APPENDIX L
Electro-Magnetic Field Calculations

EMF Study

Castle Rock Solar Project
Dakota County, Minnesota.
Stantec Project #: 193709215

November 8, 2024

Prepared for:

Castle Rock Solar LLC

Prepared by:

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Revision Chart

Rev	Reason for Change	Author	Reviewer	Approved by	Issue Date
0	Released for Review	AG	PM	KKM	08/30/2024
1	Released for Review – Addition of overhead collector lines	AG	PM		

Sign-off Sheet

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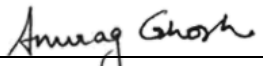
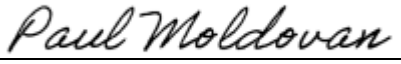
Prepared by:	 (signature)
Name / Title	Anurag Ghosh, Electrical Engineer
Reviewed by:	 (signature)
Name / Title	Paul Moldovan, Manager - Studies
Approved by:	 (signature)
Name / Title	Jennifer Kamm, Project Manager

Table of Contents

LIST OF APPENDICES

1.0 Summary

Castle Rock Solar LLC (Client) is proposing to construct the Castle Rock Solar Project (Project) in Dakota County, Minnesota. The proposed Project is to be located to the southeast of the city of Farmington, Minnesota in Castle Rock Township. The Project will develop approximately 934.2 acres of land and will have a maximum nameplate generating capacity of up to 150 Megawatts (MW) Alternating Current (AC).

Proposed Project developments, including ancillary facilities, will consist of solar panels and tracking systems, access roads, underground collector circuits, transformers, junction boxes, and a Project substation. A project gen-tie line interconnects the projects with the Point-of-Interconnect (POI). The client retained the services of Stantec Consulting Services Inc. (Stantec) to conduct an Electric and Magnetic Field (EMF) study and Electromagnetic Interferences for the Project.

Stantec conducted the overhead line EMF study using the Bonneville Power Administration (BPA) Corona and Field Effects software and underground line EMF study using CYMCAP software. Assumed general underground cable orientations and typical overhead pole configurations were used to perform the study.

2.0 Purpose and Project Description

The Project is a 150 MW_{AC} solar generating facility proposed in Dakota County, Minnesota. The proposed underground collector system for the Project is designed to be rated at 34.5 kV and have a maximum of five (5) - 1000 kcmil circuits routed in parallel trenches, each 6 feet apart. Further, a proposed 345 kV gen-tie line will connect the Project to the POI.

The purpose of the study was to estimate the EMF strength created by the underground collector system and the overhead gen-tie line of the project. For the underground collector system five (5) different scenarios were considered based on the number of 1000 kcmil circuits, as detailed in Section 3.1-Underground Collector System Scenarios. For the project gen-tie line, two (2) different scenarios were considered as detailed in Section 4.1 – Project Gen-Tie Scenarios.

3.0 Collector System

The collector circuit is comprised of both underground and aboveground scenarios. The entire collector underground system was assumed to have a 36-inch burial depth. The underground collector system will be buried in parallel trenches located approximately six (6) feet apart. The edge of ROW for all the underground scenario is assumed to be 4 feet from the outermost cable. The magnetic field impact has been calculated at one (1) meter (~3.28 feet) above ground. This follows convention undertaken in other states.

3.1 UNDERGROUND COLLECTOR SYSTEM SCENARIOS

Based on the conceptual layout (refer to Appendix B.1) and the Google Earth file of the collector circuits of the project, five collector circuits enter the project substation from the north side and two collector circuits enter the project substation from the west side.

Based on the details mentioned above, it was determined that following scenarios shown in the table below should be studied.

UNDERGROUND SYSTEM	
Scenario 1	Single Circuit 1 - 1000 kcmil cable (typical buried collector circuit)
Scenario 2	Two (2) Circuits - 1000 kcmil cables in parallel, 6 feet apart
Scenario 3	Three (3) Circuits - 1000 kcmil cables in parallel, 6 feet apart
Scenario 4	Four (4) Circuits - 1000 kcmil cables in parallel, 6 feet apart
Scenario 5	Five (5) Circuits - 1000 kcmil cables in parallel, 6 feet apart

The underground collector cables are assumed to be carrying a maximum current of 422 Amperes in each circuit.

3.2 OVERHEAD COLLECTOR SYSTEM SCENARIO

The EMF analysis for the overhead collector system is based on the conceptual structure drawing (refer to Appendix B.2. The minimum ground clearance is assumed to be approximately 22-feet. Below is the conductor details assumed for the overhead collector lines considered under this study.

CONDUCTOR DETAILS	
Description	**34.5 kV Line (Single Circuit)**
Conductor	336.4 kcmil Linnet ACSR
Conductor diameter	0.72 inch
Ampacity (Max. Loading)	422 Amperes

4.0 Overhead System

Typical steel framing pole structure configuration was considered for the study's purpose. Refer to Appendix B.3 for 345 kV structure details. The minimum ground clearance was considered to be approximately 26-feet. The electric and magnetic field impact was calculated at approximately 3.28 feet (1 meter) above ground level. Other than the proposed gen-tie line, no other existing transmission line has been assumed to be running in parallel to the proposed Project's overhead structures.

The RUS (Rural Utilities Service) Bulletin does not explicitly specify a standard minimum conductor size for 345 kV lines. For 230 kV lines, RUS Bulletin 1724E-200 recommends a minimum conductor size of 795 kcmil. Therefore, in the absence of the specific design for 345 kV project gen-tie line of the project, the same conductor size has been assumed for the 345kV project gen-tie line.

Below are the conductor details assumed for all the overhead lines considered under this study.

CONDUCTOR DETAILS	
Description	**345 kV Line (Single Circuit)**
Conductor	795 kcmil Drake ACSR
Conductor diameter	1.107 inch
Ampacity (Max. Loading)	907 Amperes

4.1 PROJECT GEN-TIE LINE SCENARIOS

Based on the different type of pole configurations on the overhead lines, two scenarios have been identified.

Phasing of the conductors of the various overhead lines plays an important role in determining the electrical and magnetic field impacts of the lines, when two or more circuits are in parallel. The overhead lines considered under this project are all single circuit and are assumed to be equally loaded, therefore in a given pole configuration, different phasing configuration would produce similar EMF values.

Following two scenarios, based on various overhead configurations on poles, have been studied.

OVERHEAD SYSTEM	
Scenario 7	345 kV Single circuit: Tangent pole
Scenario 8	345 kV Single circuit: Angle pole

The above-mentioned scenarios were primarily checked for the ampacities assumed under Section 4.0.

5.0 Conclusion

The information presented above for underground system were modeled in CYMCAP and the overhead line data was introduced into the BPA Corona and Field Effects software to calculate the electromagnetic interference levels for the individual scenarios.

5.1 COLLECTOR SYSTEM

The maximum magnetic field strength estimated near or at the centerline of the underground collector circuit trench was calculated and is summarized in the table below. The magnetic field strength estimated at the edge of ROW, as defined in Section 3.0, is also summarized in the table below. Electric field intensity was not calculated for the underground cable scenarios in the analysis because it is canceled out due to the shielding by the metallic screen on the underground cables.

Appendices A.1 to A.5 provide detailed results for the five underground cable scenarios.

UNDERGROUND (UG) CABLES	MAXIMUM MAGNETIC FIELD (mG)	MAGNETIC FIELD AT EDGE OF ROW (mG)
Scenario 1: 1 UG cable	16.32	11.61
Scenario 2: 2 parallel UG cables	19.01	15.11
Scenario 3: 3 parallel UG cables	19.18	16.23
Scenario 4: 4 parallel UG cables	19.17	16.84
Scenario 5: 5 parallel UG cables	19.21	17.21

Appendix A.6 provides detailed results for the overhead collector circuit scenario.

OVERHEAD COLLECTOR LINES	Near Centerline	
	MAXIMUM ELECTRIC FIELD (kV/m)	MAXIMUM MAGNETIC FIELD (mG)
Scenario 6: 34.5kV Single circuit	0.54	83.24

5.2 PROJECT GEN-TIE LINE

The maximum electric field strength and magnetic field strength estimated near or at the centerline of the project's gen-tie line is illustrated in column (2) and (3) below, respectively. The maximum values recorded at the edge of the Right of Way (ROW), which is assumed to be 100 feet wide for 345kV line, is calculated and listed in column (4) and (5) of the table below. Refer to Appendices A.7 to A.8 for detailed results of the overhead line scenarios.

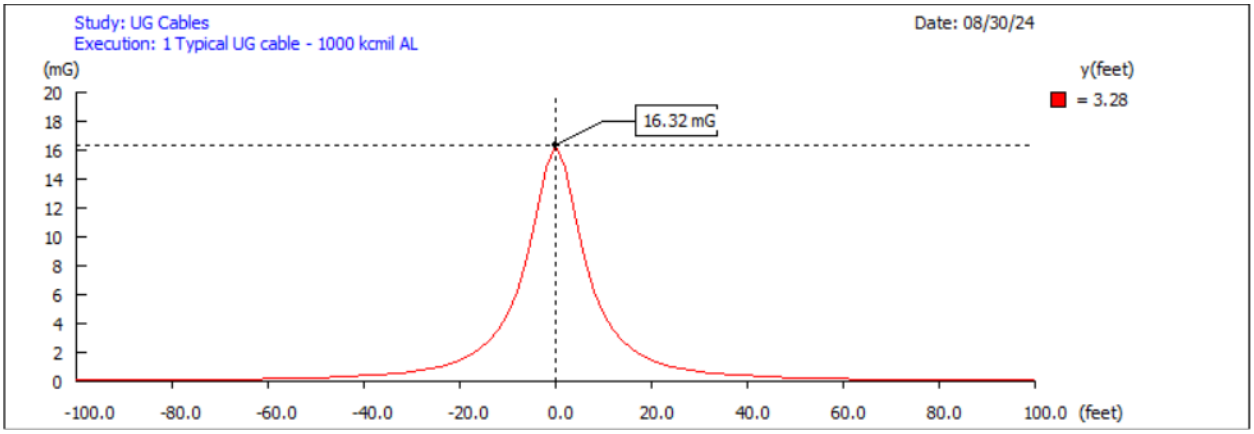
Project Gen-tie Line	**Near Centerline**		**At Edge of ROW**	
	(2) **MAXIMUM ELECTRIC FIELD (kV/m)**	(3) **MAXIMUM MAGNETIC FIELD (mG)**	(4) **ELECTRIC FIELD (kV/m)**	(5) **MAGNETIC FIELD (mG)**
Scenario 7: 345kV Single circuit: Tangent pole	4.92	155.19	1.42	52.01
Scenario 8: 345kV Single circuit: Angle pole	5.14	148.85	0.50	64.94

For reference, according to the World Health Organization (WHO https://www.who.int/peh-emf/about/WhatisEMF/en/index3.html), a typical iron or a refrigerator gives off 0.12 kV/m and a typical microwave gives off 40-80 mG, when at a distance of around 1 foot from the equipment.

Appendix A Detailed Results

A.1 SCENARIO 1: SINGLE CIRCUIT–UNDERGROUND CABLE

Scenario 1: 1-Circuit-1000 kcmil cable



Input data:

Circuit No.	Phase	X (feet)	Y (feet)	Ampacity	Angle
1	A	-0.095	3.054	422.0	0.0
1	B	0.095	3.054	422.0	-120.0
1	C	0.0	2.89	422.0	120.0

MAGNETIC FLUX DENSITY [mG]
==========

Study : UG Cables
Execution: 1 Typical UG cable - 1000 kcmil AL

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X (feet)	Y=3.28 (feet) B(mG)
-100.0	0.0641
-99.0	0.0654
-98.0	0.0667
-97.0	0.0681
-96.0	0.0695
-95.0	0.071
-94.0	0.0725
-93.0	0.074
-92.0	0.0757
-91.0	0.0773
-90.0	0.079
-89.0	0.0808
-88.0	0.0826
-87.0	0.0845
-86.0	0.0865
-85.0	0.0886
-84.0	0.0907
-83.0	0.0928
-82.0	0.0951
-81.0	0.0975
-80.0	0.0999
-79.0	0.1024
-78.0	0.1051
-77.0	0.1078
-76.0	0.1106
-75.0	0.1136
-74.0	0.1166
-73.0	0.1198
-72.0	0.1232
-71.0	0.1266
-70.0	0.1302
-69.0	0.134
-68.0	0.1379
-67.0	0.1421
-66.0	0.1464
-65.0	0.1509
-64.0	0.1556
-63.0	0.1605
-62.0	0.1657
-61.0	0.1711
-60.0	0.1768
-59.0	0.1827
-58.0	0.189
-57.0	0.1956
-56.0	0.2026
-55.0	0.2099
-54.0	0.2177
-53.0	0.2258
-52.0	0.2345
-51.0	0.2436
-50.0	0.2533
-49.0	0.2636
-48.0	0.2745
-47.0	0.2861
-46.0	0.2985
-45.0	0.3116
-44.0	0.3256
-43.0	0.3406
-42.0	0.3567
-41.0	0.3739
-40.0	0.3924
-39.0	0.4123
-38.0	0.4337

