



# **Final Report**

## **Crowned Ridge II Wind Farm**

### **Shadow Flicker Study**

#### **Codington, Deuel and Grant Counties, SD**

**Submitted To:**

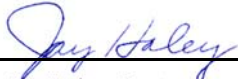
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## ***TABLE OF CONTENTS***

<b>1. INTRODUCTION.....</b>	<b>3</b>
<b>2. BACKGROUND AND COUNTY REGULATIONS.....</b>	<b>3</b>
<b>3. STUDY METHODOLOGY .....</b>	<b>5</b>
<b>4. RESULTS OF ANALYSIS .....</b>	<b>8</b>
<b>5. CONCLUSIONS.....</b>	<b>12</b>
<b>APPENDIX A: CROWNED RIDGE II WIND ENERGY PROJECT SITE OVERVIEW MAP.....</b>	<b>13</b>
<b>APPENDIX B: WIND TURBINE COORDINATES .....</b>	<b>15</b>
<b>APPENDIX C: TABLE OF SHADOW FLICKER RESULTS .....</b>	<b>20</b>
<b>APPENDIX D: STANDARD RESOLUTION SHADOW FLICKER MAPS.....</b>	<b>37</b>

## ***LIST OF TABLES***

Table 1: Huron, SD monthly sunshine probabilities .....	7
Table 2: Codington County occupied structures cumulative realistic shadow flicker distribution.	9
Table 3: Deuel County occupied structures cumulative realistic shadow flicker distribution. ....	10
Table 4: Grant County occupied structures cumulative realistic shadow flicker distribution.....	11
Table 5: Summary of shadow flicker predictions. ....	12

### **Report Update**

EAPC bears no responsibility to update this report for any changes occurring subsequent to the final issuance of this report.

### **Revision History**

Revision No.	Revision Purpose	Date	Revised By
0	Original	3/19/2020	J. Haley
1	Moved CR11-81	3/22/2020	J. Haley
2	Updated land status	5/7/2020	J. Haley

## ***Executive Summary***

EAPC was hired to provide estimates of the potential shadow flicker impacts for a proposed wind turbine layout in Codington, Deuel and Grant Counties of the Crowned Ridge II wind farm project in northeastern South Dakota. The scope of this report includes all proposed turbines included in the Crowned Ridge II project that will be permitted through the South Dakota Public Utilities Commission. Locations of area occupied structures and a wind turbine layout (135 turbines, including 4 alternates) using a mixture of wind turbines manufactured by General Electric (GE) were provided to EAPC by Crowned Ridge Wind II, LLC. Locations of the adjacent Crowned Ridge wind farm (138 turbines, including 8 alternates) were supplied to EAPC by Crowned Ridge Wind, LLC. The adjacent Deuel Harvest wind farm was not included because no shadow impacts will be experienced from those turbines due to the long distances from Crowned Ridge Wind II receptors. A computer model was built combining digital elevation data with the information supplied to generate shadow flicker models for the site. The resulting models were then used to perform shadow flicker calculations for the 273 turbines. Cumulative shadow flicker was calculated including the effects from both wind farms, and site-wide realistic shadow flicker maps were produced to predict the shadow flicker at nearby residences within the Crowned Ridge II Project area.

The Crowned Ridge II wind farm project was modeled for all counties within the turbine layout and is described in this report as one project. However, for purposes of organization and because of the differences in compliance criteria, the modeling and results of the study are presented individually for each county.

The model is based on a number of conservative assumptions. No credit was taken for the blocking effects of trees or buildings. The receptors were omni-directional rather than modeling specific facades of buildings, and the study assumes 100% turbine availability.

The scope of this study includes the shadow flicker impacts of the Crowned Ridge II wind farm on the three counties it is located within, Codington, Deuel and Grant. The shadow flicker ordinances of all three counties limit the maximum number of shadow flicker to 30 hours per year at occupied structures.

### **Crowned Ridge II Codington County Turbines**

Codington County's current Ordinance #68 Zoning Ordinance Section 5.22.03.12.a notes that the applicable Shadow flicker limit is 30 hr/yr at an occupied structure, which is what has been evaluated in this report for Codington County.

For the shadow study in Codington County, 152 occupied structures (39 participating and 113 non-participating) were represented in the model by omni-directional shadow receptors that simulate a 1 m x 1 m window at 1 m above ground level.

### Crowned Ridge II Deuel County Turbines

Deuel County's current Ordinance B2004-01-23B, Section 1215.03 paragraph 13 b.) sets the limit at 30 hr/yr at the perimeter of existing residences, which is what has been evaluated in this report for Deuel County.

For the shadow study in Deuel County, 104 occupied structures (21 participating and 83 non-participating) were represented in the model by omni-directional shadow receptors that simulate a 1 m x 1 m window at 1 m above ground level.

### Crowned Ridge II Grant County Turbines

Grant County's current Ordinance 2016-01C, Section 1211.04, paragraph 9 set the limit at 30 hours per year at occupied structures, which is what has been evaluated in this report for Grant County.

For the shadow study in Grant County, 4 occupied structures (1 participating and 3 non-participating) were represented in the model by omni-directional shadow receptors that simulate a 1 m x 1 m window at 1 m above ground level.

For the Crowned Ridge II turbine array provided, no occupied structures experienced more than 30 hours of shadow flickering per year based on realistic assumptions regarding operational time and sunshine probability, with the exception of 1 participating landowner with 38 hours and 21 minutes of shadow flicker per year and 1 non-participating landowner with 32 hours and 6 minutes of shadow flicker per year. Assuming either curtailment or a signed waiver for these 2 receptors, the Crowned Ridge II wind farm is in compliance with the shadow flicker limitations set forth in Codington County's Section 5.22.03 paragraph 13 of Ordinance #68, Deuel County's Section 1215.03, paragraph 13 b.) of Ordinance B2004-01-23B and Section 1211.04 paragraph 14 of Grant County's Ordinance 2016-01C, which is 30 hours per year.

## **1. INTRODUCTION**

EAPC was hired to conduct shadow flicker studies for the regional development of the Crowned Ridge II wind farm project located in Codington, Deuel and Grant Counties in northeastern South Dakota. The layout consists of 13 GE 2.1 MW wind turbines with a hub height of 80 meters and 122 GE 2.3 MW wind turbines with a hub height of 90 meters (including 4 alternate turbine locations) for a total of 135 wind turbines. The adjacent Crowned Ridge project consisting of 129 GE 2.3 MW wind turbines with a hub height of 90 meters (including 8 alternate turbine locations) and 9 GE 2.1 MW wind turbines with a hub height of 80 meters for a total of 138 wind turbines was included in the analysis. The locations of the proposed wind turbines were supplied by Crowned Ridge Wind II, LLC and Crowned Ridge Wind, LLC.

From the database of occupied structures and coordinates supplied by Crowned Ridge Wind II, LLC, 152 occupied structures (39 participating and 113 non-participating) in Codington County and 104 occupied structures (21 participating and 83 non-participating) in Deuel County, and 4 occupied structures (1 participating and 3 non-participating) in Grant County for a total of 261 occupied structures (61 participating and 200 non-participating) were found to be within 2 kilometers of a wind turbine and were included in the shadow models. Shadow flicker does not extend beyond a distance of approximately 1,700 meters from the wind turbine base.

The area of interest for this report is located in Codington, Deuel and Grant Counties near the town of Watertown in northeastern South Dakota. The surrounding terrain has a change in elevation across the project site ranging from 569 to 616 meters (1,867 to 2,021 feet) at the wind turbine base. The region's vegetation is comprised primarily of prairie grass and agricultural land. The project overview map can be found in Appendix A.

## **2. BACKGROUND AND COUNTY REGULATIONS**

To determine if the layout provided would be compliant for the Crowned Ridge II Project and in line with each county's regulations, detailed shadow flicker scenarios were analyzed using a computer model.

Shadow flicker from wind turbines occurs when rotating wind turbine blades move between the sun and the observer. Shadow flicker is generally experienced in areas near wind turbines where the distance between the observer and wind turbine blade is short enough that sunlight has not been significantly diffused by the atmosphere. When the blades rotate, this shadow creates a pulsating effect, known as shadow flicker. If the blade's shadow is passing over the window of a building, it will have the effect of increasing and decreasing the light intensity in the room at a low frequency in the range of 0.4 to 0.78 Hz, hence the term "flicker." In this case, with a maximum rotational speed of 15.6 rpm for the GE 2.3-116, the frequency would be 0.78 Hz. This flickering effect can also be experienced outdoors, but the effect is typically less intense, and becomes less intense when farther from the wind turbine causing the flicker.

This flickering effect is most noticeable within approximately 1,000 meters of the turbine, and becomes more and more diffused as the distance increases. Beyond 1,700 meters, the shadow flicker effects are indistinguishable. There are no uniform standards defining what distance from the turbine is regarded as an acceptable limit beyond which the shadow flicker is considered to be insignificant. The same applies to the number of hours of flickering that is deemed to be acceptable. For this study, in the interest of being conservative, any occupied structure within 2,000 meters of a wind turbine was included in the analysis.

Shadow flicker is typically greatest in the winter months when the angle of the sun is lower and casts longer shadows. The effect is also more pronounced around sunrise and sunset when the sun is near the horizon and the shadows are longer. A number of factors influence the amount of shadow flicker on the shadow receptors.

One consideration is the environment around the shadow receptor. Obstacles such as terrain, trees or buildings between the wind turbine and the receptor can significantly reduce or eliminate shadow flicker effects. Deciduous trees may block the shadow flickering effect to some degree, depending on the tree density, species present and time of year. Deciduous trees can lead to a reduction of shadow flicker during the summer when the trees are bearing leaves. However, during the winter months, these trees are without their leaves and their impact on shadow flicker is not as significant. Coniferous trees tend to provide mitigation from shadow flicker year round. For this study, no credit was taken for any potential shading effects from any type of trees or other obstacles that would reduce the number of shadow flickering hours at the structures which will make the shadow flicker prediction more conservative (higher than in reality).

Another consideration is the time of day when shadow flicker occurs. For example, it may be more acceptable for private homes to experience the shadow flickering during daytime hours when family members may be at work or school. Likewise, a commercial property would not be significantly affected if all the shadow flicker impact occurred before or after business hours.

The climate also needs to be considered when assessing shadow flicker. In areas with a significant amount of overcast weather, there would be less shadow flicker, as there are no shadows if the sun is blocked by clouds. Also, if the wind is not blowing, the turbines would not be operational and therefore not creating shadow flickering.

#### Crowned Ridge II Codington County Regulations

Codington County's current Ordinance #68 Zoning Ordinance Section 5.22.03, paragraph 13 prescribes shadow flicker limits for wind turbine projects as follows:

"13. Flicker Analysis. A Flicker Analysis shall include the duration and location of flicker potential for all schools, churches, businesses and occupied dwellings within a one (1) mile radius of each turbine within a project. The applicant shall provide a site map identifying the locations of shadow flicker that may be caused by the project and the

expected durations of the flicker at these locations from sun-rise to sun-set over the course of a year. The analysis shall account for topography but not for obstacles such as accessory structures and trees. Flicker at any receptor shall not exceed thirty (30) hours per year within the analysis area.”

Therefore, Codington County’s only applicable shadow flicker limit is 30 hr/yr at schools, churches, businesses and occupied dwellings, which is what has been evaluated in this report for Codington County. For purposes of this report, these residences will be referred to as occupied structures.

#### Crowned Ridge II Deuel County Regulations

Deuel County’s current ordinance B2004-01-23B, Section 1215.03, paragraph 13 b.) prescribes shadow flicker limits for wind turbine projects as follows:

“b. Limit for allowable shadow flicker at existing residences to no more than 30 hours annually.”

