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 84 Vestas V136-4.2 wind turbines, which includes 12 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 12 alternate wind turbines is 54 hours, 8 minutes. This receptor is a Project participant. The maximum expected annual duration of flicker at a non-participating receptor is 27 hours, 25 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").

Since the initial shadow flicker report, dated January 5, 2018, changes have been made to the proposed layout including the locations and the quantity of wind turbines. The conclusions of both reports are the same in that the amount of expect annual shadow flicker at all non-participating receptors is below 30 hours per year.

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. A total of 12 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 12 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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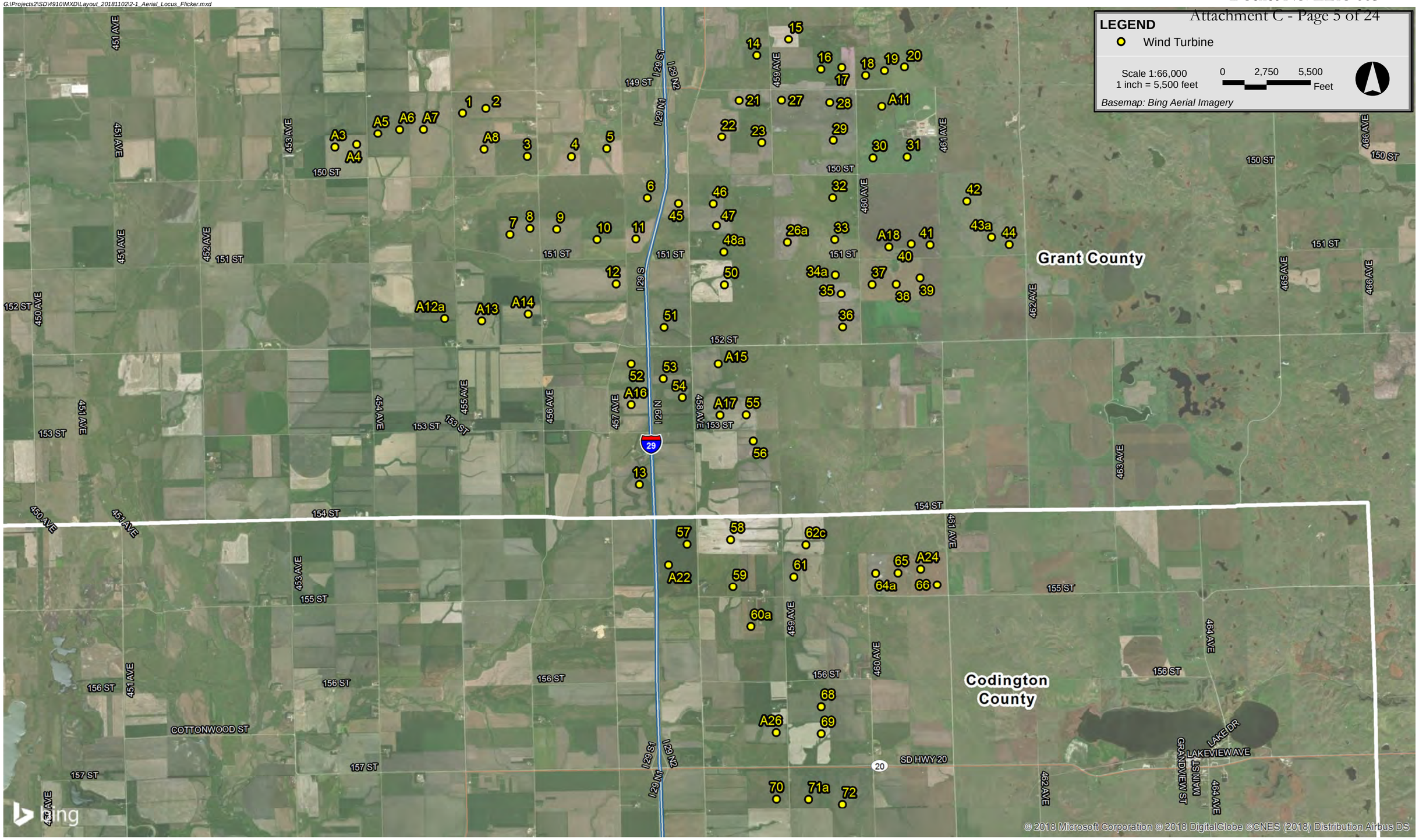

Dakota Range Wind **Grant County/Codington County, South Dakota**

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 (LAY-045) for the Project dated November 2, 2018 was provided by Apex. Of the 84 conservatively modeled wind turbines, 12 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 V136-4.2
♦ 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

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

where the ten times rotor diameter approach has been accepted in multiple European 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.

