SHADOW FLICKER MODELING REPORT

Dakota Range Wind Project
Codington & Grant Counties, South Dakota

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1.0 EXECUTIVE SUMMARY

The Dakota Range Wind Project (the Project) is a proposed wind power electric generation facility expected to consist of 72 wind turbines in Codington and Grant Counties, South Dakota. The Project is being developed by Apex Clean Energy, Inc. (Apex). Epsilon Associates, Inc. (Epsilon) has been retained by Apex to conduct a shadow flicker modeling study for the Project. This report presents results of the study.

Shadow flicker modeling was conservatively conducted for 97 Vestas V136-4.2 wind turbines, which includes 25 alternate wind turbine locations. The purpose of this analysis is to predict the expected annual durations of wind turbine shadow flicker at nearby occupied structures ("sensitive receptors"). The design goal of the Project is to not exceed the industry guideline of 30 hours per year of expected shadow flicker at any non-participating sensitive receptor.

The maximum expected annual duration of shadow flicker at a sensitive receptor resulting from the operation of the 72 proposed and 25 alternate wind turbines is 54 hours, 7 minutes. This receptor is a Project participant. The maximum expected annual duration of flicker at a non-participating receptor is 29 hours, 0 minutes. The modeling results are conservative in that modeling receptors were treated as structures with windows on all sides ("greenhouses") and the surrounding area was assumed to be without vegetation or structures ("bare earth").

2.0 INTRODUCTION

The Dakota Range Wind Project to be located in Codington and Grant Counties, South Dakota will consist of 72 Vestas wind turbines and an electrical substation. A total of 25 alternate wind turbine locations are also proposed for the Project. The wind turbines will be Vestas V136-4.2 serrated trailing edge blade units. The V136-4.2 wind turbines have a hub height of 82 meters and a rotor diameter of 136 meters. Figure 2-1 shows the locations of the 72 proposed and 25 alternate wind turbines over aerial imagery in Codington and Grant Counties.

With respect to wind turbines, shadow flicker can be defined as an intermittent change in the intensity of light in a given area resulting from the operation of a wind turbine due to its interaction with the sun. While indoors, an observer experiences repeated changes in the brightness of the room as shadows cast from the wind turbine blades briefly pass by windows as the blades rotate. In order for this to occur, the wind turbine must be operating, the sun must be shining, and the window must be within the shadow region of the wind turbine, otherwise there is no shadow flicker. A stationary wind turbine only generates a stationary shadow similar to any other structure.

Based on the current design and operation of typical modern wind turbines, shadow flicker impacts are generally an annoyance issue and not a health effects concern. Often the public is concerned about the possibility of epileptic seizures being caused by shadow flicker. According to the Epilepsy Foundation, "Generally, flashing lights most likely to trigger seizures are between the frequency of 5 to 30 flashes per second (Hertz)."[1] The wind turbines for this Project have a maximum rotational speed of 10.4 rpm which corresponds to a shadow flicker frequency of 0.5 Hz. This frequency is well below the frequency identified by the Epilepsy Foundation; therefore, the triggering of epileptic seizures is not a concern with this Project.

This report presents the findings of a shadow flicker modeling study for the Project. The wind turbines were modeled with the WindPRO software package using information provided by Apex. The expected annual duration of shadow flicker was calculated at sensitive receptor points and shadow flicker isolines for the area surrounding the Project were generated. The results of the modeling are found within this report.

[1] Epilepsy Foundation, http://www.epilepsy.com/learn/triggers-seizures/photosensitivity-and-seizures. Accessed in December 2017.

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LEGEND

Wind Turbine

Scale 1:66,000
1 inch = 5,500 feet

0 2,750 5,500 Feet

Basemap: Bing Aerial Imagery

Grant County

Codington County

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Dakota Range Wind **Grant County/Codington County, South Dakota**

Figure 2-1
Aerial Locus

3.0 SHADOW FLICKER MODELING

3.1 Modeling Methodology

Shadow flicker was modeled using a software package, WindPRO version 3.1.617. WindPRO is a software suite developed by EMD International A/S and is used for assessing potential environmental impacts from wind turbines. Using the Shadow module within WindPRO, worst-case shadow flicker in the area surrounding the wind turbines was calculated based on data inputs including: location of the wind turbines, location of discrete receptor points, wind turbine dimensions, flicker calculation limits, and terrain data. Based on these data, the model was able to incorporate the appropriate sun angle and maximum daily sunlight for this latitude into the calculations. The resulting worst-case calculations assume that the sun is always shining during daylight hours and that the wind turbine is always operating. The WindPRO Shadow module can be further refined by incorporating sunshine probabilities and wind turbine operational estimates by wind direction over the course of a year. The values produced by this further refinement, also known as the "expected" shadow flicker, are presented in this section.

The proposed wind turbine layout for the Project dated December 18, 2017 was provided by Apex. Of the 97 conservatively modeled wind turbines, 25 are alternative wind turbine locations. Locations of the turbines are shown in Figure 3-1 and the coordinates are provided in Appendix A. All wind turbines are proposed to be Vestas V136-4.2 units with an 82 meter hub height and a 136 meter rotor diameter. Each wind turbine has the following characteristics based on the technical data provided by Apex or by WindPRO:

		Vestas V136-4.0
♦ Rated Power	=	4,200 kW
♦ Hub Height	=	82 meters
♦ Rotor Diameter	=	136 meters
♦ Cut-in Wind Speed	=	3 m/s
♦ Cut-out Wind Speed	=	25 m/s
♦ Maximum RPM	=	10.4 rpm

To-date, there are no federal, state, or local regulations regarding the maximum radial distance from a wind turbine to which shadow flicker should be analyzed applicable to this Project. In the United States, shadow flicker is commonly evaluated out to a distance of ten times the rotor diameter. According to the Massachusetts Model Bylaw for wind energy facilities, shadow flicker impacts are minimal at and beyond a distance of ten rotor diameters.[2] Defining the shadow flicker calculation area has also been addressed in Europe where the ten times rotor diameter approach has been accepted in multiple European