-37.0	0.4567
-36.0	0.4817
-35.0	0.5088
-34.0	0.5381
-33.0	0.5701
-32.0	0.6049
-31.0	0.643
-30.0	0.6848
-29.0	0.7307
-28.0	0.7812
-27.0	0.8372
-26.0	0.8992
-25.0	0.9682
-24.0	1.0453
-23.0	1.1317
-22.0	1.229
-21.0	1.339
-20.0	1.4639
-19.0	1.6065
-18.0	1.7701
-17.0	1.9587
-16.0	2.1775
-15.0	2.4328
-14.0	2.7325
-13.0	3.0864
-12.0	3.5071
-11.0	4.0099
-10.0	4.6139
-9.0	5.3418
-8.0	6.2198
-7.0	7.2749
-6.0	8.5288
-5.0	9.985
-4.0	11.6065
-3.0	13.2842
-2.0	14.8138
-1.0	15.9131
0.0	16.3168
1.0	15.9131
2.0	14.8138
3.0	13.2842
4.0	11.6065
5.0	9.9851
6.0	8.5288
7.0	7.2749
8.0	6.2198
9.0	5.3418
10.0	4.6139
11.0	4.0099
12.0	3.5071
13.0	3.0864
14.0	2.7325
15.0	2.4328
16.0	2.1775
17.0	1.9587
18.0	1.7701
19.0	1.6065
20.0	1.4639
21.0	1.339
22.0	1.229
23.0	1.1317
24.0	1.0453
25.0	0.9682
26.0	0.8992
27.0	0.8372
28.0	0.7812
29.0	0.7307
30.0	0.6848
31.0	0.643
32.0	0.6049
33.0	0.5701
34.0	0.5381
35.0	0.5088
36.0	0.4817
37.0	0.4567
38.0	0.4337
39.0	0.4123
40.0	0.3924

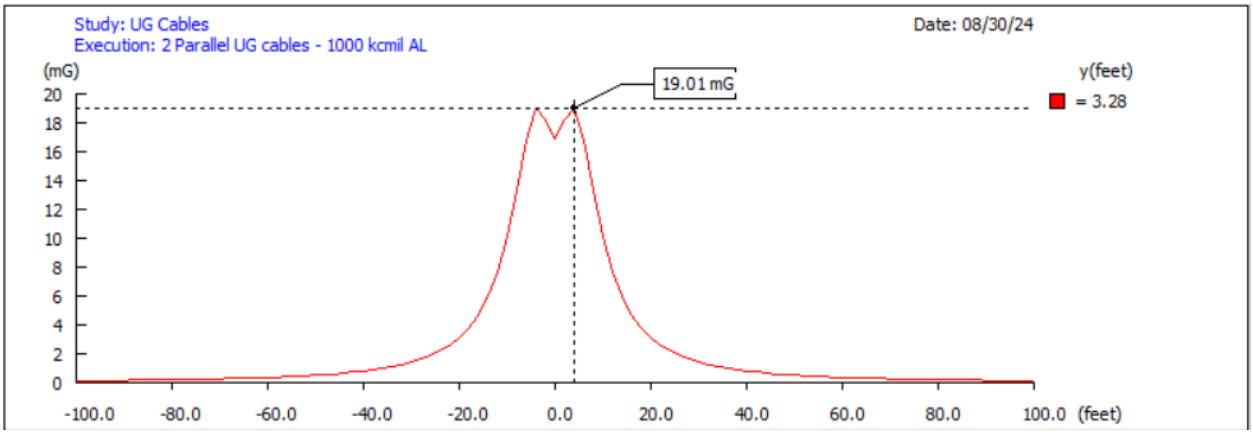
41.0	0.3739
42.0	0.3567
43.0	0.3406
44.0	0.3256
45.0	0.3116
46.0	0.2985
47.0	0.2861
48.0	0.2745
49.0	0.2636
50.0	0.2533
51.0	0.2436
52.0	0.2345
53.0	0.2258
54.0	0.2177
55.0	0.2099
56.0	0.2026
57.0	0.1956
58.0	0.189
59.0	0.1827
60.0	0.1768
61.0	0.1711
62.0	0.1657
63.0	0.1605
64.0	0.1556
65.0	0.1509
66.0	0.1464
67.0	0.1421
68.0	0.1379
69.0	0.134
70.0	0.1302
71.0	0.1266
72.0	0.1232
73.0	0.1198
74.0	0.1166
75.0	0.1136
76.0	0.1106
77.0	0.1078
78.0	0.1051
79.0	0.1024
80.0	0.0999
81.0	0.0975
82.0	0.0951
83.0	0.0928
84.0	0.0907
85.0	0.0886
86.0	0.0865
87.0	0.0845
88.0	0.0826
89.0	0.0808
90.0	0.079
91.0	0.0773
92.0	0.0757
93.0	0.074
94.0	0.0725
95.0	0.071
96.0	0.0695
97.0	0.0681
98.0	0.0667
99.0	0.0654
100.0	0.0641

Peak value found at:

X (feet)	Y=3.28 (feet)
	B(mG)
0.0	16.3168

A.2 SCENARIO 2: TWO (2) CIRCUITS–UNDERGROUND CABLES

Scenario 2: 2-Circuits - 1000 kcmil cables



Input data:

Circuit No.	Phase	X (feet)	Y (feet)	Ampacity	Angle
1	A	-3.097	3.054	422.0	0.0
1	B	-2.904	3.054	422.0	-120.0
1	C	-2.999	2.89	422.0	120.0
2	A	2.904	3.054	422.0	0.0
2	B	3.097	3.054	422.0	-120.0
2	C	2.999	2.89	422.0	120.0

MAGNETIC FLUX DENSITY [mG]
==========

Study : UG Cables
Execution: 2 Parallel UG cables - 1000 kcmil AL

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X (feet)	Y=3.28 (feet) B(mG)
-100.0	0.1295
-99.0	0.1321
-98.0	0.1349
-97.0	0.1376
-96.0	0.1405
-95.0	0.1435
-94.0	0.1466
-93.0	0.1497
-92.0	0.153
-91.0	0.1564
-90.0	0.1599
-89.0	0.1635
-88.0	0.1672
-87.0	0.171
-86.0	0.175
-85.0	0.1792
-84.0	0.1835
-83.0	0.1879
-82.0	0.1925
-81.0	0.1973
-80.0	0.2022
-79.0	0.2074
-78.0	0.2127
-77.0	0.2183
-76.0	0.224
-75.0	0.23
-74.0	0.2363
-73.0	0.2428
-72.0	0.2495
-71.0	0.2566
-70.0	0.264
-69.0	0.2717
-68.0	0.2797
-67.0	0.2881
-66.0	0.2968
-65.0	0.306
-64.0	0.3156
-63.0	0.3257
-62.0	0.3362
-61.0	0.3473
-60.0	0.3589
-59.0	0.3712
-58.0	0.384
-57.0	0.3975
-56.0	0.4118
-55.0	0.4269
-54.0	0.4427
-53.0	0.4595
-52.0	0.4773
-51.0	0.4961
-50.0	0.516
-49.0	0.5371
-48.0	0.5596
-47.0	0.5835
-46.0	0.609
-45.0	0.6362
-44.0	0.6652
-43.0	0.6963
-42.0	0.7295
-41.0	0.7652
-40.0	0.8036
-39.0	0.8449
-38.0	0.8895

-37.0	0.9377
-36.0	0.9899
-35.0	1.0465
-34.0	1.1081
-33.0	1.1753
-32.0	1.2487
-31.0	1.3291
-30.0	1.4175
-29.0	1.515
-28.0	1.6227
-27.0	1.7421
-26.0	1.8751
-25.0	2.0235
-24.0	2.19
-23.0	2.3775
-22.0	2.5895
-21.0	2.8303
-20.0	3.1051
-19.0	3.4204
-18.0	3.7839
-17.0	4.2053
-16.0	4.6963
-15.0	5.2714
-14.0	5.948
-13.0	6.7467
-12.0	7.691
-11.0	8.8056
-10.0	10.1122
-9.0	11.6201
-8.0	13.3089
-7.0	15.1016
-6.0	16.8331
-5.0	18.2389
-4.0	19.0127
-3.0	18.9662
-2.0	18.2313
-1.0	17.3265
0.0	16.9184
1.0	17.3265
2.0	18.2313
3.0	18.9662
4.0	19.0127
5.0	18.239
6.0	16.8331
7.0	15.1016
8.0	13.3089
9.0	11.6201
10.0	10.1122
11.0	8.8056
12.0	7.691
13.0	6.7467
14.0	5.948
15.0	5.2714
16.0	4.6963
17.0	4.2053
18.0	3.7839
19.0	3.4204
20.0	3.1051
21.0	2.8303
22.0	2.5895
23.0	2.3775
24.0	2.19
25.0	2.0235
26.0	1.8751
27.0	1.7421
28.0	1.6227
29.0	1.515
30.0	1.4175
31.0	1.3291
32.0	1.2487
33.0	1.1753
34.0	1.1081
35.0	1.0465
36.0	0.9899
37.0	0.9377
38.0	0.8895
39.0	0.8449
40.0	0.8036

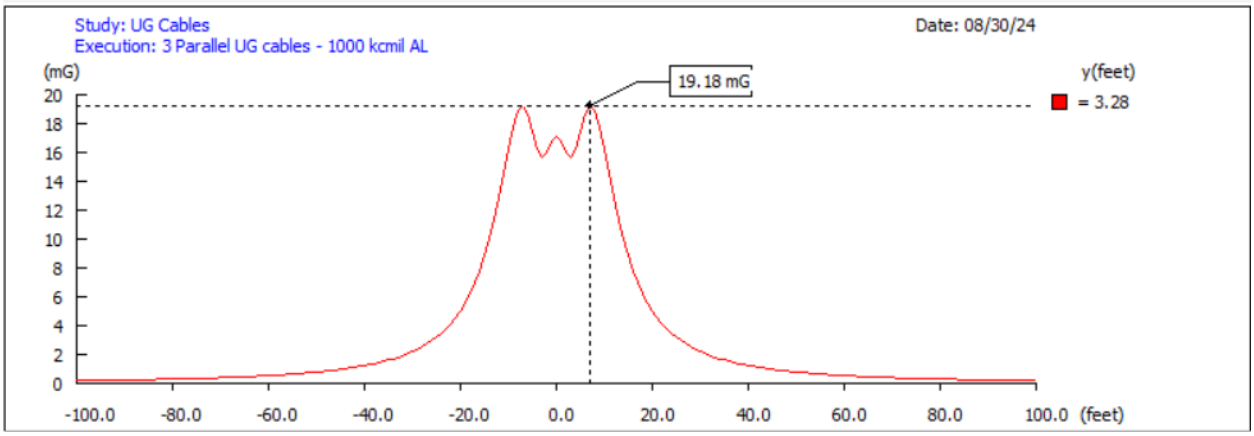
41.0	0.7652
42.0	0.7295
43.0	0.6963
44.0	0.6652
45.0	0.6362
46.0	0.609
47.0	0.5835
48.0	0.5596
49.0	0.5371
50.0	0.516
51.0	0.4961
52.0	0.4773
53.0	0.4595
54.0	0.4427
55.0	0.4269
56.0	0.4118
57.0	0.3975
58.0	0.384
59.0	0.3712
60.0	0.3589
61.0	0.3473
62.0	0.3362
63.0	0.3257
64.0	0.3156
65.0	0.306
66.0	0.2968
67.0	0.2881
68.0	0.2797
69.0	0.2717
70.0	0.264
71.0	0.2566
72.0	0.2495
73.0	0.2428
74.0	0.2363
75.0	0.23
76.0	0.224
77.0	0.2183
78.0	0.2127
79.0	0.2074
80.0	0.2022
81.0	0.1973
82.0	0.1925
83.0	0.1879
84.0	0.1835
85.0	0.1792
86.0	0.175
87.0	0.171
88.0	0.1672
89.0	0.1635
90.0	0.1599
91.0	0.1564
92.0	0.153
93.0	0.1497
94.0	0.1466
95.0	0.1435
96.0	0.1405
97.0	0.1376
98.0	0.1349
99.0	0.1321
100.0	0.1295

Peak value found at:

X (feet)	Y=3.28 (feet)
	B(mG)
4.0	19.0127

A.3 SCENARIO 3: THREE (3) CIRCUITS–UNDERGROUND CABLES

Scenario 3: 3-Circuits - 1000 kcmil cables



Input data:

Circuit No.	Phase	X (feet)	Y (feet)	Ampacity	Angle
1	A	-6.096	3.054	422.0	0.0
1	B	-5.905	3.054	422.0	-120.0
1	C	-6.001	2.89	422.0	120.0
2	A	-0.095	3.054	422.0	0.0
2	B	0.095	3.054	422.0	-120.0
2	C	0.0	2.89	422.0	120.0
3	A	5.905	3.054	422.0	0.0
3	B	6.096	3.054	422.0	-120.0
3	C	6.001	2.89	422.0	120.0