Therefore, Deuel County’s only applicable shadow flicker limit is 30 hr/yr at the perimeter of existing residences. For purposes of this report, these residences will be referred to as occupied structures.

#### Crowned Ridge II Grant County Regulations

Grant County’s current Ordinance 2016-01C, Section 1211.04, paragraph 9 prescribes shadow flicker limits for wind turbine projects as follows:

“9. Flicker Analysis. A Flicker Analysis shall include the duration and location of flicker potential for all schools, churches, businesses and occupied dwellings within a one (1) mile radius of each turbine within a project. The applicant shall provide a site map identifying the locations of shadow flicker that may be caused by the project and the expected durations of the flicker at these locations from sun-rise to sun-set over the course of a year. The analysis shall account for topography but not for obstacles such as accessory structures and trees. Flicker at any receptor shall not exceed thirty (30) hours per year within the analysis area.”

Therefore, Grant County’s current applicable shadow flicker limit is 30 hr/yr for all schools, churches, businesses and occupied dwellings within a one (1) mile radius of each turbine within a project. For purposes of this report, these schools, churches, residences, businesses, and occupied dwellings will hereafter be referred to as occupied structures.

### **3. STUDY METHODOLOGY**

This shadow flicker analysis was performed utilizing windPRO, which has the ability to calculate detailed shadow flicker maps across an entire area of interest or at site-specific locations using shadow receptors.



Shadow maps which indicate where the shadows will be cast and for how long, are generated using windPRO, calculating the shadow flicker in varying user-defined resolutions. Standard resolution was used for this study and represents shadow flicker being calculated every three minutes of every day over the period of an entire year over a grid with a 20 m x 20 m resolution.

In addition to generating a shadow flicker map, the amount of shadow flicker that may occur at a specific point can be calculated more precisely by placing a shadow receptor at the location of interest and essentially “recording” the shadow flicker that occurs as the relative sunrise to sunset motion of the sun is simulated throughout an entire year.

The point-specific shadow flicker calculation is run at a higher resolution as compared to the shadow flicker map calculation to utilize the highest precision available within windPRO. Shadow flicker at each shadow receptor location is calculated every minute of every day for an entire year. Shadow receptors can be configured to represent an omnidirectional window of a specific size at a specific point (greenhouse mode) or a window facing a single direction of a specific size at a specific point (single direction mode). The shadow receptors used in this analysis were configured as greenhouse-mode receptors representing a 1 m x 1 m window located 1 m above ground level. This represents more of a “worst-case” scenario and thus will produce more conservative results since it assumes that all windows are always in direct line of sight with the turbines and the sun.

As a part of the calculation method, windPRO must determine whether or not a turbine will be visible at the receptor locations and not blocked by local topography or obstacles. It does this by performing a preliminary Zones of Visual Influence (ZVI) calculation, utilizing 10 m grid spacing. If a particular turbine is not visible within the 10 m x 10 m area that the shadow receptor is contained within, then that turbine is not included in the shadow flicker calculation for that receptor.

The inputs for the windPRO shadow flicker calculation include the following:

- Turbine Coordinates
- Turbine Specifications
- Shadow Receptor Coordinates
- Monthly Sunshine Probabilities
- Joint Wind Speed and Direction Frequency Distribution
- USGS Digital Elevation Model (DEM) (height contour data)

A description of each input variable and how they affect the shadow flicker calculation are included below.

**Turbine Coordinates:** The location of a wind turbine in relation to a shadow receptor is one of the most important factors in determining shadow flicker impacts. A line-of-sight is required for shadow flicker to occur. The intensity of the shadow flicker is dependent

upon the distance from the wind turbine and weather conditions. The table of Crowned Ridge II wind turbine coordinates can be found in Appendix B.

**Turbine Specifications:** A wind turbine's total height and rotor diameter will be included in the windPRO shadow flicker model. The taller the wind turbine, the more likely shadow flicker could have an impact on local shadow receptors as the ability to clear obstacles (such as hills or trees) is greater, although in this analysis, no credit is taken for any such blockage from trees. The larger the rotor diameter is, the wider the area where shadows will be cast. Also included with the turbine specifications are the cut-in and cut-out wind speeds within which the wind turbine is operational. If the wind speed is below the cut-in threshold or above the cut-out threshold, the turbine rotor will not be spinning and thus shadow flicker will not occur.

**Shadow Receptor Coordinates:** As with the wind turbine coordinates, the elevation, distance and orientation of a shadow receptor in relation to the wind turbines and the sun are the main factors in determining the impact of shadow flicker. EAPC was provided with coordinates for all participating and non-participating occupied structures found to be located within 2 kilometers of the 135 proposed wind turbine locations.

**Monthly Sunshine Probabilities:** windPRO calculates sunrise and sunset times to determine the total annual hours of daylight for the modeled area. To further refine the shadow flicker calculations, the monthly probability of sunshine is included to account for cloud cover. The greater the probability of cloud cover, the less of an impact from shadow flicker. The monthly sunshine probabilities for many of the larger cities across the United States are available from the National Climatic Data Center (NCDC). For this study, 18 years' worth of monthly sunshine probability data were retrieved for Huron, SD, which was the closest, most representative station, to create the long-term representative monthly sunshine probabilities. The long-term representative monthly average sunshine probabilities are presented below in Table 1.

Table 1: Huron, SD monthly sunshine probabilities

Huron, SD Monthly Sunshine Probabilities (1965-1983)												
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sunshine %	0.62	0.62	0.62	0.59	0.66	0.69	0.76	0.74	0.69	0.59	0.51	0.51
retrieved from: <a href="http://www1.ncdc.noaa.gov/pub/data/ccd-data/pctpos15.dat">http://www1.ncdc.noaa.gov/pub/data/ccd-data/pctpos15.dat</a>												

**Joint Wind Speed and Direction Frequency Distribution:** A set of long-term corrected wind distributions was provided by Crowned Ridge Wind II, LLC to represent the annual wind speed and direction distribution for the project site. This data was used to estimate the probable number of operational hours for the wind turbines from each of the 12 wind direction sectors. During operation, the wind turbine rotors will always be assumed to face into the wind and automatically orient themselves as the wind direction changes. Shadow flicker can only occur when the blades are turning and the wind turbine

rotor is between the sun and the receptor. Shadow flicker is most significant when the rotor is facing the sun.

**USGS Digital Elevation Model (DEM) (height contour data):** For this study, 3-meter resolution USGS National Elevation Database (NED) DEM's were used to construct 10-foot interval height contour lines for the windPRO shadow flicker model. The height contour information is important to the shadow flicker calculation since it allows the model to place the wind turbines and the shadow receptors at the correct elevations. The height contour lines also allow the model to include the topography of the site when calculating the zones of visual influence surrounding the wind turbine and shadow receptor locations.

**Wind Turbines from Adjacent Projects:** The Crowned Ridge project is adjacent to the Crowned Ridge II project. Because shadow flicker impacts are cumulative, there will be impacts from the Crowned Ridge project that will be additive to the impacts from the Crowned Ridge II project. The Crowned Ridge wind turbine array was included in the model to capture the full shadow flicker impacts on the receptors. The Dakota Range and Deuel Harvest wind farms, which are adjacent to the Crowned Ridge and Crowned Ridge II wind farms, are too far away to have any significant cumulative impacts on The Crowned Ridge II wind farm and therefore are not included in the study. Crowned Ridge Wind II, LLC is not aware of any other operating energy conversion facilities, existing or under construction, or other major industrial facilities under regulation within or adjacent to the Project Area.

The actual calculation of potential shadow flicker at a given shadow receptor is carried out by simulating the environment near the wind turbines and the shadow receptors. The position of the sun relative to the turbine rotor disk and the resulting shadow is calculated in time steps of one minute throughout an entire year. If the shadow of the rotor disk (which in the calculation is assumed solid) at any time casts a shadow on a receptor window, then this step will be registered as one minute of shadow flicker. The calculation also requires that the sun must be at least 3.0° above the horizon in order to register shadow flicker. When the sun angle is less than 3.0°, the shadow quickly becomes too diffuse to be distinguishable since the amount of atmosphere that the light must pass through is 15 times greater than when the sun is directly overhead.

The sun's path with respect to each wind turbine location is calculated by the software to determine the paths of cast shadows for every minute of every day over a full year. The turbine runtime and direction are calculated from the site's long-term wind speed and direction distribution. Finally, the effects of cloud cover are calculated using long-term reference data (monthly sunshine probability) to arrive at the projected annual flicker time at each receptor.

#### **4. RESULTS OF ANALYSIS**

The term "realistic" as used in this report means that turbine operational hours and direction as well as local sunshine probabilities have been factored in, but no blocking or

shading effects due to trees or structures have been accounted for. This means that the realistic estimates are still inherently conservative values. Also, the realistic shadow flicker hours predicted by windPRO assumes an availability factor of 100% which is very unlikely to be the case. Actual availability factors will likely be in the range of 95-98%, however, with a conservative approach to estimating shadow flicker totals, the realistic estimates are not discounted accordingly.

#### Crowned Ridge II Codington County Turbines

For Codington County, a total of 152 occupied structures (39 participating and 113 non-participating) within 2 kilometers of a wind turbine were analyzed and standard resolution realistic shadow flicker maps were generated for the turbine array.

The 152 shadow receptors were then modeled as greenhouse-mode receptors and the estimated shadow flicker was calculated for the array. No shadow receptors are expected to experience more than 30 hours of shadow flicker per year except for one non-participating receptor (CR2-C98-NP) with 32 hours and 6 minutes of shadow flicker per year, and one participating receptor (CR1-C10-P) with 38 hours and 21 minutes of shadow flicker per year. Assuming curtailment will be used to limit the shadow flicker at receptor CR2-C98-NP, the Crowned Ridge II wind farm would be in compliance with Section 5.22.03 paragraph 13 of Ordinance #68. Of the 152 receptors, the number that registered no shadow flicker hours was 54 (35.5%).

The maximum modeled expected shadow flicker at a participating receptor is 38 hours and 21 minutes and the maximum modeled expected shadow flicker at a non-participating receptor is 32 hours and 6 minutes. Table 2 contains the realistic shadow flicker distribution of the 152 occupied residences.

Table 2: Codington County occupied structures cumulative realistic shadow flicker distribution.

<b>Realistic Shadow Flicker (hrs/year)</b>	<b>Number of Non-Participating Occupied Structures</b>	<b>Number of Participating Occupied Structures</b>
<b>0</b>	48	6
<b>0 to 5</b>	27	10
<b>5 to 10</b>	20	7
<b>10 to 15</b>	9	8
<b>15 to 20</b>	5	4
<b>20 to 25</b>	1	1
<b>25 to 30</b>	2	2
<b>30+</b>	1	1

### Crowned Ridge II Deuel County Turbines

For Deuel County, 104 occupied structures (21 participating and 83 non-participating) within 2 kilometers of a wind turbine were found and analyzed. Standard resolution realistic shadow flicker maps were generated for the turbine array.

The 104 shadow receptors were then modeled as greenhouse-mode receptors and the estimated shadow flicker was calculated for the array. No occupied structures are expected to experience more than 29 hours and 32 minutes of shadow flicker per year. Therefore, the Crowned Ridge II wind farm would be in compliance with Section 1215.03, paragraph 13 b.) of Deuel County Ordinance B2004-01-23B. Of the 104 occupied structures, the number that registered no shadow flicker hours was 34 (32.4%).

The maximum modeled expected shadow flicker at a participating receptor is 29 hours and 32 minutes and the maximum modeled expected shadow flicker at a non-participating receptor is 28 hours and 59 minutes. Table 3 contains the realistic shadow flicker distribution of the 105 occupied structures.

Table 3: Deuel County occupied structures cumulative realistic shadow flicker distribution.