[2] Massachusetts Department of Energy Resources, "Model As-of-Right Zoning Ordinance or Bylaw: Allowing Use of Wind Energy Facilities" 2009.

countries.[3] Some jurisdictions conservatively require a larger calculation area. The New Hampshire Site Evaluation Committee through rulemaking docket 2014-04 adopted rules on December 15, 2015 outlining application requirements and criteria for energy facilities, including wind energy facilities. As part of these revised regulations, Site 301.08(a)(2) requires an evaluation distance of at least 1 mile from a wind turbine.[4] Section 16-50j-94, part (g), of the Regulations of Connecticut State Agencies identifies the components required in a shadow flicker evaluation report which includes the calculation of shadow flicker from each proposed wind turbine to any off-site occupied structure within a 1.25 mile radius.[5] For this Project, ten times the rotor diameter of the proposed wind turbine corresponds to a distance of 0.85 miles (1,360 m). Conservatively, this analysis follows the Connecticut guidance and includes shadow flicker calculations out to 1.25 miles (2,012 m) from each wind turbine in the model for the proposed layout. This is a conservative assumption because the shadows are likely to be diffused significantly beyond a distance of ten rotor diameters.

A modeling receptor dataset with participation status information dated November 17, 2017 was provided by Apex. Only receptors within 5 miles of any wind turbine were included in the model, which accommodates the 1.25-mile calculation extent. These sensitive receptors were modeled as discrete points and are shown on Figure 3-1. Each modeling point was assumed to have a window facing all directions ("greenhouse" mode) which yields conservative results. In addition, a dataset containing parcel boundaries and lease status dated November 10, 2017 was provided by Apex. Parcels identified as "agreement signed" were included as participating and are identified on Figure 3-1. The model was set to limit calculations to 2,012 meters from a wind turbine, the equivalent of 1.25 miles. Consequently, shadow flicker at any of the 189 modeling receptors greater than the corresponding limitation distance from a wind turbine was zero. In addition to modeling discrete points, shadow flicker was calculated at grid points in the area surrounding the modeled wind turbines to generate flicker isolines. A 10-meter spacing was used for this grid.

The terrain height contour elevations for the modeling domain were generated from elevation information derived from the National Elevation Dataset (NED) developed by the U.S. Geological Survey. Conservatively, obstacles, i.e. buildings and vegetation, were excluded from the analysis. This is effectively a "bare earth" scenario which is

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[3] Parsons Brinckerhoff, "Update of UK Shadow Flicker Evidence Base" Prepared for Department of Energy and Climate Change, 2011.

[4] State of New Hampshire Site Evaluation Committee Site 300 Rules (2015), available at http://www.gencourt.state.nh.us/rules/state_agencies/site100-300.html Accessed in October 2017.

[5] State of Connecticut CSC Wind Regulations (2014), available at https://www.cga.ct.gov/aspx/CGARegulations/CGARegulations.aspx?Yr=2014&Reg=2012-054&Amd=E Accessed in October 2017.

conservative. When accounted for in the shadow flicker calculations, such obstacles may significantly mitigate or eliminate the flicker effect depending on their size, type, and location. In addition, shadow flicker durations were calculated only when the angle of the sun was at least 3° above the horizon.

Monthly sunshine probability values were input for each month from January to December. These numbers were obtained from a publicly available historical dataset for Huron, South Dakota from the National Oceanic and Atmospheric Administration's (NOAA) National Centers for Environmental Information (NCEI).[6] Table 3-1 shows the percentage of sunshine hours by month used in the shadow flicker modeling. These values are the percentages that the sun is expected to be shining during daylight hours.

The number of hours the wind turbines are expected to operate for the 16 cardinal wind directions was input into the model. Wind direction frequency percentages for operational wind speeds (using wind data scaled to an 82-meter height) were provided by Apex from meteorological data collected at an onsite tower over no less than 1 year. Using the percentage of wind data annually below cut-in wind speed, Epsilon calculated the number of operational hours per wind direction sector. These hours per wind direction sector are used by WindPRO to estimate the "wind direction" and "operation time" reduction factors. Based on this dataset, the wind turbines would operate 96% of the year due to cut-in and cut-out specifications of the proposed unit. Table 3-2 shows the distribution of operational hours for the 16 wind directions.

[6] NCEI (formerly NCDC), http://www1.ncdc.noaa.gov/pub/data/ccd-data/pctpos15.txt. Accessed in December 2017.

Table 3-1 Monthly Percent of Possible Sunshine

Month	Possible Sunshine
January	62%
February	62%
March	62%
April	59%
May	66%
June	69%
July	76%
August	74%
September	69%
October	59%
November	51%
December	51%

Table 3-2 Operational Hours per Wind Direction Sector

Wind Sector	Operational Hours
N	556
NNE	556
NE	324
ENE	284
E	272
ESE	414
SE	411
SSE	562
S	777
SSW	629
SW	408
WSW	387
W	518
WNW	803
NW	796
NNW	721
Annual	8,418

