GEOTECHNICAL ENGINEERING REPORT

AIMRIGHT Project No. 13070623
August 3, 2023

OMPA Waynoka Transmission Line

Prepared for:
CEC Corporation

AIMRIGHT
TESTING & ENGINEERING

Construction Materials Testing • Special Inspections • Geotechnical Engineering

August 3, 2023

CEC Corporation
4617 East 91st Street
Tulsa, OK 74137
(918) 663-9401

Attn: Joel Blair, P.E., joel.blair@connectcec.com

Re: Geotechnical Engineering Report | Project No. 13070623
OMPA Waynoka, Transmission Line
Waynoka, OK

AIMRIGHT is pleased to submit this report for the proposed construction at the referenced project sites. The Boring Location Plans, Boring Logs, and other supporting data are attached to this report. Our Scope of Services consisted of completing six (6) soil test borings (borings) (B-1 to B-6) within the locations as designated by you; performing selective laboratory testing of the soil samples obtained; and providing a summary report to include estimated soil parameters for the proposed drilled pier foundation axial design and lateral load analysis.

Our Scope of Services did not include analysis of any rapid drawdown of water levels, potential seismic hazards, liquefaction potential analysis, surveying of the existing topography boring elevations/locations, quantity estimates, preparation of plans or specifications, or the identification and evaluation of environmental aspects of the project sites.

Field Exploration and Laboratory Testing

The borings were advanced to depths of 30 to 50 feet using an ATV-mounted drill rig equipped with an automatic hammer and continuous flight augers. At regular intervals within the borings, representative soil samples were obtained using a standard 2-inch outside diameter split-barrel sampler in general compliance with American Society of Testing and Materials (ASTM) Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils (ASTM D1586) standards for visual classification based on texture and plasticity and to evaluate the consistency and general engineering properties of the subsurface soils.

During the drilling process, all encounters with groundwater, if any, were recorded. Upon completion of drilling, the borings were backfilled per OWRB requirements. The samples obtained from the exploration were transported to our laboratory for selective testing.

Laboratory Testing

Laboratory tests were conducted on selected samples in general accordance with the American Association of State and Highway Transportation Officials (AASHTO) and ASTM standards. The laboratory testing performed consisted of determining the moisture content, liquid and plastic limits, and sieve analysis of material (No. 200 wash method). The results of the laboratory testing are presented on the Boring Logs.

Drilled Pier Recommendations

The attached Drilled Pier Design Parameter tables summarize the general estimated soil/rock parameters that may be utilized to assist in axial load design and lateral load analysis for each boring location. The project structural engineer should determine the final foundation sizes based on the actual design loads, building code requirements, and other structural considerations.

Straight-sided drilled piers with a minimum pier diameter of eighteen (18) inches may be used to support the proposed structures. Utilizing maximum column loads of 10 to 20 kip, we estimate that foundation settlements for the structures will be at or less than 1 inch for piers bearing in the applicable soil or rock stratum.

Installation of the drilled piers and placement of concrete within the piers should be performed in accordance with the most recent ACI Specifications and installation monitoring shall be observed under supervision by AIMRIGHT. A representative of the geotechnical engineer should observe the drilled pier installation to verify that the recommend bearing materials are encountered and sufficiently penetrated as well as to observe the concreting techniques.

We anticipate the near-surface soils at the site can be excavated using conventional drill rigs with sufficient torque and ability. Our experience indicates rock in a weathered, boulder, and/or massive form may vary erratically in location and depth within the referenced site. Therefore, there is always a potential that these materials could be encountered at shallower depths between the boring locations and should be anticipated during construction.

The drilling rig should be equipped with earth augers and rock augers that contain conical carbide-tipped teeth and other necessary tools to excavate, clean and level rock bottoms properly, and without construction delay. The contractor should assess the subsurface conditions prior to mobilizing and should be prepared to utilize other techniques such as rock coring, jack-hammering, or other suitable methods to reach planned pier bottom depths, especially if auger refusal was encountered.

Following drilling, loose, or disturbed materials and any accumulated water should be removed from the bottom of the drilled piers prior to concrete placement. To facilitate construction, reinforcing steel should be ready and on site, and concrete should be available within a very short period for placement after excavation is completed. Drilled pier excavations must not set overnight prior to placing concrete.

Groundwater and/or caving was encountered in some of the borings. Therefore, the need for casings may be required. Water traveling through soil and rock is often unpredictable and may be present in other areas at shallower depths. Due to the seasonal changes in groundwater and the unpredictable nature of groundwater paths, groundwater levels can fluctuate.

Where casings are used, it is recommended that the concrete have a slump in the range of 5 to 7 inches to reduce the potential of arching when removing the casing. When removing the casing, the concrete inside the casing should be maintained at enough level to reduce any earth and hydrostatic pressure outside the casing during removal.

Concrete slump should be at least 5 inches, and generally in the range of 5 to 7 inches; however, a higher slump may be used to increase fluidity if appropriate for the concrete mix used. An uninterrupted supply and placement of concrete is recommended to produce a monolithic shaft. The maximum size of the concrete aggregate should not exceed one-third of the minimum clear spacing between individual reinforcing bars or bundles.

Driven Pile Recommendations

Driven steel H-piles (HP12x53, AASHTO M270 Grade 50) utilizing side and end bearing capacities may be used to support the proposed structure(s) at the location for boring B-2. The allowable total bearing and uplift capacities for the stated driven pile depths may be utilized for design as outlined in the table below. Utilizing maximum loads stated in the table below, we estimate that foundation settlements (tip) and uplift displacements (top) for the piles will be at or less than 1 inch.