<b>Realistic Shadow Flicker (hrs/year)</b>	<b>Number of Non-Participating Occupied Structures</b>	<b>Number of Participating Occupied Structures</b>
<b>0</b>	31	3
<b>0 to 5</b>	16	1
<b>5 to 10</b>	10	4
<b>10 to 15</b>	13	3
<b>15 to 20</b>	7	6
<b>20 to 25</b>	4	1
<b>25 to 30</b>	2	3
<b>30+</b>	0	0

### Crowned Ridge II Grant County Turbines

For Grant County, 4 (1 participating and 3 non-participating) occupied structures within 2 kilometers of a wind turbine were found and analyzed. Standard resolution realistic shadow flicker maps were generated for the turbine array.

The 4 shadow receptors were then modeled as greenhouse-mode receptors and the estimated shadow flicker was calculated for the array. No occupied structures are expected to experience more than 8 hours and 56 minutes of shadow flicker per year.

Therefore, the Crowned Ridge II wind farm would be in compliance with Section 1211.04 paragraph 14 of Grant County's Ordinance 2016-01C.

The maximum modeled expected shadow flicker at a participating receptor is 8 hours and 56 minutes and the maximum modeled expected shadow flicker at a non-participating receptor is 6 hours and 29 minutes. Table 3 contains the realistic shadow flicker distribution of the 2 occupied structures.

Table 4: Grant County occupied structures cumulative realistic shadow flicker distribution.

<b>Realistic Shadow Flicker (hrs/year)</b>	<b>Number of Non-Participating Occupied Structures</b>	<b>Number of Participating Occupied Structures</b>
<b>0</b>	2	0
<b>0 to 5</b>	0	0
<b>5 to 10</b>	1	1
<b>10 to 15</b>	0	0
<b>15 to 20</b>	0	0
<b>20 to 25</b>	0	0
<b>25 to 30</b>	0	0
<b>30+</b>	0	0

#### Crowned Ridge II Turbines Summary

For the Crowned Ridge II Project, no occupied structures are expected to experience more than 30 hours of shadow flicker per year, for all three counties, except for one non-participating receptor (CR2-C98-NP) with 32 hours and 6 minutes of shadow flicker per year, and one participating receptor (CR1-C10-P) with 38 hours and 21 minutes of shadow flicker per year. The summary of results is shown in table 4 below. The full table of results from the realistic shadow flicker study can be found in Appendix C. Table C-1 lists the results sorted by receptor number and Table C-2 lists the results sorted by shadow flicker hours from highest to lowest. The Crowned Ridge wind turbine array was included in the model to capture the full shadow flicker impacts on the receptors, which are included in the tabular results. The maps showing the shadow flicker impact iso-lines for the Crowned Ridge II wind farm are in Appendix D. The maps include adjacent wind farm turbines that are within 2 km of an occupied structure within the Crowned Ridge II footprint.

Table 5: Summary of shadow flicker predictions.

County	Feature	Shadow Limit (hr/yr)	Maximum Predicted (hr/yr)
<b>Codington</b>	Participating Occupied Structures	30	38:21
	Non-Participating Occupied Structures	30	32:06
<b>Deuel</b>	Participating Occupied Structures	30	29:32
	Non-Participating Occupied Structures	30	28:59
<b>Grant</b>	Participating Occupied Structures	30	8:56
	Non-Participating Occupied Structures	30	6:29

## 5. CONCLUSIONS

The shadow flicker impact on the receptors was calculated with reductions due to turbine operational direction and sunshine probabilities included. For all three counties, no occupied structures are expected to experience more than 30 hours of shadow flicker per year, except for two receptors in Codington County, one non-participating receptor (CR2-C98-NP) with 32 hours and 6 minutes of shadow flicker per year, and one participating receptor (CR1-C10-P) with 38 hours and 21 minutes of shadow flicker per year. Assuming curtailment will be used to limit the shadow flicker at receptor CR2-C98-NP, the Crowned Ridge II wind farm would be in compliance with Section 5.22.03 paragraph 13 of Codington County Ordinance #68.

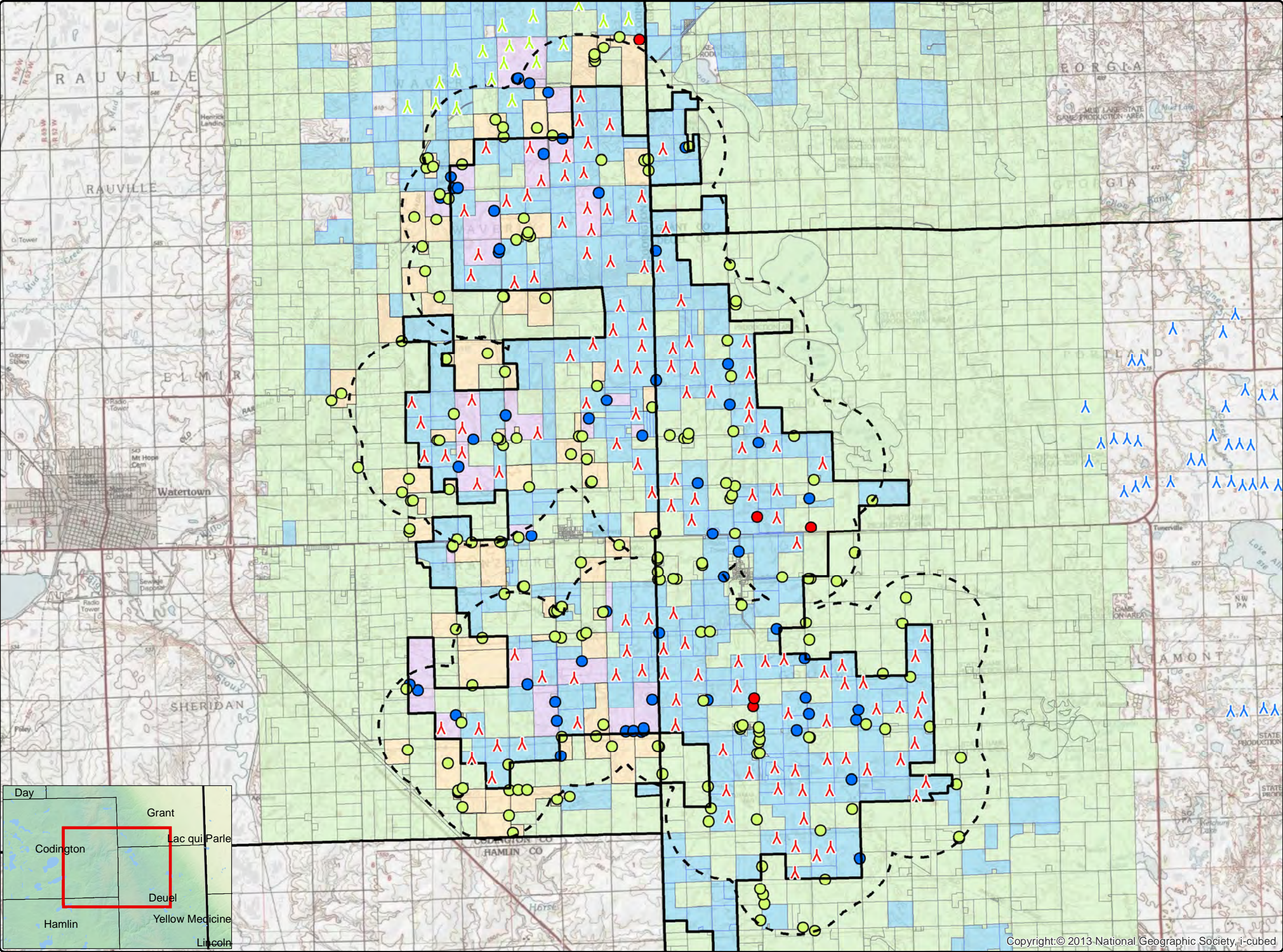
This shadow flicker analysis is based on a number of conservative assumptions including:


- No credit was taken for the blocking effects of trees or buildings.
- The receptors were omni-directional rather than modeling specific facades of buildings.
- Study assumes 100% turbine availability
- Study assumes all turbine locations, including alternates, are built and operating

The overall effect of using these conservative assumptions indicate that realistically, the number of hours of shadow flicker that would be observed will be less than those predicted by this study.

## **APPENDIX A: CROWNED RIDGE II WIND ENERGY PROJECT SITE OVERVIEW MAP**







**EAPC**  
WIND ENERGY

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**Crowned Ridge II Wind Farm  
300 MW  
Overview Map**

**Client**  
SWCA Environmental Consultants

**Project Description**  
Wind turbine layout with land parcels within the project footprint and existing occupied structures.  
  
Codington County land parcels within 2 km of a wind turbine.

**Location:** Watertown, SD  
**Project #:** 20174431

**Issue Dates**

1	Original	2020.05.07
#	Description	Date

**Drawn By:** AS      **Checked By:** JH

**Legend**

- Crowned Ridge II Turbines 300 MW
- Crowned Ridge Turbines
- Deuel Harvest Turbines
- 2 km Turbine Buffer
- County Lines
- CR II Project Boundary
- CR II Intervenor
- Non-Participants Noise
- Participants Noise
- Non-Participating Codington Parcels
- Participating Codington\_Parcels
- Non-Participating Parcels
- Participating Parcels

Day

Codington

Hamlin

Grant

Lac qui Parle


Deuel

Yellow Medicine

Lincoln

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## **APPENDIX B: WIND TURBINE COORDINATES**