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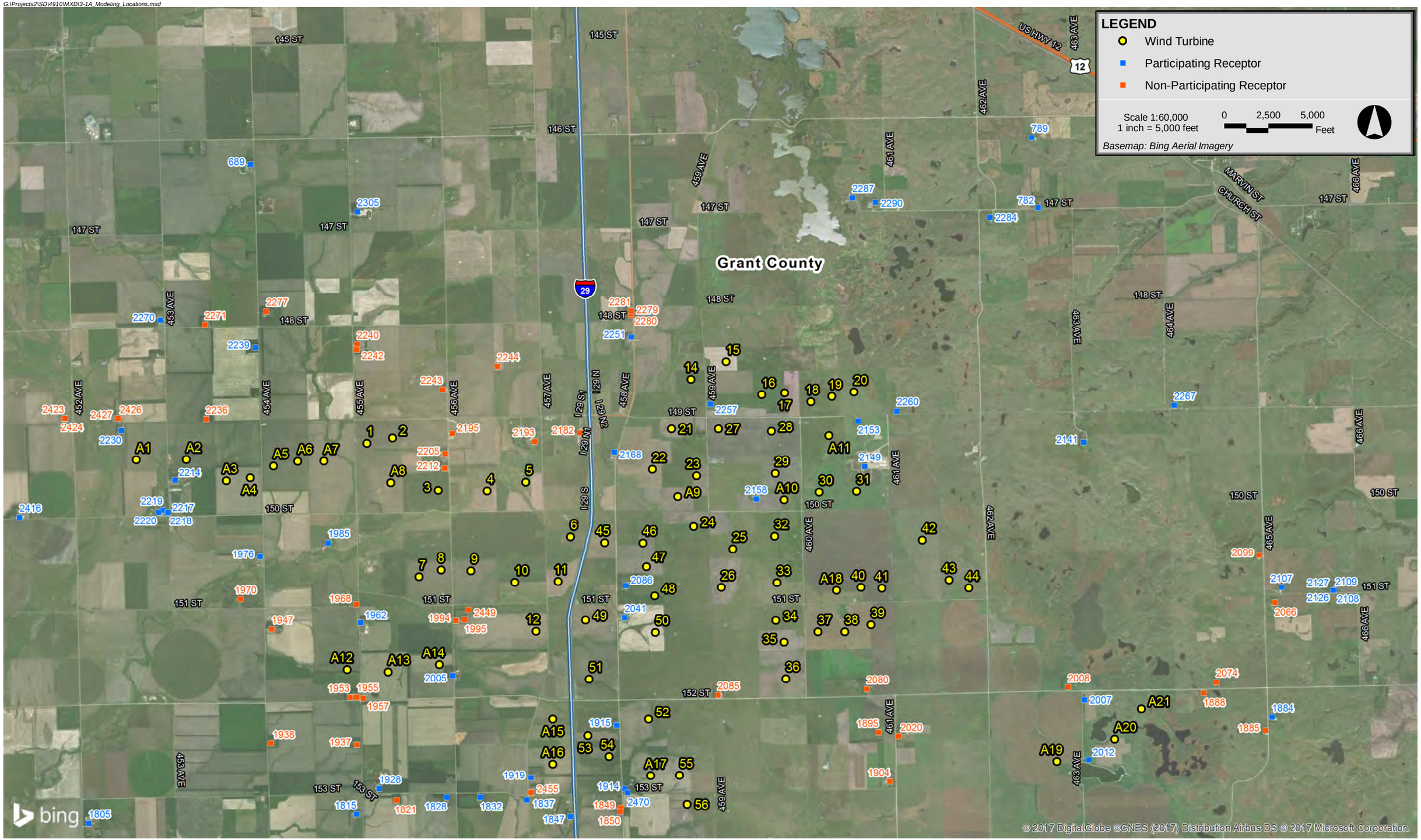

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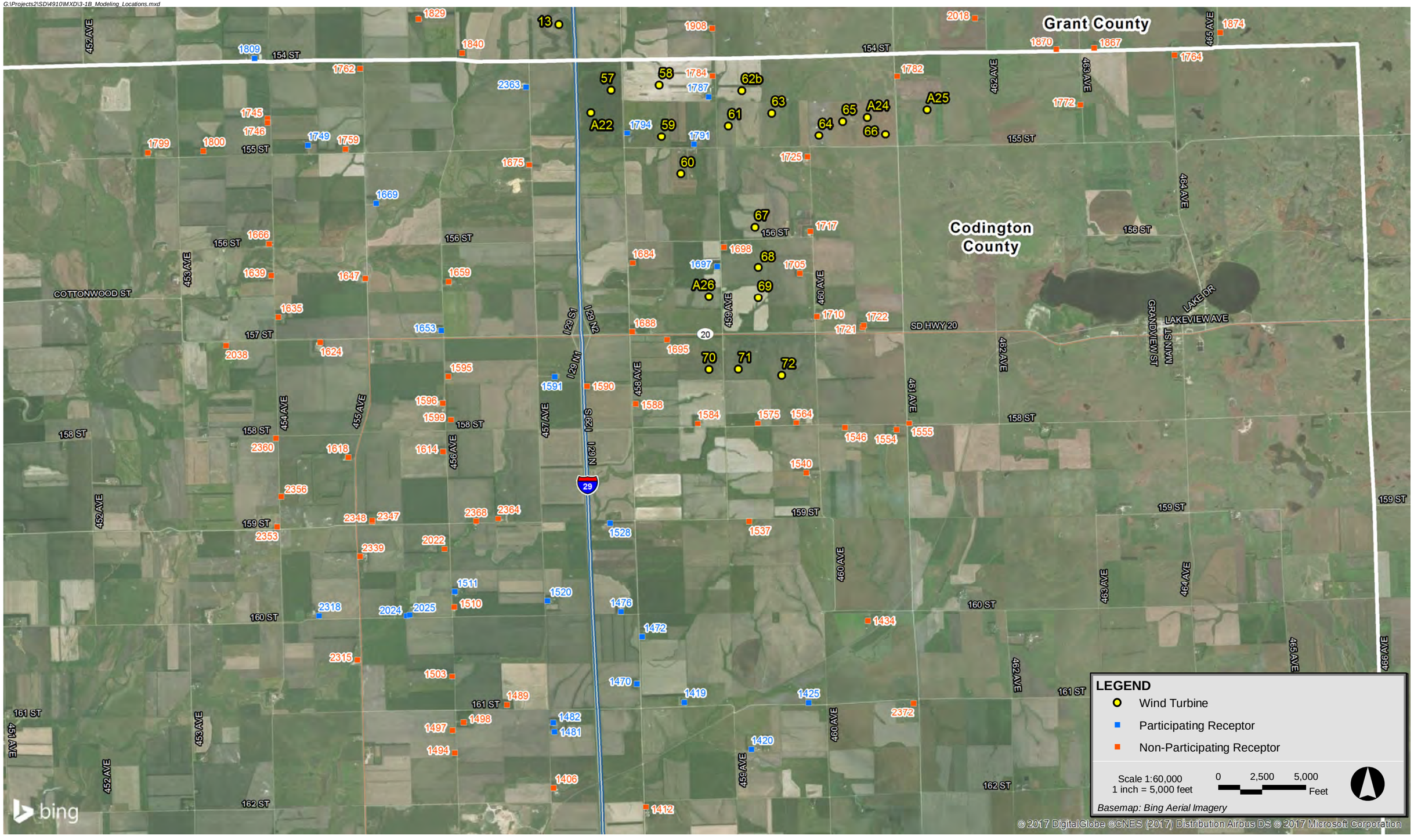

