

Tension Load Test Result for PLT-3 B

Project I	nformation							
	Project Name:	Pine County Solar		Tension T	est Results		Davisson Offset Limit Lines	\$
	Project Location:	Pine County, Minnesota	% of	Axial	Deflection A (in)	Elastic	Davisson Offest	Co
	Project Number: Installation Date:	MP235178	Design	Load	Deflection Δ (in.)	Data (in.)	Limit (in.)	Comments
	installation Date.	12/ 3/ 2023	0%	0	0 000	(PL/AE)	(0.15+D/120+(PL/AE)) 0.100	
Axial Loa	d Test Set Up		3%	500	0.005	0.000	0.200	
	Number of Gauges:	2	7%	1000	0.024	0.002	0.202	
	Height of Gauges [in.]:	6	10%	1500	0.045	0.004	0.203	
	Load Cell:	Dillion Ed Junior	13%	2000	0.083	0.005	0.204	
			17%	2500	0.121	0.006	0.205	
			20%	3000	0.192	0.007	0.207	
Test Date	and Representative		23%	3500	0.273	0.009	0.208	
	Tested By Terracon Rep:	CJ	2/%	4000	0.335	0.010	0.209	
	Date Tested:	12/14/2023	30%	4500	0.388	0.011	0.210	
			37%	5500	0.473	0.012	0.212	
Pile Infor	mation		40%	6000	0.643	0.014	0.213	
	Pile ID:	PLT-3 B	43%	6500	0.716	0.015	0.215	
	Latitude [deg.]:	46.28665	47%	7000	0.815	0.017	0.216	
	Longitude[deg.]:	-92.83717	50%	7500	0.909	0.019	0.218	
	Pile Type:	W6x9	53%	8000	0.993	0.020	0.219	
Pile	Embedment Depth [in.]:	192	56%	8400	1.045	0.021	0.220	
	Pile Diameter [in.]:	5.9	60%	9000		0.022	0.221	
	Pile Stick-Up [in.]:	36	63%	9500		0.023	0.223	
	Axial Design Load [lbs.]:	15,000	67%	10000		0.025	0.224	
	Pile Area [sq. in.]:	2.68	70%	10500		0.026	0.225	
	Drive Time [sec]	29,000	73%	11500		0.027	0.220	
Oversi	ized Pre-Drill Depth [in.]:	36	80%	12000		0.028	0.220	
		1	83%	12500		0.031	0.230	
			87%	13000		0.032	0.231	
			90%	13500		0.033	0.233	
			93%	14000		0.035	0.234	
			97%	14500		0.036	0.235	
			100%	15000		0.037	0.236	
			17%	2500	1.014	0.006	0.205	
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			U	plift Axi	al Load (lbs.)			