**Crowned Ridge II Wind Farm 300 MW**  
**GE 2.3-116-90 m HH, GE 2.1-116-80 m HH WTG's**  
**UTM NAD83 Zone 14**

WTG	Type	Turbine Model	Easting (m)	Northing (m)	Base Elev. AMSL (m)	Sound Profile
CR11-1	Primary	GE2.3 116RD 90HH r1.madAGKB	671,559	4,962,133	612.0	LNTE
CR11-2	Primary	GE2.3 116RD 90HH r1.madAGKB	672,263	4,962,678	614.9	LNTE
CR11-3	Primary	GE2.3 116RD 90HH r1.madAGKB	672,701	4,962,945	611.2	LNTE
CR11-4	Primary	GE2.3 116RD 90HH r1.madAGKB	671,580	4,962,979	614.7	LNTE
CR11-5	Primary	GE2.3 116RD 90HH r1.madAGKB	670,978	4,963,241	610.6	LNTE
CR11-6	Primary	GE2.3 116RD 90HH r1.madAGKB	671,848	4,963,864	609.0	LNTE
CR11-7	Primary	GE2.3 116RD 90HH r1.madAGKB	669,433	4,963,919	609.0	LNTE
CR11-8	Primary	GE2.3 116RD 90HH r1.madAGKB	675,459	4,964,605	586.7	LNTE
CR11-9	Primary	GE2.3 116RD 90HH r1.madAGKB	672,673	4,964,773	606.0	LNTE
CR11-10	Primary	GE2.3 116RD 90HH r1.madAGKB	671,807	4,964,788	605.1	LNTE
CR11-11	Primary	GE2.3 116RD 90HH r1.madAGKB	671,018	4,964,835	608.3	LNTE
CR11-12	Primary	GE2.3 116RD 90HH r1.madAGKB	675,767	4,965,047	582.5	LNTE
CR11-13	Alternate	GE2.3 116RD 90HH r1.madAGKB	661,844	4,965,186	585.0	LNTE
CR11-14	Primary	GE2.3 116RD 90HH r1.madAGKB	670,096	4,965,331	604.8	LNTE
CR11-15	Primary	GE2.3 116RD 90HH r1.madAGKB	673,873	4,965,445	594.0	LNTE
CR11-16	Primary	GE2.3 116RD 90HH r1.madAGKB	670,913	4,965,509	599.1	LNTE
CR11-17	Primary	GE2.3 116RD 90HH r1.madAGKB	674,945	4,965,753	588.8	LNTE
CR11-18	Primary	GE2.3 116RD 90HH r1.madAGKB	672,601	4,965,770	605.8	LNTE
CR11-19	Primary	GE2.3 116RD 90HH r1.madAGKB	661,198	4,965,805	588.0	LNTE
CR11-20	Primary	GE2.3 116RD 90HH r1.madAGKB	673,203	4,965,803	598.0	LNTE
CR11-21	Primary	GE2.3 116RD 90HH r1.madAGKB	669,253	4,966,080	599.3	LNTE
CR11-22	Primary	GE2.3 116RD 90HH r1.madAGKB	662,014	4,966,215	588.0	LNTE
CR11-23	Primary	GE2.3 116RD 90HH r1.madAGKB	662,811	4,966,264	589.7	LNTE
CR11-24	Primary	GE2.3 116RD 90HH r1.madAGKB	675,403	4,966,303	585.0	LNTE
CR11-25	Primary	GE2.3 116RD 90HH r1.madAGKB	661,425	4,966,745	588.0	LNTE
CR11-26	Primary	GE2.3 116RD 90HH r1.madAGKB	660,209	4,966,765	576.7	LNTE
CR11-27	Primary	GE2.3 116RD 90HH r1.madAGKB	667,732	4,966,874	579.0	LNTE
CR11-28	Primary	GE2.3 116RD 90HH r1.madAGKB	664,581	4,966,932	577.5	LNTE
CR11-29	Primary	GE2.3 116RD 90HH r1.madAGKB	672,573	4,966,992	597.0	LNTE
CR11-30	Primary	GE2.3 116RD 90HH r1.madAGKB	675,513	4,967,261	581.4	LNTE
CR11-31	Primary	GE2.3 116RD 90HH r1.madAGKB	674,175	4,967,380	592.7	LNTE
CR11-32	Primary	GE2.3 116RD 90HH r1.madAGKB	671,344	4,967,239	598.9	LNTE
CR11-33	Primary	GE2.3 116RD 90HH r1.madAGKB	674,929	4,967,436	588.6	LNTE
CR11-34	Primary	GE2.3 116RD 90HH r1.madAGKB	667,754	4,967,680	580.6	LNTE
CR11-35	Primary	GE2.3 116RD 90HH r1.madAGKB	675,641	4,967,746	577.3	LNTE
CR11-36	Primary	GE2.3 116RD 90HH r1.madAGKB	669,703	4,968,108	596.8	LNTE
CR11-37	Primary	GE2.3 116RD 90HH r1.madAGKB	673,159	4,968,199	596.9	LNTE
CR11-38	Primary	GE2.3 116RD 90HH r1.madAGKB	673,748	4,968,230	593.9	LNTE
CR11-39	Primary	GE2.3 116RD 90HH r1.madAGKB	664,482	4,968,373	585.0	LNTE
CR11-40	Primary	GE2.3 116RD 90HH r1.madAGKB	663,447	4,968,418	591.0	LNTE
CR11-41	Primary	GE2.3 116RD 90HH r1.madAGKB	665,827	4,968,475	585.6	LNTE

Crowned Ridge II Wind Farm 300 MW  
GE 2.3-116-90 m HH, GE 2.1-116-80 m HH WTG's  
UTM NAD83 Zone 14  
*continued*

WTG	Type	Turbine Model	Easting (m)	Northing (m)	Base Elev. AMSL (m)	Sound Profile
CR11-42	Primary	GE2.3 116RD 90HH r1.madAGKB	668,455	4,968,482	595.8	LNTE
CR11-43	Primary	GE2.3 116RD 90HH r1.madAGKB	667,376	4,968,511	586.4	LNTE
CR11-44	Primary	GE2.3 116RD 90HH r1.madAGKB	672,498	4,968,577	600.0	LNTE
CR11-45	Primary	GE2.3 116RD 90HH r1.madAGKB	673,072	4,968,788	597.2	LNTE
CR11-46	Primary	GE2.3 116RD 90HH r1.madAGKB	671,213	4,968,978	600.0	LNTE
CR11-47	Primary	GE2.3 116RD 90HH r1.madAGKB	670,606	4,968,910	597.8	LNTE
CR11-48	Primary	GE2.3 116RD 90HH r1.madAGKB	669,752	4,968,912	594.0	LNTE
CR11-49	Primary	GE2.3 116RD 90HH r1.madAGKB	662,575	4,969,126	594.0	LNTE
CR11-50	Primary	GE2.3 116RD 90HH r1.madAGKB	675,428	4,969,085	577.8	LNTE
CR11-51	Primary	GE2.3 116RD 90HH r1.madAGKB	666,174	4,969,250	597.0	LNTE
CR11-52	Primary	GE2.3 116RD 90HH r1.madAGKB	667,344	4,969,319	598.1	LNTE
CR11-53	Primary	GE2.3 116RD 90HH r1.madAGKB	668,037	4,969,495	597.8	LNTE
CR11-54	Primary	GE2.3 116RD 90HH r1.madAGKB	675,726	4,969,723	570.0	LNTE
CR11-55	Primary	GE2.3 116RD 90HH r1.madAGKB	666,872	4,970,279	606.0	LNTE
CR11-56	Primary	GE2.3 116RD 90HH r1.madAGKB	666,135	4,970,237	593.4	LNTE
CR11-57	Primary	GE2.3 116RD 90HH r1.madAGKB	667,670	4,970,471	608.9	LNTE
CR11-58	Primary	GE2.1 116RD 80HH rev2.mad	671,619	4,972,700	594.0	LNTE
CR11-59	Primary	GE2.3 116RD 90HH r1.madAGKB	668,248	4,973,458	613.5	LNTE
CR11-60	Primary	GE2.3 116RD 90HH r1.madAGKB	670,973	4,973,527	597.0	LNTE
CR11-61	Primary	GE2.3 116RD 90HH r1.madAGKB	667,589	4,973,910	615.0	LNTE
CR11-62	Primary	GE2.3 116RD 90HH r1.madAGKB	670,983	4,974,414	593.9	LNTE
CR11-63	Primary	GE2.3 116RD 90HH r1.madAGKB	668,350	4,974,115	615.7	LNTE
CR11-64	Primary	GE2.3 116RD 90HH r1.madAGKB	666,982	4,974,334	615.0	LNTE
CR11-65	Primary	GE2.3 116RD 90HH r1.madAGKB	661,369	4,974,608	600.0	LNTE
CR11-66	Primary	GE2.3 116RD 90HH r1.madAGKB	667,711	4,974,761	615.0	LNTE
CR11-67	Primary	GE2.3 116RD 90HH r1.madAGKB	662,077	4,974,986	604.1	LNTE
CR11-69	Primary	GE2.3 116RD 90HH r1.madAGKB	666,524	4,975,244	614.7	LNTE
CR11-70	Primary	GE2.3 116RD 90HH r1.madAGKB	672,450	4,975,267	576.9	LNTE
CR11-71	Primary	GE2.3 116RD 90HH r1.madAGKB	659,674	4,975,487	579.6	LNTE
CR11-72	Alternate	GE2.3 116RD 90HH r1.madAGKB	660,346	4,975,509	590.7	LNTE
CR11-73	Primary	GE2.3 116RD 90HH r1.madAGKB	670,963	4,975,812	590.8	LNTE
CR11-74	Primary	GE2.3 116RD 90HH r1.madAGKB	669,864	4,975,768	600.0	LNTE
CR11-75	Primary	GE2.3 116RD 90HH r1.madAGKB	665,849	4,975,895	608.1	LNTE
CR11-76	Primary	GE2.3 116RD 90HH r1.madAGKB	663,309	4,976,260	597.0	LNTE
CR11-77	Alternate	GE2.3 116RD 90HH r1.madAGKB	660,889	4,976,403	594.0	LNTE
CR11-78	Primary	GE2.1 116RD 80HH rev2.mad	670,593	4,976,444	594.0	LNTE
CR11-79	Primary	GE2.3 116RD 90HH r1.madAGKB	659,556	4,976,577	576.6	LNTE
CR11-80	Primary	GE2.1 116RD 80HH rev2.mad	670,089	4,976,781	597.0	LNTE
CR11-81	Primary	GE2.3 116RD 90HH r1.madAGKB	666,468	4,976,852	615.0	LNTE
CR11-82	Primary	GE2.3 116RD 90HH r1.madAGKB	664,868	4,977,195	606.0	LNTE
CR11-83	Primary	GE2.3 116RD 90HH r1.madAGKB	659,267	4,977,221	570.0	LNTE

Crowned Ridge II Wind Farm 300 MW  
GE 2.3-116-90 m HH, GE 2.1-116-80 m HH WTG's  
UTM NAD83 Zone 14  
*continued*

WTG	Type	Turbine Model	Easting (m)	Northing (m)	Base Elev. AMSL (m)	Sound Profile
CRII-84	Primary	GE2.3 116RD 90HH r1.madAGKB	661,202	4,977,297	585.0	LNTE
CRII-85	Primary	GE2.1 116RD 80HH rev2.mad	670,104	4,977,199	594.4	LNTE
CRII-86	Primary	GE2.1 116RD 80HH rev2.mad	668,086	4,977,549	605.9	LNTE
CRII-87	Primary	GE2.1 116RD 80HH rev2.mad	668,884	4,977,561	594.0	LNTE
CRII-88	Primary	GE2.3 116RD 90HH r1.madAGKB	666,503	4,978,327	612.1	LNTE
CRII-89	Primary	GE2.1 116RD 80HH rev2.mad	667,591	4,978,362	615.0	LNTE
CRII-90	Primary	GE2.1 116RD 80HH rev2.mad	670,109	4,978,176	589.0	LNTE
CRII-91	Primary	GE2.1 116RD 80HH rev2.mad	668,348	4,978,315	600.0	LNTE
CRII-92	Primary	GE2.3 116RD 90HH r1.madAGKB	664,354	4,978,724	594.7	LNTE
CRII-93	Primary	GE2.1 116RD 80HH rev2.mad	665,882	4,978,374	609.0	LNTE
CRII-94	Primary	GE2.3 116RD 90HH r1.madAGKB	667,644	4,978,955	607.9	LNTE
CRII-95	Primary	GE2.3 116RD 90HH r1.madAGKB	666,647	4,979,039	615.0	LNTE
CRII-96	Primary	GE2.3 116RD 90HH r1.madAGKB	665,082	4,979,106	604.6	LNTE
CRII-97	Primary	GE2.3 116RD 90HH r1.madAGKB	668,163	4,979,177	586.4	LNTE
CRII-98	Primary	GE2.1 116RD 80HH rev2.mad	670,003	4,979,175	585.4	LNTE
CRII-99	Primary	GE2.3 116RD 90HH r1.madAGKB	665,723	4,979,545	607.0	LNTE
CRII-100	Primary	GE2.3 116RD 90HH r1.madAGKB	666,675	4,979,716	613.8	LNTE
CRII-101	Primary	GE2.3 116RD 90HH r1.madAGKB	665,960	4,980,327	606.0	LNTE
CRII-102	Primary	GE2.1 116RD 80HH rev2.mad	667,903	4,980,491	600.1	LNTE
CRII-104	Primary	GE2.3 116RD 90HH r1.madAGKB	662,560	4,981,078	588.0	LNTE
CRII-105	Primary	GE2.3 116RD 90HH r1.madAGKB	663,201	4,981,245	594.0	LNTE
CRII-106	Primary	GE2.3 116RD 90HH r1.madAGKB	661,170	4,981,296	586.2	LNTE
CRII-107	Primary	GE2.1 116RD 80HH rev2.mad	666,729	4,981,576	598.4	LNTE
CRII-108	Primary	GE2.3 116RD 90HH r1.madAGKB	667,242	4,981,585	592.4	LNTE
CRII-110	Primary	GE2.3 116RD 90HH r1.madAGKB	665,644	4,981,745	609.0	LNTE
CRII-111	Primary	GE2.3 116RD 90HH r1.madAGKB	661,406	4,981,960	591.0	LNTE
CRII-112	Primary	GE2.3 116RD 90HH r1.madAGKB	664,889	4,982,000	612.6	LNTE
CRII-114	Primary	GE2.3 116RD 90HH r1.madAGKB	665,029	4,982,755	613.5	LNTE
CRII-115	Primary	GE2.3 116RD 90HH r1.madAGKB	667,423	4,982,834	585.7	LNTE
CRII-116	Primary	GE2.3 116RD 90HH r1.madAGKB	664,098	4,982,988	603.0	LNTE
CRII-117	Primary	GE2.3 116RD 90HH r1.madAGKB	666,339	4,983,199	600.6	LNTE
CRII-118	Primary	GE2.3 116RD 90HH r1.madAGKB	665,536	4,983,411	608.1	LNTE
CRII-119	Primary	GE2.3 116RD 90HH r1.madAGKB	664,901	4,983,463	603.4	LNTE
CRII-120	Primary	GE2.3 116RD 90HH r1.madAGKB	662,307	4,983,683	592.9	LNTE
CRII-121	Primary	GE2.3 116RD 90HH r1.madAGKB	666,651	4,983,822	588.7	LNTE
CRII-122	Primary	GE2.3 116RD 90HH r1.madAGKB	662,977	4,983,870	603.9	LNTE
CRII-123	Primary	GE2.3 116RD 90HH r1.madAGKB	663,421	4,984,335	606.6	LNTE
CRII-124	Primary	GE2.3 116RD 90HH r1.madAGKB	664,181	4,984,488	606.0	LNTE
CRII-125	Primary	GE2.3 116RD 90HH r1.madAGKB	664,784	4,984,583	604.2	LNTE
CRII-126	Primary	GE2.3 116RD 90HH r1.madAGKB	664,221	4,985,123	606.0	LNTE
CRII-128	Primary	GE2.3 116RD 90HH r1.madAGKB	667,329	4,985,347	582.0	LNTE