MAGNETIC FLUX DENSITY [mG]
==========

Study : UG Cables
Execution: 3 Parallel UG cables - 1000 kcmil AL

Report created on: 08/30/24 8:23:31 AM

X (feet)	Y=3.28 (feet) B(mG)
-100.0	0.1939
-99.0	0.1979
-98.0	0.202
-97.0	0.2062
-96.0	0.2105
-95.0	0.215
-94.0	0.2196
-93.0	0.2244
-92.0	0.2293
-91.0	0.2344
-90.0	0.2396
-89.0	0.2451
-88.0	0.2507
-87.0	0.2565
-86.0	0.2625
-85.0	0.2688
-84.0	0.2752
-83.0	0.2819
-82.0	0.2889
-81.0	0.2961
-80.0	0.3036
-79.0	0.3113
-78.0	0.3194
-77.0	0.3278
-76.0	0.3365
-75.0	0.3456
-74.0	0.3551
-73.0	0.3649
-72.0	0.3752
-71.0	0.3859
-70.0	0.3971
-69.0	0.4087
-68.0	0.4209
-67.0	0.4337
-66.0	0.447
-65.0	0.461
-64.0	0.4756
-63.0	0.4909
-62.0	0.507
-61.0	0.5239
-60.0	0.5416
-59.0	0.5603
-58.0	0.58
-57.0	0.6007
-56.0	0.6225
-55.0	0.6456
-54.0	0.67
-53.0	0.6957
-52.0	0.723
-51.0	0.752
-50.0	0.7827
-49.0	0.8153
-48.0	0.8501
-47.0	0.8871
-46.0	0.9266
-45.0	0.9687
-44.0	1.0139
-43.0	1.0623
-42.0	1.1142
-41.0	1.1701
-40.0	1.2302
-39.0	1.2952
-38.0	1.3654

-37.0	1.4415
-36.0	1.5242
-35.0	1.6142
-34.0	1.7124
-33.0	1.8198
-32.0	1.9377
-31.0	2.0674
-30.0	2.2106
-29.0	2.369
-28.0	2.5451
-27.0	2.7415
-26.0	2.9612
-25.0	3.2082
-24.0	3.4869
-23.0	3.8029
-22.0	4.1626
-21.0	4.5743
-20.0	5.0476
-19.0	5.5942
-18.0	6.2284
-17.0	6.9667
-16.0	7.8285
-15.0	8.8344
-14.0	10.0047
-13.0	11.3532
-12.0	12.8769
-11.0	14.537
-10.0	16.2312
-9.0	17.7647
-8.0	18.8493
-7.0	19.1799
-6.0	18.6175
-5.0	17.3993
-4.0	16.1726
-3.0	15.6535
-2.0	16.0185
-1.0	16.7268
0.0	17.0647
1.0	16.7268
2.0	16.0185
3.0	15.6535
4.0	16.1726
5.0	17.3993
6.0	18.6175
7.0	19.1799
8.0	18.8493
9.0	17.7647
10.0	16.2312
11.0	14.537
12.0	12.8769
13.0	11.3532
14.0	10.0047
15.0	8.8344
16.0	7.8285
17.0	6.9667
18.0	6.2284
19.0	5.5942
20.0	5.0476
21.0	4.5743
22.0	4.1626
23.0	3.8029
24.0	3.4869
25.0	3.2082
26.0	2.9612
27.0	2.7415
28.0	2.5451
29.0	2.369
30.0	2.2106
31.0	2.0674
32.0	1.9377
33.0	1.8198
34.0	1.7124
35.0	1.6142
36.0	1.5242
37.0	1.4415
38.0	1.3654
39.0	1.2952
40.0	1.2302

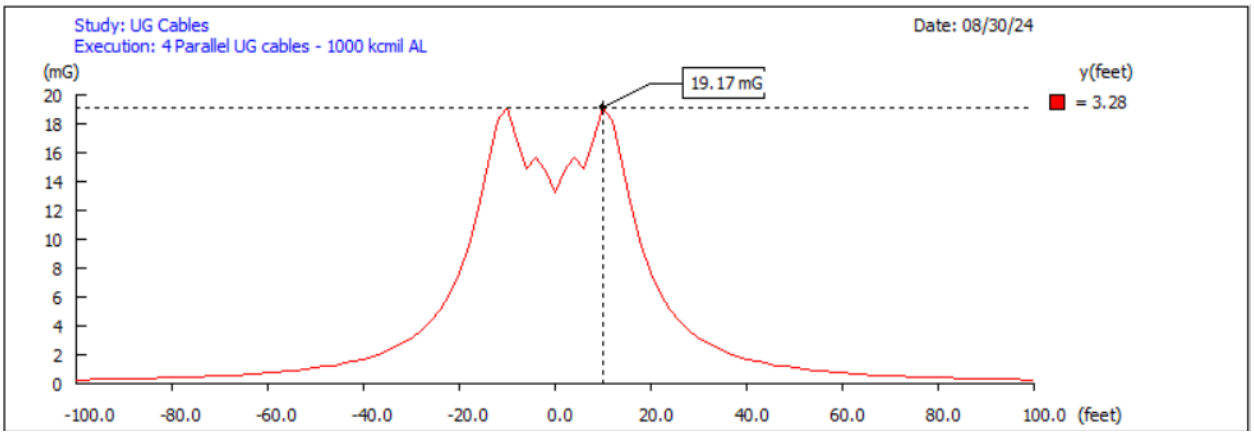
41.0	1.1701
42.0	1.1142
43.0	1.0623
44.0	1.0139
45.0	0.9687
46.0	0.9266
47.0	0.8871
48.0	0.8501
49.0	0.8153
50.0	0.7827
51.0	0.752
52.0	0.723
53.0	0.6957
54.0	0.67
55.0	0.6456
56.0	0.6225
57.0	0.6007
58.0	0.58
59.0	0.5603
60.0	0.5416
61.0	0.5239
62.0	0.507
63.0	0.4909
64.0	0.4756
65.0	0.461
66.0	0.447
67.0	0.4337
68.0	0.4209
69.0	0.4087
70.0	0.3971
71.0	0.3859
72.0	0.3752
73.0	0.3649
74.0	0.3551
75.0	0.3456
76.0	0.3365
77.0	0.3278
78.0	0.3194
79.0	0.3113
80.0	0.3036
81.0	0.2961
82.0	0.2889
83.0	0.2819
84.0	0.2752
85.0	0.2688
86.0	0.2625
87.0	0.2565
88.0	0.2507
89.0	0.2451
90.0	0.2396
91.0	0.2344
92.0	0.2293
93.0	0.2244
94.0	0.2196
95.0	0.215
96.0	0.2105
97.0	0.2062
98.0	0.202
99.0	0.1979
100.0	0.1939

Peak value found at:

X (feet)	Y=3.28 (feet)
	B(mG)
7.0	19.1799

A.4 SCENARIO 4: FOUR (4) CIRCUITS–UNDERGROUND CABLES

Scenario 4: 4-Circuits - 1000 kcmil cables



Input data:

Circuit No.	Phase	X (feet)	Y (feet)	Ampacity	Angle
1	A	-3.097	3.054	422.0	0.0
1	B	-2.904	3.054	422.0	-120.0
1	C	-2.999	2.89	422.0	120.0
2	A	2.904	3.054	422.0	0.0
2	B	3.097	3.054	422.0	-120.0
2	C	2.999	2.89	422.0	120.0
3	A	-9.094	3.054	422.0	0.0
3	B	-8.904	3.054	422.0	-120.0
3	C	-8.999	2.89	422.0	120.0
4	A	8.904	3.054	422.0	0.0
4	B	9.094	3.054	422.0	-120.0
4	C	8.999	2.89	422.0	120.0

MAGNETIC FLUX DENSITY [mG]
==========

Study : UG Cables
Execution: 4 Parallel UG cables - 1000 kcmil AL

Report created on: 08/30/24 8:22:26 AM

X (feet)	Y=3.28 (feet) B(mG)
-100.0	0.2608
-99.0	0.2661
-98.0	0.2716
-97.0	0.2773
-96.0	0.2832
-95.0	0.2893
-94.0	0.2955
-93.0	0.302
-92.0	0.3086
-91.0	0.3155
-90.0	0.3227
-89.0	0.33
-88.0	0.3377
-87.0	0.3456
-86.0	0.3538
-85.0	0.3622
-84.0	0.371
-83.0	0.3802
-82.0	0.3896
-81.0	0.3994
-80.0	0.4096
-79.0	0.4202
-78.0	0.4312
-77.0	0.4427
-76.0	0.4546
-75.0	0.467
-74.0	0.4799
-73.0	0.4934
-72.0	0.5074
-71.0	0.5221
-70.0	0.5374
-69.0	0.5534
-68.0	0.5701
-67.0	0.5876
-66.0	0.6059
-65.0	0.6251
-64.0	0.6452
-63.0	0.6663
-62.0	0.6885
-61.0	0.7118
-60.0	0.7364
-59.0	0.7622
-58.0	0.7894
-57.0	0.8181
-56.0	0.8485
-55.0	0.8805
-54.0	0.9144
-53.0	0.9504
-52.0	0.9885
-51.0	1.029
-50.0	1.072
-49.0	1.1179
-48.0	1.1667
-47.0	1.2189
-46.0	1.2747
-45.0	1.3344
-44.0	1.3985
-43.0	1.4673
-42.0	1.5415
-41.0	1.6214
-40.0	1.7078
-39.0	1.8014
-38.0	1.903

-37.0	2.0135
-36.0	2.134
-35.0	2.2659
-34.0	2.4104
-33.0	2.5693
-32.0	2.7447
-31.0	2.9387
-30.0	3.1543
-29.0	3.3945
-28.0	3.6633
-27.0	3.9654
-26.0	4.3061
-25.0	4.6923
-24.0	5.1318
-23.0	5.6344
-22.0	6.2115
-21.0	6.8768
-20.0	7.6462
-19.0	8.5375
-18.0	9.5696
-17.0	10.759
-16.0	12.1144
-15.0	13.6251
-14.0	15.2414
-13.0	16.8472
-12.0	18.2337
-11.0	19.1049
-10.0	19.165
-9.0	18.3115
-8.0	16.8424
-7.0	15.4623
-6.0	14.877
-5.0	15.1462
-4.0	15.6125
-3.0	15.5594
-2.0	14.7808
-1.0	13.7301
0.0	13.2314
1.0	13.7301
2.0	14.7808
3.0	15.5594
4.0	15.6125
5.0	15.1462
6.0	14.877
7.0	15.4623
8.0	16.8424
9.0	18.3115
10.0	19.165
11.0	19.1049
12.0	18.2337
13.0	16.8472
14.0	15.2414
15.0	13.6251
16.0	12.1144
17.0	10.759
18.0	9.5696
19.0	8.5375
20.0	7.6462
21.0	6.8768
22.0	6.2115
23.0	5.6344
24.0	5.1318
25.0	4.6923
26.0	4.3061
27.0	3.9654
28.0	3.6633
29.0	3.3945
30.0	3.1543
31.0	2.9387
32.0	2.7447
33.0	2.5693
34.0	2.4104
35.0	2.2659
36.0	2.134
37.0	2.0135
38.0	1.903
39.0	1.8014
40.0	1.7078

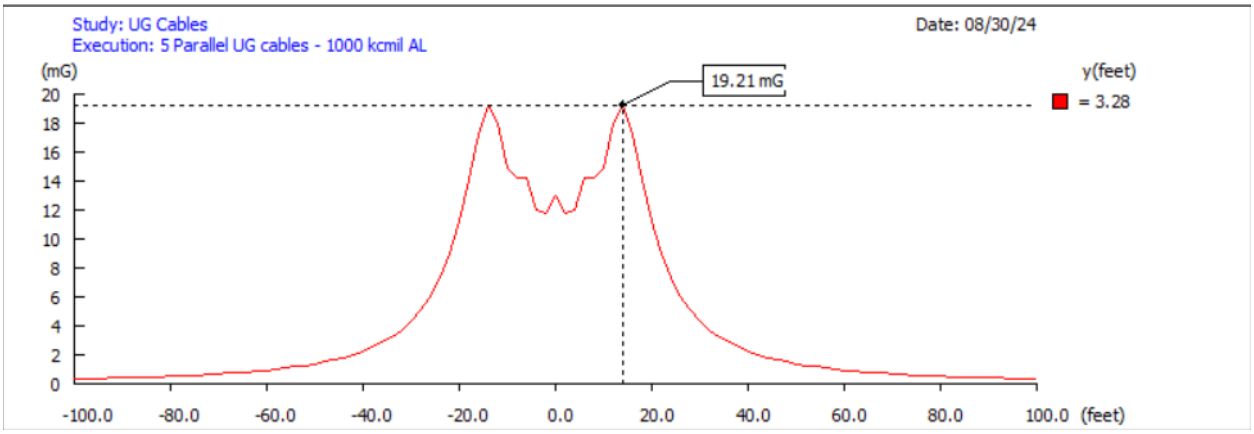
41.0	1.6214
42.0	1.5415
43.0	1.4673
44.0	1.3985
45.0	1.3344
46.0	1.2747
47.0	1.2189
48.0	1.1667
49.0	1.1179
50.0	1.072
51.0	1.029
52.0	0.9885
53.0	0.9504
54.0	0.9144
55.0	0.8805
56.0	0.8485
57.0	0.8181
58.0	0.7894
59.0	0.7622
60.0	0.7364
61.0	0.7118
62.0	0.6885
63.0	0.6663
64.0	0.6452
65.0	0.6251
66.0	0.6059
67.0	0.5876
68.0	0.5701
69.0	0.5534
70.0	0.5374
71.0	0.5221
72.0	0.5074
73.0	0.4934
74.0	0.4799
75.0	0.467
76.0	0.4546
77.0	0.4427
78.0	0.4312
79.0	0.4202
80.0	0.4096
81.0	0.3994
82.0	0.3896
83.0	0.3802
84.0	0.371
85.0	0.3622
86.0	0.3538
87.0	0.3456
88.0	0.3377
89.0	0.33
90.0	0.3227
91.0	0.3155
92.0	0.3086
93.0	0.302
94.0	0.2955
95.0	0.2893
96.0	0.2832
97.0	0.2773
98.0	0.2716
99.0	0.2661
100.0	0.2608

