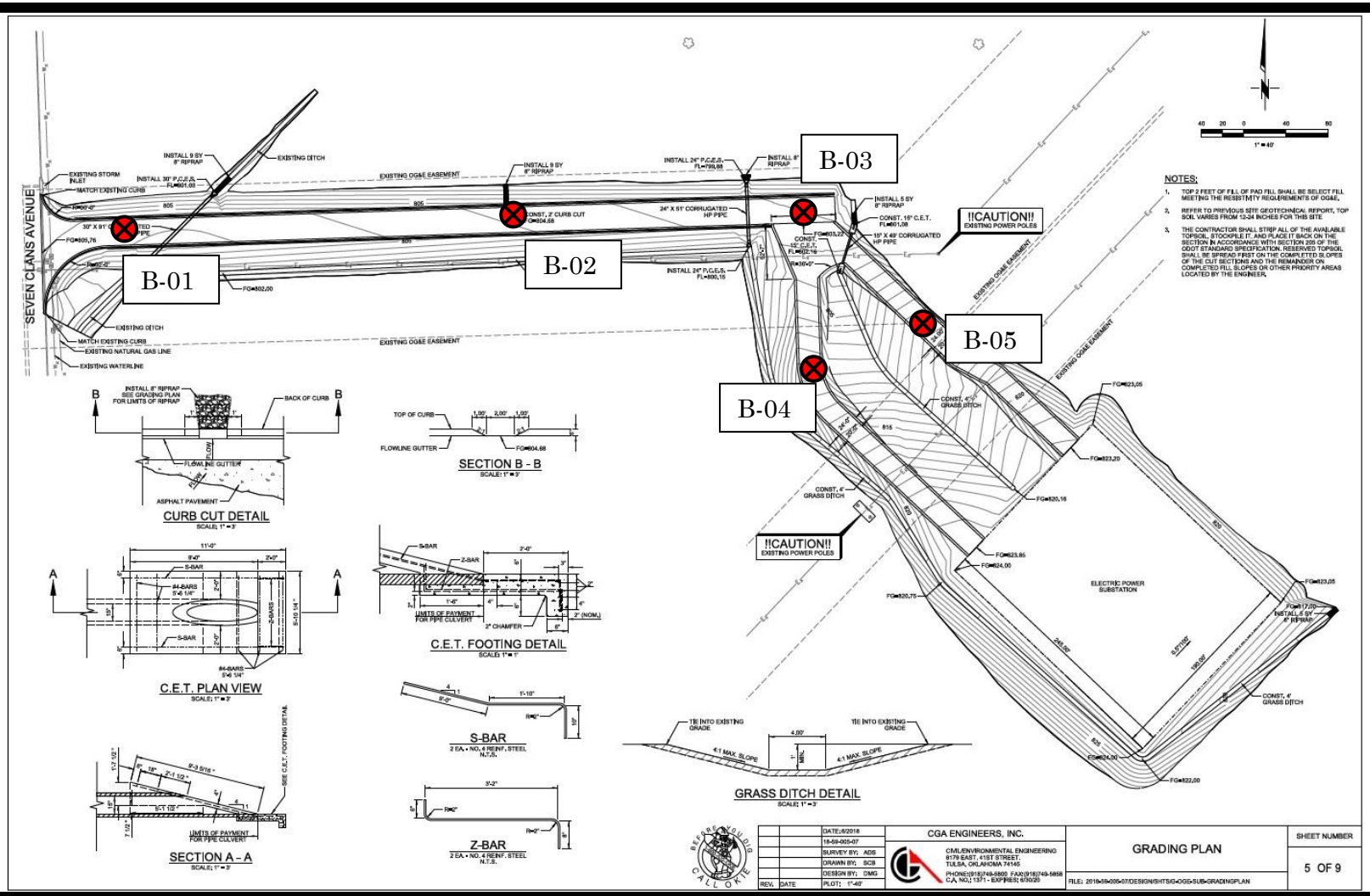
CLOSING

We appreciate the opportunity to provide subsurface exploration services for the above referenced project. If you have any questions regarding the information in this report or need any additional information, please call us.