Tension Load Test Result for PLT-4 A

Project Name:	Pine County Solar		Tension T	est Results		Davisson Offset Limit Line	S
Project Location:	Pine County, Minnesota	% of	Axial		Elastic	Davisson Offest	
Project Number:	MP235178	Design	Load	Deflection Δ (in.)	Data (in.)	Limit (in.)	Comment
Installation Date:	12/9/2023	Load	[lbs.]	Gauges #1 & #2	(PL/AE)	(0.15+D/120+(PL/AE))	
		0%	0	0.000	0.000	0.199	
xial Load Test Set Up		3%	500	0.002	0.001	0.200	
Number of Gauges:	2	7%	1000	0.003	0.002	0.201	
Height of Gauges [in.]:	6	10%	1500	0.006	0.003	0.202	
Load Cell:	Dillion Ed Junior	13%	2000	0.008	0.004	0.203	
		1/%	2500	0.011	0.005	0.204	
act Data and Bonrocontative		20%	3000	0.023	0.006	0.205	
Tested By Terracon Ren	lC1	23%	4000	0.029	0.008	0.208	
Date Tested:	12/14/2023	30%	4500	0.085	0.007	0.207	
	12, 11, 2020	33%	5000	0.130	0.009	0.208	
		37%	5500	0.259	0.010	0.209	
ile Information		40%	6000	0.379	0.011	0.210	
Pile ID:	PLT-4 A	43%	6400	1.127	0.012	0.211	
Latitude [deg.]:	46.30108	47%	7000		0.013	0.212	
Longitude[deg.]:	-92.84383	50%	7500		0.014	0.213	
Pile Type:	W6x9	53%	8000		0.015	0.214	
Pile Embedment Depth [in.]:	144	57%	8500		0.016	0.215	
Pile Diameter [in.]:	5.9	60%	9000		0.017	0.216	
Pile Stick-Up [in.]:	36	63%	9500		0.018	0.217	
Axial Design Load [lbs.]:	15,000	67%	10000		0.019	0.218	
Pile Area [sq. in.]:	2.68	70%	10500		0.019	0.219	
Elastic Modulus [ksi.]:	29,000	73%	11000		0.020	0.220	
Drive Time [sec.]:	90	77%	11500		0.021	0.220	
Oversized Pre-Drill Depth [in.]:	36	80%	12000		0.022	0.221	
		83%	12500		0.023	0.222	
		87%	13000		0.024	0.223	
		90%	13500		0.025	0.224	
		93%	14000		0.026	0.225	
		97%	14500		0.027	0.226	
		100%	12000	1 116	0.028	0.227	
		0%	2300	1.097	0.004	0.100	
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Tension Load Test Result for PLT-4 B

Project Name:	Pine County Solar		Tension T	est Results		Davisson Offset Limit Lines	S
Project Location:	Pine County, Minnesota	% of	Axial		Elastic	Davisson Offest	
Project Number:	MP235178	Design	Load	Deflection Δ (in.)	Data (in.)	Limit (in.)	Comments
Installation Date:	12/9/2023	Load	[lbs.]	Gauges #1 & #2	(PL/AE)	(0.15+D/120+(PL/AE))	
	1	0%	0	0.000	0.000	0.199	
Axial Load Test Set Up		3%	500	0.006	0.001	0.200	
Number of Gauges:	2	7%	1000	0.008	0.002	0.202	
Height of Gauges [in.]:	6	10%	1500	0.010	0.004	0.203	
Load Cell:	Dillion Ed Junior	13%	2000	0.013	0.005	0.204	
		17%	2500	0.016	0.006	0.205	
		20%	3000	0.018	0.007	0.207	
Test Date and Representative		23%	3500	0.019	0.009	0.208	
Tested By Terracon Rep:	CJ	27%	4000	0.024	0.010	0.209	
Date Tested:	12/14/2023	30%	4500	0.026	0.011	0.210	
		33%	5000	0.029	0.012	0.212	
		37%	5500	0.035	0.014	0.213	
Pile Information		40%	6000	0.036	0.015	0.214	
Pile ID:	PLT-4 B	43%	6500	0.044	0.016	0.215	
Latitude [deg.]:	46.30108	47%	7000	0.059	0.017	0.216	
Longitude[deg.]:	-92.84383	50%	7500	0.068	0.019	0.218	
Pile Type:	W6x9	53%	8000	0.088	0.020	0.219	
Pile Embedment Depth [in.]:	192	57%	8500	0.096	0.021	0.220	
Pile Diameter [in.]:	5.9	60%	9000	0.111	0.022	0.221	
Pile Stick-Up [in.]:	36	63%	9500	0.144	0.023	0.223	
Axial Design Load [lbs.]:	15,000	67%	10000	0.164	0.025	0.224	
Pile Area [sq. in.]:	2.68	70%	10500	0.196	0.026	0.225	
Elastic Modulus [ksi.]:	29,000	73%	11000	0.237	0.027	0.226	
Drive Time [sec.]:	272	77%	11500	0.312	0.028	0.228	
Oversized Pre-Drill Depth [in.]:	36	80%	12000	0.368	0.030	0.229	
		83%	12500	0.443	0.031	0.230	
		87%	13000	0.657	0.032	0.231	
		90%	13500	0.740	0.033	0.233	
		93%	14000	0.879	0.035	0.234	
		97%	14500		0.036	0.235	
		100%	15000		0.037	0.236	
		49%	7400	0.868	0.018	0.217	
		0%	0	0.813	0.000	0.199	