Dakota Range Wind **Grant County/Codington County, South Dakota**

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Figure 3-1B

Shadow Flicker Modeling Locations

3.2 Results

Following the modeling methodology outlined in Section 3.1, WindPRO was used to calculate shadow flicker at the 189 discrete modeling points in Codington and Grant Counties and generate shadow flicker isolines based on the grid calculations.

Table B-1 in Appendix B presents the modeling results for the 189 modeling receptor locations. The predicted expected annual shadow flicker duration ranged from 0 hours, 0 minutes per year to 54 hours, 7 minutes per year. The majority of the sensitive receptors (110) were predicted to experience no annual shadow flicker. 48 locations were predicted to experience some shadow flicker but less than 10 hours per year. The modeling results showed that 20 locations would be expected to have 10 to 30 hours of shadow flicker per year while 11 locations would be expected to have over 30 hours of shadow flicker per year. All of these 11 locations are participating receptors. Figure 3-2 displays the modeled flicker isolines over aerial imagery in relation to modeled wind turbines and sensitive receptors.

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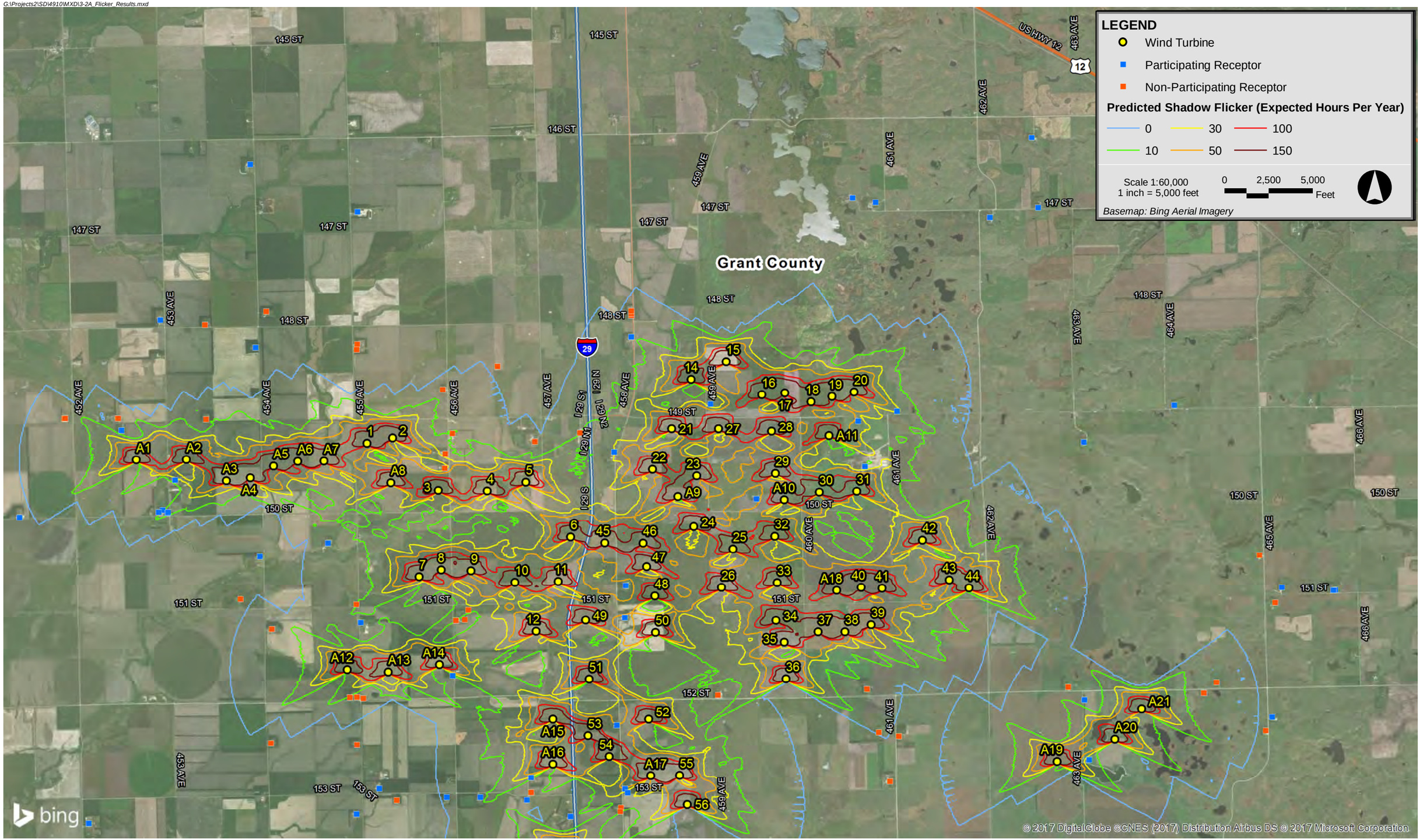