Peak value found at:

X (feet)	Y=3.28 (feet)
	B(mG)
10.0	19.165

A.5 SCENARIO 5: FIVE (5) CIRCUITS–UNDERGROUND CABLES

Scenario 5: 5-Circuits - 1000 kcmil cables



Input data:

Circuit No.	Phase	X (feet)	Y (feet)	Ampacity	Angle
1	A	-6.096	3.054	422.0	0.0
1	B	-5.905	3.054	422.0	-120.0
1	C	-6.001	2.89	422.0	120.0
2	A	-0.095	3.054	422.0	0.0
2	B	0.095	3.054	422.0	-120.0
2	C	0.0	2.89	422.0	120.0
3	A	5.905	3.054	422.0	0.0
3	B	6.096	3.054	422.0	-120.0
3	C	6.001	2.89	422.0	120.0
4	A	-12.096	3.054	422.0	0.0
4	B	-11.903	3.054	422.0	-120.0
4	C	-12.001	2.89	422.0	120.0
5	A	11.903	3.054	422.0	0.0
5	B	12.096	3.054	422.0	-120.0
5	C	12.001	2.89	422.0	120.0

MAGNETIC FLUX DENSITY [mG]
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Study : UG Cables
Execution: 5 Parallel UG cables - 1000 kcmil AL

Report created on: 08/30/24 8:21:34 AM

X (feet)	Y=3.28 (feet) B(mG)
-100.0	0.3288
-99.0	0.3355
-98.0	0.3426
-97.0	0.3498
-96.0	0.3573
-95.0	0.365
-94.0	0.3729
-93.0	0.3812
-92.0	0.3897
-91.0	0.3984
-90.0	0.4075
-89.0	0.417
-88.0	0.4267
-87.0	0.4368
-86.0	0.4473
-85.0	0.4581
-84.0	0.4693
-83.0	0.481
-82.0	0.4931
-81.0	0.5057
-80.0	0.5188
-79.0	0.5324
-78.0	0.5465
-77.0	0.5612
-76.0	0.5765
-75.0	0.5925
-74.0	0.6091
-73.0	0.6265
-72.0	0.6446
-71.0	0.6635
-70.0	0.6833
-69.0	0.704
-68.0	0.7256
-67.0	0.7483
-66.0	0.772
-65.0	0.797
-64.0	0.8231
-63.0	0.8506
-62.0	0.8795
-61.0	0.91
-60.0	0.942
-59.0	0.9758
-58.0	1.0115
-57.0	1.0492
-56.0	1.0891
-55.0	1.1314
-54.0	1.1762
-53.0	1.2237
-52.0	1.2743
-51.0	1.3281
-50.0	1.3854
-49.0	1.4466
-48.0	1.512
-47.0	1.5821
-46.0	1.6572
-45.0	1.738
-44.0	1.8249
-43.0	1.9186
-42.0	2.0198
-41.0	2.1295
-40.0	2.2486
-39.0	2.3781
-38.0	2.5195

-37.0	2.674
-36.0	2.8436
-35.0	3.0302
-34.0	3.2361
-33.0	3.4642
-32.0	3.7177
-31.0	4.0005
-30.0	4.3172
-29.0	4.6735
-28.0	5.0758
-27.0	5.5321
-26.0	6.0519
-25.0	6.6464
-24.0	7.329
-23.0	8.1149
-22.0	9.0209
-21.0	10.0642
-20.0	11.2591
-19.0	12.6106
-18.0	14.1029
-17.0	15.6794
-16.0	17.2154
-15.0	18.4938
-14.0	19.2147
-13.0	19.0883
-12.0	18.0322
-11.0	16.3742
-10.0	14.8435
-9.0	14.1396
-8.0	14.2718
-7.0	14.5372
-6.0	14.2291
-5.0	13.1938
-4.0	11.9488
-3.0	11.3542
-2.0	11.774
-1.0	12.6103
0.0	13.0081
1.0	12.6103
2.0	11.774
3.0	11.3542
4.0	11.9488
5.0	13.1937
6.0	14.2291
7.0	14.5372
8.0	14.2718
9.0	14.1396
10.0	14.8435
11.0	16.3742
12.0	18.0322
13.0	19.0883
14.0	19.2147
15.0	18.4938
16.0	17.2154
17.0	15.6794
18.0	14.1029
19.0	12.6106
20.0	11.2591
21.0	10.0642
22.0	9.0209
23.0	8.1149
24.0	7.329
25.0	6.6464
26.0	6.0519
27.0	5.5321
28.0	5.0758
29.0	4.6735
30.0	4.3172
31.0	4.0005
32.0	3.7177
33.0	3.4642
34.0	3.2361
35.0	3.0302
36.0	2.8436
37.0	2.674
38.0	2.5195
39.0	2.3781
40.0	2.2486

41.0	2.1295
42.0	2.0198
43.0	1.9186
44.0	1.8249
45.0	1.738
46.0	1.6572
47.0	1.5821
48.0	1.512
49.0	1.4466
50.0	1.3854
51.0	1.3281
52.0	1.2743
53.0	1.2237
54.0	1.1762
55.0	1.1314
56.0	1.0891
57.0	1.0492
58.0	1.0115
59.0	0.9758
60.0	0.942
61.0	0.91
62.0	0.8795
63.0	0.8506
64.0	0.8231
65.0	0.797
66.0	0.772
67.0	0.7483
68.0	0.7256
69.0	0.704
70.0	0.6833
71.0	0.6635
72.0	0.6446
73.0	0.6265
74.0	0.6091
75.0	0.5925
76.0	0.5765
77.0	0.5612
78.0	0.5465
79.0	0.5324
80.0	0.5188
81.0	0.5057
82.0	0.4931
83.0	0.481
84.0	0.4693
85.0	0.4581
86.0	0.4473
87.0	0.4368
88.0	0.4267
89.0	0.417
90.0	0.4075
91.0	0.3984
92.0	0.3897
93.0	0.3812
94.0	0.3729
95.0	0.365
96.0	0.3573
97.0	0.3498
98.0	0.3426
99.0	0.3355
100.0	0.3288

Peak value found at:

X (feet)	Y=3.28 (feet)
	B(mG)
-14.0	19.2147

A.6 SCENARIO 6: ABOVEGROUND COLLECTOR CIRCUIT

Scenario 6 - Single circuit overhead collector line
Electric field intensity

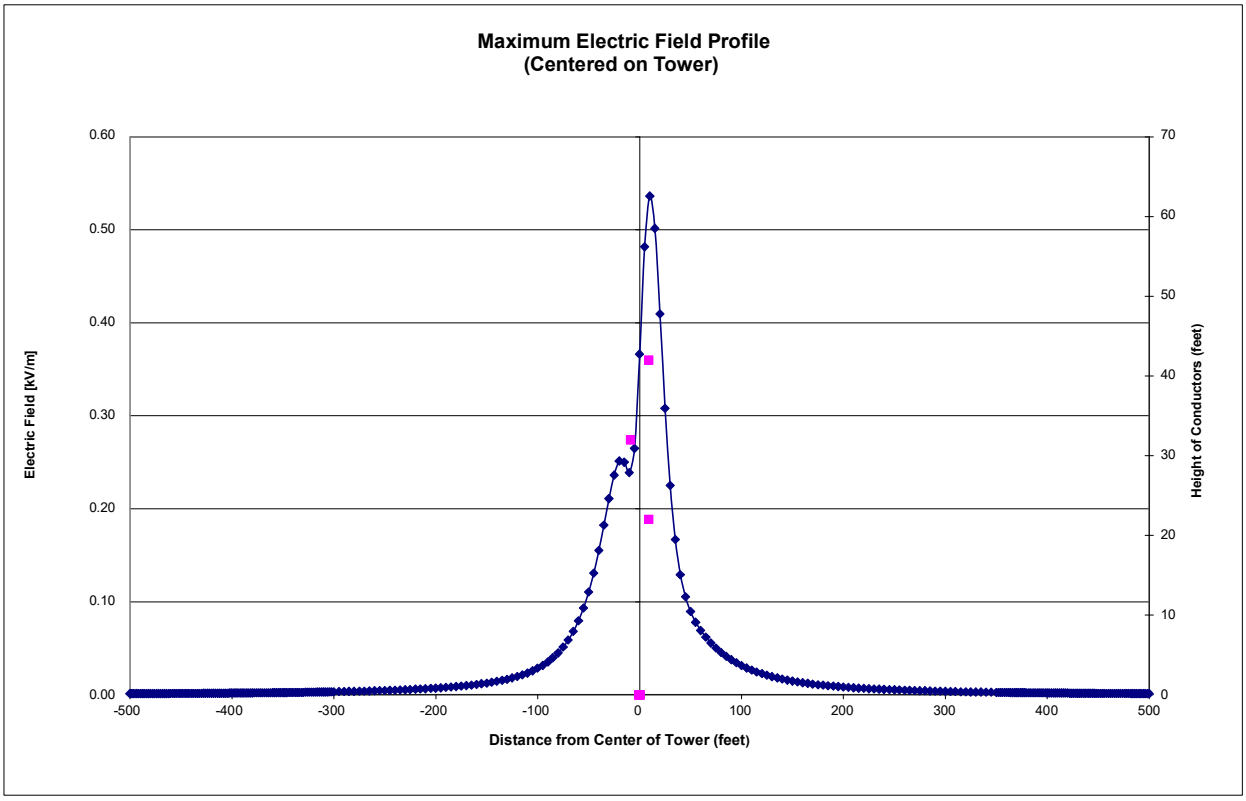
Bundle	x-feet	y-feet	n cond	Conductor Diameter [inches]	Conductor Spacing [inches]	l-n voltage (max)	phase	l-l voltage (rated)
1	9.00	22.000	1	0.72	0	20.91	0	34.5
2	-9.00	32.000	1	0.72	0	20.91	120	34.5
3	9.00	42.000	1	0.72	0	20.91	240	34.5