Lateral Load Test Results for PLT-1 A

Project Information		% of Design	Lateral Load	Deflection Δ (in.)	Comments
Project Name:	Pine County Solar	Load	[lbs.]	Gauges #1 & #2	
Project Location:	Pine County, Minnesota	0%	0	0.000	
Project Number:	MP235178	7%	500	0.221	
Installation Date:	11/1/2023	14%	1,000	0.430	
		21%	1,500	0.661	
Lateral Load Test Set Up		0%	0	0.048	
Number of Top Gauges:	N/A	21%	1,500	0.692	
Number of Bottom Gauges:	2	29%	2,000	0.906	
Height of Top Gauges [in.]:	N/A	36%	2,500	1.134	
Height of Bottom Gauges [in.]:	6	0%	0	0.093	
Height of Applied Load [in.]:	24	36%	2,500	1.147	
Load Cell:	Dillion Ed Junior	43%	3,000	1.375	
		50%	3,500	1.638	
		0%	0	0.144	
Test Date and Representative		50%	3,500	1.679	
Tested By Terracon Rep:	CJ	57%	4,000	1.876	
Date Tested:	12/14/2023	60%	4,200	1.985	
		0%	0		
		64%	4,500		
Pile Information		71%	5,000		
Pile ID:	PLT-1 A	79%	5,500		
Latitude [deg.]:	46.26426	0%	0		
Longitude [deg.]:	-92.83619	79%	5,500		
Pile Type:	W6x9	86%	6,000		
Pile Embedment Depth [in.]:	144	93%	6,500		
Pile Stick-Up [in.]:	36	100%	7,000		
Lateral Design Load [lbs.]:	7,000	31%	2,150	1.331	
Drive Time [sec.]:	96	0%	0	0.071	
Oversized Pre-Drill Depth [in.]:	36				



Lateral Load Test Results for PLT-1 B

Project Information		% of Design	Lateral Load	Deflection Δ (in.)	Comments
Project Name:	Pine County Solar	Load	[lbs.]	Gauges #1 & #2	
Project Location:	Pine County, Minnesota	0%	0	0.000	
Project Number:	MP235178	7%	500	0.229	
Installation Date:	11/1/2023	14%	1,000	0.433	
		21%	1,500	0.682	
Lateral Load Test Set Up		0%	0	0.094	
Number of Top Gauges:	N/A	21%	1,500	0.715	
Number of Bottom Gauges:	2	29%	2,000	0.878	
Height of Top Gauges [in.]:	N/A	36%	2,500	1.112	
Height of Bottom Gauges [in.]:	6	0%	0	0.159	
Height of Applied Load [in.]:	24	36%	2,500	1.171	
Load Cell:	Dillion Ed Junior	43%	3,000	1.356	
		50%	3,500	1.580	
		0%	0	0.252	
Test Date and Representative		50%	3,500	1.653	
Tested By Terracon Rep:	CJ	57%	4,000		
Date Tested:	12/14/2023	64%	4,500		
		0%	0		
		64%	4,500		
Pile Information		71%	5,000		
Pile ID:	PLT-1 B	79%	5,500		
Latitude [deg.]:	46.26426	0%	0		
Longitude [deg.]:	-92.83619	79%	5,500		
Pile Type:	W6x9	86%	6,000		
Pile Embedment Depth [in.]:	192	93%	6,500		
Pile Stick-Up [in.]:	36	100%	7,000		
Lateral Design Load [lbs.]:	7,000	29%	2,000	1.309	
Drive Time [sec.]:	159	0%	0	0.136	
Oversized Pre-Drill Depth [in.]:	36				