**Crowned Ridge II Wind Farm 300 MW**  
**GE 2.3-116-90 m HH, GE 2.1-116-80 m HH WTG's**  
**UTM NAD83 Zone 14**  
*continued*

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## **APPENDIX C: TABLE OF SHADOW FLICKER RESULTS**

**Table C-1: Crowned Ridge II 300 MW Shadow Flicker Tabular Results Sorted by Receptor ID**

Realistic case shadow results at occupied structures

Results using GE 2.3-116-90 m HH, GE 2.1-116-80 m HH WTG's

UTM NAD83 Zone 14

Codrington County

Receptor ID	Participation Status	Easting (m)	Northing (m)	Elevation AMSL (m)	Real Case Shadow (hrs/year)	Distance to Nearest Turbine (ft)
CR2-C1-NP	Non-P	662,198	4,980,622	591.0	3:51	1,909
CR2-C2-NP	Non-P	662,238	4,980,604	590.9	1:03	1,880
CR2-C3-NP	Non-P	664,345	4,964,571	556.0	0:00	7,497
CR1-C4-NP	Non-P	659,744	4,984,749	606.0	0:00	5,981
CR1-C5-NP	Non-P	659,958	4,984,794	604.8	0:00	5,659
CR1-C7-NP	Non-P	660,893	4,984,861	593.2	0:00	3,022
CR2-C7-NP	Non-P	665,694	4,966,179	570.0	0:00	4,409
CR1-C8-P	Participant	660,532	4,984,445	599.4	0:00	3,740
CR1-C9-NP	Non-P	665,352	4,985,004	609.0	18:09	2,283
CR2-C10-NP	Non-P	665,189	4,966,505	570.0	0:00	2,438
CR1-C10-P	Participant	663,510	4,985,195	609.0	38:21	1,634
CR1-C11-P	Participant	664,111	4,985,679	609.0	10:28	1,860
CR1-C12-NP	Non-P	662,222	4,985,736	603.0	17:08	2,201
CR1-C12-1-NP	Non-P	662,199	4,986,047	606.0	10:34	2,818
CR1-C13-NP	Non-P	663,792	4,985,785	612.0	19:02	2,589
CR1-C15-NP	Non-P	663,291	4,986,026	615.0	2:16	2,175
CR2-C16-NP	Non-P	665,418	4,966,866	567.0	7:30	2,756
CR1-C16-NP	Non-P	661,960	4,986,288	606.0	6:17	2,648
CR1-C18-P	Participant	663,651	4,987,157	610.4	5:58	3,409
CR1-C20-P	Participant	663,054	4,987,455	606.0	14:37	2,336
CR1-C21-P	Participant	660,756	4,984,086	594.0	1:00	2,388
CR2-C22-NP	Non-P	661,202	4,972,711	597.0	0:00	6,247
CR1-C22-P	Participant	660,755	4,984,082	594.0	1:01	2,375
CR2-C23-NP	Non-P	664,069	4,969,661	594.0	0:58	4,439
CR1-C23-P	Participant	660,619	4,984,078	595.8	0:00	2,523
CR1-C24-NP	Non-P	660,176	4,983,887	601.1	7:45	3,038
CR2-C24-NP	Non-P	661,541	4,969,653	600.0	3:21	3,809
CR1-C25-P	Participant	660,190	4,983,788	602.3	6:43	2,838
CR2-C26-P	Participant	664,733	4,968,915	591.0	6:09	1,959
CR2-C27-P	Participant	662,985	4,968,167	582.0	18:06	1,726
CR1-C28-NP	Non-P	665,429	4,988,598	590.9	2:41	2,831
CR2-C28-P	Participant	659,208	4,968,159	572.8	0:00	5,630
CR1-C29-NP	Non-P	666,572	4,988,867	575.9	6:54	2,457
CR2-C29-NP	Non-P	661,223	4,968,144	595.2	0:00	4,639
CR2-C30-NP	Non-P	659,100	4,968,023	568.6	0:00	5,502
CR1-C31-NP	Non-P	665,939	4,988,950	585.4	0:00	2,126
CR2-C31-P	Participant	663,117	4,972,923	606.0	0:00	7,579
CR2-C32-P	Participant	659,469	4,967,984	575.2	0:00	4,678
CR2-C33-P	Participant	663,878	4,967,612	576.1	2:28	2,999



**Table C-1: Crowned Ridge II 300 MW Shadow Flicker Tabular Results Sorted by Receptor ID****Realistic case shadow results at occupied structures****Results using GE 2.3-116-90 m HH, GE 2.1-116-80 m HH WTG's****UTM NAD83 Zone 14****Codington County*****continued***

<b>Receptor ID</b>	<b>Participation Status</b>	<b>Easting (m)</b>	<b>Northing (m)</b>	<b>Elevation AMSL (m)</b>	<b>Real Case Shadow (hrs/year)</b>	<b>Distance to Nearest Turbine (ft)</b>
CR2-C34-P	Participant	663,934	4,966,991	570.1	14:11	2,133
CR2-C35-NP	Non-P	658,964	4,974,334	566.8	0:00	4,442
CR2-C36-NP	Non-P	660,475	4,974,426	578.6	8:20	2,992
CR2-C37-NP	Non-P	663,037	4,974,496	606.0	9:34	3,537
CR2-C38-NP	Non-P	660,874	4,966,929	585.5	25:57	1,906
CR2-C39-NP	Non-P	664,089	4,966,486	566.2	2:27	2,178
CR2-C40-NP	Non-P	659,189	4,974,765	578.3	1:39	2,854
CR2-C41-P	Participant	660,770	4,975,147	596.4	17:30	1,532
CR2-C42-NP	Non-P	664,887	4,975,388	597.0	12:14	3,566
CR2-C43-NP	Non-P	664,382	4,975,544	597.0	1:42	4,232
CR2-C44-NP	Non-P	659,145	4,966,062	561.4	0:43	4,183
CR2-C45-P	Participant	664,058	4,965,862	570.0	4:12	3,907
CR2-C46-NP	Non-P	660,435	4,965,627	582.0	12:12	2,569
CR2-C47-NP	Non-P	662,200	4,975,837	594.5	9:41	2,821
CR2-C48-NP	Non-P	662,370	4,965,588	590.3	19:13	2,172
CR2-C49-NP	Non-P	660,907	4,964,846	582.0	6:36	3,271
CR2-C50-P	Participant	661,252	4,976,035	597.0	19:22	1,696
CR2-C51-NP	Non-P	662,977	4,964,794	584.0	4:41	3,934
CR2-C52-NP	Non-P	662,688	4,964,792	585.9	14:32	3,054
CR2-C53-NP	Non-P	662,401	4,964,782	582.0	0:00	2,257
CR2-C54-NP	Non-P	662,636	4,976,079	597.0	12:36	2,287
CR2-C55-NP	Non-P	660,765	4,964,777	582.0	4:36	3,658
CR2-C56-NP	Non-P	660,759	4,964,737	582.0	4:54	3,789
CR2-C57-P	Participant	666,667	4,976,162	613.8	5:03	2,356
CR2-C58-NP	Non-P	660,764	4,964,686	582.0	5:51	3,904
CR2-C59-P	Participant	664,952	4,976,698	601.9	4:29	1,654
CR2-C60-P	Participant	662,287	4,976,800	594.0	13:54	3,793
CR2-C61-NP	Non-P	660,630	4,976,840	582.5	12:08	1,667
CR2-C62-NP	Non-P	666,992	4,977,048	615.0	17:16	1,834
CR2-C63-P	Participant	665,528	4,977,285	612.0	14:34	2,185
CR2-C64-NP	Non-P	660,901	4,964,220	582.0	0:00	4,429
CR2-C65-NP	Non-P	665,217	4,977,746	609.0	7:09	2,139
CR1-C66-NP	Non-P	659,718	4,985,032	606.0	0:00	5,800
CR2-C66-NP	Non-P	662,396	4,963,954	582.0	0:00	4,429
CR1-C67-NP	Non-P	659,789	4,985,057	606.0	0:00	5,791
CR2-C67-NP	Non-P	660,379	4,978,592	556.1	0:00	5,033
CR2-C68-NP	Non-P	662,517	4,963,408	579.0	0:00	6,237
CR1-C68-P	Participant	662,652	4,987,606	609.0	6:42	2,146