Modeling receptor datasets, one with a participation status of participating and another with a participation status of non-participating, dated November 5, 2018 were 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. 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 173 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 conservative. When accounted for in the shadow flicker calculations, such obstacles may

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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.

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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LEGEND

- Wind Turbine
- Participating Receptor
- Non-Participating Receptor

Scale 1:60,000
1 inch = 5,000 feet

0 2,500 5,000 Feet

Basemap: Bing Aerial Imagery

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

Figure 3-1A
Shadow Flicker Modeling Locations

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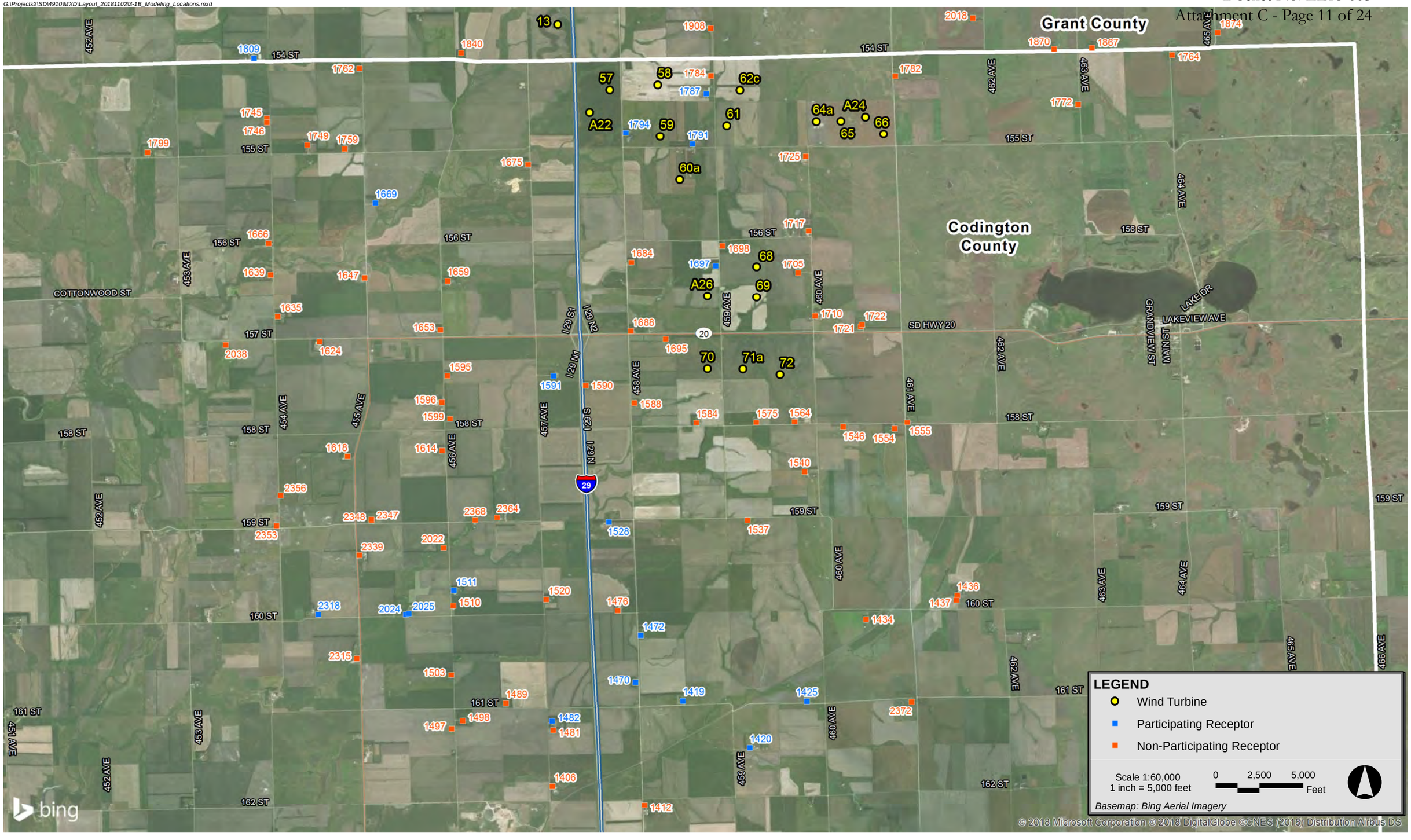