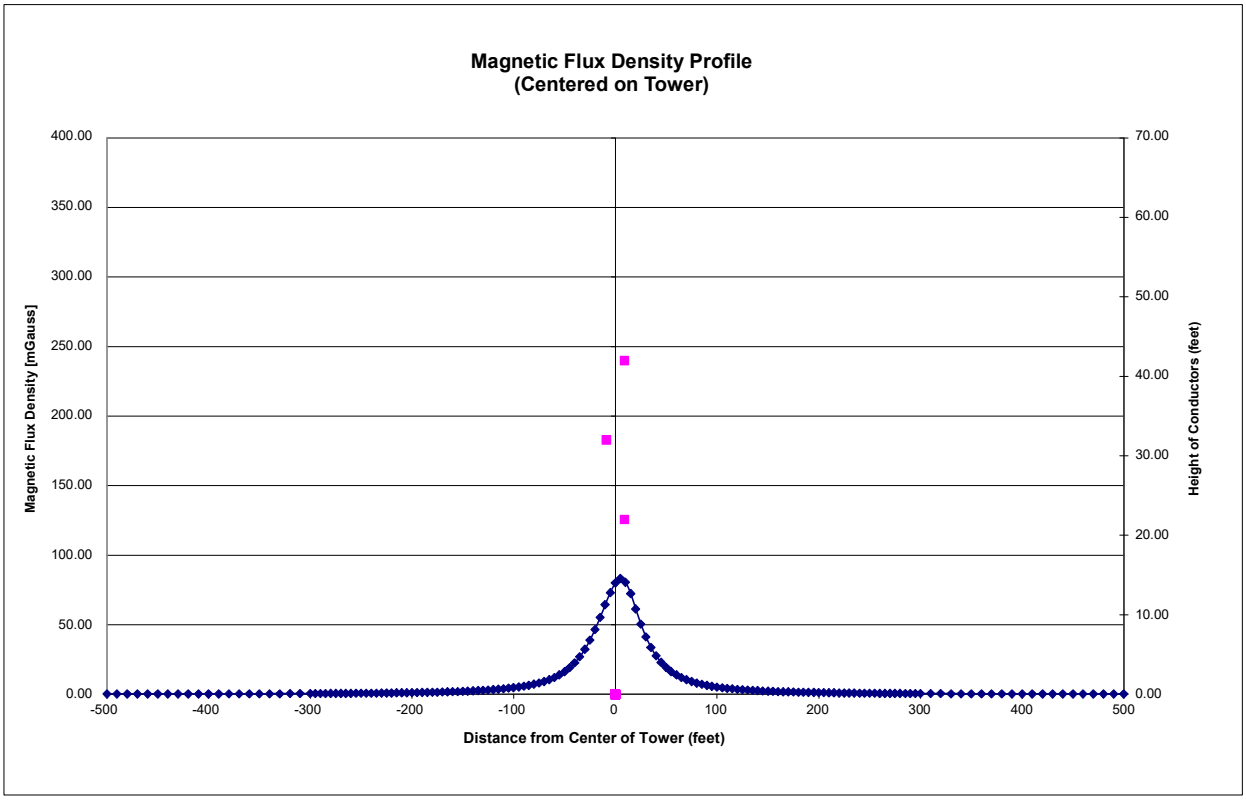
Dist (ft)	Vert	kV/M	Dist (ft)	Vert	kV/M	Dist (ft)	Vert	kV/M
-300	3.28	0.0033	-95	3.28	0.0317	110	3.28	0.0266
-295	3.28	0.0034	-90	3.28	0.0354	115	3.28	0.0245
-290	3.28	0.0035	-85	3.28	0.0398	120	3.28	0.0227
-285	3.28	0.0036	-80	3.28	0.0450	125	3.28	0.0210
-280	3.28	0.0037	-75	3.28	0.0513	130	3.28	0.0195
-275	3.28	0.0039	-70	3.28	0.0590	135	3.28	0.0182
-270	3.28	0.0040	-65	3.28	0.0683	140	3.28	0.0169
-265	3.28	0.0042	-60	3.28	0.0796	145	3.28	0.0158
-260	3.28	0.0043	-55	3.28	0.0935	150	3.28	0.0148
-255	3.28	0.0045	-50	3.28	0.1105	155	3.28	0.0139
-250	3.28	0.0047	-45	3.28	0.1310	160	3.28	0.0131
-245	3.28	0.0048	-40	3.28	0.1552	165	3.28	0.0123
-240	3.28	0.0050	-35	3.28	0.1825	170	3.28	0.0116
-235	3.28	0.0052	-30	3.28	0.2110	175	3.28	0.0109
-230	3.28	0.0055	-25	3.28	0.2363	180	3.28	0.0103
-225	3.28	0.0057	-20	3.28	0.2515	185	3.28	0.0098
-220	3.28	0.0060	-15	3.28	0.2503	190	3.28	0.0093
-215	3.28	0.0062	-10	3.28	0.2390	195	3.28	0.0088
-210	3.28	0.0065	-5	3.28	0.2649	200	3.28	0.0084
-205	3.28	0.0068	0	3.28	0.3664	205	3.28	0.0080
-200	3.28	0.0072	5	3.28	0.4817	210	3.28	0.0076
-195	3.28	0.0075	10	3.28	**0.54**	215	3.28	0.0072
-190	3.28	0.0079	15	3.28	0.5017	220	3.28	0.0069
-185	3.28	0.0084	20	3.28	0.4095	225	3.28	0.0066
-180	3.28	0.0088	25	3.28	0.3081	230	3.28	0.0063
-175	3.28	0.0093	30	3.28	0.2252	235	3.28	0.0060
-170	3.28	0.0099	35	3.28	0.1670	240	3.28	0.0058
-165	3.28	0.0105	40	3.28	0.1293	245	3.28	0.0056
-160	3.28	0.0111	45	3.28	0.1053	250	3.28	0.0053
-155	3.28	0.0118	50	3.28	0.0894	255	3.28	0.0051
-150	3.28	0.0126	55	3.28	0.0781	260	3.28	0.0049
-145	3.28	0.0135	60	3.28	0.0692	265	3.28	0.0047
-140	3.28	0.0145	65	3.28	0.0619	270	3.28	0.0046
-135	3.28	0.0156	70	3.28	0.0557	275	3.28	0.0044
-130	3.28	0.0168	75	3.28	0.0503	280	3.28	0.0042
-125	3.28	0.0182	80	3.28	0.0456	285	3.28	0.0041
-120	3.28	0.0197	85	3.28	0.0414	290	3.28	0.0039
-115	3.28	0.0215	90	3.28	0.0377	295	3.28	0.0038
-110	3.28	0.0235	95	3.28	0.0344	300	3.28	0.0037
-105	3.28	0.0258	100	3.28	0.0315			
-100	3.28	0.0285	105	3.28	0.0289			

Scenario 6 - Single circuit overhead collector line
Magnetic field intensity

Bundle	x-feet	y-feet	amps	phase
1	9.00	22.0000	422	0
2	-9.00	32.0000	422	120
3	9.00	42.0000	422	240

Dist - ft	Vert	milligauss	Dist - ft	Vert	milligauss	Dist - ft	Vert	milligauss
-300	3.28	0.5584	-95	3.28	5.3244	110	3.28	4.3317
-295	3.28	0.5775	-90	3.28	5.8909	115	3.28	3.9606
-290	3.28	0.5975	-85	3.28	6.5492	120	3.28	3.6343
-285	3.28	0.6187	-80	3.28	7.3193	125	3.28	3.3460
-280	3.28	0.6409	-75	3.28	8.2264	130	3.28	3.0901
-275	3.28	0.6644	-70	3.28	9.3030	135	3.28	2.8620
-270	3.28	0.6892	-65	3.28	10.5907	140	3.28	2.6579
-265	3.28	0.7154	-60	3.28	12.1434	145	3.28	2.4746
-260	3.28	0.7431	-55	3.28	14.0304	150	3.28	2.3094
-255	3.28	0.7724	-50	3.28	16.3414	155	3.28	2.1600
-250	3.28	0.8036	-45	3.28	19.1901	160	3.28	2.0245
-245	3.28	0.8366	-40	3.28	22.7170	165	3.28	1.9012
-240	3.28	0.8717	-35	3.28	27.0858	170	3.28	1.7887
-235	3.28	0.9090	-30	3.28	32.4661	175	3.28	1.6859
-230	3.28	0.9488	-25	3.28	38.9898	180	3.28	1.5915
-225	3.28	0.9912	-20	3.28	46.6727	185	3.28	1.5048
-220	3.28	1.0365	-15	3.28	55.3151	190	3.28	1.4250
-215	3.28	1.0850	-10	3.28	64.4219	195	3.28	1.3513
-210	3.28	1.1369	-5	3.28	73.1437	200	3.28	1.2831
-205	3.28	1.1927	0	3.28	80.1094	205	3.28	1.2199
-200	3.28	1.2526	5	3.28	**83.24**	210	3.28	1.1612
-195	3.28	1.3171	10	3.28	80.5779	215	3.28	1.1067
-190	3.28	1.3866	15	3.28	72.3801	220	3.28	1.0559
-185	3.28	1.4618	20	3.28	61.4442	225	3.28	1.0085
-180	3.28	1.5432	25	3.28	50.6147	230	3.28	0.9641
-175	3.28	1.6315	30	3.28	41.2852	235	3.28	0.9227
-170	3.28	1.7276	35	3.28	33.7290	240	3.28	0.8838
-165	3.28	1.8323	40	3.28	27.7515	245	3.28	0.8473
-160	3.28	1.9467	45	3.28	23.0479	250	3.28	0.8131
-155	3.28	2.0721	50	3.28	19.3345	255	3.28	0.7808
-150	3.28	2.2098	55	3.28	16.3814	260	3.28	0.7504
-145	3.28	2.3615	60	3.28	14.0115	265	3.28	0.7218
-140	3.28	2.5292	65	3.28	12.0913	270	3.28	0.6948
-135	3.28	2.7150	70	3.28	10.5204	275	3.28	0.6692
-130	3.28	2.9218	75	3.28	9.2231	280	3.28	0.6450
-125	3.28	3.1527	80	3.28	8.1420	285	3.28	0.6221
-120	3.28	3.4115	85	3.28	7.2336	290	3.28	0.6005
-115	3.28	3.7028	90	3.28	6.4642	295	3.28	0.5799
-110	3.28	4.0322	95	3.28	5.8077	300	3.28	0.5603
-105	3.28	4.4065	100	3.28	5.2437			
-100	3.28	4.8338	105	3.28	4.7559			


Maximum Electric Field Profile
(Centered on Tower)
Electric Field [kV/m]
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Height of Conductors (feet)
70
60
50
40
30
20
10
0
-500
-400
-300
-200
-100
0
100
200
300
400
500
Distance from Center of Tower (feet)


Magnetic Flux Density Profile
(Centered on Tower)
Magnetic Flux Density [mGauss]
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
Height of Conductors (feet)
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
-500
-400
-300
-200
-100
0
100
200
300
400
500
Distance from Center of Tower (feet)

A.7 SCENARIO 7: 345KV SINGLE CIRCUIT: TANGENT POLE

Scenario 7 - Single circuit overhead line - Tangent pole
Electric field intensity

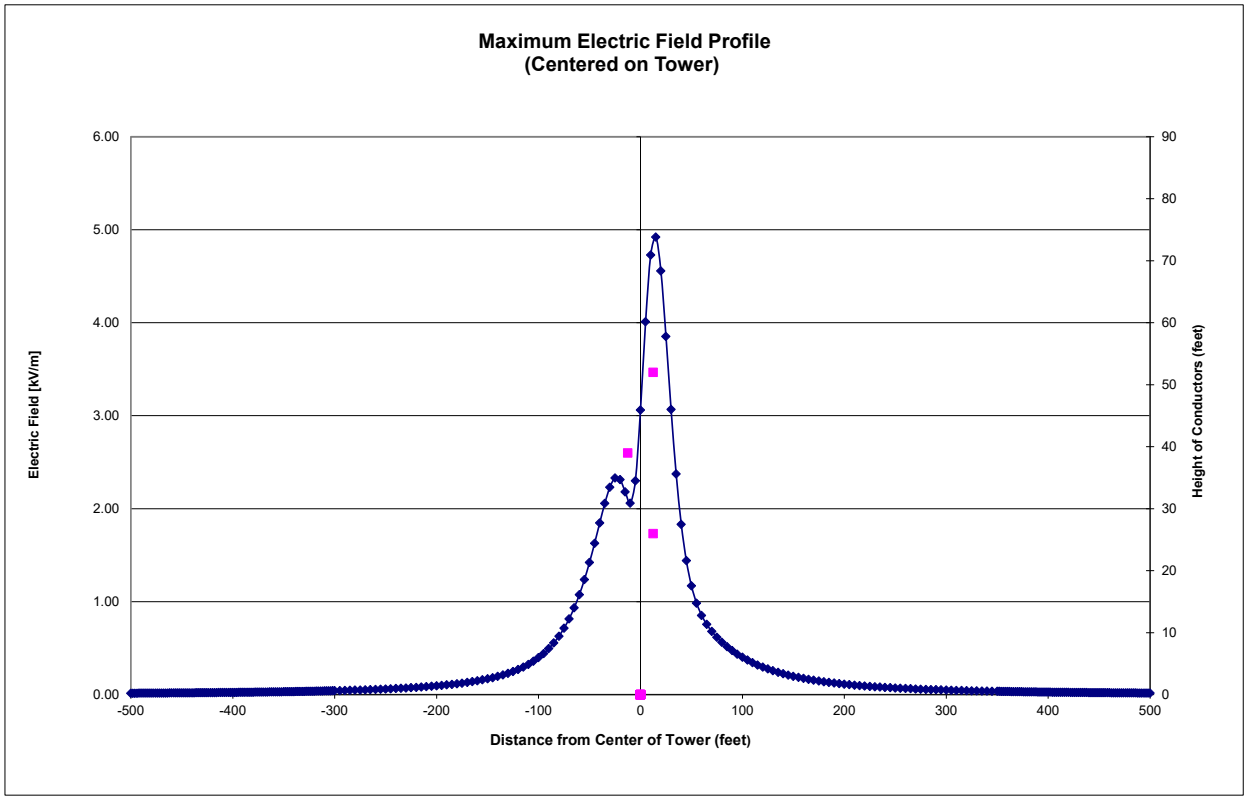
Bundle	x-feet	y-feet	n cond	Conductor Diameter [inches]	Conductor Spacing [inches]	l-n voltage (max)	phase	l-l voltage (rated)
1	12.42	26.000	1	1.107	0	209.15	0	345
2	-12.42	39.000	1	1.107	0	209.15	120	345
3	12.42	52.000	1	1.107	0	209.15	240	345