Driven Pile Tip Depth Below Existing Ground Surface (ft)	Allowable Total Bearing Capacity (FS ≥ 2.5) (kip)	Allowable Uplift Capacity (FS ≥ 2.5) (kip)
20	9	10
25	14	15
30	16	21
35	19	26
40	23	30
45	28	36

Interpretation of groundwater table should be approximated within the water level encountered during drilling and/or at the completion of drilling at this site. For location at boring B-2, the groundwater table was interpreted to be at as high as 13.5 feet for recommendations provided in the table above. We anticipate the piles at the boring B-2 site can be driven using conventional driving hammers through the existing native soils without encountering any adverse driving resistance and obstructions are not anticipated.

Installation of the driven piles should be performed in general accordance Section 514 of the current Oklahoma Department of Transportation (ODOT) Standard Specification for Highway Construction. Installation monitoring shall be observed under supervision by AIMRIGHT. A representative of the geotechnical engineer should observe the driven pier installation to observe the driving equipment, materials, and techniques.

Limitations

This analysis is based on our observations at the sites, interpretation and analysis of the field and laboratory data obtained during this exploration, and our experience with previous exploration and testing with similar projects. Subsurface conditions in unexplored locations may vary from those encountered. If structure location or elevations are changed, we request that we be advised so that we may re-evaluate our recommendations.

The recommendations provided are based in part on project information provided to us and they only apply to the specific project and site(s) discussed in this report. Experienced geotechnical personnel should observe and document the construction procedures used and the conditions encountered. Unanticipated conditions and inadequate procedures should be reported to the design team along with timely recommendations to solve the problems created.

The conclusions and recommendations presented in this report were derived in accordance with standard geotechnical engineering practices and no other warranty is expressed or implied. We look forward to serving as your geotechnical engineer and construction materials testing laboratory on the remainder of this and future projects.

Respectfully submitted,

AIMRIGHT Testing & Engineering, LLC
CA No. 5794 (exp. 6/30/24)
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Engineering Manager
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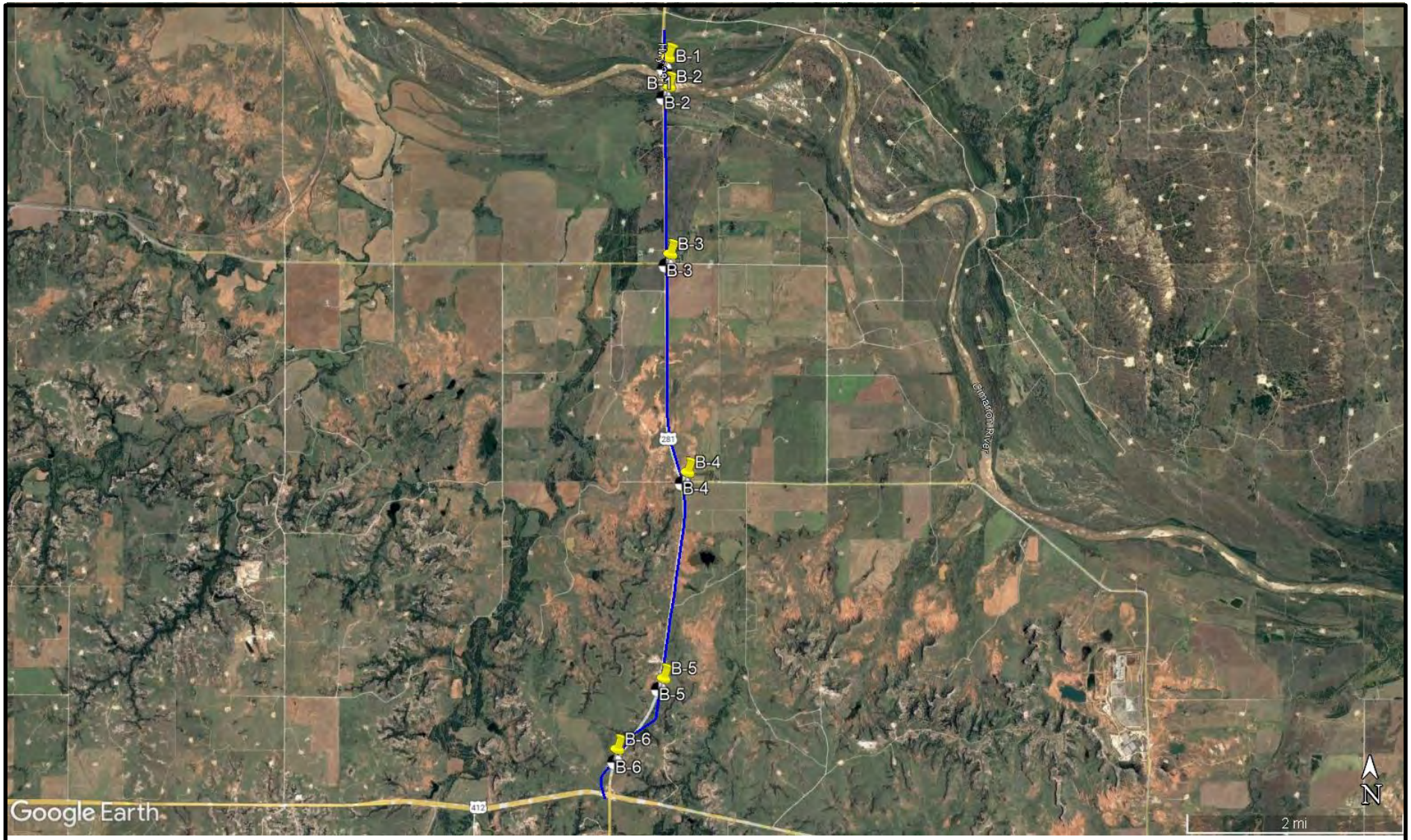

APPROXIMATE BORING LOCATIONS

BORING LOCATION PLAN

PROJECT NO.: 13070623
BORING NO.: B-1 to B-6

PROJECT: OMPA Waynoka Transmission Line
CLIENT: CEC Corporation

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APPROXIMATE BORING LOCATIONS

BORING LOCATION PLAN

PROJECT NO.: 13070623
BORING NO.: B-1

PROJECT: OMPA Waynoka Transmission Line
CLIENT: CEC Corporation

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APPROXIMATE BORING LOCATIONS