Dakota Range Wind **Grant County/Codington County, South Dakota**

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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 173 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 173 modeling receptor locations. The predicted expected annual shadow flicker duration ranged from 0 hours, 0 minutes per year to 54 hours, 8 minutes per year. The majority of the sensitive receptors (104) were predicted to experience no annual shadow flicker. 38 locations were predicted to experience some shadow flicker but less than 10 hours per year. The modeling results showed that 24 locations would be expected to have 10 to 30 hours of shadow flicker per year while 7 locations would be expected to have over 30 hours of shadow flicker per year. All of these 7 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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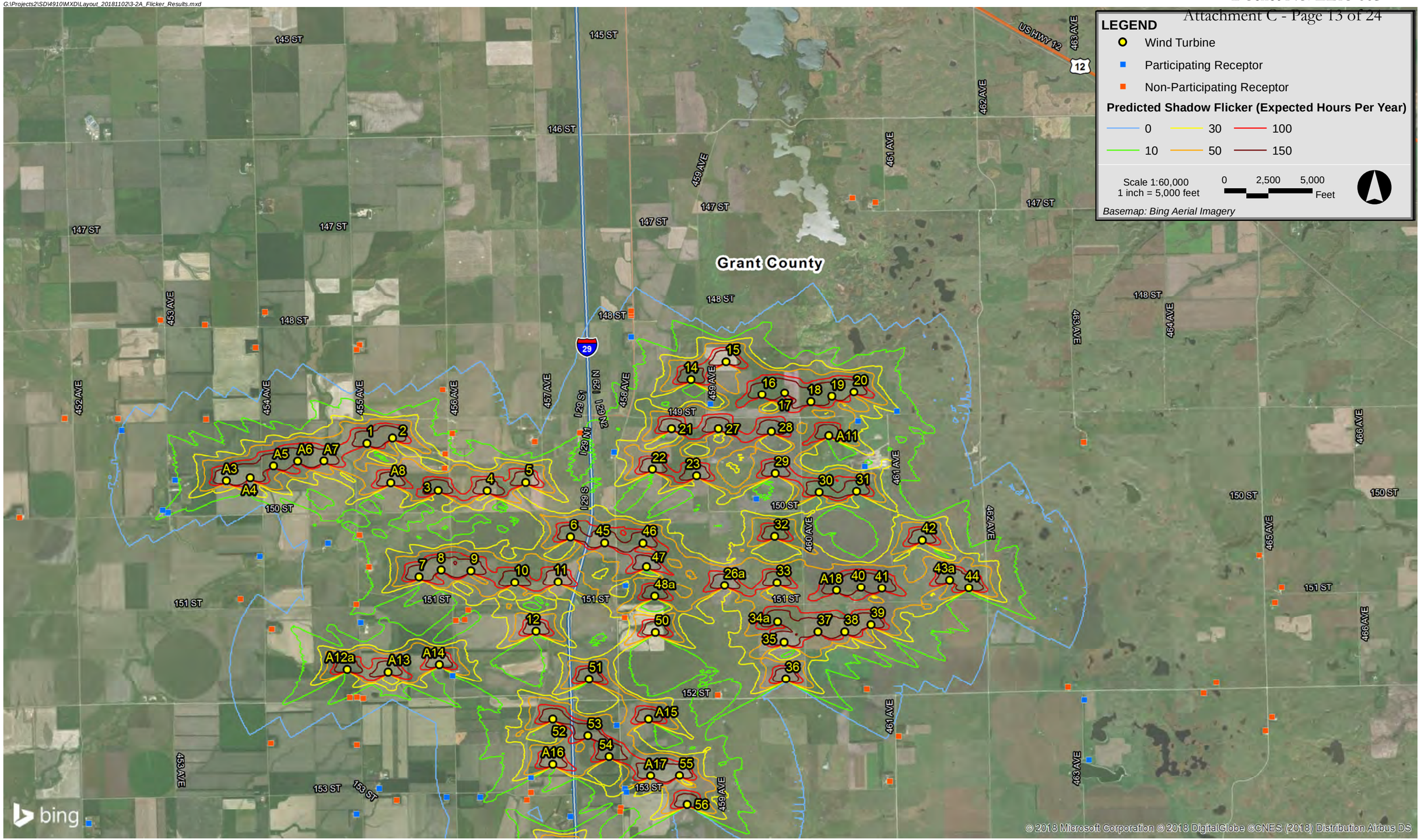