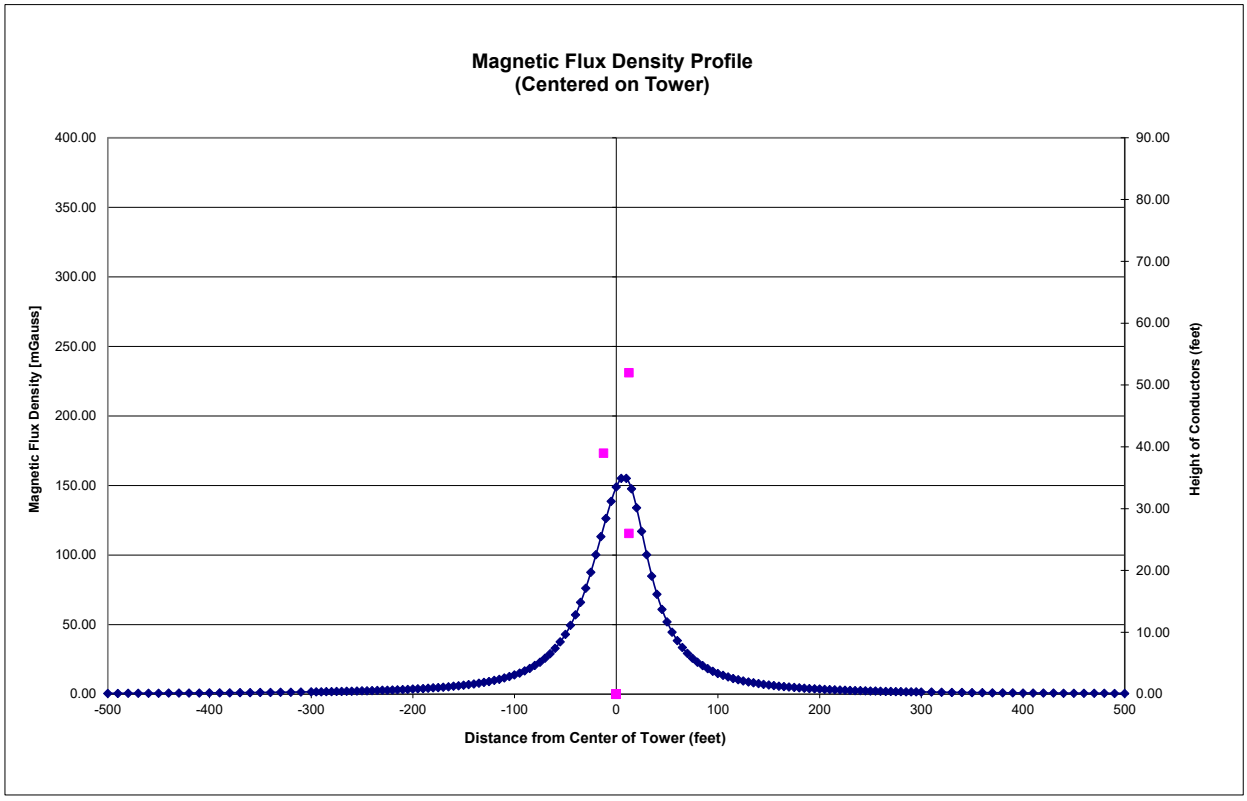
Dist (ft)	Vert	kV/M	Dist (ft)	Vert	kV/M	Dist (ft)	Vert	kV/M
-300	3.28	0.0429	-95	3.28	0.4430	110	3.28	0.3448
-295	3.28	0.0443	-90	3.28	0.4955	115	3.28	0.3198
-290	3.28	0.0458	-85	3.28	0.5571	120	3.28	0.2971
-285	3.28	0.0474	-80	3.28	0.6296	125	3.28	0.2765
-280	3.28	0.0491	-75	3.28	0.7151	130	3.28	0.2577
-275	3.28	0.0508	-70	3.28	0.8162	135	3.28	0.2406
-270	3.28	0.0527	-65	3.28	0.9353	140	3.28	0.2251
-265	3.28	0.0546	-60	3.28	1.0751	145	3.28	0.2108
-260	3.28	0.0567	-55	3.28	1.2377	150	3.28	0.1978
-255	3.28	0.0589	-50	3.28	1.4234	155	3.28	0.1859
-250	3.28	0.0613	-45	3.28	1.6293	160	3.28	0.1750
-245	3.28	0.0638	-40	3.28	1.8466	165	3.28	0.1649
-240	3.28	0.0664	-35	3.28	2.0575	170	3.28	0.1556
-235	3.28	0.0692	-30	3.28	2.2321	175	3.28	0.1471
-230	3.28	0.0722	-25	3.28	2.3300	180	3.28	0.1392
-225	3.28	0.0754	-20	3.28	2.3129	185	3.28	0.1319
-220	3.28	0.0789	-15	3.28	2.1810	190	3.28	0.1251
-215	3.28	0.0825	-10	3.28	2.0594	195	3.28	0.1189
-210	3.28	0.0865	-5	3.28	2.2994	200	3.28	0.1130
-205	3.28	0.0907	0	3.28	3.0622	205	3.28	0.1076
-200	3.28	0.0953	5	3.28	4.0105	210	3.28	0.1025
-195	3.28	0.1003	10	3.28	4.7296	215	3.28	0.0978
-190	3.28	0.1056	15	3.28	4.92	220	3.28	0.0934
-185	3.28	0.1114	20	3.28	4.5583	225	3.28	0.0893
-180	3.28	0.1178	25	3.28	3.8523	230	3.28	0.0854
-175	3.28	0.1246	30	3.28	3.0677	235	3.28	0.0818
-170	3.28	0.1322	35	3.28	2.3736	240	3.28	0.0784
-165	3.28	0.1405	40	3.28	1.8324	245	3.28	0.0752
-160	3.28	0.1495	45	3.28	1.4414	250	3.28	0.0721
-155	3.28	0.1596	50	3.28	1.1704	255	3.28	0.0693
-150	3.28	0.1707	55	3.28	0.9843	260	3.28	0.0666
-145	3.28	0.1830	60	3.28	0.8531	265	3.28	0.0641
-140	3.28	0.1968	65	3.28	0.7561	270	3.28	0.0617
-135	3.28	0.2122	70	3.28	0.6799	275	3.28	0.0594
-130	3.28	0.2296	75	3.28	0.6171	280	3.28	0.0573
-125	3.28	0.2492	80	3.28	0.5634	285	3.28	0.0553
-120	3.28	0.2715	85	3.28	0.5162	290	3.28	0.0533
-115	3.28	0.2968	90	3.28	0.4743	295	3.28	0.0515
-110	3.28	0.3259	95	3.28	0.4368	300	3.28	0.0498
-105	3.28	0.3593	100	3.28	0.4030			
-100	3.28	0.3980	105	3.28	0.3724			

Scenario 7 - Single circuit overhead line - Tangent pole
Magnetic field intensity

Bundle	x-feet	y-feet	amps	phase
1	12.42	26.0000	907	0
2	-12.42	39.0000	907	120
3	12.42	52.0000	907	240

Dist - ft	Vert	milligauss	Dist - ft	Vert	milligauss	Dist - ft	Vert	milligauss
-300	3.28	1.6538	-95	3.28	15.2470	110	3.28	12.3761
-295	3.28	1.7101	-90	3.28	16.7986	115	3.28	11.3250
-290	3.28	1.7693	-85	3.28	18.5845	120	3.28	10.3983
-285	3.28	1.8317	-80	3.28	20.6505	125	3.28	9.5778
-280	3.28	1.8973	-75	3.28	23.0527	130	3.28	8.8482
-275	3.28	1.9666	-70	3.28	25.8597	135	3.28	8.1969
-270	3.28	2.0396	-65	3.28	29.1555	140	3.28	7.6134
-265	3.28	2.1168	-60	3.28	33.0414	145	3.28	7.0888
-260	3.28	2.1985	-55	3.28	37.6380	150	3.28	6.6155
-255	3.28	2.2849	-50	3.28	43.0845	155	3.28	6.1873
-250	3.28	2.3765	-45	3.28	49.5335	160	3.28	5.7986
-245	3.28	2.4736	-40	3.28	57.1373	165	3.28	5.4448
-240	3.28	2.5768	-35	3.28	66.0209	170	3.28	5.1219
-235	3.28	2.6865	-30	3.28	76.2390	175	3.28	4.8265
-230	3.28	2.8034	-25	3.28	87.7214	180	3.28	4.5557
-225	3.28	2.9279	-20	3.28	100.2262	185	3.28	4.3067
-220	3.28	3.0609	-15	3.28	113.3256	190	3.28	4.0773
-215	3.28	3.2030	-10	3.28	126.4197	195	3.28	3.8656
-210	3.28	3.3552	-5	3.28	138.6957	200	3.28	3.6697
-205	3.28	3.5184	0	3.28	148.9234	205	3.28	3.4883
-200	3.28	3.6936	5	3.28	155.19	210	3.28	3.3198
-195	3.28	3.8821	10	3.28	155.2053	215	3.28	3.1632
-190	3.28	4.0852	15	3.28	147.7082	220	3.28	3.0173
-185	3.28	4.3045	20	3.28	133.9636	225	3.28	2.8811
-180	3.28	4.5417	25	3.28	117.1281	230	3.28	2.7540
-175	3.28	4.7988	30	3.28	100.2045	235	3.28	2.6350
-170	3.28	5.0780	35	3.28	84.9143	240	3.28	2.5235
-165	3.28	5.3818	40	3.28	71.8451	245	3.28	2.4189
-160	3.28	5.7133	45	3.28	60.9672	250	3.28	2.3207
-155	3.28	6.0759	50	3.28	52.0101	255	3.28	2.2283
-150	3.28	6.4733	55	3.28	44.6515	260	3.28	2.1412
-145	3.28	6.9103	60	3.28	38.5928	265	3.28	2.0592
-140	3.28	7.3920	65	3.28	33.5813	270	3.28	1.9819
-135	3.28	7.9247	70	3.28	29.4120	275	3.28	1.9088
-130	3.28	8.5156	75	3.28	25.9213	280	3.28	1.8397
-125	3.28	9.1732	80	3.28	22.9796	285	3.28	1.7743
-120	3.28	9.9076	85	3.28	20.4846	290	3.28	1.7123
-115	3.28	10.7309	90	3.28	18.3549	295	3.28	1.6536
-110	3.28	11.6574	95	3.28	16.5260	300	3.28	1.5980
-105	3.28	12.7043	100	3.28	14.9462			
-100	3.28	13.8925	105	3.28	13.5741			


Maximum Electric Field Profile
(Centered on Tower)
Electric Field [kV/m]
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Height of Conductors (feet)
90
80
70
60
50
40
30
20
10
0
-500
-400
-300
-200
-100
0
100
200
300
400
500
Distance from Center of Tower (feet)


Magnetic Flux Density Profile
(Centered on Tower)
Magnetic Flux Density [mGauss]
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
Height of Conductors (feet)
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
-500
-400
-300
-200
-100
0
100
200
300
400
500
Distance from Center of Tower (feet)

A.8 SCENARIO 8: 345KV SINGLE CIRCUIT – ANGLE POLE

Scenario 8 - Single circuit overhead line - Angle pole
Electric field intensity

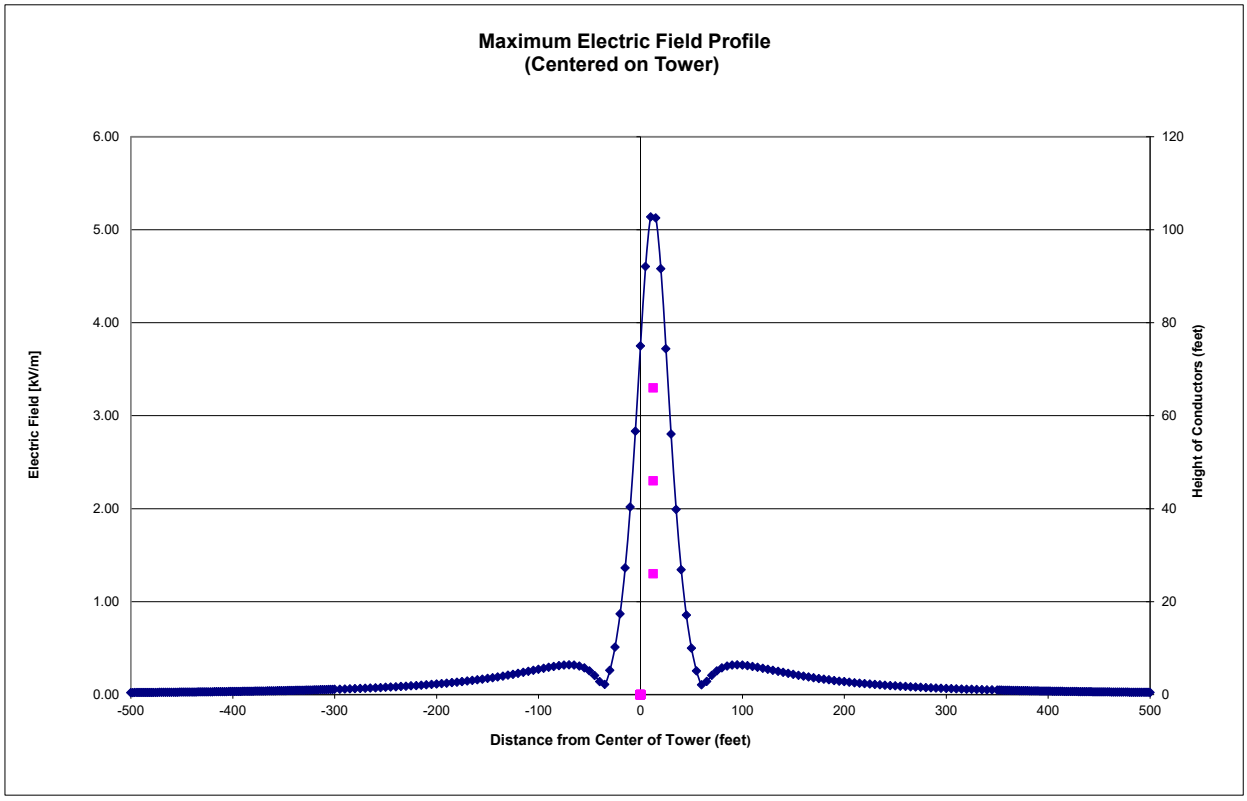
Bundle	x-feet	y-feet	n cond	Conductor Diameter [inches]	Conductor Spacing [inches]	l-n voltage (max)	phase	l-l voltage (rated)
1	12.42	26.000	1	1.107	0	209.15	0	345
2	12.42	46.000	1	1.107	0	209.15	120	345
3	12.42	66.000	1	1.107	0	209.15	240	345