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Figure 3-2A
Shadow Flicker Modeling Results

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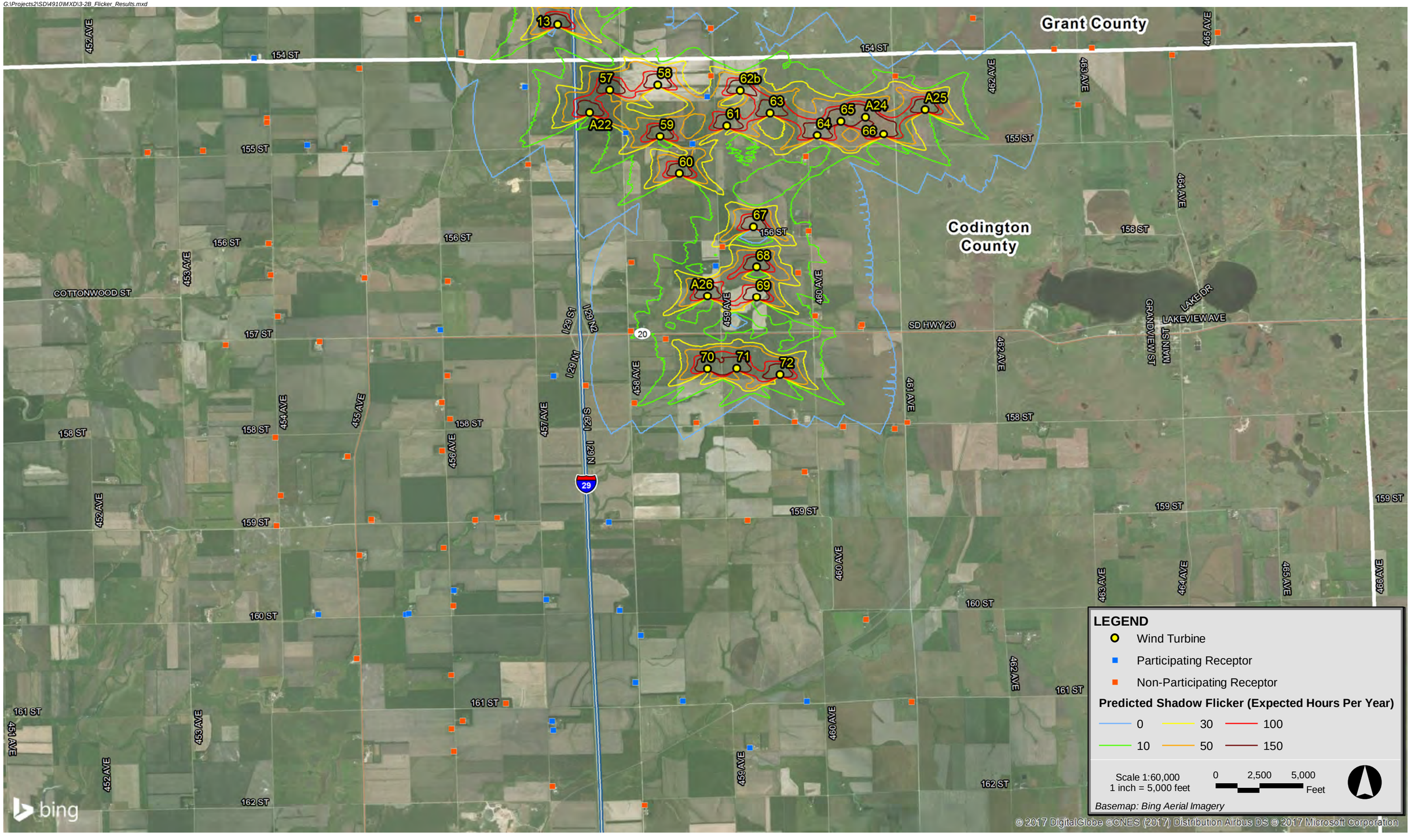

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Figure 3-2B
Shadow Flicker Modeling Results

4.0 CONCLUSIONS

A shadow flicker analysis was conducted to determine the duration of shadow flicker in the vicinity of the proposed Dakota Range Wind Project within Codington and Grant Counties, SD. Shadow flicker resulting from the operation of the proposed wind turbine layout and alternate wind turbine locations was calculated at 189 occupied structures, and isolines were generated from a grid encompassing the area surrounding the wind turbines.

The shadow flicker design goal at non-participating occupied structures is 30 hours per year. The maximum expected annual duration of shadow flicker at a modeling receptor is 54 hours, 7 minutes. This receptor is a Project participant. The maximum expected annual duration of flicker at a non-participating receptor is 29 hours, 0 minutes. Therefore, the Project design goal is met. The modeling results are conservative in that modeling receptors were treated as structures with windows on all sides ("greenhouses") and the surrounding area was assumed to be without vegetation or structures ("bare earth").

Appendix A
Wind Turbine Coordinates

Table A-1: Wind Turbine Coordinates

Wind Turbine ID	Coordinates NAD83 UTM Zone 14N (meters)	
	X (Easting)	Y (Northing)
1	649150.68	5009210.55
2	649592.64	5009301.39
3	650382.14	5008394.08
4	651221.24	5008388.66
5	651887.81	5008536.33
6	652659.21	5007595.70
7	650048.07	5006906.21
8	650429.11	5007023.84
9	650941.68	5007007.69
10	651702.10	5006813.09
11	652445.44	5006824.28
12	652067.96	5005967.41
13	652508.47	5002155.46
14	654738.65	5010309.74
15	655342.56	5010617.87
16	655959.75	5010046.16
17	656353.73	5010078.42
18	656807.12	5009925.65
19	657165.19	5010016.56
20	657545.03	5010093.22
21	654403.27	5009456.11
22	654073.85	5008759.99
23	654834.57	5008649.35
24	654782.01	5007771.84
25	655461.81	5007386.09
26	655262.58	5006726.86
27	655209.73	5009458.69
28	656123.54	5009415.49
29	656190.63	5008691.29
30	656948.30	5008364.53
31	657593.24	5008379.77
32	656181.41	5007604.26
33	656220.17	5006808.38
34	656202.73	5006154.17
35	656341.29	5005779.24
36	656373.09	5005145.37
37	656928.93	5005957.45
38	657387.82	5005959.70
39	657839.76	5006079.27
40	657670.73	5006726.57
41	658031.93	5006708.57

Note: "A" at the front of the wind turbine ID indicates an alternate location.