BORING LOCATION PLAN

PROJECT NO.: 13070623
BORING NO.: B-2

PROJECT: OMPA Waynoka Transmission Line
CLIENT: CEC Corporation

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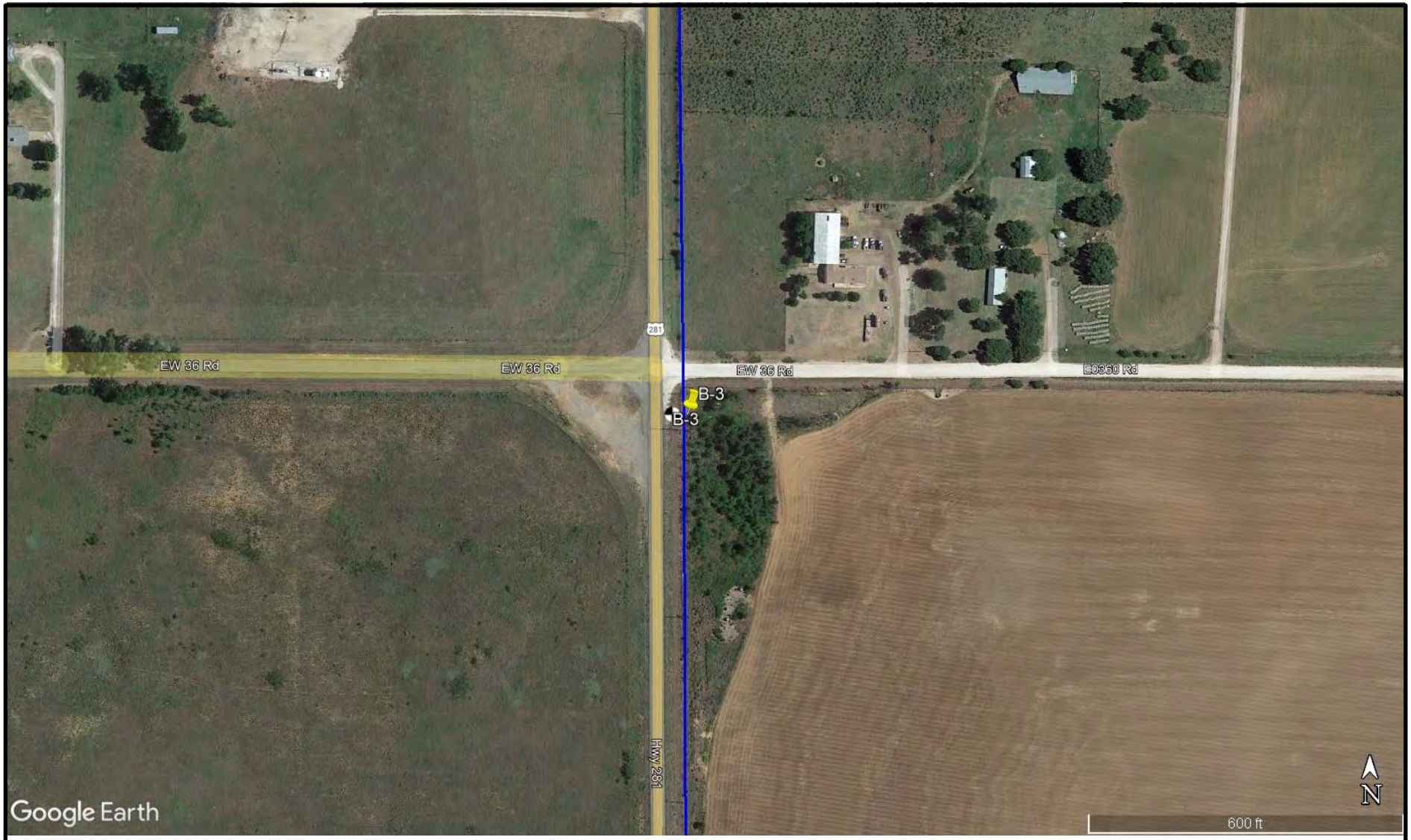

APPROXIMATE BORING LOCATIONS

BORING LOCATION PLAN

PROJECT NO.: 13070623
BORING NO.: B-3

PROJECT: OMPA Waynoka Transmission Line
CLIENT: CEC Corporation

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APPROXIMATE BORING LOCATIONS

BORING LOCATION PLAN

PROJECT NO.: 13070623
BORING NO.: B-4

PROJECT: OMPA Waynoka Transmission Line
CLIENT: CEC Corporation

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APPROXIMATE BORING LOCATIONS

BORING LOCATION PLAN

PROJECT NO.: 13070623
BORING NO.: B-5

PROJECT: OMPA Waynoka Transmission Line
CLIENT: CEC Corporation

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APPROXIMATE BORING LOCATIONS