Lateral Load Test Results for PLT-2 A

Project Information		% of Design	Lateral Load	Deflection Δ (in.)	Comments
Project Name:	Pine County Solar	Load	[lbs.]	Gauges #1 & #2	
Project Location:	Pine County, Minnesota	0%	0	0.000	
Project Number:	MP235178	7%	500	0.224	
Installation Date:	11/1/2023	14%	1,000	0.387	
	1	21%	1,500	0.553	
Lateral Load Test Set Up		0%	0	0.109	
Number of Top Gauges:	N/A	21%	1,500	0.612	
Number of Bottom Gauges:	2	29%	2,000	0.788	
Height of Top Gauges [in.]:	N/A	36%	2,500	0.969	
Height of Bottom Gauges [in.]:	6	0%	0	0.204	
Height of Applied Load [in.]:	24	36%	2,500	1.023	
Load Cell:	Dillion Ed Junior	43%	3,000	1.216	
	•	50%	3,500	1.397	
		0%	0	0.225	
Test Date and Representative		50%	3,500	1.495	
Tested By Terracon Rep:	CJ	57%	4,000	1.679	
Date Tested:	12/14/2023	64%	4,500	1.887	
		0%	0	0.336	
		64%	4,500		
Pile Information		71%	5,000		
Pile ID:	PLT-2 A	79%	5,500		
Latitude [deg.]:	46.27718	0%	0		
Longitude [deg.]:	-92.85556	79%	5,500		
Pile Type:	W6x9	86%	6,000		
Pile Embedment Depth [in.]:	144	93%	6,500		
Pile Stick-Up [in.]:	36	100%	7,000		
Lateral Design Load [lbs.]:	7,000	33%	2,300		
Drive Time [sec.]:	47	0%	0		
Oversized Pre-Drill Depth [in.]:	36				



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Lateral Load Test Results for PLT-2 B

Project Information		% of Design	Lateral Load	Deflection Δ (in.)	Comments
Project Name:	Pine County Solar	Load	[lbs.]	Gauges #1 & #2	
Project Location:	Pine County, Minnesota	0%	0	0.000	
Project Number:	MP235178	7%	500	0.093	
Installation Date:	11/1/2023	14%	1,000	0.220	
		21%	1,500	0.359	
Lateral Load Test Set Up		0%	0	0.035	
Number of Top Gauges:	N/A	21%	1,500	0.387	
Number of Bottom Gauges:	2	29%	2,000	0.525	
Height of Top Gauges [in.]:	N/A	36%	2,500	0.659	
Height of Bottom Gauges [in.]:	6	0%	0	0.091	
Height of Applied Load [in.]:	24	36%	2,500	0.707	
Load Cell:	Dillion Ed Junior	43%	3,000	0.829	
		50%	3,500	0.971	
		0%	0	0.104	
Test Date and Representative		50%	3,500	1.009	
Tested By Terracon Rep:	CJ	57%	4,000	1.133	
Date Tested:	12/14/2023	64%	4,500	1.241	
		0%	0	0.099	
		64%	4,500	1.328	
Pile Information		71%	5,000	1.437	
Pile ID:	PLT-2 B	79%	5,500	1.606	
Latitude [deg.]:	46.27718	0%	0	0.162	
Longitude [deg.]:	-92.85556	79%	5,500	1.663	
Pile Type:	W6x9	86%	6,000		
Pile Embedment Depth [in.]:	192	93%	6,500		
Pile Stick-Up [in.]:	36	100%	7,000		
Lateral Design Load [lbs.]:	7,000	47%	3,300	1.532	
Drive Time [sec.]:	140	0%	0	0.256	
Oversized Pre-Drill Depth [in.]:	36				

0.00 -Lateral - Gauges at 6-inches above ground surface 0.25 0.50 Deflection (inches) 0.75 1.00 1.25 1.50 1.75 2.00 500 1,000 1,500 2,000 2,500 3,000 3,500 4,000 4,500 7,000 5,000 5,500 6,500 6,000 Lateral Load (lbs.)