Table A-1: Wind Turbine Coordinates

Wind Turbine ID	Coordinates NAD83 UTM Zone 14N (meters)	
	X (Easting)	Y (Northing)
42	658728.18	5007539.26
43	659189.32	5006853.26
44	659530.88	5006717.26
45	653250.85	5007492.28
46	653912.36	5007486.35
47	653971.67	5007079.89
48	654112.53	5006577.23
49	652919.63	5006162.99
50	654125.10	5005948.82
51	652979.75	5005140.46
52	654007.77	5004448.60
53	652959.73	5004165.46
54	653326.71	5003802.14
55	654539.43	5003479.34
56	654671.50	5002980.82
57	653412.66	5001019.09
58	654243.67	5001103.58
59	654285.80	5000211.18
60	654621.54	4999566.28
61	655443.20	5000399.81
62b	655678.86	5001007.79
63	656197.91	5000617.81
64	657012.96	5000231.13
65	657424.44	5000476.02
66	658166.89	5000251.64
67	655906.42	4998639.32
68	655964.72	4997936.95
69	655962.56	4997416.19
70	655110.53	4996175.39
71	655618.94	4996179.18
72	656367.12	4996073.95
A1	645172.45	5008926.68
A2	646038.25	5008927.64
A3	646726.68	5008563.81
A4	647137.99	5008616.63
A5	647539.89	5008820.59
A6	647956.98	5008901.81
A7	648409.37	5008903.36
A8	649560.48	5008528.49
A9	654509.77	5008288.83
A10	656345.65	5008235.30

Note: "A" at the front of the wind turbine ID indicates an alternate location.

Table A-1: Wind Turbine Coordinates

Wind Turbine ID	Coordinates NAD83 UTM Zone 14N (meters)	
	X (Easting)	Y (Northing)
A11	657114.06	5009343.43
A12	648810.69	5005302.13
A13	649516.40	5005259.92
A14	650398.22	5005389.99
A15	652354.92	5004448.62
A16	652353.57	5003672.36
A17	654041.01	5003475.27
A18	657249.87	5006672.81
A19	661049.92	5003716.42
A20	662041.92	5004103.34
A21	662506.37	5004630.35
A22	653061.13	5000624.85
A24	657850.58	5000545.83
A25	658890.90	5000677.60
A26	655109.25	4997437.35

Note: "A" at the front of the wind turbine ID indicates an alternate location.

Appendix B
Shadow Flicker Modeling Results: Sensitive Receptors

Table B-1: Shadow Flicker Modeling Results at Sensitive Receptors

Modeling ID	Participation Status	County	Coordinates NAD83 UTM Zone 14N (meters)		Expected Shadow Flicker Hours per Year
			X (Easting)	Y (Northing)	(HH:MM/year)
689	Participating	Grant	647139.01	5014024.33	0:00
782	Participating	Grant	660720.97	5013271.92	0:00
789	Participating	Grant	660610.61	5014484.49	0:00
1406	Non-Participating	Codington	652415.58	4988918.69	0:00
1412	Non-Participating	Codington	654015.11	4988590.25	0:00
1419	Participating	Codington	654681.58	4990406.38	0:00
1420	Participating	Codington	655846.86	4989588.29	0:00
1425	Participating	Codington	656834.67	4990400.04	0:00
1434	Non-Participating	Codington	657862.31	4991817.05	0:00
1470	Participating	Codington	653857.99	4990720.09	0:00
1472	Participating	Codington	653950.59	4991543.64	0:00
1476	Participating	Codington	653587.51	4991975.31	0:00
1481	Participating	Codington	652432.12	4989894.34	0:00
1482	Participating	Codington	652413.64	4990050.68	0:00
1489	Non-Participating	Codington	651609.43	4990364.76	0:00
1494	Non-Participating	Codington	650703.87	4989527.33	0:00
1497	Non-Participating	Codington	650662.06	4989915.49	0:00
1498	Non-Participating	Codington	650856.93	4990053.74	0:00
1503	Non-Participating	Codington	650657.74	4990852.72	0:00
1510	Non-Participating	Codington	650692.61	4992057.70	0:00
1511	Participating	Codington	650706.98	4992320.66	0:00
1520	Participating	Codington	652311.29	4992164.18	0:00
1528	Participating	Codington	653394.86	4993505.03	0:00
1537	Non-Participating	Codington	655804.37	4993535.65	0:00
1540	Non-Participating	Codington	656798.10	4994383.05	0:00
1546	Non-Participating	Codington	657464.70	4995163.56	0:00
1554	Non-Participating	Codington	658362.21	4995127.56	0:00
1555	Non-Participating	Codington	658578.51	4995244.25	0:00
1564	Non-Participating	Codington	656621.54	4995250.50	0:00
1575	Non-Participating	Codington	655954.93	4995240.17	0:00
1584	Non-Participating	Codington	654917.16	4995237.31	4:26
1588	Non-Participating	Codington	653838.26	4995578.48	6:06
1590	Non-Participating	Codington	652995.68	4995885.56	0:00
1591	Participating	Codington	652436.54	4996047.89	0:00
1595	Non-Participating	Codington	650593.29	4996054.48	0:00
1596	Non-Participating	Codington	650496.01	4995587.28	0:00
1599	Non-Participating	Codington	650636.90	4995303.04	0:00
1614	Non-Participating	Codington	650501.55	4994753.62	0:00
1618	Non-Participating	Codington	648862.47	4994649.83	0:00
1624	Non-Participating	Codington	648375.40	4996645.46	0:00
1635	Non-Participating	Codington	647647.95	4997080.29	0:00
1639	Non-Participating	Codington	647523.41	4997799.99	0:00
1647	Non-Participating	Codington	649154.79	4997753.24	0:00
1653	Participating	Codington	650473.00	4996848.32	0:00
1659	Non-Participating	Codington	650595.55	4997697.39	0:00
1666	Non-Participating	Codington	647488.92	4998352.98	0:00