BORING LOCATION PLAN

PROJECT NO.: 13070623
BORING NO.: B-6

PROJECT: OMPA Waynoka Transmission Line
CLIENT: CEC Corporation

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LOG OF BORING B-1

PROJECT: OMPA Waynoka Transmission Line

CLIENT: CEC Corporation **PROJECT NO.:** 13070623

PROJECT LOCATION: Waynoka, OK

LOCATION: see Boring Location Plan **ELEVATION:** N/A

DRILLER: Preston S. **LOGGED BY:** R. Dear **DRILLING RIG:** D-50 ATV-Mounted

DRILLING METHOD: Rotary Continuous Flight Augers **DATE:** 7/20/23

DEPTH TO WATER> INITIAL: ▽ 10 **AT COMPLETION:** ▽ N/A **CAVING>** ℄ 8.5

Depth (feet)	Sampler Type	Description	Graphic	USCS Symbol	SPT N-value (bpf)	Groundwater	Moisture Content	% < #200	Liquid Limit	Plastic Limit	Plasticity Index
0		TOPSOIL - 3 inches			4						
0.25											
1		SILTY SAND		SM	5		4.2	27.4	11	NP	NP
2		loose, medium and light brown, moist									
3											
4					10						
5											
6		SILTY SAND			3						
7		very loose to loose, medium brown, moist to wet									
8						℄					
9				SM	4		19.1	16.2	16	NP	NP
10						▽					
11											
12											
13											
14					3						
15											
16											
17											
18											
18.5											
19		POORLY GRADED SAND			11		16.5	3.5			
20		medium dense, light brown, moist to wet									
21											
22											
23											
24		POORLY GRADED SAND			4						
25		loose, light brown, moist to wet									
26											
27											
28											
28.5											
29		LEAN CLAY w/ SAND, trace shale fragments		CL	41		22.6	77.6	41	25	16
30		very stiff to hard, dark reddish brown, moist									
31											
32											
33											
34					21						
35											
36											
37											
38											
39		LEAN CLAY w/ trace sand, shale fragments		CL	26		18.7	88.0	31	15	16
40		very stiff, medium and dark reddish brown mottled medium gray, moist									
41											
42											
43											
43.5											
44		SHALE highly weathered			50/5.75						
45		soft, medium and light grayish brown, moist									
46											
47											
48											
		Boring terminated at 48.92 ft.			50/5.0						

NP - Non-Plastic

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LOG OF BORING B-2

PROJECT: OMPA Waynoka Transmission Line

CLIENT: CEC Corporation **PROJECT NO.:** 13070623

PROJECT LOCATION: Waynoka, OK

LOCATION: see Boring Location Plan **ELEVATION:** N/A

DRILLER: Preston S. **LOGGED BY:** R. Dear **DRILLING RIG:** D-50 ATV-Mounted

DRILLING METHOD: Rotary Continuous Flight Augers **DATE:** 7/20/23

DEPTH TO WATER> INITIAL: ▽ 18 **AT COMPLETION:** ▽ 14 **CAVING>** ℄ 14.5

Depth (feet)	Description	USCS Symbol	SPT N-value (bpf)	Moisture Content	% < #200	Liquid Limit	Plastic Limit	Plasticity Index
0	TOPSOIL - 3 inches		9					
0.25	POORLY GRADED SAND w/ SILT, trace concrete fragments (FILL) loose to medium dense, medium and light grayish brown, moist	SP-SM	13	5.5	4.9	14	NP	NP
			11					
			5					
8.5	SILTY SAND medium dense, medium reddish brown, moist	SM	12	5.5	14.8	12	NP	NP
13.5	CLAYEY SAND loose, dark and medium brown, moist to very moist		7					
18.5	POORLY GRADED SAND very loose to medium dense, light brown, moist to wet		3	18.6	1.6			
			11					
			12	16.5	0.5			
			4					
38.5	POORLY GRADED SAND w/ SILT medium dense, light reddish brown, moist		21	14.3	8.0			
43.5	POORLY GRADED SAND loose, light reddish brown, very moist to wet		7					
			7					
	Boring terminated at 50 ft.							

Groundwater: ▽ 13.5 ▽ 18.5

NP - Non-Plastic

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

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LOG OF BORING B-3

PROJECT: OMPA Waynoka Transmission Line

CLIENT: CEC Corporation **PROJECT NO.:** 13070623

PROJECT LOCATION: Waynoka, OK

LOCATION: see Boring Location Plan **ELEVATION:** N/A

DRILLER: Preston S. **LOGGED BY:** R. Dear **DRILLING RIG:** D-50 ATV-Mounted

DRILLING METHOD: Rotary Continuous Flight Augers **DATE:** 7/20/23

DEPTH TO WATER> INITIAL: ▽ 13 **AT COMPLETION:** ▼ 12 **CAVING>** ℄ 14

Depth (feet)	Description	USCS Symbol	SPT N-value (bpf)	Moisture Content	% < #200	Liquid Limit	Plastic Limit	Plasticity Index
0	TOPSOIL - 2 inches (0.167)		7					
2	SILTY CLAYEY SAND (FILL) loose, dark reddish brown, moist	SC-SM	9	10.9	42.4	17	11	6
4			5					
6	SILTY SAND medium dense, light reddish brown, moist	SM	18	5.5	13.8	10	NP	NP
8			21					
14	SILTY SAND medium dense, medium reddish brown, moist to very moist	SM	18	12.2	14.8	12	NP	NP
18			15					
23.5	POORLY GRADED SAND w/ SILT medium dense, medium reddish brown, moist	SP-SM	19	11.6	9.6	9	NP	NP
28.5	SANDY LEAN CLAY stiff, dark reddish brown, moist to very moist		12					
30	Boring terminated at 30 ft.							

Groundwater: ▽ 13 ▼ 12 ℄ 14

NP - Non-Plastic

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

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LOG OF BORING B-4

PROJECT: OMPA Waynoka Transmission Line

CLIENT: CEC Corporation **PROJECT NO.:** 13070623

PROJECT LOCATION: Waynoka, OK

LOCATION: see Boring Location Plan **ELEVATION:** N/A

DRILLER: Preston S. **LOGGED BY:** R. Dear **DRILLING RIG:** D-50 ATV-Mounted

DRILLING METHOD: Rotary Continuous Flight Augers **DATE:** 7/20/23

DEPTH TO WATER> INITIAL: ▽ Dry **AT COMPLETION:** ▼ Dry **CAVING>** ℄ None

Depth (feet)	Sampler Type	Description	Graphic	USCS Symbol	SPT N-value (bpf)	Groundwater	Moisture Content	% < #200	Liquid Limit	Plastic Limit	Plasticity Index
0											
1		TOPSOIL - 5 inches			15						
2		0.417									
3		LEAN CLAY w/ SAND, trace limestone fragments very stiff, dark reddish grayish brown, moist		CL	24		8.2	71.7	32	14	18
4					27						
5		LEAN CLAY w/ trace sand, sandstone, shale fragments									
6		hard, medium to dark reddish grayish brown, moist		CL	39		21.0	86.1	47	23	24
7											
8											
9					44						
10											
11											
12											
13		13.5									
14		SHALE highly weathered			44						
15		soft, dark and medium reddish brown, moist			50/4.75						
16											
17											
18											
19					38						
20					50/5.0						
21											
22											
23											
24					50/5.0						
25											
26											
27											
28					50/4.5						
		Boring terminated at 28.88 ft.									