Lateral Load Test Results for PLT-3 A

		% of	Lateral	Deflection Δ (in.)	6
Project Information	Dine County Color	Design	Load		Comments
Project Name:	Pine County Solar	Load	[lbs.]	Gauges #1 & #2	
Project Location:	Pine County, Minnesota	0%	0	0.000	
Project Number:	MP235178	7%	500	0.294	
Installation Date:	10/31/2023	14%	1,000	0.755	
		21%	1,500	1.448	
Lateral Load Test Set Up		0%	0	0.197	
Number of Top Gauges:	N/A	21%	1,500	1.540	
Number of Bottom Gauges:	2	29%	2,000		
Height of Top Gauges [in.]:	N/A	36%	2,500		
Height of Bottom Gauges [in.]:	6	0%	0		
Height of Applied Load [in.]:	24	36%	2,500		
Load Cell:	Dillion Ed Junior	43%	3,000		
		50%	3,500		
		0%	0		
Test Date and Representative		50%	3,500		
Tested By Terracon Rep:	CJ	57%	4,000		
Date Tested:	12/14/2023	64%	4,500		
		0%	0		
		64%	4,500		
Pile Information		71%	5,000		
Pile ID:	PLT-3 A	79%	5,500 <		
Latitude [deg.]:	46.28665	0%	0		
Longitude [deg.]:	-92.83717	79%	5,500		
Pile Type:	W6x9	86%	6,000		
Pile Embedment Depth [in.]:	144	93%	6,500		
Pile Stick-Up [in.]:	36	100%	7,000		
Lateral Design Load [lbs.]:	7,000	14%	950	1.219	
Drive Time [sec.]:	24	0%	0	0.502	
Oversized Pre-Drill Depth [in.]:	36				7



Lateral Load Test Results for PLT-3 B

Project Information		% of Design	Lateral Load	Deflection Δ (in.)	Comments
Project Name:	Pine County Solar	Load	[lbs.]	Gauges #1 & #2	
Project Location:	Pine County, Minnesota	0%	0	0.000	
Project Number:	MP235178	7%	500	0.223	
Installation Date:	10/31/2023	14%	1,000	0.754	
		21%	1,500	1.221	
Lateral Load Test Set Up		0%	0	0.111	
Number of Top Gauges:	N/A	21%	1,500	1.271	
Number of Bottom Gauges:	2	29%	2,000	1.862	
Height of Top Gauges [in.]:	N/A	36%	2,500		
Height of Bottom Gauges [in.]:	6	0%	0		
Height of Applied Load [in.]:	24	36%	2,500		
Load Cell:	Dillion Ed Junior	43%	3,000		
		50%	3,500		
		0%	0		
Test Date and Representative		50%	3,500		
Tested By Terracon Rep:	CJ	57%	4,000		
Date Tested:	12/14/2023	64%	4,500		
		0%	0		
		64%	4,500		
Pile Information		71%	5,000		
Pile ID:	PLT-3 B	79%	5,500		
Latitude [deg.]:	46.28665	0%	0		
Longitude [deg.]:	-92.83717	79%	5,500		
Pile Type:	W6x9	86%	6,000		
Pile Embedment Depth [in.]:	192	93%	6,500		
Pile Stick-Up [in.]:	36	100%	7,000		
Lateral Design Load [lbs.]:	7,000	16%	1,100	1.363	
Drive Time [sec.]:	72	0%	0	0.240	
Oversized Pre-Drill Depth [in.]:	36				



Lateral Load Test Results for PLT-4 A

Project Information		% of Design	Lateral Load	Deflection Δ (in.)	Comments
Project Name:	Pine County Solar	Load	[lbs.]	Gauges #1 & #2	
Project Location:	Pine County, Minnesota	0%	0	0.000	
Project Number:	MP235178	7%	500	0.146	
Installation Date:	10/31/2023	14%	1,000	0.372	
		21%	1,500	0.612	
Lateral Load Test Set Up		0%	0	0.051	
Number of Top Gauges:	N/A	21%	1,500	0.636	
Number of Bottom Gauges:	2	29%	2,000	0.875	
Height of Top Gauges [in.]:	N/A	36%	2,500	1.111	
Height of Bottom Gauges [in.]:	6	0%	0	0.148	
Height of Applied Load [in.]:	24	36%	2,500	1.177	
Load Cell:	Dillion Ed Junior	43%	3,000	1.408	
		50%	3,500	1.653	
		0%	0	0.260	
Test Date and Representative	1	50%	3,500	1.723	
Tested By Terracon Rep:	L)	57%	4,000		
Date Tested:	12/14/2023	64%	4,500		
		0%	0		
		64%	4,500		
Pile Information		71%	5,000		
Pile ID:	PLT-4 A	79%	5,500		
Latitude [deg.]:	46.30108	0%	0		
Longitude [deg.]:	-92.84383	79%	5,500		
Pile Type:	W6x9	86%	6,000		
Pile Embedment Depth [in.]:	144	93%	6,500		
Pile Stick-Up [in.]:	36	100%	7,000		
Lateral Design Load [lbs.]:	7,000	30%	2,100	1.348	
Drive Time [sec.]:	90	0%	0	0.301	
Oversized Pre-Drill Depth [in.]:	36				