**Table C-1: Crowned Ridge II 300 MW Shadow Flicker Tabular Results Sorted by Receptor ID**

**Realistic case shadow results at occupied structures**

**Results using GE 2.3-116-90 m HH, GE 2.1-116-80 m HH WTG's**

**UTM NAD83 Zone 14**

**Codington County**

*continued*

Receptor ID	Participation Status	Easting (m)	Northing (m)	Elevation AMSL (m)	Real Case Shadow (hrs/year)	Distance to Nearest Turbine (ft)
CR2-C69-NP	Non-P	661,701	4,978,792	564.0	0:00	5,171
CR1-C69-P	Participant	662,685	4,987,619	609.0	6:03	2,185
CR1-C70-NP	Non-P	665,135	4,988,293	595.9	12:03	3,540
CR2-C70-P	Participant	665,521	4,970,518	588.9	13:57	2,215
CR2-C71-NP	Non-P	665,411	4,970,503	586.1	10:14	2,529
CR1-C71-NP	Non-P	665,137	4,988,378	595.6	7:23	3,451
CR1-C72-NP	Non-P	665,158	4,988,170	594.6	7:37	3,779
CR2-C72-NP	Non-P	663,856	4,970,488	597.0	0:00	6,135
CR1-C73-NP	Non-P	663,066	4,982,530	591.0	6:57	3,704
CR1-C74-NP	Non-P	662,869	4,983,122	595.7	2:34	2,480
CR2-C74-NP	Non-P	660,687	4,969,931	586.5	0:00	6,732
CR2-C75-NP	Non-P	664,866	4,969,808	583.7	5:05	4,396
CR1-C75-NP	Non-P	663,010	4,982,658	588.0	4:25	3,730
CR1-C76-NP	Non-P	662,981	4,982,580	588.3	5:26	3,901
CR2-C76-NP	Non-P	664,747	4,969,738	584.8	3:53	4,560
CR2-C77-NP	Non-P	663,865	4,969,694	597.0	1:28	4,406
CR1-C77-P	Participant	661,915	4,983,367	591.0	12:12	1,654
CR2-C78-P	Participant	665,273	4,983,933	609.0	25:17	1,919
CR1-C78-P	Participant	660,190	4,983,788	602.3	6:43	2,835
CR1-C79-NP	Non-P	660,452	4,983,750	595.9	22:38	2,037
CR2-C79-NP	Non-P	666,869	4,984,663	587.9	0:00	2,703
CR1-C80-NP	Non-P	659,351	4,983,174	604.4	0:40	5,308
CR2-C80-NP	Non-P	664,705	4,972,092	597.3	0:00	7,684
CR1-C81-NP	Non-P	660,062	4,983,083	597.0	6:15	3,094
CR1-C84-NP	Non-P	659,607	4,982,216	594.0	0:00	5,856
CR1-C85-NP	Non-P	659,706	4,981,419	588.0	1:22	4,819
CR2-C86-NP	Non-P	662,880	4,971,302	603.0	0:00	7,208
CR1-C86-P	Participant	662,086	4,982,135	585.0	16:51	2,303
CR1-C87-NP	Non-P	662,628	4,982,425	585.4	4:09	4,258
CR2-C87-NP	Non-P	662,841	4,971,294	603.0	0:00	7,165
CR1-C88-NP	Non-P	660,156	4,980,595	570.9	0:00	4,045
CR2-C89-NP	Non-P	662,244	4,971,076	603.0	0:00	6,489
CR1-C89-P	Participant	662,062	4,982,029	584.3	21:40	2,165
CR2-C90-NP	Non-P	664,088	4,970,672	594.0	0:00	6,863
CR2-C91-NP	Non-P	663,938	4,970,546	597.0	0:00	6,457
CR2-C92-NP	Non-P	663,855	4,970,535	597.0	0:00	6,247
CR2-C93-NP	Non-P	659,203	4,973,158	584.9	0:00	7,795
CR2-C94-NP	Non-P	659,202	4,973,052	583.9	0:00	8,136

**Table C-1: Crowned Ridge II 300 MW Shadow Flicker Tabular Results Sorted by Receptor ID**

**Realistic case shadow results at occupied structures**

**Results using GE 2.3-116-90 m HH, GE 2.1-116-80 m HH WTG's**

**UTM NAD83 Zone 14**

**Codington County**

*continued*

Receptor ID	Participation Status	Easting (m)	Northing (m)	Elevation AMSL (m)	Real Case Shadow (hrs/year)	Distance to Nearest Turbine (ft)
CR2-C95-NP	Non-P	659,248	4,974,054	567.0	0:00	4,905
CR2-C96-NP	Non-P	659,316	4,974,063	570.6	0:00	4,816
CR2-C97-NP	Non-P	660,093	4,976,001	583.8	29:00	1,814
CR2-C98-NP	Non-P	660,155	4,976,007	582.8	32:06	1,749
CR2-C99-P	Participant	660,584	4,972,570	591.0	0:00	7,165
CR2-C100-NP	Non-P	660,592	4,972,602	591.0	0:00	7,057
CR2-C101-NP	Non-P	660,732	4,972,807	591.0	0:00	6,266
CR2-C102-NP	Non-P	662,025	4,976,085	594.1	8:29	3,609
CR2-C103-NP	Non-P	662,046	4,976,067	594.8	8:17	3,547
CR2-C104-NP	Non-P	662,109	4,972,735	604.0	0:00	6,608
CR2-C105-NP	Non-P	662,122	4,976,029	595.3	7:47	3,425
CR2-C106-NP	Non-P	662,165	4,972,711	604.7	0:00	6,749
CR2-C107-NP	Non-P	662,265	4,978,194	577.7	4:21	4,564
CR2-C109-NP	Non-P	662,699	4,972,874	606.0	0:00	7,169
CR2-C112-NP	Non-P	665,928	4,972,630	603.0	0:00	6,575
CR2-C115-NP	Non-P	663,555	4,980,564	575.2	8:18	2,520
CR2-C116-NP	Non-P	664,640	4,976,142	591.1	4:50	3,533
CR2-C117-NP	Non-P	664,742	4,976,142	594.2	4:53	3,481
CR2-C118-NP	Non-P	665,014	4,974,639	600.0	1:57	4,947
CR2-C119-NP	Non-P	665,052	4,974,682	600.0	2:06	4,760
CR2-C123-P	Participant	666,146	4,966,653	579.4	2:13	5,216
CR2-C126-P	Participant	666,389	4,966,670	585.0	1:40	4,455
CR2-C128-P	Participant	666,636	4,966,649	589.0	3:00	3,671
CR2-C129-P	Participant	666,716	4,966,751	591.0	3:31	3,356
CR2-C130-P	Participant	666,727	4,966,695	591.0	3:42	3,350
CR2-C131-NP	Non-P	666,732	4,984,987	591.0	10:06	2,287
CR2-C132-NP	Non-P	666,857	4,985,021	588.2	1:47	1,883
CR2-C133-P	Participant	666,992	4,967,681	571.2	13:37	2,500
CR2-C134-NP	Non-P	667,097	4,973,011	613.0	3:42	3,363
CR2-C135-NP	Non-P	667,172	4,966,196	595.2	0:00	2,884
CR2-C136-NP	Non-P	667,209	4,966,166	595.4	0:00	2,887
CR2-C137-NP	Non-P	658,951	4,979,194	568.2	0:00	6,555
CR2-C142-NP	Non-P	656,697	4,977,269	566.9	0:00	8,432
CR2-C143-NP	Non-P	657,016	4,977,505	553.6	0:00	7,444
CR2-C151-NP	Non-P	663,934	4,964,475	556.1	0:00	6,929
CR2-C154-P	Participant	660,684	4,967,166	588.0	30:00	2,041
CR2-C155-NP	Non-P	657,554	4,975,128	554.6	0:00	7,054

**Table C-1: Crowned Ridge II 300 MW Shadow Flicker Tabular Results Sorted by Receptor ID**

**Realistic case shadow results at occupied structures**

**Results using GE 2.3-116-90 m HH, GE 2.1-116-80 m HH WTG's**

**UTM NAD83 Zone 14**

**Deuel County**

**continued**

Receptor ID	Participation Status	Easting (m)	Northing (m)	Elevation AMSL (m)	Real Case Shadow (hrs/year)	Distance to Nearest Turbine (ft)
CR2-D3-NP	Non-P	672,390	4,963,482	612.0	6:47	2,037
CR2-D5-NP	Non-P	668,781	4,964,897	603.0	15:51	1,923
CR2-D6-P	Participant	668,762	4,967,671	591.0	17:17	2,844
CR2-D9-NP	Non-P	668,597	4,971,999	611.5	0:00	4,921
CR2-D11-NP	Non-P	669,646	4,974,534	604.4	20:54	2,028
CR2-D12-NP	Non-P	668,558	4,969,840	604.7	18:07	2,051
CR2-D14-NP	Non-P	670,351	4,973,543	606.0	13:33	2,041
CR2-D15-NP	Non-P	674,387	4,968,515	588.0	24:01	2,297
CR2-D16-P	Participant	671,626	4,966,693	601.7	5:21	2,018
CR2-D17-NP	Non-P	672,023	4,969,597	597.0	13:45	3,343
CR2-D18-NP	Non-P	671,540	4,976,154	582.0	22:04	2,201
CR2-D19-NP	Non-P	668,870	4,964,178	606.0	13:59	2,034
CR2-D20-NP	Non-P	675,261	4,968,400	579.0	3:00	2,313
CR2-D21-NP	Non-P	669,517	4,978,053	596.1	28:59	1,985
CR2-D22-NP	Non-P	668,798	4,963,767	603.1	14:21	2,142
CR2-D23-NP	Non-P	669,671	4,980,468	573.0	0:00	4,380
CR2-D30-NP	Non-P	669,549	4,974,233	611.9	16:46	2,113
CR2-D36-NP	Non-P	669,812	4,966,746	591.0	2:59	2,854
CR2-D37-NP	Non-P	674,048	4,974,071	573.0	0:00	6,548
CR2-D38-P	Participant	667,108	4,982,083	597.0	5:02	1,693
CR2-D39-P	Participant	668,443	4,974,627	614.4	18:50	1,706
CR2-D41-NP	Non-P	670,437	4,966,409	597.0	2:06	3,340
CR2-D44-NP	Non-P	670,434	4,965,956	593.8	24:03	2,149
CR2-D45-NP	Non-P	668,018	4,976,064	611.5	0:55	4,393
CR2-D46-NP	Non-P	669,797	4,966,804	591.0	1:23	2,972
CR2-D48-P	Participant	668,923	4,972,998	609.0	0:00	2,680
CR2-D49-P	Participant	672,024	4,974,135	583.2	8:42	3,537
CR2-D50-P	Participant	672,015	4,967,209	602.8	24:58	1,965
CR2-D51-NP	Non-P	675,005	4,970,131	577.8	8:27	2,717
CR2-D52-NP	Non-P	667,172	4,971,776	606.0	0:00	4,583
CR2-D53-P	Participant	670,392	4,975,925	592.8	27:32	1,808
CR2-D54-NP	Non-P	672,012	4,966,477	600.0	5:15	2,500
CR2-D56-P	Participant	667,119	4,977,925	612.0	8:10	2,110
CR2-D62-NP	Non-P	669,355	4,974,624	609.0	10:36	3,015
CR2-D63-NP	Non-P	670,546	4,961,419	615.0	0:00	4,065
CR2-D64-P	Participant	669,417	4,978,434	588.0	14:03	2,425
CR2-D65-NP	Non-P	670,422	4,966,654	597.0	5:26	3,583
CR2-D71-NP	Non-P	669,402	4,979,216	588.0	18:30	1,975