Dakota Range Wind **Grant County/Codington County, South Dakota**

Figure 3-2A
Shadow Flicker Modeling Results

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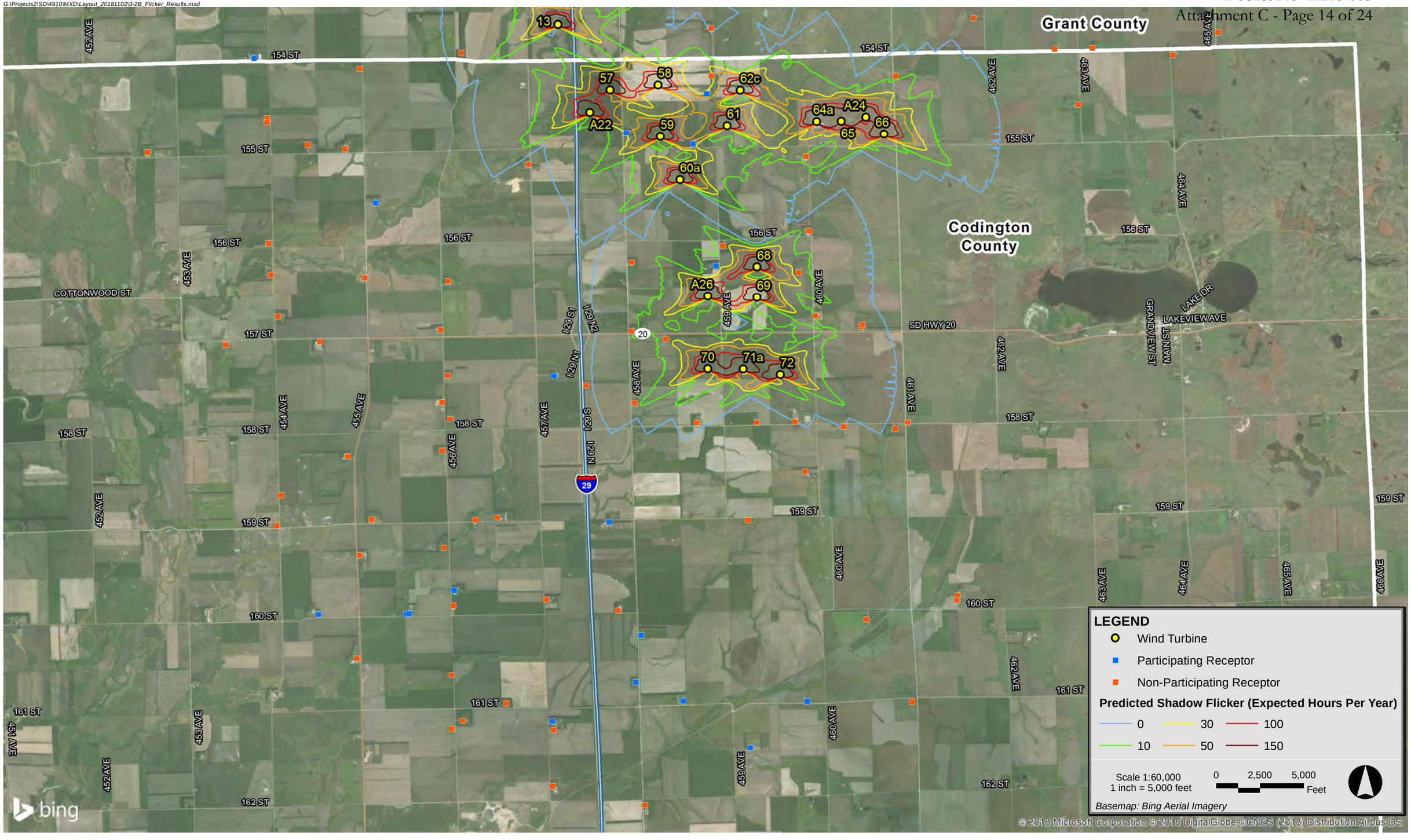