Lateral Load Test Results for PLT-4 B

Project Information		% of Design	Lateral Load	Deflection Δ (in.)	Comments
Project Name:	Pine County Solar	Load	[lbs.]	Gauges #1 & #2	
Project Location:	Pine County, Minnesota	0%	0	0.000	
Project Number:	MP235178	7%	500	0.216	
Installation Date:	10/31/2023	14%	1,000	0.375	
		21%	1,500	0.598	
Lateral Load Test Set Up		0%	0	0.058	
Number of Top Gauges:	N/A	21%	1,500	0.602	
Number of Bottom Gauges:	2	29%	2,000	0.794	
Height of Top Gauges [in.]:	N/A	36%	2,500	0.938	
Height of Bottom Gauges [in.]:	6	0%	0	0.114	
Height of Applied Load [in.]:	24	36%	2,500	1.009	
Load Cell:	Dillion Ed Junior	43%	3,000	1.199	
		50%	3,500	1.364	
		0%	0	0.160	
Test Date and Representative		50%	3,500	1.432	
Tested By Terracon Rep:	CJ	57%	4,000	1.607	
Date Tested:	12/14/2023	64%	4,500	1.772	
		0%	0	0.260	
		64%	4,500	1.840	
Pile Information		71%	5,000		
Pile ID:	PLT-4 B	79%	5,500		
Latitude [deg.]:	46.30108	0%	0		
Longitude [deg.]:	-92.84383	79%	5,500		
Pile Type:	W6x9	86%	6,000		
Pile Embedment Depth [in.]:	192	93%	6,500		
Pile Stick-Up [in.]:	36	100%	7,000		
Lateral Design Load [lbs.]:	7,000	50%	3,500	1.579	
Drive Time [sec.]:	272	0%	0	0.283	
Oversized Pre-Drill Depth [in.]:	36				

0.00 ↔ Lateral - Gauges at 6-inches above ground surface 0.25 0.50 Deflection (inches) 0.75 1.00 1.25 1.50 1.75 2.00 500 1,000 1,500 2,000 2,500 3,000 3,500 4,000 7,000 4,500 5,500 6,500 5,000 6,000 Lateral Load (lbs.)

Preliminary Geotechnical Engineering Report Pine County Solar | Pine County, Minnesota January 5, 2023 | Terracon Project No. MP235178



Supporting Information

Contents:

General Notes Unified Soil Classification System Drilled Shaft Design Table

Note: All attachments are one page unless noted above.