**Table C-1: Crowned Ridge II 300 MW Shadow Flicker Tabular Results Sorted by Receptor ID**

**Realistic case shadow results at occupied structures**

**Results using GE 2.3-116-90 m HH, GE 2.1-116-80 m HH WTG's**

**UTM NAD83 Zone 14**

**Deuel County**

***continued***

Receptor ID	Participation Status	Easting (m)	Northing (m)	Elevation AMSL (m)	Real Case Shadow (hrs/year)	Distance to Nearest Turbine (ft)
CR2-D72-NP	Non-P	671,925	4,970,149	603.0	0:00	4,495
CR2-D73-NP	Non-P	672,072	4,971,556	600.0	0:00	4,035
CR2-D74-NP	Non-P	668,130	4,976,068	609.2	0:00	4,505
CR2-D75-NP	Non-P	669,473	4,981,625	570.0	0:00	6,355
CR2-D77-NP	Non-P	672,044	4,966,468	600.0	5:58	2,444
CR2-D79-NP	Non-P	672,172	4,974,737	585.0	2:16	1,962
CR2-D82-NP	Non-P	669,855	4,970,718	603.0	0:00	5,935
CR2-D83-NP	Non-P	675,891	4,966,810	579.0	12:25	1,929
CR2-D84-NP	Non-P	667,159	4,972,169	598.2	0:00	5,535
CR2-D85-NP	Non-P	669,593	4,976,302	603.0	4:36	1,965
CR2-D86-NP	Non-P	673,842	4,966,875	597.0	12:07	1,985
CR2-D90-NP	Non-P	670,516	4,962,327	612.0	7:36	3,360
CR2-D91-NP	Non-P	667,546	4,976,173	618.0	2:59	4,180
CR2-D92-NP	Non-P	671,159	4,971,610	597.2	0:00	3,881
CR2-D95-NP	Non-P	671,994	4,971,562	600.0	0:00	3,930
CR2-D96-NP	Non-P	672,899	4,971,469	594.0	0:00	5,827
CR2-D97-NP	Non-P	667,164	4,972,232	600.0	0:00	5,371
CR2-D98-P	Participant	669,757	4,972,426	606.0	0:00	5,381
CR2-D99-NP	Non-P	668,148	4,976,230	608.8	0:00	4,331
CR2-D100-NP	Non-P	668,589	4,972,064	609.9	0:00	4,708
CR2-D101-NP	Non-P	672,538	4,961,910	612.8	5:29	2,677
CR2-D103-NP	Non-P	670,588	4,961,119	615.0	0:00	4,606
CR2-D104-NP	Non-P	670,443	4,961,600	613.8	5:06	4,058
CR2-D105-NP	Non-P	670,348	4,963,826	611.7	17:57	2,821
CR2-D106-NP	Non-P	667,315	4,965,297	594.0	0:00	5,351
CR2-D107-NP	Non-P	670,405	4,966,321	597.0	6:22	3,143
CR2-D108-NP	Non-P	670,354	4,965,949	594.0	25:37	2,198
CR2-D109-NP	Non-P	676,885	4,965,806	576.0	4:51	4,432
CR2-D110-NP	Non-P	670,260	4,967,728	597.0	3:14	2,211
CR2-D111-P	Participant	671,876	4,969,006	600.0	29:32	2,178
CR2-D112-NP	Non-P	667,666	4,971,554	604.6	0:00	3,553
CR2-D113-NP	Non-P	667,774	4,971,544	606.9	0:00	3,537
CR2-D115-P	Participant	670,974	4,969,938	606.0	2:04	3,245
CR2-D116-NP	Non-P	673,491	4,972,398	577.8	0:00	6,220
CR2-D119-P	Participant	673,378	4,965,126	602.6	16:30	1,932
CR2-D120-NP	Non-P	673,401	4,964,165	609.0	2:19	3,110
CR2-D121-NP	Non-P	674,461	4,966,734	594.0	12:06	2,316
CR2-D122-P	Participant	673,601	4,967,341	594.0	18:17	1,886

Realistic case shadow results at occupied structures  
Results using GE 2.3-116-90 m HH, GE 2.1-116-80 m HH WTG's  
UTM NAD83 Zone 14  
Deuel County  
*continued*

[illegible]

Realistic case shadow results at occupied structures  
Results using GE 2.3-116-90 m HH, GE 2.1-116-80 m HH WTG's  
UTM NAD83 Zone 14  
Grant County  
*continued*

[illegible]

**Table C-2: Crowned Ridge II 300 MW Shadow Flicker Tabular Results Sorted by Real Case Shadow Flicker Hours/Year**  
**Realistic case shadow results at occupied structures**  
**Results using GE 2.3-116-90 m HH, GE 2.1-116-80 m HH WTG's**  
**UTM NAD83 Zone 14**  
**Codington County**

Receptor ID	Participation Status	Easting (m)	Northing (m)	Elevation AMSL (m)	Real Case Shadow (hrs/year)	Distance to Nearest Turbine (ft)
CR2-C98-NP	Non-P	660,155	4,976,007	582.8	32:06	1,749
CR2-C97-NP	Non-P	660,093	4,976,001	583.8	29:00	1,814
CR2-C38-NP	Non-P	660,874	4,966,929	585.5	25:57	1,906
CR1-C79-NP	Non-P	660,452	4,983,750	595.9	22:38	2,037
CR2-C48-NP	Non-P	662,370	4,965,588	590.3	19:13	2,172
CR1-C13-NP	Non-P	663,792	4,985,785	612.0	19:02	2,589
CR1-C9-NP	Non-P	665,352	4,985,004	609.0	18:09	2,283
CR2-C62-NP	Non-P	666,992	4,977,048	615.0	17:16	1,834
CR1-C12-NP	Non-P	662,222	4,985,736	603.0	17:08	2,201
CR2-C52-NP	Non-P	662,688	4,964,792	585.9	14:32	3,054
CR2-C54-NP	Non-P	662,636	4,976,079	597.0	12:36	2,287
CR2-C42-NP	Non-P	664,887	4,975,388	597.0	12:14	3,566
CR2-C46-NP	Non-P	660,435	4,965,627	582.0	12:12	2,569
CR2-C61-NP	Non-P	660,630	4,976,840	582.5	12:08	1,667
CR1-C70-NP	Non-P	665,135	4,988,293	595.9	12:03	3,540
CR1-C12-1-NP	Non-P	662,199	4,986,047	606.0	10:34	2,818
CR2-C71-NP	Non-P	665,411	4,970,503	586.1	10:14	2,529
CR2-C131-NP	Non-P	666,732	4,984,987	591.0	10:06	2,287
CR2-C47-NP	Non-P	662,200	4,975,837	594.5	9:41	2,821
CR2-C37-NP	Non-P	663,037	4,974,496	606.0	9:34	3,537
CR2-C102-NP	Non-P	662,025	4,976,085	594.1	8:29	3,609
CR2-C36-NP	Non-P	660,475	4,974,426	578.6	8:20	2,992
CR2-C115-NP	Non-P	663,555	4,980,564	575.2	8:18	2,520
CR2-C103-NP	Non-P	662,046	4,976,067	594.8	8:17	3,547
CR2-C105-NP	Non-P	662,122	4,976,029	595.3	7:47	3,425
CR1-C24-NP	Non-P	660,176	4,983,887	601.1	7:45	3,038
CR1-C72-NP	Non-P	665,158	4,988,170	594.6	7:37	3,779
CR2-C16-NP	Non-P	665,418	4,966,866	567.0	7:30	2,756
CR1-C71-NP	Non-P	665,137	4,988,378	595.6	7:23	3,451
CR2-C65-NP	Non-P	665,217	4,977,746	609.0	7:09	2,139
CR1-C73-NP	Non-P	663,066	4,982,530	591.0	6:57	3,704
CR1-C29-NP	Non-P	666,572	4,988,867	575.9	6:54	2,457
CR2-C49-NP	Non-P	660,907	4,964,846	582.0	6:36	3,271
CR1-C16-NP	Non-P	661,960	4,986,288	606.0	6:17	2,648
CR1-C81-NP	Non-P	660,062	4,983,083	597.0	6:15	3,094
CR2-C58-NP	Non-P	660,764	4,964,686	582.0	5:51	3,904
CR1-C76-NP	Non-P	662,981	4,982,580	588.3	5:26	3,901
CR2-C75-NP	Non-P	664,866	4,969,808	583.7	5:05	4,396
CR2-C56-NP	Non-P	660,759	4,964,737	582.0	4:54	3,789



**Table C-2: Crowned Ridge II 300 MW Shadow Flicker Tabular Results Sorted by Real Case Shadow Flicker Hours/Year**  
**Realistic case shadow results at occupied structures**  
**Results using GE 2.3-116-90 m HH, GE 2.1-116-80 m HH WTG's**  
**UTM NAD83 Zone 14**  
**Codington County**  
*continued*

Receptor ID	Participation Status	Easting (m)	Northing (m)	Elevation AMSL (m)	Real Case Shadow (hrs/year)	Distance to Nearest Turbine (ft)
CR2-C117-NP	Non-P	664,742	4,976,142	594.2	4:53	3,481
CR2-C116-NP	Non-P	664,640	4,976,142	591.1	4:50	3,533
CR2-C51-NP	Non-P	662,977	4,964,794	584.0	4:41	3,934
CR2-C55-NP	Non-P	660,765	4,964,777	582.0	4:36	3,658
CR1-C75-NP	Non-P	663,010	4,982,658	588.0	4:25	3,730
CR2-C107-NP	Non-P	662,265	4,978,194	577.7	4:21	4,564
CR1-C87-NP	Non-P	662,628	4,982,425	585.4	4:09	4,258
CR2-C76-NP	Non-P	664,747	4,969,738	584.8	3:53	4,560
CR2-C1-NP	Non-P	662,198	4,980,622	591.0	3:51	1,909
CR2-C134-NP	Non-P	667,097	4,973,011	613.0	3:42	3,363
CR2-C24-NP	Non-P	661,541	4,969,653	600.0	3:21	3,809
CR1-C28-NP	Non-P	665,429	4,988,598	590.9	2:41	2,831
CR1-C74-NP	Non-P	662,869	4,983,122	595.7	2:34	2,480
CR2-C39-NP	Non-P	664,089	4,966,486	566.2	2:27	2,178
CR1-C15-NP	Non-P	663,291	4,986,026	615.0	2:16	2,175
CR2-C119-NP	Non-P	665,052	4,974,682	600.0	2:06	4,760
CR2-C118-NP	Non-P	665,014	4,974,639	600.0	1:57	4,947
CR2-C132-NP	Non-P	666,857	4,985,021	588.2	1:47	1,883
CR2-C43-NP	Non-P	664,382	4,975,544	597.0	1:42	4,232
CR2-C40-NP	Non-P	659,189	4,974,765	578.3	1:39	2,854
CR2-C77-NP	Non-P	663,865	4,969,694	597.0	1:28	4,406
CR1-C85-NP	Non-P	659,706	4,981,419	588.0	1:22	4,819
CR2-C2-NP	Non-P	662,238	4,980,604	590.9	1:03	1,880
CR2-C23-NP	Non-P	664,069	4,969,661	594.0	0:58	4,439
CR2-C44-NP	Non-P	659,145	4,966,062	561.4	0:43	4,183
CR1-C80-NP	Non-P	659,351	4,983,174	604.4	0:40	5,308
CR2-C137-NP	Non-P	658,951	4,979,194	568.2	0:00	6,555
CR2-C142-NP	Non-P	656,697	4,977,269	566.9	0:00	8,432
CR2-C143-NP	Non-P	657,016	4,977,505	553.6	0:00	7,444
CR1-C31-NP	Non-P	665,939	4,988,950	585.4	0:00	2,126
CR1-C4-NP	Non-P	659,744	4,984,749	606.0	0:00	5,981
CR1-C5-NP	Non-P	659,958	4,984,794	604.8	0:00	5,659
CR1-C66-NP	Non-P	659,718	4,985,032	606.0	0:00	5,800
CR1-C67-NP	Non-P	659,789	4,985,057	606.0	0:00	5,791
CR1-C7-NP	Non-P	660,893	4,984,861	593.2	0:00	3,022
CR1-C84-NP	Non-P	659,607	4,982,216	594.0	0:00	5,856
CR1-C88-NP	Non-P	660,156	4,980,595	570.9	0:00	4,045
CR2-C100-NP	Non-P	660,592	4,972,602	591.0	0:00	7,057

**Table C-2: Crowned Ridge II 300 MW Shadow Flicker Tabular Results Sorted by Real Case Shadow Flicker Hours/Year**  
**Realistic case shadow results at occupied structures**  
**Results using GE 2.3-116-90 m HH, GE 2.1-116-80 m HH WTG's**  
**UTM NAD83 Zone 14**  
**Codington County**  
*continued*