Dakota Range Wind **Grant County/Codington County, South Dakota**

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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 173 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, 8 minutes. This receptor is a Project participant. The maximum expected annual duration of flicker at a non-participating receptor is 27 hours, 25 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	649151.00	5009211.00
2	649593.00	5009301.00
3	650382.00	5008394.00
4	651221.00	5008389.00
5	651888.00	5008536.00
6	652659.00	5007596.00
7	650048.00	5006906.00
8	650429.00	5007024.00
9	650942.00	5007008.00
10	651702.00	5006813.00
11	652445.00	5006824.00
12	652068.00	5005967.00
13	652508.00	5002155.00
14	654739.00	5010310.00
15	655343.00	5010618.00
16	655960.00	5010046.00
17	656354.00	5010078.00
18	656807.00	5009926.00
19	657165.00	5010017.00
20	657545.00	5010093.00
21	654403.00	5009456.00
22	654074.00	5008760.00
23	654835.00	5008649.00
27	655210.00	5009459.00
28	656124.00	5009415.00
29	656191.00	5008691.00
30	656948.00	5008365.00
31	657593.00	5008380.00
32	656181.00	5007604.00
33	656220.00	5006808.00
35	656341.00	5005779.00
36	656373.00	5005145.00
37	656929.00	5005957.00
38	657388.00	5005960.00
39	657840.00	5006079.00
40	657671.00	5006727.00
41	658032.00	5006709.00
42	658728.00	5007539.00
44	659531.00	5006717.00
45	653251.00	5007492.00
46	653912.00	5007486.00

Table A-1: Wind Turbine Coordinates

Wind Turbine ID	Coordinates NAD83 UTM Zone 14N (meters)	
	X (Easting)	Y (Northing)
47	653972.00	5007080.00
50	654125.00	5005949.00
51	652980.00	5005140.00
52	652355.00	5004449.00
53	652960.00	5004165.00
54	653327.00	5003802.00
55	654539.00	5003479.00
56	654672.00	5002981.00
57	653413.00	5001019.00
58	654244.00	5001104.00
59	654286.00	5000211.00
61	655443.00	5000400.00
65	657424.00	5000476.00
66	658167.00	5000252.00
68	655965.00	4997937.00
69	655963.00	4997416.00
70	655111.00	4996175.00
72	656367.00	4996074.00
26a	655319.00	5006761.00
34a	656231.00	5006133.00
43a	659200.00	5006854.00
48a	654112.99	5006574.06
60a	654626.00	4999457.00
62c	655673.00	5001011.00
64a	656999.00	5000470.00
71a	655723.00	4996172.00
A11	657114.00	5009343.00
A12a	648811.13	5005306.34
A13	649516.40	5005259.92
A14	650398.22	5005389.99
A15	654008.00	5004449.00
A16	652354.00	5003672.00
A17	654041.01	5003475.27
A18	657250.00	5006673.00
A22	653061.12	5000624.85
A24	657851.00	5000546.00
A26	655109.25	4997437.35
A3	646726.68	5008563.81
A4	647137.99	5008616.63
A5	647539.89	5008820.59
A6	647956.98	5008901.81

Table A-1: Wind Turbine Coordinates

Wind Turbine ID	Coordinates NAD83 UTM Zone 14N (meters)	
	X (Easting)	Y (Northing)
A7	648409.37	5008903.36
A8	649560.48	5008528.49