NP - Non-Plastic

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

AIMRIGHT TESTING & ENGINEERING

LOG OF BORING B-5

PROJECT: OMPA Waynoka Transmission Line

CLIENT: CEC Corporation **PROJECT NO.:** 13070623

PROJECT LOCATION: Waynoka, OK

LOCATION: see Boring Location Plan **ELEVATION:** N/A

DRILLER: Preston S. **LOGGED BY:** R. Dear **DRILLING RIG:** D-50 ATV-Mounted

DRILLING METHOD: Rotary Continuous Flight Augers **DATE:** 7/20/23

DEPTH TO WATER> INITIAL: Dry **AT COMPLETION:** Dry **CAVING>** None

Depth (feet)	Sampler Type	Description	Graphic	USCS Symbol	SPT N-value (bpf)	Groundwater	Moisture Content	% < #200	Liquid Limit	Plastic Limit	Plasticity Index
0		TOPSOIL - 6 inches									
0.5											
1		LEAN CLAY w/ trace sand, sandstone fragments			10						
2		stiff to hard, dark grayish to dark reddish grayish brown, moist		CL	41		21.8	92.6	41	22	19
3											
4					35						
5											
6		LEAN CLAY w/ SAND, shale fragments		CL	77		17.8	75.1	37	19	18
7		hard to very hard, dark to medium grayish reddish brown, moist									
8											
9					64						
10											
11											
12											
13											
14					74						
15											
16											
17											
18											
18.5											
19		SHALE highly weathered			36						
20		soft, light grayish to dark reddish brown, moist			50/4.5						
21											
22											
23											
24					38						
25					50/4.75						
26											
27											
28											
29					45						
		Boring terminated at 29.75 ft.			50/3.0						

NP - Non-Plastic

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

AMRIGHT TESTING & ENGINEERING

LOG OF BORING B-6

PROJECT: OMPA Waynoka Transmission Line

CLIENT: CEC Corporation **PROJECT NO.:** 13070623

PROJECT LOCATION: Waynoka, OK

LOCATION: see Boring Location Plan **ELEVATION:** N/A

DRILLER: Preston S. **LOGGED BY:** R. Dear **DRILLING RIG:** D-50 ATV-Mounted

DRILLING METHOD: Rotary Continuous Flight Augers **DATE:** 7/20/23

DEPTH TO WATER> INITIAL: Dry **AT COMPLETION:** Dry **CAVING>** None

Depth (feet)	Sampler Type	Description	Graphic	USCS Symbol	SPT N-value (bpf)	Groundwater	Moisture Content	% < #200	Liquid Limit	Plastic Limit	Plasticity Index
0		TOPSOIL - 4 inches			6						
0.333											
1		LEAN CLAY w/ SAND, trace sandstone fragments			8						
2		medium stiff to very stiff, dark to medium reddish brown, moist									
3											
4				CL	13		12.3	82.6	38	16	22
5											
6											
7		LEAN CLAY w/ SAND, sandstone fragments			52						
8		hard, medium and light grayish reddish brown, moist									
8.5											
9		SANDSTONE seam			50/1.25						
10											
10											
11											
12		LEAN CLAY w/ SAND, trace shale fragments									
13		very stiff, medium gray, moist									
14					15						
15											
16											
17											
18											
19		LEAN CLAY w/ SAND, shale fragments			40						
20		hard, dark reddish grayish brown, moist									
21											
22											
23											
23.5											
24		SHALE highly weathered			37						
25		soft, dark reddish brown mottled light gray, moist			50/3.75						
26											
27											
28											
29					50/3.0						
		Boring terminated at 29.25 ft.									

NP - Non-Plastic

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

KEY TO SYMBOLS

Symbol **Description**

Strata Symbols

 **Topsoil**

 **Silty Sand**

 **Poorly Graded Sand**

 **Low Plasticity Clay**

 **Shale**

 **Fill**

 **Clayey Sand**

 **Poorly Graded Sand with Silt**

 **Sandstone**

Misc. Symbols

 **Water Table during Drilling**

 **Depth to Caving**

 **Water Table at Boring Completion**

Soil Samplers

 **Standard Penetration Test**

Depth Interval (ft)	L-Pile Layer Type[1]	Unit Weight γ[1] (pcf)	Friction Angle Φ (°) or Undrained Cohesion c_u (psf)	L-Pile Horizontal Subgrade Modulus		MFAD Deformation Modulus E_D (ksi)	Strain Factor ε_{50}/k_{rm}	Allowable End Bearing Capacity[2] (FS ≥ 2.5) (ksf)	Allowable Unit Side Resistance[3] (FS = 2.5) (ksf)
				$k_{dry(sand)}$ or $k_{static(clay)}$ (pci)	$k_{sat(sand)}$ or $k_{cyclic(clay)}$ (pci)				
0 to 18.5*	Sand	95	27°	25	20	0.2	N/A	N/A	0.13
18.5 to 28.5	Sand	90	29°	25	20	0.3	N/A	1.4	0.10
28.5 to 43.5	Stiff Clay	120	2,000	1,000	400	1.5	0.005	6.0	0.44
43.5 to 50	Weak Rock[4]	130	30°	N/A	N/A	500	0.0005	15.0	1.00