Table B-1: Shadow Flicker Modeling Results at Sensitive Receptors

Modeling ID	Participation Status	County	Coordinates NAD83 UTM Zone 14N (meters)		Expected Shadow Flicker Hours per Year
			X (Easting)	Y (Northing)	(HH:MM/year)
1669	Participating	Codington	649340.75	4999049.86	0:00
1675	Non-Participating	Codington	651994.47	4999721.14	0:00
1684	Non-Participating	Codington	653787.02	4998022.59	2:14
1688	Non-Participating	Codington	653778.28	4996825.57	7:24
1695	Non-Participating	Codington	654384.51	4996687.82	20:07
1697	Participating	Codington	655253.74	4997956.71	24:47
1698	Non-Participating	Codington	655368.87	4998297.41	26:52
1705	Non-Participating	Codington	656685.45	4997836.26	20:21
1710	Non-Participating	Codington	656976.54	4997093.04	8:25
1717	Non-Participating	Codington	656867.97	4998569.91	9:53
1721	Non-Participating	Codington	657770.19	4996904.04	1:42
1722	Non-Participating	Codington	657792.58	4996940.40	1:35
1725	Non-Participating	Codington	656815.87	4999863.27	7:53
1745	Non-Participating	Codington	647461.13	5000525.45	0:00
1746	Non-Participating	Codington	647456.46	5000456.03	0:00
1749	Participating	Codington	648159.89	5000058.41	0:00
1759	Non-Participating	Codington	648809.41	4999992.49	0:00
1762	Non-Participating	Codington	649063.96	5001386.23	0:00
1764	Non-Participating	Codington	663178.63	5001621.05	0:00
1772	Non-Participating	Codington	661543.34	5000761.33	0:00
1782	Non-Participating	Codington	658372.24	5001257.48	13:30
1784	Non-Participating	Codington	655170.00	5001262.14	29:00
1787	Participating	Codington	655103.41	5000902.29	46:13
1791	Participating	Codington	654852.45	5000075.99	52:26
1794	Participating	Codington	653692.68	5000273.03	37:41
1799	Non-Participating	Codington	645387.42	4999931.96	0:00
1800	Non-Participating	Codington	646345.40	4999959.62	0:00
1805	Participating	Grant	644356.98	5002651.43	0:00
1809	Participating	Grant	647235.37	5001567.12	0:00
1815	Participating	Grant	648970.50	5002809.01	0:00
1821	Non-Participating	Grant	649665.32	5003050.76	0:00
1828	Participating	Grant	650524.49	5003103.91	0:49
1829	Non-Participating	Grant	650075.00	5002248.60	0:00
1832	Participating	Grant	651107.55	5003102.45	6:22
1837	Participating	Grant	651909.87	5003057.90	5:06
1840	Non-Participating	Grant	650832.97	5001658.43	1:26
1847	Participating	Grant	652660.85	5002765.85	5:42
1849	Non-Participating	Grant	653530.94	5002924.70	16:52
1850	Non-Participating	Grant	653518.23	5002856.66	11:30
1867	Non-Participating	Grant	661784.38	5001742.15	0:00
1870	Non-Participating	Grant	661126.69	5001722.46	0:00
1874	Non-Participating	Grant	663970.35	5002019.97	0:00
1884	Participating	Grant	664755.72	5004486.66	0:00
1885	Non-Participating	Grant	664644.10	5004250.93	0:00
1888	Non-Participating	Grant	663576.49	5004901.72	4:18
1895	Non-Participating	Grant	657975.48	5004220.64	1:00