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)
1406	Non-Participating	Codington	652,415.58	4,988,918.69	0:00
1412	Non-Participating	Codington	654,015.11	4,988,590.25	0:00
1419	Participating	Codington	654,681.58	4,990,406.38	0:00
1420	Participating	Codington	655,846.86	4,989,588.29	0:00
1425	Participating	Codington	656,834.67	4,990,400.04	0:00
1434	Non-Participating	Codington	657,862.31	4,991,817.05	0:00
1436	Non-Participating	Codington	659,446.92	4,992,232.95	0:00
1437	Non-Participating	Codington	659,433.47	4,992,153.30	0:00
1470	Participating	Codington	653,857.99	4,990,720.09	0:00
1472	Participating	Codington	653,950.59	4,991,543.64	0:00
1476	Non-Participating	Codington	653,549.62	4,991,972.23	0:00
1481	Non-Participating	Codington	652,432.12	4,989,894.34	0:00
1482	Participating	Codington	652,413.64	4,990,050.68	0:00
1489	Non-Participating	Codington	651,609.43	4,990,364.76	0:00
1497	Non-Participating	Codington	650,662.06	4,989,915.49	0:00
1498	Non-Participating	Codington	650,856.93	4,990,053.74	0:00
1503	Non-Participating	Codington	650,657.74	4,990,852.72	0:00
1510	Non-Participating	Codington	650,692.61	4,992,057.70	0:00
1511	Participating	Codington	650,706.98	4,992,320.66	0:00
1520	Non-Participating	Codington	652,311.29	4,992,164.18	0:00
1528	Participating	Codington	653,394.86	4,993,505.03	0:00
1537	Non-Participating	Codington	655,804.37	4,993,535.65	0:00
1540	Non-Participating	Codington	656,798.10	4,994,383.05	0:00
1546	Non-Participating	Codington	657,464.70	4,995,163.56	0:00
1554	Non-Participating	Codington	658,362.21	4,995,127.56	0:00
1555	Non-Participating	Codington	658,578.51	4,995,244.25	0:00
1564	Non-Participating	Codington	656,621.54	4,995,250.50	0:00
1575	Non-Participating	Codington	655,954.93	4,995,240.17	0:00
1584	Non-Participating	Codington	654,917.16	4,995,237.31	4:26
1588	Non-Participating	Codington	653,838.26	4,995,578.48	5:48
1590	Non-Participating	Codington	652,995.68	4,995,885.56	0:00
1591	Participating	Codington	652,436.54	4,996,047.89	0:00
1595	Non-Participating	Codington	650,593.29	4,996,054.48	0:00
1596	Non-Participating	Codington	650,496.01	4,995,587.28	0:00
1599	Non-Participating	Codington	650,636.90	4,995,303.04	0:00
1614	Non-Participating	Codington	650,501.55	4,994,753.62	0:00
1618	Non-Participating	Codington	648,862.47	4,994,649.83	0:00
1624	Non-Participating	Codington	648,375.40	4,996,645.46	0:00
1635	Non-Participating	Codington	647,647.95	4,997,080.29	0:00
1639	Non-Participating	Codington	647,523.41	4,997,799.99	0:00
1647	Non-Participating	Codington	649,154.79	4,997,753.24	0:00
1653	Non-Participating	Codington	650,473.00	4,996,848.32	0:00
1659	Non-Participating	Codington	650,595.55	4,997,697.39	0:00
1666	Non-Participating	Codington	647,488.92	4,998,352.98	0:00
1669	Participating	Codington	649,340.75	4,999,049.86	0:00
1675	Non-Participating	Codington	651,994.47	4,999,721.14	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)
1684	Non-Participating	Codington	653,787.02	4,998,022.59	2:14
1688	Non-Participating	Codington	653,778.28	4,996,825.57	6:25
1695	Non-Participating	Codington	654,384.51	4,996,687.82	19:27
1697	Participating	Codington	655,253.74	4,997,956.71	24:45
1698	Non-Participating	Codington	655,366.22	4,998,311.58	17:29
1705	Non-Participating	Codington	656,685.45	4,997,836.26	20:21
1710	Non-Participating	Codington	656,976.54	4,997,093.04	9:09
1717	Non-Participating	Codington	656,867.97	4,998,569.91	5:02
1721	Non-Participating	Codington	657,770.19	4,996,904.04	1:42
1722	Non-Participating	Codington	657,792.58	4,996,940.40	1:35
1725	Non-Participating	Codington	656,815.87	4,999,863.27	7:54
1745	Non-Participating	Codington	647,461.13	5,000,525.45	0:00
1746	Non-Participating	Codington	647,456.46	5,000,456.03	0:00
1749	Non-Participating	Codington	648,159.89	5,000,058.41	0:00
1759	Non-Participating	Codington	648,809.41	4,999,992.49	0:00
1762	Non-Participating	Codington	649,063.96	5,001,386.23	0:00
1764	Non-Participating	Codington	663,178.63	5,001,621.05	0:00
1772	Non-Participating	Codington	661,543.34	5,000,761.33	0:00
1782	Non-Participating	Codington	658,372.24	5,001,257.48	8:03
1784	Non-Participating	Codington	655,170.00	5,001,262.14	27:17
1787	Participating	Codington	655,087.18	5,000,951.82	35:56
1791	Participating	Codington	654,852.45	5,000,075.99	49:39
1794	Participating	Codington	653,692.68	5,000,273.03	32:46
1799	Non-Participating	Codington	645,387.42	4,999,931.96	0:00
1805	Participating	Grant	644,356.98	5,002,651.43	0:00
1809	Participating	Grant	647,235.37	5,001,567.12	0:00
1815	Participating	Grant	648,970.50	5,002,809.01	0:00
1821	Non-Participating	Grant	649,665.32	5,003,050.76	0:00
1828	Participating	Grant	650,524.49	5,003,103.91	0:49
1832	Participating	Grant	651,107.55	5,003,102.45	6:24
1837	Non-Participating	Grant	651,909.87	5,003,057.90	5:04
1840	Non-Participating	Grant	650,832.97	5,001,658.43	1:26
1847	Participating	Grant	652,660.85	5,002,765.85	5:41
1849	Non-Participating	Grant	653,530.94	5,002,924.70	16:52
1850	Non-Participating	Grant	653,518.23	5,002,856.66	11:30
1867	Non-Participating	Grant	661,784.38	5,001,742.15	0:00
1870	Non-Participating	Grant	661,126.69	5,001,722.46	0:00
1874	Non-Participating	Grant	663,970.35	5,002,019.97	0:00
1884	Non-Participating	Grant	664,755.72	5,004,486.66	0:00
1885	Non-Participating	Grant	664,644.10	5,004,250.93	0:00
1888	Non-Participating	Grant	663,576.49	5,004,901.72	0:00
1904	Non-Participating	Grant	658,164.88	5,003,370.45	0:00
1908	Non-Participating	Grant	655,165.86	5,002,087.27	0:00
1914	Participating	Grant	653,600.45	5,003,245.37	44:01
1915	Participating	Grant	653,456.51	5,004,343.87	54:08
1919	Participating	Grant	651,979.07	5,003,440.36	20:33