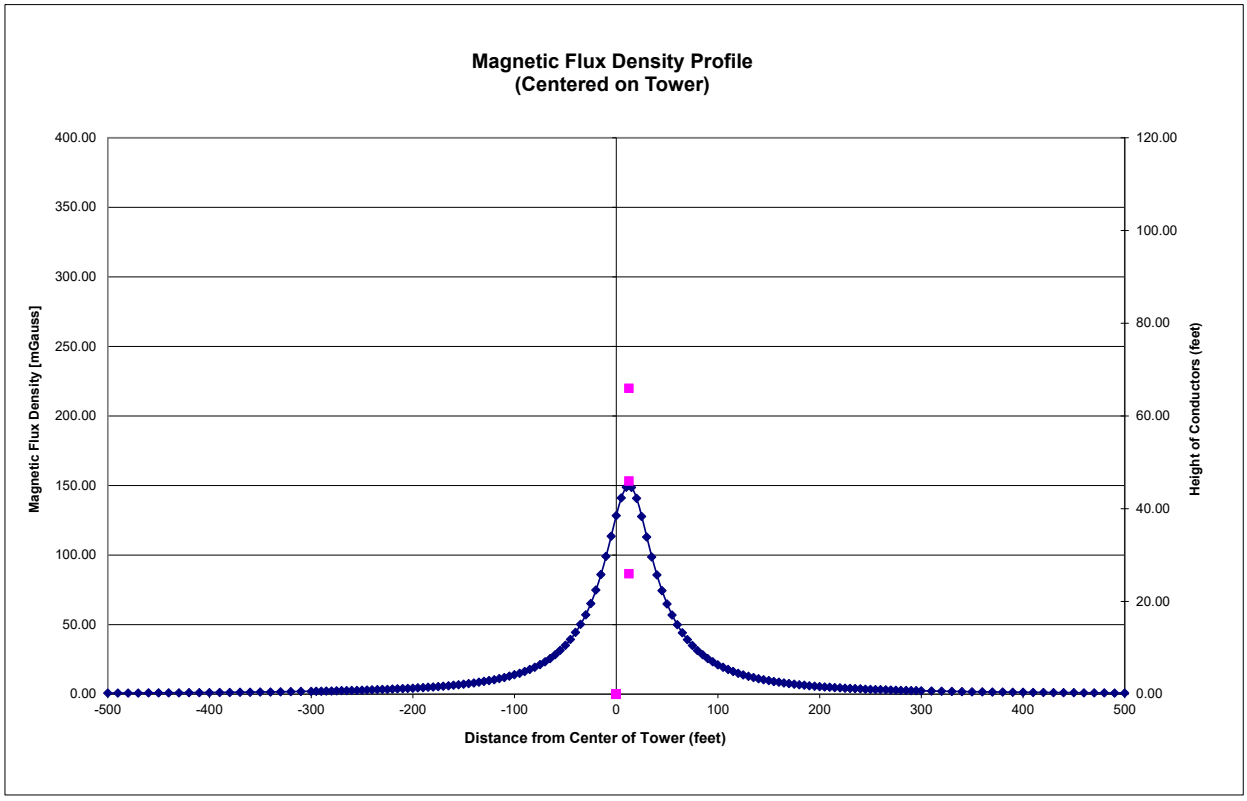
Dist (ft)	Vert	kV/M	Dist (ft)	Vert	kV/M	Dist (ft)	Vert	kV/M
-300	3.28	0.0578	-95	3.28	0.2844	110	3.28	0.3043
-295	3.28	0.0595	-90	3.28	0.2949	115	3.28	0.2946
-290	3.28	0.0613	-85	3.28	0.3046	120	3.28	0.2840
-285	3.28	0.0632	-80	3.28	0.3127	125	3.28	0.2730
-280	3.28	0.0652	-75	3.28	0.3184	130	3.28	0.2618
-275	3.28	0.0673	-70	3.28	0.3207	135	3.28	0.2507
-270	3.28	0.0695	-65	3.28	0.3180	140	3.28	0.2398
-265	3.28	0.0718	-60	3.28	0.3081	145	3.28	0.2292
-260	3.28	0.0742	-55	3.28	0.2883	150	3.28	0.2190
-255	3.28	0.0767	-50	3.28	0.2553	155	3.28	0.2092
-250	3.28	0.0793	-45	3.28	0.2057	160	3.28	0.1998
-245	3.28	0.0821	-40	3.28	0.1403	165	3.28	0.1909
-240	3.28	0.0850	-35	3.28	0.1103	170	3.28	0.1824
-235	3.28	0.0880	-30	3.28	0.2624	175	3.28	0.1744
-230	3.28	0.0912	-25	3.28	0.5114	180	3.28	0.1668
-225	3.28	0.0946	-20	3.28	0.8700	185	3.28	0.1595
-220	3.28	0.0982	-15	3.28	1.3639	190	3.28	0.1527
-215	3.28	0.1019	-10	3.28	2.0177	195	3.28	0.1463
-210	3.28	0.1059	-5	3.28	2.8333	200	3.28	0.1402
-205	3.28	0.1100	0	3.28	3.7511	205	3.28	0.1344
-200	3.28	0.1144	5	3.28	4.6061	210	3.28	0.1289
-195	3.28	0.1191	10	3.28	5.14	215	3.28	0.1238
-190	3.28	0.1239	15	3.28	5.1282	220	3.28	0.1189
-185	3.28	0.1291	20	3.28	4.5812	225	3.28	0.1143
-180	3.28	0.1346	25	3.28	3.7203	230	3.28	0.1099
-175	3.28	0.1404	30	3.28	2.8039	235	3.28	0.1057
-170	3.28	0.1465	35	3.28	1.9932	240	3.28	0.1018
-165	3.28	0.1529	40	3.28	1.3449	245	3.28	0.0981
-160	3.28	0.1598	45	3.28	0.8560	250	3.28	0.0945
-155	3.28	0.1670	50	3.28	0.5014	255	3.28	0.0911
-150	3.28	0.1746	55	3.28	0.2558	260	3.28	0.0879
-145	3.28	0.1827	60	3.28	0.1070	265	3.28	0.0849
-140	3.28	0.1912	65	3.28	0.1426	270	3.28	0.0820
-135	3.28	0.2001	70	3.28	0.2076	275	3.28	0.0792
-130	3.28	0.2095	75	3.28	0.2567	280	3.28	0.0766
-125	3.28	0.2193	80	3.28	0.2892	285	3.28	0.0741
-120	3.28	0.2295	85	3.28	0.3085	290	3.28	0.0717
-115	3.28	0.2402	90	3.28	0.3181	295	3.28	0.0694
-110	3.28	0.2511	95	3.28	0.3207	300	3.28	0.0673
-105	3.28	0.2622	100	3.28	0.3183			
-100	3.28	0.2734	105	3.28	0.3125			

Scenario 8 - Single circuit overhead line - Angle pole
Magnetic field intensity

Bundle	x-feet	y-feet	amps	phase
1	12.42	26.0000	907	0
2	12.42	46.0000	907	120
3	12.42	66.0000	907	240

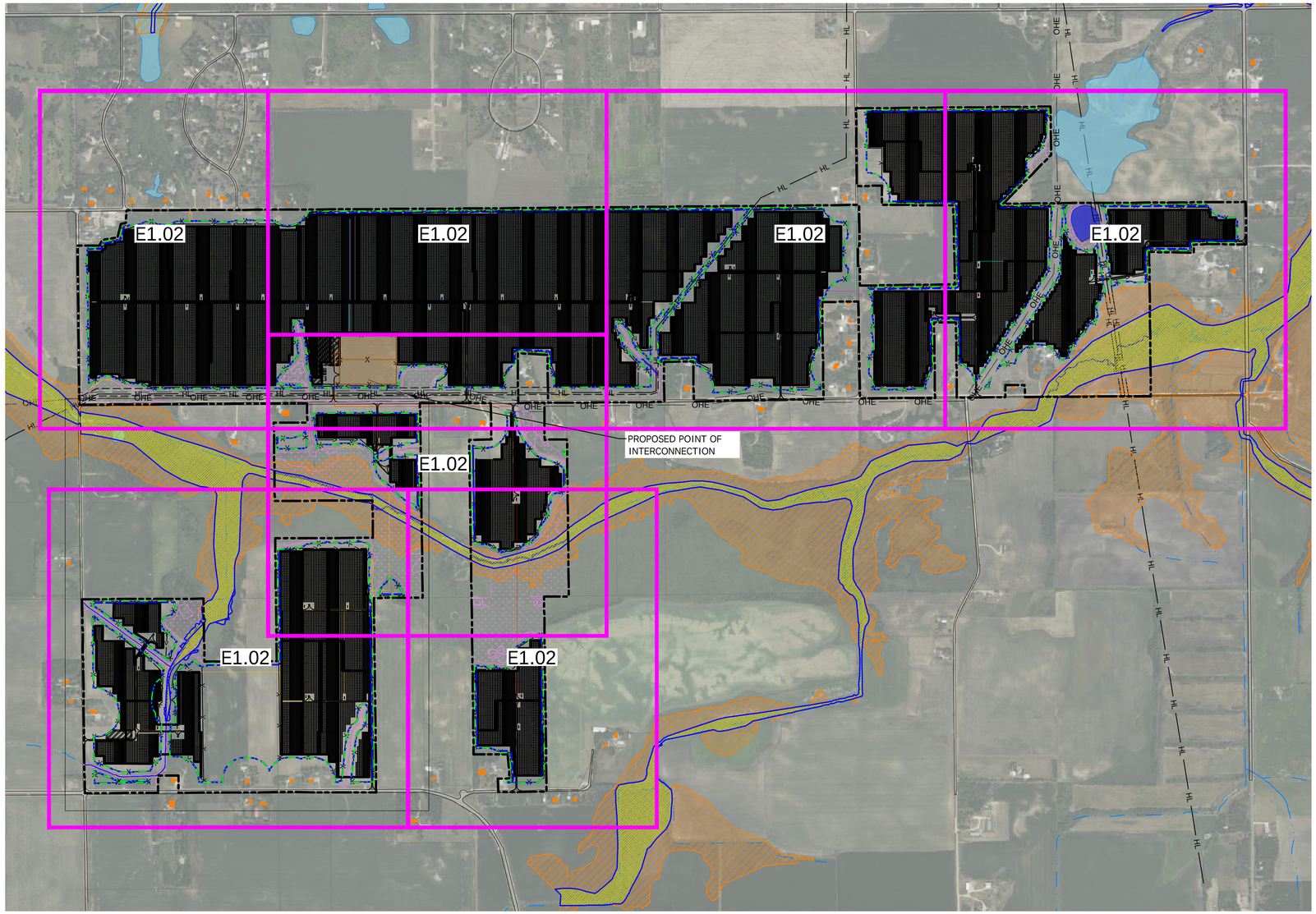
Dist - ft	Vert	milligauss	Dist - ft	Vert	milligauss	Dist - ft	Vert	milligauss
-300	3.28	2.0650	-95	3.28	15.1025	110	3.28	17.7506
-295	3.28	2.1311	-90	3.28	16.3728	115	3.28	16.3281
-290	3.28	2.2005	-85	3.28	17.8011	120	3.28	15.0626
-285	3.28	2.2733	-80	3.28	19.4129	125	3.28	13.9330
-280	3.28	2.3498	-75	3.28	21.2393	130	3.28	12.9210
-275	3.28	2.4301	-70	3.28	23.3172	135	3.28	12.0115
-270	3.28	2.5146	-65	3.28	25.6915	140	3.28	11.1916
-265	3.28	2.6036	-60	3.28	28.4166	145	3.28	10.4503
-260	3.28	2.6973	-55	3.28	31.5591	150	3.28	9.7780
-255	3.28	2.7960	-50	3.28	35.2002	155	3.28	9.1668
-250	3.28	2.9003	-45	3.28	39.4395	160	3.28	8.6096
-245	3.28	3.0105	-40	3.28	44.3989	165	3.28	8.1004
-240	3.28	3.1269	-35	3.28	50.2272	170	3.28	7.6341
-235	3.28	3.2502	-30	3.28	57.1031	175	3.28	7.2059
-230	3.28	3.3808	-25	3.28	65.2338	180	3.28	6.8121
-225	3.28	3.5194	-20	3.28	74.8420	185	3.28	6.4489
-220	3.28	3.6665	-15	3.28	86.1226	190	3.28	6.1135
-215	3.28	3.8230	-10	3.28	99.1333	195	3.28	5.8032
-210	3.28	3.9895	-5	3.28	113.5631	200	3.28	5.5154
-205	3.28	4.1670	0	3.28	128.3334	205	3.28	5.2482
-200	3.28	4.3564	5	3.28	141.1787	210	3.28	4.9996
-195	3.28	4.5588	10	3.28	148.85	215	3.28	4.7680
-190	3.28	4.7754	15	3.28	148.7092	220	3.28	4.5518
-185	3.28	5.0076	20	3.28	140.8149	225	3.28	4.3499
-180	3.28	5.2568	25	3.28	127.8560	230	3.28	4.1609
-175	3.28	5.5247	30	3.28	113.0678	235	3.28	3.9838
-170	3.28	5.8131	35	3.28	98.6735	240	3.28	3.8176
-165	3.28	6.1243	40	3.28	85.7183	245	3.28	3.6615
-160	3.28	6.4606	45	3.28	74.4957	250	3.28	3.5146
-155	3.28	6.8247	50	3.28	64.9402	255	3.28	3.3763
-150	3.28	7.2196	55	3.28	56.8549	260	3.28	3.2460
-145	3.28	7.6490	60	3.28	50.0172	265	3.28	3.1229
-140	3.28	8.1167	65	3.28	44.2205	270	3.28	3.0067
-135	3.28	8.6274	70	3.28	39.2873	275	3.28	2.8967
-130	3.28	9.1863	75	3.28	35.0698	280	3.28	2.7927
-125	3.28	9.7994	80	3.28	31.4469	285	3.28	2.6941
-120	3.28	10.4738	85	3.28	28.3195	290	3.28	2.6005
-115	3.28	11.2176	90	3.28	25.6070	295	3.28	2.5117
-110	3.28	12.0404	95	3.28	23.2434	300	3.28	2.4274
-105	3.28	12.9530	100	3.28	21.1746			
-100	3.28	13.9686	105	3.28	19.3559			