1. Interpretation of groundwater table should be approximated within the water level encountered during drilling and/or at the completion of drilling at this site. The depth interval where water was encountered during drilling within the applicable layer is indicated in the table with an asterisk (*) and effective unit weights should be determined, where applicable. As such, L-Pile layer types of Clay "with" and "without" free water shall be used accordingly.
2. The recommended net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the pier base elevation.
3. Where provided, the unit side resistance between the pier and surrounding bearing material can be used to develop pier capacity in compression and uplift resistance. The pier weight and maximum allowable unit side resistance may be utilized to resist structural upward loadings. At minimum, the upper 5 feet of pier and one (1) pier diameter above the pier base should be ignored for unit side resistance in piers bearing in the clay soils stratum.
4. For weak rock, the following shall be utilized: Initial Modulus of Rock Mass = 7.5 to 35 ksi; Rock Quality Designation (RQD) = 10 to 60%; Uniaxial Compressive Strength = 100 to 500 psi; MFAD Rock Cohesion = 2 ksf; MFAD Rock/Concrete Bond Strength = 13 ksf.
5. Auger refusal was encountered, please review boring logs carefully. Auger refusal is defined as material that could not be penetrated with the drill rig equipment used on the project. Auger refusal material may be caused by large boulders, rock ledges, lenses, seams, or the top of parent bedrock. The drilling rig should be equipped with an earth and rock augers and other necessary tools to excavate, clean and level rock bottoms properly, and without construction delay. The contractor should assess the subsurface conditions prior to mobilizing and should be prepared to utilize other techniques such as rock coring to reach planned pier bottom depths.
6. Where minimum cyclic lateral pressures are anticipated, soil expansion uplift pressures of up to 0.25 to 0.5 ksf may develop and should be included in design for portion of pier extending through moderately to highly expansive soils within the upper 5 feet.

DRILLED PIER DESIGN PARAMETERS

PROJECT NO.: 13070623
BORING NO.: B-1

PROJECT: OMPA Waynoka Transmission Line
CLIENT: CEC Corporation

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Depth Interval (ft)	L-Pile Layer Type[1]	Unit Weight γ[1] (pcf)	Friction Angle Φ (°) or Undrained Cohesion c_u (psf)	L-Pile Horizontal Subgrade Modulus		MFAD Deformation Modulus E_D (ksi)	Strain Factor ε_{50}/k_{rm}	Allowable End Bearing Capacity[2] (FS ≥ 2.5) (ksf)	Allowable Unit Side Resistance[3] (FS = 2.5) (ksf)
				$k_{dry(sand)}$ or $k_{static(clay)}$ (pci)	$k_{sat(sand)}$ or $k_{cyclic(clay)}$ (pci)				
0 to 8.5	Sand	100	30°	25	20	0.4	N/A	N/A	0.20
8.5 to 13.5	Sand	105	32°	90	60	0.6	N/A	N/A	0.37
13.5 to 23.5*	Sand	90	26°	25	20	0.2	N/A	0.9	0.15
23.5 to 30	Sand	105	32°	90	60	0.5	N/A	2.6	0.42
30 to 38.5	Sand	90	26°	25	20	0.2	N/A	0.9	0.20
38.5 to 50*	Sand	100	29°	25	20	0.3	N/A	1.6	0.26

1. Interpretation of groundwater table should be approximated within the water level encountered during drilling and/or at the completion of drilling at this site. The depth interval where water was encountered during drilling within the applicable layer is indicated in the table with an asterisk (*) and effective unit weights should be determined, where applicable. As such, L-Pile layer types of Clay “with” and “without” free water shall be used accordingly.
2. The recommended net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the pier base elevation.
3. Where provided, the unit side resistance between the pier and surrounding bearing material can be used to develop pier capacity in compression and uplift resistance. The pier weight and maximum allowable unit side resistance may be utilized to resist structural upward loadings. At minimum, the upper 5 feet of pier and one (1) pier diameter above the pier base should be ignored for unit side resistance in piers bearing in the clay soils stratum.
4. For weak rock, the following shall be utilized: Initial Modulus of Rock Mass = 7.5 to 35 ksi; Rock Quality Designation (RQD) = 10 to 60%; Uniaxial Compressive Strength = 100 to 500 psi; MFAD Rock Cohesion = 2 ksf; MFAD Rock/Concrete Bond Strength = 13 ksf.
5. Auger refusal was encountered, please review boring logs carefully. Auger refusal is defined as material that could not be penetrated with the drill rig equipment used on the project. Auger refusal material may be caused by large boulders, rock ledges, lenses, seams, or the top of parent bedrock. The drilling rig should be equipped with an earth and rock augers and other necessary tools to excavate, clean and level rock bottoms properly, and without construction delay. The contractor should assess the subsurface conditions prior to mobilizing and should be prepared to utilize other techniques such as rock coring to reach planned pier bottom depths.
6. Where minimum cyclic lateral pressures are anticipated, soil expansion uplift pressures of up to 0.25 to 0.5 ksf may develop and should be included in design for portion of pier extending through moderately to highly expansive soils within the upper 5 feet.

DRILLED PIER DESIGN PARAMETERS

PROJECT NO.: 13070623
BORING NO.: B-2
PROJECT: OMPA Waynoka Transmission Line
CLIENT: CEC Corporation

AIMRIGHT TESTING & ENGINEERING

Depth Interval (ft)	L-Pile Layer Type[1]	Unit Weight γ[1] (pcf)	Friction Angle Φ (°) or Undrained Cohesion c_u (psf)	L-Pile Horizontal Subgrade Modulus		MFAD Deformation Modulus E_D (ksi)	Strain Factor ε_{50}/k_{rm}	Allowable End Bearing Capacity[2] (FS ≥ 2.5) (ksf)	Allowable Unit Side Resistance[3] (FS = 2.5) (ksf)
				$k_{dry(sand)}$ or $k_{static(clay)}$ (pci)	$k_{sat(sand)}$ or $k_{cyclic(clay)}$ (pci)				
0 to 6	Sand	90	28°	25	20	0.3	N/A	N/A	0.12
6 to 23.5*	Sand	110	35°	90	60	0.9	N/A	4.0	0.45
23.5 to 28.5	Sand	105	35°	90	60	1.0	N/A	4.0	0.61
28.5 to 30*	Stiff Clay	120	1,500	500	200	0.8	0.007	3.0	0.33