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)
1928	Participating	Grant	649,363.69	5,003,248.44	0:00
1937	Non-Participating	Grant	648,977.78	5,004,008.60	0:00
1938	Non-Participating	Grant	647,494.42	5,004,033.38	0:00
1947	Non-Participating	Grant	647,511.12	5,006,001.75	2:49
1953	Non-Participating	Grant	648,855.29	5,004,824.59	6:19
1955	Non-Participating	Grant	648,976.90	5,004,831.73	2:08
1957	Non-Participating	Grant	649,090.23	5,004,809.12	3:01
1962	Participating	Grant	649,045.78	5,006,117.82	2:54
1968	Non-Participating	Grant	648,969.51	5,006,429.63	10:20
1970	Non-Participating	Grant	646,968.92	5,006,520.98	0:00
1976	Participating	Grant	647,303.97	5,007,251.04	0:00
1985	Participating	Grant	648,480.56	5,007,489.68	2:08
1988	Non-Participating	Grant	649,022.20	5,007,623.82	14:46
1991	Non-Participating	Grant	649,187.06	5,007,077.92	10:25
1994	Non-Participating	Grant	650,684.64	5,006,150.39	9:27
1995	Non-Participating	Grant	650,837.63	5,006,168.70	6:46
2005	Participating	Grant	650,626.79	5,005,202.02	8:00
2007	Participating	Grant	661,518.31	5,004,784.40	0:00
2008	Non-Participating	Grant	661,242.84	5,005,002.70	0:00
2012	Participating	Grant	661,599.97	5,003,749.29	0:00
2018	Non-Participating	Grant	659,717.08	5,002,264.17	0:00
2020	Non-Participating	Grant	658,319.47	5,004,153.08	0:00
2022	Non-Participating	Codington	650,528.30	4,993,061.83	0:00
2024	Participating	Codington	649,871.67	4,991,903.75	0:00
2025	Participating	Codington	649,921.89	4,991,917.62	0:00
2038	Non-Participating	Codington	646,743.98	4,996,587.90	0:00
2041	Non-Participating	Grant	653,593.66	5,006,201.50	27:25
2066	Non-Participating	Grant	664,805.69	5,006,459.59	0:00
2074	Non-Participating	Grant	663,797.17	5,005,085.81	0:00
2080	Non-Participating	Grant	657,770.35	5,004,970.01	4:17
2085	Non-Participating	Grant	655,202.17	5,004,865.99	5:10
2086	Participating	Grant	653,612.64	5,006,755.67	27:20
2099	Non-Participating	Grant	664,537.21	5,007,281.04	0:00
2107	Non-Participating	Grant	664,924.28	5,006,725.78	0:00
2141	Non-Participating	Grant	661,510.62	5,009,229.70	0:00
2149	Participating	Grant	657,734.58	5,008,810.13	14:45
2153	Participating	Grant	657,618.71	5,009,594.79	44:55
2158	Participating	Grant	655,865.10	5,008,248.23	13:13
2168	Participating	Grant	653,411.62	5,009,060.41	24:08
2182	Non-Participating	Grant	652,821.24	5,009,387.00	9:16
2193	Non-Participating	Grant	652,045.23	5,009,239.11	1:22
2195	Non-Participating	Grant	650,621.29	5,009,376.36	10:11
2205	Non-Participating	Grant	650,503.26	5,009,033.74	23:34
2212	Non-Participating	Grant	650,493.66	5,008,776.86	24:50
2214	Participating	Grant	645,840.98	5,008,574.90	8:35
2217	Participating	Grant	645,708.61	5,008,004.25	12:55