General Notes

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS							
SAMPL	ING	WATI	ER LEVEL			FIELD T	ESTS
	X	Water	Initially Encountered		(HP)	Hand P	Penetrometer
Auger	Split Spoon	Water Leve	Water Level After a Specified Period of Time			Т	orvane
Shelby Tube	Macro Core	Water Leve	el After a Specified Per of Time	iod	(b/f) St	andard Peneti	ration Test (blows per foot)
		Water levels indicated on the	Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Subsurface water level variations will occur over time. In ow permeability soils, accurate determination of when the source based is anti-parallela with chart term			Photo-I on	ization Detector
Ring Sampler	Rock Core	Subsurface water level var low permeability soils, subsurface water levels is				Organic V	Vapor Analyzer
		water level observations.			(DCP)	Dynamic Co	one Penetrometer
Grab Sample	No Recovery			FLOATION			
sieve; their princi sieve; they are pr modifiers and m	Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.						
		LOCAT	ION AND ELEVATIO	N NOTES			
Unless otherwise r Surface elevation	noted, Latitude a data annotated si	nd Longitude are approximat with +/- indicates that no ac urface elevation was approxim	tely determined using tual topographical sur mately determined fro	a hand-hel vey was co m topograp	d GPS device. nducted to co phic maps of t	The accuracy c nfirm the surfac he area.	of such devices is variable. ce elevation. Instead, the
			STRENGTH TERMS	5			
RELATIVE D Density determ	DENSITY OF NC	ON-COHESIVE SOLLS d Penetration Resistance	Consistency detern	CONSIS mined by la rocedures,	TENCY OF C boratory sheat or standard p	OHESIVE SOIL ar strength testi enetration resis	LS ing, field visual-manual stance
Descriptive T (Density)	erm Star	ndard Penetration or N- Value Blows/Ft.	Descriptive Term (Consistency)	Unconfii Stre	ned Compres ngth, Qu, ts	ssive f	dard Penetration or N- Value Blows/Ft.
Very Loose	e	0 – 3	Very Soft	Le	ss than 0.25		0 – 1
Loose		4 - 9	Soft	0	.25 to 0.50		2 – 4
Medium Den	se	10 – 29	Medium Stiff	0	.50 to 1.00		4 – 8
Dense		30 – 50	Stiff	1	.00 to 2.00		8 – 15
Very Dense	e	> 50	Very Stiff	2	.00 to 4.00		15 – 30
			Hard		> 4.00		> 30

RELATIVE PROPORTIONS OF SAND AND GRAVEL					
Descriptive term(s) of other constituents	Percent (%) of dry weight				
Trace	< 15				
With	15 – 29				
Modifier	> 30				

RELATIVE PROPORTIONS OF FINES				
Descriptive term(s) of other constituents	Percent (%) of dry weight			
Trace	< 5			
With	5 – 12			
Modifier	> 12			

GRAIN SIZE TERMINOLOGY				
Major component of sample	Particle size			
Boulders	Over 12 in. (300mm)			
Cobbles	12 in. to 3 in. (300mm to 75mm)			
Gravel	3 in. to #4 sieve (75mm to 4.75mm)			
Sand	#4 to #200 sieve (4.75mm to 0.075mm)			
Silt or Clay	Passing #200 sieve (0.075mm)			
PLASTICITY DESCRIPTION				
Term	Plasticity Index			
Non plastic	0			
Low	1 – 10			
Medium	11 – 30			
High	> 30			



Unified Soil Classification System

Criteria for Assigning Group Symbols and Group Names Using					Soil Classification	
Laboratory Tests ^A				Group Symbol	Group Name ^B	
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	Gravels: More than 50% of coarse fraction	Clean Gravels:	Cu≥4 and 1≤Cc≤3 ^E	GW	Well-graded gravel ^F	
		Less than 5% fines ^c	Cu<4 and/or [Cc<1 or Cc>3.0] $^{\mbox{E}}$	GP	Poorly graded gravel ^F	
		Gravels with Fines: More than 12% fines ^c	Fines classify as ML or MH	GM	Silty gravel ^{F, G, H}	
	sieve		Fines classify as CL or CH	GC	Clayey gravel ^{F, G, H}	
	Sands: 50% or more of coarse fraction passes No. 4 sieve	Clean Sands: Less than 5% fines ^D	Cu≥6 and 1≤Cc≤3 ^E	SW	Well-graded sand ^I	
			Cu<6 and/or [Cc<1 or Cc>3.0] E	SP	Poorly graded sand ¹	
		Sands with Fines: More than 12% fines ^D	Fines classify as ML or MH	SM	Silty sand G, H, I	
			Fines classify as CL or CH	SC	Clayey sand ^{G, H, I}	
Fine-Grained Soils: 50% or more passes the No. 200 sieve		Inorganic:	PI > 7 and plots above "A" line J	CL	Lean clay ^{K, L, M}	
	Silts and Clays:		PI < 4 or plots below "A" line ^J	ML	Silt ^{K, L, M}	
	50	Organici	LL oven dried	01	Organic clay ^{K, L, M, N}	
		organic.	LL not dried < 0.73	UL	Organic silt ^{K, L, M, O}	
	Silts and Clays: Liquid limit 50 or more	Inorgania	PI plots on or above "A" line	СН	Fat clay ^{K, L, M}	
		morganic.	PI plots below "A" line	MH	Elastic silt ^{K, L, M}	
		Organic	LL oven dried	ОН	Organic clay ^{K, L, M, P}	
		organic.	LL not dried < 0.75		Organic silt ^{K, L, M, Q}	
Highly organic soils:	Primarily organic matter, dark in color, and organic odor				Peat	