1. Interpretation of groundwater table should be approximated within the water level encountered during drilling and/or at the completion of drilling at this site. The depth interval where water was encountered during drilling within the applicable layer is indicated in the table with an asterisk (*) and effective unit weights should be determined, where applicable. As such, L-Pile layer types of Clay "with" and "without" free water shall be used accordingly.
2. The recommended net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the pier base elevation.
3. Where provided, the unit side resistance between the pier and surrounding bearing material can be used to develop pier capacity in compression and uplift resistance. The pier weight and maximum allowable unit side resistance may be utilized to resist structural upward loadings. At minimum, the upper 5 feet of pier and one (1) pier diameter above the pier base should be ignored for unit side resistance in piers bearing in the clay soils stratum.
4. For weak rock, the following shall be utilized: Initial Modulus of Rock Mass = 7.5 to 35 ksi; Rock Quality Designation (RQD) = 10 to 60%; Uniaxial Compressive Strength = 100 to 500 psi; MFAD Rock Cohesion = 2 ksf; MFAD Rock/Concrete Bond Strength = 13 ksf.
5. Auger refusal was encountered, please review boring logs carefully. Auger refusal is defined as material that could not be penetrated with the drill rig equipment used on the project. Auger refusal material may be caused by large boulders, rock ledges, lenses, seams, or the top of parent bedrock. The drilling rig should be equipped with an earth and rock augers and other necessary tools to excavate, clean and level rock bottoms properly, and without construction delay. The contractor should assess the subsurface conditions prior to mobilizing and should be prepared to utilize other techniques such as rock coring to reach planned pier bottom depths.
6. Where minimum cyclic lateral pressures are anticipated, soil expansion uplift pressures of up to 0.25 to 0.5 ksf may develop and should be included in design for portion of pier extending through moderately to highly expansive soils within the upper 5 feet.

DRILLED PIER DESIGN PARAMETERS

PROJECT NO.: 13070623
BORING NO.: B-3

PROJECT: OMPA Waynoka Transmission Line
CLIENT: CEC Corporation

AIMRIGHT TESTING & ENGINEERING

Depth Interval (ft)	L-Pile Layer Type[1]	Unit Weight γ[1] (pcf)	Friction Angle Φ (°) or Undrained Cohesion c_u (psf)	L-Pile Horizontal Subgrade Modulus		MFAD Deformation Modulus E_D (ksi)	Strain Factor ε_{50}/k_{rm}	Allowable End Bearing Capacity[2] (FS ≥ 2.5) (ksf)	Allowable Unit Side Resistance[3] (FS = 2.5) (ksf)
				$k_{dry(sand)}$ or $k_{static(clay)}$ (pci)	$k_{sat(sand)}$ or $k_{cyclic(clay)}$ (pci)				
0 to 6	Stiff Clay	115	2,000	500	200	1.5	0.007	N/A	N/A
6 to 13.5	Stiff Clay	120	2,500	1,000	400	2.5	0.005	6.0	0.55
13.5 to 30	Weak Rock[4]	130	30°	N/A	N/A	500	0.0005	15.0	1.00

1. Interpretation of groundwater table should be approximated within the water level encountered during drilling and/or at the completion of drilling at this site. The depth interval where water was encountered during drilling within the applicable layer is indicated in the table with an asterisk (*) and effective unit weights should be determined, where applicable. As such, L-Pile layer types of Clay “with” and “without” free water shall be used accordingly.
2. The recommended net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the pier base elevation.
3. Where provided, the unit side resistance between the pier and surrounding bearing material can be used to develop pier capacity in compression and uplift resistance. The pier weight and maximum allowable unit side resistance may be utilized to resist structural upward loadings. At minimum, the upper 5 feet of pier and one (1) pier diameter above the pier base should be ignored for unit side resistance in piers bearing in the clay soils stratum.
4. For weak rock, the following shall be utilized: Initial Modulus of Rock Mass = 7.5 to 35 ksi; Rock Quality Designation (RQD) = 10 to 60%; Uniaxial Compressive Strength = 100 to 500 psi; MFAD Rock Cohesion = 2 ksf; MFAD Rock/Concrete Bond Strength = 13 ksf.
5. Auger refusal was encountered, please review boring logs carefully. Auger refusal is defined as material that could not be penetrated with the drill rig equipment used on the project. Auger refusal material may be caused by large boulders, rock ledges, lenses, seams, or the top of parent bedrock. The drilling rig should be equipped with an earth and rock augers and other necessary tools to excavate, clean and level rock bottoms properly, and without construction delay. The contractor should assess the subsurface conditions prior to mobilizing and should be prepared to utilize other techniques such as rock coring to reach planned pier bottom depths.
6. Where minimum cyclic lateral pressures are anticipated, soil expansion uplift pressures of up to 0.25 to 0.5 ksf may develop and should be included in design for portion of pier extending through moderately to highly expansive soils within the upper 5 feet.