Respectfully Submitted,
BUILDING & EARTH SCIENCES, INC.
Certificate of Authorization #3975, Expires 6/30/2020

Joseph D. Vistad, P.E.
Geotechnical Manager

Dharmateja Maganti, E.I.
Project Manager



REFERENCE USED TO PRODUCE THIS DRAWING:	**BORING LOCATION PLAN**	**DATE: 7/25/2018**
Grading Plan prepared by CGA Engineers dated June 2018	**PROJECT NO.** OK180167	**PROJECT NAME / LOCATION:** Cherokee Springs Substation Road Tahlequah, Oklahoma
		SCALE: As Shown

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LOG OF BORING

Designation: P-01

Sheet 1 of 1

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Project Name: Cherokee Springs Substation Roadway
Project Number: OK180167
Drilling Method: Hollow Stem Auger
Equipment Used: CME-75
Hammer Type: Automatic
Boring Location: 11+00

Project Location: Tahlequah, OK
Date Drilled: 7/18/18
Weather Conditions:
Surface Elevation: 104.0
Drill Crew: Mohawk
Logged By: Taru

DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	N-Value / Qu (tsf) / Atterberg Limits / % Moisture	SOIL DESCRIPTION	GRAPHIC	REMARKS
			1	5-18-19		0.3 TOPSOIL = 4 inches (103.7) LEAN CLAY WITH GRAVEL (CL): hard, brown, dark brown, with roots and cherty limestone gravel, moderate plasticity, dry to moist		
			2	5-6-3		- stiff, brown to dark brown with minor ferrous staining, trace fine roots, low to moderate plasticity, moist		
100								
5			3	2-3-4		5.0 (99.0) FAT CLAY (CH): stiff, gray, yellowish brown, reddish brown, with roots and trace cherty limestone fragments, minor ferrous staining and nodules, high plasticity, moist		
			4	50/1"	>>	8.3 (95.8) AUGER REFUSAL at 8.25 feet on apparent limestone		
95								
10								
90								
15								

Groundwater was not encountered at the time of drilling and borehole dry upon completion.

Boring backfilled 7/18/2018

Consistency/relative density based on correction factor for automatic hammer

SAMPLE TYPE ☒ Split Spoon

N-VALUE	STANDARD PENETRATION RESISTANCE (AASHTO T-206)	**REC**	RECOVERY
% MOISTURE	PERCENT NATURAL MOISTURE CONTENT	**RQD**	ROCK QUALITY DESIGNATION
▽	GROUNDWATER LEVEL IN THE BOREHOLE	**UD**	UNDISTURBED
Qu	UNCONFINED COMPRESSIVE STRENGTH ESTIMATE FROM POCKET PENETROMETER TEST		

LOG OF BORING 2 UPDATED GINT.GPJ BESI.GDT 7/25/18

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LOG OF BORING

Designation: P-02

Sheet 1 of 1

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Office: (918) 439-9005
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Project Name: Cherokee Springs Substation Roadway
Project Number: OK180167
Drilling Method: Hollow Stem Auger
Equipment Used: CME-75
Hammer Type: Automatic
Boring Location: 15+00

Project Location: Tahlequah, OK
Date Drilled: 7/18/18
Weather Conditions:
Surface Elevation: 102.7
Drill Crew: Mohawk
Logged By: Taru

DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	N-Value / Qu (tsf) / Atterberg Limits / % Moisture	SOIL DESCRIPTION	GRAPHIC	REMARKS
						TOPSOIL = 8 inches		
						0.7 / 102.0		
			1	2-2-2		SILTY CLAY (CL-ML): medium stiff, brown, dark brown, with roots and ferrous nodules, few chert fragments, trace plasticity, moist		
						2.5 / 100.2		
	100		2	4-4-4		LEAN CLAY (CL) stiff, brownish gray, trace fine roots and minor ferrous staining and nodules, low plasticity, moist		
5			3	5-6-4		- with yellowish brown weathered limestone fragments		
						7.0 / 95.7		
			4	50/3.5"	>>	7.5 LIMESTONE: moderately hard, light gray / 95.2		
	95					AUGER REFUSAL at 7.5 feet		
10								
	90							
15								

Groundwater was not encountered at the time of drilling and borehole dry upon completion.