^A Based on the material passing the 3-inch (75-mm) sieve.

- ^B If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
- ^c Gravels with 5 to 12% fines require dual symbols: GW-GM wellgraded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.
- poorly graded gravel with silt, GP-GC poorly graded gravel with clay.
 Sands with 5 to 12% fines require dual symbols: SW-SM wellgraded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.

^E
$$Cu = D_{60}/D_{10}$$
 $Cc = (D_{30})^2$

D₁₀ x D₆₀

- ^F If soil contains \geq 15% sand, add "with sand" to group name.
- ^G If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

- ^H If fines are organic, add "with organic fines" to group name.
- If soil contains \geq 15% gravel, add "with gravel" to group name.
- ^J If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.
- K If soil contains 15 to 29% plus No. 200, add "with sand" or
- "with gravel," whichever is predominant.
- ^L If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.
- ^M If soil contains \geq 30% plus No. 200, predominantly gravel, add "gravelly" to group name.
- ^N PI ≥ 4 and plots on or above "A" line.
- ^O PI < 4 or plots below "A" line.
- P PI plots on or above "A" line.
- ^Q PI plots below "A" line.





DRILLED SHAFT DESIGN PARAMETERS Pine County Solar Pine County, Minnesota

Boring B-2 Terracon Project No. MP235178

Approx. Depth Below Boring Ground Surface (feet)	Soil Model Type	Layer Thickness (feet)	Total / Effective Unit Weight γ (pcf) ^{1, 2}	Internal Friction Angle Ø (degrees) ²	Cohesion c (psf) ²	Allowable Side Friction (psf) (FS=2) ^{3, 4}	Allowable End Bearing (psf) (FS=3) ^{3, 5}	MFAD Deformation Modulus E _D (ksi) ⁶
0 to 5	sand	5	110	30		Recommend axial	and lateral capacity be feet	neglected in upper 5
5 to 15	sand	10	120	32		400	5,000	1.2
15 to 18	sand	3	125	36		550	10,000	4.0
18 to 30	sand	12	130	38		700	20,000	10.0
30 to 50	sand	20	130	38		850	20,000	10.0

1. Groundwater depth of 5 feet below ground surface suggested for calculation of effective stress.

2. Effective unit weight, cohesion, and internal friction angle have no factor of safety applied.

3. Axial and lateral resistance should be neglected in the upper 3.5 feet due to the potential for disturbance and freeze/thaw effects. From a depth of 3.5 to 5 feet, reduced lateral and axial resistance parameters are provided.

4. In designing to resist uplift loading, 2/3 of the side friction values provided could be used along with the effective weight of the drilled shaft.

5. The drilled shaft must extend at least one shaft diameter into the bearing strata to achieve the full listed capacity. If, by design, the drilled shaft would bear within one shaft diameter of lower strength underlying stratum, the allowable end bearing capacity for the lower strength material should be used for design.

6. Based on correlations provided in EPRI guidance documents based on SPT N-values.

7. NR = Not Recommended

Appendix A Exhibits

A.5 LAND COVER AND DRAINAGE PLANS











Notes 1. Coordinate System: NAD 1983 UTM Zone 15N 2. Data Sources: Stantec, USGS, NADS, Pine County 3. Background: 2021 NAIP



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Figure No.

4



DRAFT



Notes 1. Coordinate System: NAD 1983 UTM Zone 15N 2. Data Sources: Stantec, USGS, NADS, Pine County 3. Background: 2021 NAIP