Table B-1: Shadow Flicker Modeling Results at Sensitive Receptors

Modeling ID	Participation Status	County	Coordinates NAD83 UTM Zone 14N (meters)		Expected Shadow Flicker Hours per Year
			X (Easting)	Y (Northing)	(HH:MM/year)
1904	Non-Participating	Grant	658164.88	5003370.45	0:00
1908	Non-Participating	Grant	655165.86	5002087.27	0:00
1914	Participating	Grant	653600.45	5003245.37	44:03
1915	Participating	Grant	653456.51	5004343.87	54:07
1919	Participating	Grant	651979.07	5003440.36	20:23
1928	Participating	Grant	649363.69	5003248.44	0:00
1937	Non-Participating	Grant	648977.78	5004008.60	0:00
1938	Non-Participating	Grant	647494.42	5004033.38	0:00
1947	Non-Participating	Grant	647511.12	5006001.75	2:50
1953	Non-Participating	Grant	648855.29	5004824.59	6:19
1955	Non-Participating	Grant	648976.90	5004831.73	2:08
1957	Non-Participating	Grant	649090.23	5004809.12	3:01
1962	Participating	Grant	649045.78	5006117.82	2:54
1968	Non-Participating	Grant	648969.51	5006429.63	10:20
1970	Non-Participating	Grant	646968.92	5006520.98	0:00
1976	Participating	Grant	647303.97	5007251.04	0:00
1985	Participating	Grant	648480.56	5007489.68	2:08
1994	Non-Participating	Grant	650684.64	5006150.39	9:28
1995	Non-Participating	Grant	650837.63	5006168.70	6:45
2005	Participating	Grant	650626.79	5005202.02	8:00
2007	Participating	Grant	661518.31	5004784.40	4:13
2008	Non-Participating	Grant	661242.84	5005002.70	2:05
2012	Participating	Grant	661599.97	5003749.29	18:52
2018	Non-Participating	Grant	659717.08	5002264.17	0:00
2020	Non-Participating	Grant	658319.47	5004153.08	0:00
2022	Non-Participating	Codington	650528.30	4993061.83	0:00
2024	Participating	Codington	649871.67	4991903.75	0:00
2025	Participating	Codington	649921.89	4991917.62	0:00
2038	Non-Participating	Codington	646743.98	4996587.90	0:00
2041	Participating	Grant	653593.66	5006201.50	37:43
2066	Non-Participating	Grant	664805.69	5006459.59	0:00
2074	Non-Participating	Grant	663797.17	5005085.81	2:26
2080	Non-Participating	Grant	657770.35	5004970.01	4:17
2085	Non-Participating	Grant	655202.17	5004865.99	5:10
2086	Participating	Grant	653612.64	5006755.67	39:11
2099	Non-Participating	Grant	664537.21	5007281.04	0:00
2107	Participating	Grant	664924.28	5006725.78	0:00
2108	Participating	Grant	665843.59	5006677.49	0:00
2109	Participating	Grant	665811.13	5006675.75	0:00
2126	Participating	Grant	665811.13	5006675.75	0:00
2127	Participating	Grant	665811.13	5006675.75	0:00
2141	Participating	Grant	661510.62	5009229.70	0:00
2149	Participating	Grant	657734.58	5008810.13	16:19
2153	Participating	Grant	657618.71	5009594.79	44:57
2158	Participating	Grant	655865.10	5008248.23	44:59
2168	Participating	Grant	653411.62	5009060.41	30:49

Table B-1: Shadow Flicker Modeling Results at Sensitive Receptors

Modeling ID	Participation Status	County	Coordinates NAD83 UTM Zone 14N (meters)		Expected Shadow Flicker Hours per Year
			X (Easting)	Y (Northing)	(HH:MM/year)
2182	Non-Participating	Grant	652821.24	5009387.00	9:17
2193	Non-Participating	Grant	652045.23	5009239.11	1:20
2195	Non-Participating	Grant	650621.29	5009376.36	10:13
2205	Non-Participating	Grant	650503.26	5009033.74	23:31
2212	Non-Participating	Grant	650493.66	5008776.86	24:51
2214	Participating	Grant	645840.98	5008574.90	22:40
2217	Participating	Grant	645708.61	5008004.25	12:55
2218	Participating	Grant	645720.53	5008021.46	13:46
2219	Participating	Grant	645631.03	5008056.63	9:18
2220	Participating	Grant	645560.46	5008023.00	7:38
2230	Participating	Grant	644920.93	5009426.30	3:13
2236	Non-Participating	Grant	646374.72	5009624.58	8:17
2239	Participating	Grant	647229.03	5010859.63	0:00
2240	Non-Participating	Grant	648982.24	5010914.63	0:00
2242	Non-Participating	Grant	648974.09	5010822.91	0:00
2243	Non-Participating	Grant	650458.09	5010135.55	4:16
2244	Non-Participating	Grant	651399.84	5010537.19	0:00
2251	Participating	Grant	653709.32	5011041.66	7:46
2257	Participating	Grant	655074.36	5009886.86	21:40
2260	Participating	Grant	658287.22	5009765.21	32:47
2267	Participating	Grant	663067.37	5009863.43	0:00
2270	Participating	Grant	645591.52	5011330.52	0:00
2271	Non-Participating	Grant	646356.26	5011253.61	0:00
2277	Non-Participating	Grant	647415.35	5011482.18	0:00
2279	Non-Participating	Grant	653707.33	5011412.61	1:02
2280	Non-Participating	Grant	653706.52	5011445.93	1:02
2281	Non-Participating	Grant	653705.48	5011488.76	1:02
2284	Participating	Grant	659888.06	5013103.47	0:00
2287	Participating	Grant	657521.45	5013443.09	0:00
2290	Participating	Grant	657917.63	5013363.29	0:00
2305	Participating	Grant	648987.99	5013202.15	0:00
2315	Non-Participating	Codington	649018.76	4991138.66	0:00
2318	Participating	Codington	648352.31	4991902.58	0:00
2339	Non-Participating	Codington	649064.44	4992930.45	0:00
2347	Non-Participating	Codington	649279.70	4993533.72	0:00
2348	Non-Participating	Codington	649271.45	4993557.43	0:00
2353	Non-Participating	Codington	647627.18	4993444.66	0:00
2356	Non-Participating	Codington	647698.06	4993969.91	0:00
2360	Non-Participating	Codington	647604.47	4994983.66	0:00
2363	Participating	Codington	651937.86	5001067.18	5:26
2364	Non-Participating	Codington	651457.46	4993586.61	0:00
2368	Non-Participating	Codington	651076.00	4993539.97	0:00
2372	Non-Participating	Codington	658654.33	4990392.79	0:00
2416	Participating	Grant	643160.20	5007930.05	0:00
2423	Non-Participating	Grant	643933.96	5009635.42	3:00
2424	Non-Participating	Grant	643946.39	5009641.33	3:08

Table B-1: Shadow Flicker Modeling Results at Sensitive Receptors

Modeling ID	Participation Status	County	Coordinates NAD83 UTM Zone 14N (meters)		Expected Shadow Flicker Hours per Year
			X (Easting)	Y (Northing)	(HH:MM/year)
2426	Non-Participating	Grant	644853.33	5009638.98	2:55
2427	Non-Participating	Grant	644862.14	5009641.30	3:01
2449	Non-Participating	Grant	650900.06	5006334.22	16:00
2455	Non-Participating	Grant	651981.94	5003185.29	3:56
2470	Participating	Grant	653647.87	5003180.53	19:05