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)
2218	Participating	Grant	645,720.53	5,008,021.46	13:46
2219	Participating	Grant	645,631.03	5,008,056.63	9:18
2230	Participating	Grant	644,922.56	5,009,429.71	0:34
2236	Non-Participating	Grant	646,374.72	5,009,624.58	6:19
2239	Non-Participating	Grant	647,229.03	5,010,859.63	0:00
2240	Non-Participating	Grant	649,025.05	5,010,906.20	0:00
2242	Non-Participating	Grant	648,974.09	5,010,822.91	0:00
2243	Non-Participating	Grant	650,458.09	5,010,135.55	4:13
2251	Participating	Grant	653,709.32	5,011,041.66	7:46
2257	Participating	Grant	655,074.36	5,009,886.86	21:36
2260	Participating	Grant	658,287.22	5,009,765.21	32:53
2270	Non-Participating	Grant	645,591.52	5,011,330.52	0:00
2271	Non-Participating	Grant	646,356.26	5,011,253.61	0:00
2277	Non-Participating	Grant	647,394.85	5,011,472.38	0:00
2279	Non-Participating	Grant	653,707.33	5,011,412.61	1:02
2280	Non-Participating	Grant	653,706.52	5,011,445.93	1:02
2281	Non-Participating	Grant	653,705.48	5,011,488.76	1:02
2287	Non-Participating	Grant	657,521.45	5,013,443.09	0:00
2290	Non-Participating	Grant	657,917.63	5,013,363.29	0:00
2315	Non-Participating	Codington	649,018.76	4,991,138.66	0:00
2318	Participating	Codington	648,352.31	4,991,902.58	0:00
2339	Non-Participating	Codington	649,064.44	4,992,930.45	0:00
2347	Non-Participating	Codington	649,279.70	4,993,533.72	0:00
2348	Non-Participating	Codington	649,271.45	4,993,557.43	0:00
2353	Non-Participating	Codington	647,627.18	4,993,444.66	0:00
2356	Non-Participating	Codington	647,698.06	4,993,969.91	0:00
2364	Non-Participating	Codington	651,457.46	4,993,586.61	0:00
2368	Non-Participating	Codington	651,076.00	4,993,539.97	0:00
2372	Non-Participating	Codington	658,654.33	4,990,392.79	0:00
2416	Non-Participating	Grant	643,160.20	5,007,930.05	0:00
2424	Non-Participating	Grant	643,939.34	5,009,639.68	0:00
2426	Non-Participating	Grant	644,856.17	5,009,637.68	0:00
2449	Non-Participating	Grant	650,900.06	5,006,334.22	16:02
2455	Non-Participating	Grant	651,981.94	5,003,185.29	3:57
2496	Participating	Grant	653,626.22	5,003,190.21	22:43