Boring backfilled 7/18/2018

Consistency/relative density based on correction factor for automatic hammer

SAMPLE TYPE ☒ Split Spoon

N-VALUE	STANDARD PENETRATION RESISTANCE (AASHTO T-206)	**REC**	RECOVERY
% MOISTURE	PERCENT NATURAL MOISTURE CONTENT	**RQD**	ROCK QUALITY DESIGNATION
▽	GROUNDWATER LEVEL IN THE BOREHOLE	**UD**	UNDISTURBED
Qu	UNCONFINED COMPRESSIVE STRENGTH ESTIMATE FROM POCKET PENETROMETER TEST		

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LOG OF BORING

Designation: P-03

Sheet 1 of 1

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Project Name: Cherokee Springs Substation Roadway
Project Number: OK180167
Drilling Method: Hollow Stem Auger
Equipment Used: CME-75
Hammer Type: Automatic
Boring Location: 18+00

Project Location: Tahlequah, OK
Date Drilled: 7/18/18
Weather Conditions:
Surface Elevation: 101.4
Drill Crew: Mohawk
Logged By: Taru

DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	N-Value / Qu (tsf) / Atterberg Limits / % Moisture	SOIL DESCRIPTION	GRAPHIC	REMARKS
						TOPSOIL = 10 inches		
			1	2-6-5		0.9 / 100.5 SILTY CLAY (CL-ML): stiff, brown, dark brown, with roots, trace chert fragments, trace plasticity, moist		
	100					3.0 / 98.4 LEAN CLAY (CL): stiff to very stiff, brown and reddish brown, with weathered cherty limestone gravel, low plasticity, moist		
			2	5-6-6				
5						- stiff, with ferrous staining and nodules		
			3	6-4-20		6.0 / 95.4 WEATHERED CHERTY LIMESTONE: soft, light gray, fragmented		
	95							
			4	15-11-19		▽ - light gray, reddish brown, with ferrous staining and clay seams, wet		Groundwater seepage encountered at 9.7 feet during drilling
10								
			5	50/4.5"	>>	11.5 - moderately hard, gray to white / 89.9 AUGER REFUSAL at 11.5 feet on apparent limestone		
	90							
15								Boring backfilled 7/18/2018
	85							Consistency/relative density based on correction factor for automatic hammer

SAMPLE TYPE ☒ Split Spoon

N-VALUE	STANDARD PENETRATION RESISTANCE (AASHTO T-206)	**REC**	RECOVERY
% MOISTURE	PERCENT NATURAL MOISTURE CONTENT	**RQD**	ROCK QUALITY DESIGNATION
▽	GROUNDWATER LEVEL IN THE BOREHOLE	**UD**	UNDISTURBED
Qu	UNCONFINED COMPRESSIVE STRENGTH ESTIMATE FROM POCKET PENETROMETER TEST		

LOG OF BORING 2 UPDATED GINT.GPJ BESI.GDT 7/25/18

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LOG OF BORING

Designation: P-04

Sheet 1 of 1

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Project Name: Cherokee Springs Substation Roadway
Project Number: OK180167
Drilling Method: Hollow Stem Auger
Equipment Used: CME-75
Hammer Type: Automatic
Boring Location: 22+00 West Drive

Project Location: Tahlequah, OK
Date Drilled: 7/18/18
Weather Conditions:
Surface Elevation: 112.5
Drill Crew: Mohawk
Logged By: Taru

DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	N-Value / Qu (tsf) / Atterberg Limits / % Moisture	SOIL DESCRIPTION	GRAPHIC	REMARKS
						0.3 TOPSOIL = 4 inches — 112.2		
			1	9-15-18		LEAN CLAY WITH GRAVEL (CL): hard, brown, with roots and cherty limestone gravel, low plasticity, moist		
	110		2	15-9-3		- stiff to very stiff, reddish brown, with ferrous staining		
5						5.0 — 107.5		
			3	5-6-6		LEAN TO FAT CLAY (CL-CH): stiff to very stiff, reddish brown, with ferrous nodules and chert gravel, moderate to high plasticity, moist		
	105					8.0 — 104.5		
			4	4-9-8		FAT CLAY (CH): very stiff, dark reddish brown, with weathered and fractured cherty limestone gravel, and ferrous staining and nodules, high plasticity, moist		
10						13.0 — 99.5		
	100		5	50/3.5"	>> 13.8	WEATHERED CHERTY LIMESTONE: medium hard, white, light gray, with some ferrous staining, moderately fractured — 98.7		Groundwater was not encountered at the time of drilling and borehole dry upon completion.
						Boring terminated at 13.8 feet		Boring backfilled 7/18/2018
15								Consistency/relative density based on correction factor for automatic hammer

SAMPLE TYPE ☒ Split Spoon

N-VALUE	STANDARD PENETRATION RESISTANCE (AASHTO T-206)	**REC**	RECOVERY
% MOISTURE	PERCENT NATURAL MOISTURE CONTENT	**RQD**	ROCK QUALITY DESIGNATION
▽	GROUNDWATER LEVEL IN THE BOREHOLE	**UD**	UNDISTURBED
Qu	UNCONFINED COMPRESSIVE STRENGTH ESTIMATE FROM POCKET PENETROMETER TEST		

LOG OF BORING 2 UPDATED GINT.GPJ BESI.GDT 7/25/18

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LOG OF BORING

Designation: P-05

Sheet 1 of 1

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Project Name: Cherokee Springs Substation Roadway
Project Number: OK180167
Drilling Method: Hollow Stem Auger
Equipment Used: CME-75
Hammer Type: Automatic
Boring Location: 31+00 East Drive

Project Location: Tahlequah, OK
Date Drilled: 7/18/18
Weather Conditions:
Surface Elevation: 119.3
Drill Crew: Mohawk
Logged By: Taru

DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	N-Value / Qu (tsf) / Atterberg Limits / % Moisture	SOIL DESCRIPTION	GRAPHIC	REMARKS
			1	4-11-19		0.3 TOPSOIL = 4 inches (119.0) LEAN CLAY (CL): hard, brown, with roots and white cherty limestone gravel, low plasticity, dry 1.5 (117.8)		
			2	28-50/6"	>>	WEATHERED CHERTY LIMESTONE: soft, white, light gray, with ferrous staining on fractured surfaces		
5	115		3	50/6"	>>			
			4	50/5.75"	>>	6.5 (112.8) AUGER REFUSAL at 6.5 feet		
10	110							
15	105							

Groundwater was not encountered at the time of drilling and borehole dry upon completion.

Boring backfilled 7/18/2018

Consistency/relative density based on correction factor for automatic hammer

SAMPLE TYPE ☒ Split Spoon

N-VALUE	STANDARD PENETRATION RESISTANCE (AASHTO T-206)	**REC**	RECOVERY
% MOISTURE	PERCENT NATURAL MOISTURE CONTENT	**RQD**	ROCK QUALITY DESIGNATION
▽	GROUNDWATER LEVEL IN THE BOREHOLE	**UD**	UNDISTURBED
Qu	UNCONFINED COMPRESSIVE STRENGTH ESTIMATE FROM POCKET PENETROMETER TEST		

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