Maximum Electric Field Profile
(Centered on Tower)
Electric Field [kV/m]
Height of Conductors (feet)
Distance from Center of Tower (feet)
6.00
5.00
4.00
3.00
2.00
1.00
0.00
120
100
80
60
40
20
0
-500
-400
-300
-200
-100
0
100
200
300
400
500


Magnetic Flux Density Profile
(Centered on Tower)
Magnetic Flux Density [mGauss]
Height of Conductors (feet)
Distance from Center of Tower (feet)
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
-500
-400
-300
-200
-100
0
100
200
300
400
500

Appendix B Reference Data

B.1 PROJECT LAYOUT



Primary PV System Power Summary

Array Area	Inverter ID	AC Power (MW)	PV Module Rating (W)	Qty Of Modules	Qty of Strings	Qty 16-String Trackers	Qty 12-String Trackers	Qty 8-String Trackers	Qty 6-String Trackers	Qty 4-String Trackers	Qty 2-String Trackers	DC Power (MW)	DC/AC Ratio
1	INV-1	4.2	540	9,744	1624	73	14	22	14	0	14	5.26	1.25
	INV-2	4.2	540	9,600	1600	78	2	41	0	0	0	5.18	1.23
	INV-3	4.2	540	9,996	1666	83	2	31	11	0	0	5.40	1.29
	INV-4	4.2	540	9,996	1666	72	35	4	0	0	31	5.40	1.29
	INV-5	4.2	540	10,068	1678	71	39	0	0	0	37	5.44	1.29
	INV-6	4.2	540	10,080	1680	72	38	0	0	0	36	5.44	1.30
	INV-7	4.2	540	9,852	1642	88	17	0	0	0	15	5.32	1.27
	INV-8	4.2	540	9,648	1608	99	2	0	0	0	0	5.21	1.24
	INV-9	4.2	540	9,648	1608	96	6	0	0	0	0	5.21	1.24
	INV-10	4.2	540	9,648	1608	91	8	7	0	0	0	5.21	1.24
	INV-11	4.2	540	9,648	1608	61	38	22	0	0	0	5.21	1.24
	INV-12	4.2	540	8,904	1484	66	23	19	0	0	0	4.81	1.14
	INV-13	4.2	540	8,904	1484	67	31	5	0	0	0	4.81	1.14
	INV-14	4.2	540	9,312	1552	91	8	0	0	0	0	5.03	1.20
	INV-15	4.2	540	9,408	1568	83	10	15	0	0	0	5.08	1.21
	INV-16	4.2	540	9,528	1588	70	39	0	0	0	0	5.15	1.23
	INV-17	4.2	540	9,384	1564	70	37	0	0	0	0	5.07	1.21
	INV-18	4.2	540	10,032	1672	83	5	23	14	0	8	5.42	1.29
2	INV-19	2.52	540	6,360	1060	27	51	2	0	0	0	3.43	1.36
3	INV-20	4.2	540	12,336	2056	89	36	25	0	0	0	6.66	1.59
4	INV-21	4.2	540	8,664	1444	85	7	0	0	0	0	4.68	1.11
	INV-22	4.2	540	8,688	1448	87	4	1	0	0	0	4.69	1.12
	INV-23	4.2	540	8,784	1464	69	30	0	0	0	0	4.74	1.13
	INV-24	4.2	540	8,640	1440	70	16	16	0	0	0	4.67	1.11
5	INV-25	2.52	540	6,144	1024	54	12	2	0	0	0	3.32	1.32
	INV-26	2.52	540	6,120	1020	43	1	40	0	0	0	3.30	1.31
6	INV-27	4.2	540	8,760	1460	63	17	31	0	0	0	4.73	1.13
	INV-28	4.2	540	8,688	1448	55	38	14	0	0	0	4.69	1.12
7	INV-29	4.2	540	10,200	1700	95	7	12	0	0	0	5.51	1.31
	INV-30	4.2	540	10,128	1688	77	34	6	0	0	0	5.47	1.30
	INV-31	4.2	540	10,200	1700	94	9	11	0	0	0	5.51	1.31
	INV-32	4.2	540	10,272	1712	63	46	19	0	0	0	5.55	1.32
8	INV-33	4.2	540	8,676	1446	57	17	19	10	11	37	4.69	1.12
	INV-34	4.2	540	9,732	1622	84	6	12	0	0	55	5.26	1.25
9	INV-35	4.2	540	9,996	1666	99	2	5	0	0	9	5.40	1.29
	INV-36	4.2	540	9,096	1516	91	4	1	0	1	0	4.91	1.17
	INV-37	4.2	540	10,344	1724	94	8	7	6	4	8	5.59	1.33
	INV-38	4.2	540	9,864	1644	77	33	2	0	0	0	5.33	1.27
	INV-39	4.2	540	10,080	1680	98	3	2	0	0	30	5.44	1.30
	INV-40	4.2	540	10,188	1698	60	38	22	10	5	13	5.50	1.31
Total		162.96		375,360	62560	3045	773	438	65	21	293	202.69	1.35

LEGEND

EXISTING

- PARCEL
- RESIDENTIAL BUILDING
- ROAD
- OHE — OVERHEAD ELECTRICAL TRANSMISSION LINE
- OVERHEAD ELECTRICAL TRANSMISSION LINE EASEMENT
- HL — HAZARDOUS LIQUID PIPELINE
- HAZARDOUS LIQUID PIPELINE EASEMENT
- STREAM CENTERLINE
- FIELD DELINEATED WETLAND FARMED
- FIELD DELINEATED WETLAND NOT FARMED
- WATERBODY
- FIELD DELINEATED WATERWAY
- FEMA FLOODWAY
- FEMA FLOOD FRINGE

PROPOSED

- PROJECT BOUNDARY
- BUILDABLE AREA (PV ASSESTS)
- BUILDABLE AREA (FENCE AND ROAD)
- CHAIN LINK FENCE
- ACCESS ROAD
- PVCASE TRACKERS
- INVERTERS
- MV CABLES
- SUBSTATION
- LAYDOWN YARD
- STORMWATER DRAINAGE DITCH

N

0 800' 1600'

Stantec
209 Commerce Parkway
Cottage Grove, WI 53527
www.stantec.com

PRELIMINARY
NOT FOR CONSTRUCTION

CASTLE ROCK OVERALL PV LAYOUT

CASTLE ROCK SOLAR PROJECT
MATRIX RENEWABLES USA LLC
DAKOTA COUNTY, MINNESOTA

DATE OF ISSUANCE
August 2, 2024

NO.	REVISION	DATE

SURVEY	---
DRAWN	AMF
DESIGNED	DKJ
CHECKED	JMD
APPROVED	CRB
PROJ. NO.	193709215

SHEET NUMBER
E1.00

Plot Date: 08/02/2024 - 10:37 am
Drawing name: C:\Users\chandrews\AppData\Local\Temp\AcPublish_26120\193709215_electricalplans Option 1.dwg
Xref: Border, 193709215_EXST, 193709215_Layout, 193709215_CONSTRAINTS, 193709215_BMP

B.2 TYPICAL OVERHEAD COLLECTOR CIRCUIT STRUCTURE

TYPICAL 34.5 kV DEADEND

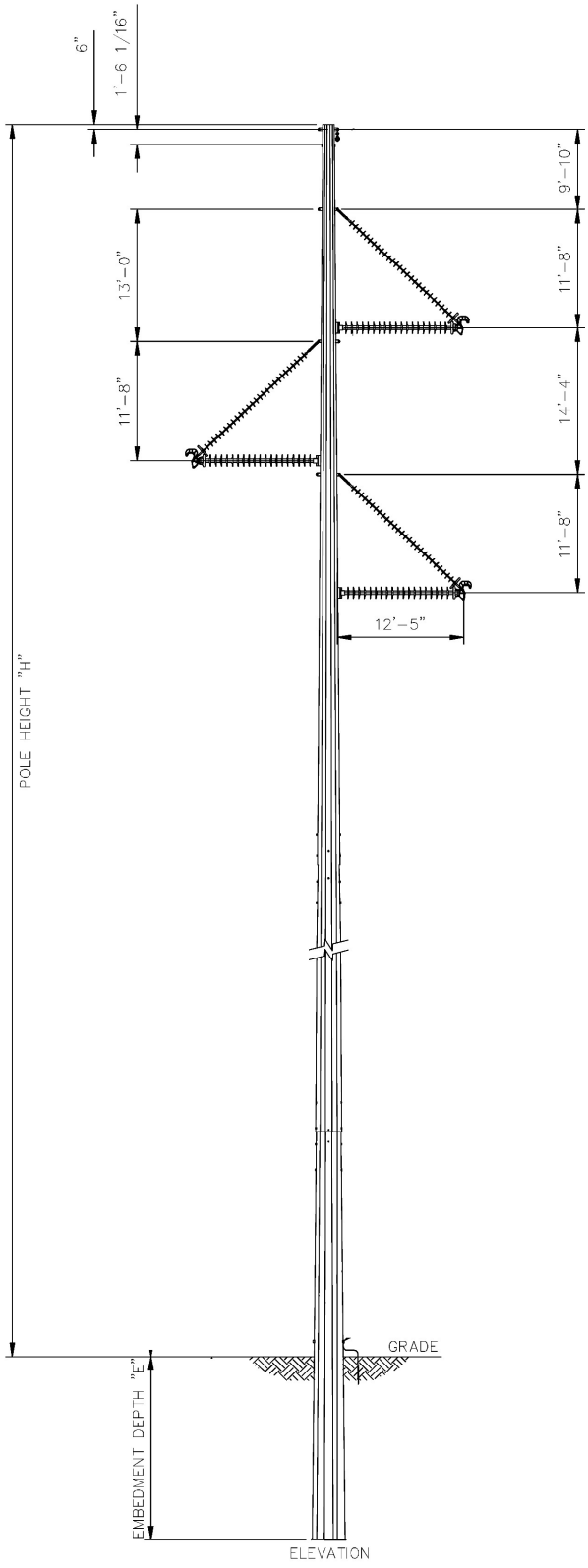
CUSTOM STEEL POLE/CONCRETE PIER

NOTES:

1. STRUCTURE DIMENSIONS BASED ON CONCEPTUAL DESIGN, SUBJECT TO CHANGE DURING DETAILED DESIGN.
2. ASSUMED CONDUCTOR: LINNET ACSR 336.4 KCMIL, ASSUMED OPGW: AC-86/646 ALUMACORE.
3. SPAN LENGTH = 1400 FT.

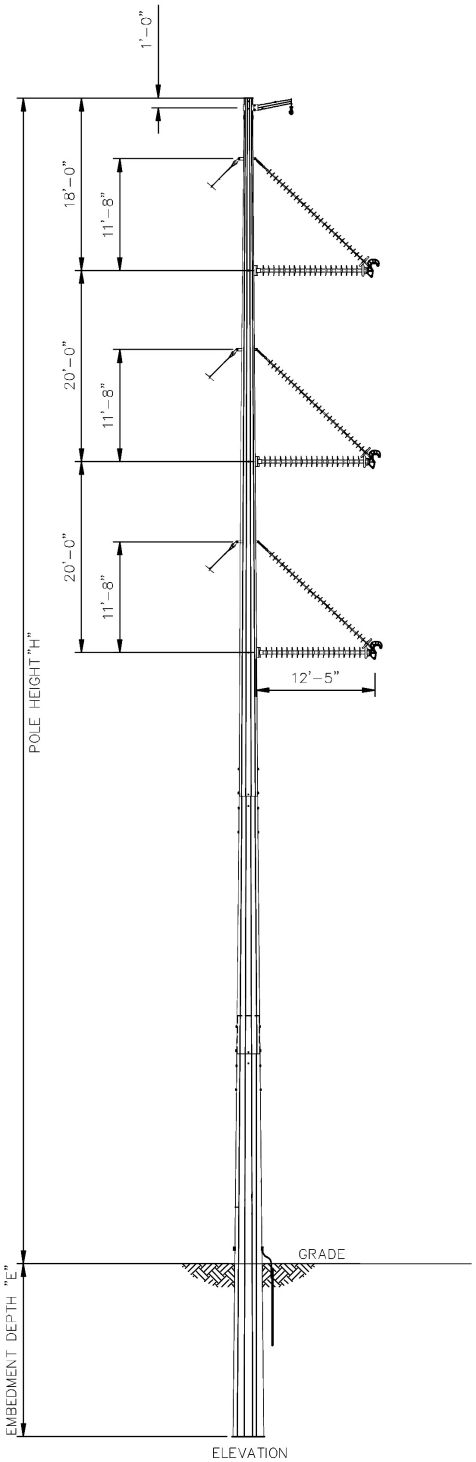
B.3 TYPICAL 345KV TOWER STRUCTURE

FOR REFERENCE ONLY



TANGENT STEEL POLE

FOR REFERENCE ONLY



RUNNING ANGLE STEEL POLE

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