DRILLED PIER DESIGN PARAMETERS

PROJECT NO.: 13070623
BORING NO.: B-4
PROJECT: OMPA Waynoka Transmission Line
CLIENT: CEC Corporation

AIMRIGHT TESTING & ENGINEERING

Depth Interval (ft)	L-Pile Layer Type[1]	Unit Weight γ[1] (pcf)	Friction Angle Φ (°) or Undrained Cohesion c_u (psf)	L-Pile Horizontal Subgrade Modulus		MFAD Deformation Modulus E_D (ksi)	Strain Factor ε_{50}/k_{rm}	Allowable End Bearing Capacity[2] (FS ≥ 2.5) (ksf)	Allowable Unit Side Resistance[3] (FS = 2.5) (ksf)
				$k_{dry(sand)}$ or $k_{static(clay)}$ (pci)	$k_{sat(sand)}$ or $k_{cyclic(clay)}$ (pci)				
0 to 3	Stiff Clay	115	1,250	500	200	0.7	0.007	N/A	N/A
3 to 6	Stiff Clay	115	2,250	1,000	400	2.5	0.005	N/A	N/A
6 to 18.5	Stiff Clay	120	4,000	2,000	800	5.0	0.004	9.0	0.88
18.5 to 30	Weak Rock[4]	130	30°	N/A	N/A	500	0.0005	15.0	1.00

1. Interpretation of groundwater table should be approximated within the water level encountered during drilling and/or at the completion of drilling at this site. The depth interval where water was encountered during drilling within the applicable layer is indicated in the table with an asterisk (*) and effective unit weights should be determined, where applicable. As such, L-Pile layer types of Clay “with” and “without” free water shall be used accordingly.
2. The recommended net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the pier base elevation.
3. Where provided, the unit side resistance between the pier and surrounding bearing material can be used to develop pier capacity in compression and uplift resistance. The pier weight and maximum allowable unit side resistance may be utilized to resist structural upward loadings. At minimum, the upper 5 feet of pier and one (1) pier diameter above the pier base should be ignored for unit side resistance in piers bearing in the clay soils stratum.
4. For weak rock, the following shall be utilized: Initial Modulus of Rock Mass = 7.5 to 35 ksi; Rock Quality Designation (RQD) = 10 to 60%; Uniaxial Compressive Strength = 100 to 500 psi; MFAD Rock Cohesion = 2 ksf; MFAD Rock/Concrete Bond Strength = 13 ksf.
5. Auger refusal was encountered, please review boring logs carefully. Auger refusal is defined as material that could not be penetrated with the drill rig equipment used on the project. Auger refusal material may be caused by large boulders, rock ledges, lenses, seams, or the top of parent bedrock. The drilling rig should be equipped with an earth and rock augers and other necessary tools to excavate, clean and level rock bottoms properly, and without construction delay. The contractor should assess the subsurface conditions prior to mobilizing and should be prepared to utilize other techniques such as rock coring to reach planned pier bottom depths.
6. Where minimum cyclic lateral pressures are anticipated, soil expansion uplift pressures of up to 0.25 to 0.5 ksf may develop and should be included in design for portion of pier extending through moderately to highly expansive soils within the upper 5 feet.

DRILLED PIER DESIGN PARAMETERS

PROJECT NO.: 13070623
BORING NO.: B-5

PROJECT: OMPA Waynoka Transmission Line
CLIENT: CEC Corporation

AIMRIGHT TESTING & ENGINEERING

Depth Interval (ft)	L-Pile Layer Type[1]	Unit Weight γ[1] (pcf)	Friction Angle Φ (°) or Undrained Cohesion c_u (psf)	L-Pile Horizontal Subgrade Modulus		MFAD Deformation Modulus E_D (ksi)	Strain Factor ε_{50}/k_{rm}	Allowable End Bearing Capacity[2] (FS ≥ 2.5) (ksf)	Allowable Unit Side Resistance[3] (FS = 2.5) (ksf)
				$k_{dry(sand)}$ or $k_{static(clay)}$ (pci)	$k_{sat(sand)}$ or $k_{cyclic(clay)}$ (pci)				
0 to 6	Stiff Clay	105	750	100	N/A	0.6	0.01	N/A	N/A
6 to 12	Stiff Clay	120	2,500	1,000	400	3.5	0.005	N/A	0.55
12 to 18.5	Stiff Clay	110	1,750	500	200	1.0	0.007	4.0	0.38
18.5 to 23.5	Stiff Clay	120	2,500	1,000	400	2.5	0.005	6.0	0.55
23.5 to 30	Weak Rock[4]	130	30°	N/A	N/A	500	0.0005	15.0	1.00

1. Interpretation of groundwater table should be approximated within the water level encountered during drilling and/or at the completion of drilling at this site. The depth interval where water was encountered during drilling within the applicable layer is indicated in the table with an asterisk (*) and effective unit weights should be determined, where applicable. As such, L-Pile layer types of Clay “with” and “without” free water shall be used accordingly.
2. The recommended net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the pier base elevation.
3. Where provided, the unit side resistance between the pier and surrounding bearing material can be used to develop pier capacity in compression and uplift resistance. The pier weight and maximum allowable unit side resistance may be utilized to resist structural upward loadings. At minimum, the upper 5 feet of pier and one (1) pier diameter above the pier base should be ignored for unit side resistance in piers bearing in the clay soils stratum.
4. For weak rock, the following shall be utilized: Initial Modulus of Rock Mass = 7.5 to 35 ksi; Rock Quality Designation (RQD) = 10 to 60%; Uniaxial Compressive Strength = 100 to 500 psi; MFAD Rock Cohesion = 2 ksf; MFAD Rock/Concrete Bond Strength = 13 ksf.
5. Auger refusal was encountered, please review boring logs carefully. Auger refusal is defined as material that could not be penetrated with the drill rig equipment used on the project. Auger refusal material may be caused by large boulders, rock ledges, lenses, seams, or the top of parent bedrock. The drilling rig should be equipped with an earth and rock augers and other necessary tools to excavate, clean and level rock bottoms properly, and without construction delay. The contractor should assess the subsurface conditions prior to mobilizing and should be prepared to utilize other techniques such as rock coring to reach planned pier bottom depths.
6. Where minimum cyclic lateral pressures are anticipated, soil expansion uplift pressures of up to 0.25 to 0.5 ksf may develop and should be included in design for portion of pier extending through moderately to highly expansive soils within the upper 5 feet.

DRILLED PIER DESIGN PARAMETERS

PROJECT NO.: 13070623
BORING NO.: B-6

PROJECT: OMPA Waynoka Transmission Line
CLIENT: CEC Corporation

AIMRIGHT TESTING & ENGINEERING