Receptor ID	Participation Status	Easting (m)	Northing (m)	Elevation AMSL (m)	Real Case Shadow (hrs/year)	Distance to Nearest Turbine (ft)
CR2-C101-NP	Non-P	660,732	4,972,807	591.0	0:00	6,266
CR2-C104-NP	Non-P	662,109	4,972,735	604.0	0:00	6,608
CR2-C106-NP	Non-P	662,165	4,972,711	604.7	0:00	6,749
CR2-C109-NP	Non-P	662,699	4,972,874	606.0	0:00	7,169
CR2-C10-NP	Non-P	665,189	4,966,505	570.0	0:00	2,438
CR2-C112-NP	Non-P	665,928	4,972,630	603.0	0:00	6,575
CR2-C135-NP	Non-P	667,172	4,966,196	595.2	0:00	2,884
CR2-C136-NP	Non-P	667,209	4,966,166	595.4	0:00	2,887
CR2-C151-NP	Non-P	663,934	4,964,475	556.1	0:00	6,929
CR2-C29-NP	Non-P	661,223	4,968,144	595.2	0:00	4,639
CR2-C30-NP	Non-P	659,100	4,968,023	568.6	0:00	5,502
CR2-C35-NP	Non-P	658,964	4,974,334	566.8	0:00	4,442
CR2-C3-NP	Non-P	664,345	4,964,571	556.0	0:00	7,497
CR2-C53-NP	Non-P	662,401	4,964,782	582.0	0:00	2,257
CR2-C64-NP	Non-P	660,901	4,964,220	582.0	0:00	4,429
CR2-C66-NP	Non-P	662,396	4,963,954	582.0	0:00	4,429
CR2-C67-NP	Non-P	660,379	4,978,592	556.1	0:00	5,033
CR2-C68-NP	Non-P	662,517	4,963,408	579.0	0:00	6,237
CR2-C69-NP	Non-P	661,701	4,978,792	564.0	0:00	5,171
CR2-C72-NP	Non-P	663,856	4,970,488	597.0	0:00	6,135
CR2-C74-NP	Non-P	660,687	4,969,931	586.5	0:00	6,732
CR2-C79-NP	Non-P	666,869	4,984,663	587.9	0:00	2,703
CR2-C7-NP	Non-P	665,694	4,966,179	570.0	0:00	4,409
CR2-C80-NP	Non-P	664,705	4,972,092	597.3	0:00	7,684
CR2-C86-NP	Non-P	662,880	4,971,302	603.0	0:00	7,208
CR2-C87-NP	Non-P	662,841	4,971,294	603.0	0:00	7,165
CR2-C89-NP	Non-P	662,244	4,971,076	603.0	0:00	6,489
CR2-C91-NP	Non-P	663,938	4,970,546	597.0	0:00	6,457
CR2-C92-NP	Non-P	663,855	4,970,535	597.0	0:00	6,247
CR2-C93-NP	Non-P	659,203	4,973,158	584.9	0:00	7,795
CR2-C94-NP	Non-P	659,202	4,973,052	583.9	0:00	8,136
CR2-C95-NP	Non-P	659,248	4,974,054	567.0	0:00	4,905
CR2-C96-NP	Non-P	659,316	4,974,063	570.6	0:00	4,816
CR2-C22-NP	Non-P	661,202	4,972,711	597.0	0:00	6,247
CR2-C90-NP	Non-P	664,088	4,970,672	594.0	0:00	6,863
CR2-C155-NP	Non-P	657,554	4,975,128	554.6	0:00	7,054
CR1-C10-P	Participant	663,510	4,985,195	609.0	38:21	1,634
CR2-C154-P	Participant	660,684	4,967,166	588.0	30:00	2,041

**Table C-2: Crowned Ridge II 300 MW Shadow Flicker Tabular Results Sorted by Real Case Shadow Flicker Hours/Year**  
**Realistic case shadow results at occupied structures**  
**Results using GE 2.3-116-90 m HH, GE 2.1-116-80 m HH WTG's**  
**UTM NAD83 Zone 14**  
**Codington County**  
*continued*

Receptor ID	Participation Status	Easting (m)	Northing (m)	Elevation AMSL (m)	Real Case Shadow (hrs/year)	Distance to Nearest Turbine (ft)
CR2-C78-P	Participant	665,273	4,983,933	609.0	25:17	1,919
CR1-C89-P	Participant	662,062	4,982,029	584.3	21:40	2,165
CR2-C50-P	Participant	661,252	4,976,035	597.0	19:22	1,696
CR2-C27-P	Participant	662,985	4,968,167	582.0	18:06	1,726
CR2-C41-P	Participant	660,770	4,975,147	596.4	17:30	1,532
CR1-C86-P	Participant	662,086	4,982,135	585.0	16:51	2,303
CR1-C20-P	Participant	663,054	4,987,455	606.0	14:37	2,336
CR2-C63-P	Participant	665,528	4,977,285	612.0	14:34	2,185
CR2-C34-P	Participant	663,934	4,966,991	570.1	14:11	2,133
CR2-C70-P	Participant	665,521	4,970,518	588.9	13:57	2,215
CR2-C60-P	Participant	662,287	4,976,800	594.0	13:54	3,793
CR2-C133-P	Participant	666,992	4,967,681	571.2	13:37	2,500
CR1-C77-P	Participant	661,915	4,983,367	591.0	12:12	1,654
CR1-C11-P	Participant	664,111	4,985,679	609.0	10:28	1,860
CR1-C78-P	Participant	660,190	4,983,788	602.3	6:43	2,835
CR1-C25-P	Participant	660,190	4,983,788	602.3	6:43	2,838
CR1-C68-P	Participant	662,652	4,987,606	609.0	6:42	2,146
CR2-C26-P	Participant	664,733	4,968,915	591.0	6:09	1,959
CR1-C69-P	Participant	662,685	4,987,619	609.0	6:03	2,185
CR1-C18-P	Participant	663,651	4,987,157	610.4	5:58	3,409
CR2-C57-P	Participant	666,667	4,976,162	613.8	5:03	2,356
CR2-C59-P	Participant	664,952	4,976,698	601.9	4:29	1,654
CR2-C45-P	Participant	664,058	4,965,862	570.0	4:12	3,907
CR2-C130-P	Participant	666,727	4,966,695	591.0	3:42	3,350
CR2-C129-P	Participant	666,716	4,966,751	591.0	3:31	3,356
CR2-C128-P	Participant	666,636	4,966,649	589.0	3:00	3,671
CR2-C33-P	Participant	663,878	4,967,612	576.1	2:28	2,999
CR2-C123-P	Participant	666,146	4,966,653	579.4	2:13	5,216
CR2-C126-P	Participant	666,389	4,966,670	585.0	1:40	4,455
CR1-C22-P	Participant	660,755	4,984,082	594.0	1:01	2,375
CR1-C21-P	Participant	660,756	4,984,086	594.0	1:00	2,388
CR1-C23-P	Participant	660,619	4,984,078	595.8	0:00	2,523
CR1-C8-P	Participant	660,532	4,984,445	599.4	0:00	3,740
CR2-C28-P	Participant	659,208	4,968,159	572.8	0:00	5,630
CR2-C31-P	Participant	663,117	4,972,923	606.0	0:00	7,579
CR2-C32-P	Participant	659,469	4,967,984	575.2	0:00	4,678
CR2-C99-P	Participant	660,584	4,972,570	591.0	0:00	7,165

**Table C-2: Crowned Ridge II 300 MW Shadow Flicker Tabular Results Sorted by Real Case Shadow Flicker Hours/Year**  
**Realistic case shadow results at occupied structures**  
**Results using GE 2.3-116-90 m HH, GE 2.1-116-80 m HH WTG's**  
**UTM NAD83 Zone 14**  
**Deuel County**  
**continued**

Receptor ID	Participation Status	Easting (m)	Northing (m)	Elevation AMSL (m)	Real Case Shadow (hrs/year)	Distance to Nearest Turbine (ft)
CR2-D21-NP	Non-P	669,517	4,978,053	596.1	28:59	1,985
CR2-D108-NP	Non-P	670,354	4,965,949	594.0	25:37	2,198
CR2-D44-NP	Non-P	670,434	4,965,956	593.8	24:03	2,149
CR2-D15-NP	Non-P	674,387	4,968,515	588.0	24:01	2,297
CR2-D18-NP	Non-P	671,540	4,976,154	582.0	22:04	2,201
CR2-D11-NP	Non-P	669,646	4,974,534	604.4	20:54	2,028
CR2-D71-NP	Non-P	669,402	4,979,216	588.0	18:30	1,975
CR2-D12-NP	Non-P	668,558	4,969,840	604.7	18:07	2,051
CR2-D105-NP	Non-P	670,348	4,963,826	611.7	17:57	2,821
CR2-D30-NP	Non-P	669,549	4,974,233	611.9	16:46	2,113
CR2-D128-NP	Non-P	668,625	4,967,652	588.0	15:58	2,779
CR2-D5-NP	Non-P	668,781	4,964,897	603.0	15:51	1,923
CR2-D132-NP	Non-P	669,497	4,974,128	609.0	15:33	2,316
CR2-D221-1-NP	Non-P	670,366	4,973,541	606.0	14:22	1,995
CR2-D22-NP	Non-P	668,798	4,963,767	603.1	14:21	2,142
CR2-D19-NP	Non-P	668,870	4,964,178	606.0	13:59	2,034
CR2-D17-NP	Non-P	672,023	4,969,597	597.0	13:45	3,343
CR2-D221-NP	Non-P	670,351	4,973,543	606.0	13:33	2,041
CR2-D14-NP	Non-P	670,351	4,973,543	606.0	13:33	2,041
CR2-D130-NP	Non-P	672,080	4,973,212	591.0	13:27	2,260
CR2-D222-NP	Non-P	672,080	4,973,212	591.0	13:27	2,264
CR2-D125-NP	Non-P	670,404	4,966,786	597.0	13:12	3,422
CR2-D83-NP	Non-P	675,891	4,966,810	579.0	12:25	1,929
CR2-D86-NP	Non-P	673,842	4,966,875	597.0	12:07	1,985
CR2-D121-NP	Non-P	674,461	4,966,734	594.0	12:06	2,316
CR2-D127-NP	Non-P	668,841	4,969,858	603.0	11:40	2,894
CR2-D62-NP	Non-P	669,355	4,974,624	609.0	10:36	3,015
CR2-D51-NP	Non-P	675,005	4,970,131	577.8	8:27	2,717
CR2-D90-NP	Non-P	670,516	4,962,327	612.0	7:36	3,360
CR2-D3-NP	Non-P	672,390	4,963,482	612.0	6:47	2,037
CR2-D208-NP	Non-P	676,741	4,964,971	579.0	6:43	3,205
CR2-D107-NP	Non-P	670,405	4,966,321	597.0	6:22	3,143
CR2-D77-NP	Non-P	672,044	4,966,468	600.0	5:58	2,444
CR2-D101-NP	Non-P	672,538	4,961,910	612.8	5:29	2,677
CR2-D65-NP	Non-P	670,422	4,966,654	597.0	5:26	3,583
CR2-D54-NP	Non-P	672,012	4,966,477	600.0	5:15	2,500
CR2-D104-NP	Non-P	670,443	4,961,600	613.8	5:06	4,058
CR2-D109-NP	Non-P	676,885	4,965,806	576.0	4:51	4,432

**Table C-2: Crowned Ridge II 300 MW Shadow Flicker Tabular Results Sorted by Real Case Shadow Flicker Hours/Year**  
**Realistic case shadow results at occupied structures**  
**Results using GE 2.3-116-90 m HH, GE 2.1-116-80 m HH WTG's**  
**UTM NAD83 Zone 14**  
**Deuel County**  
*continued*

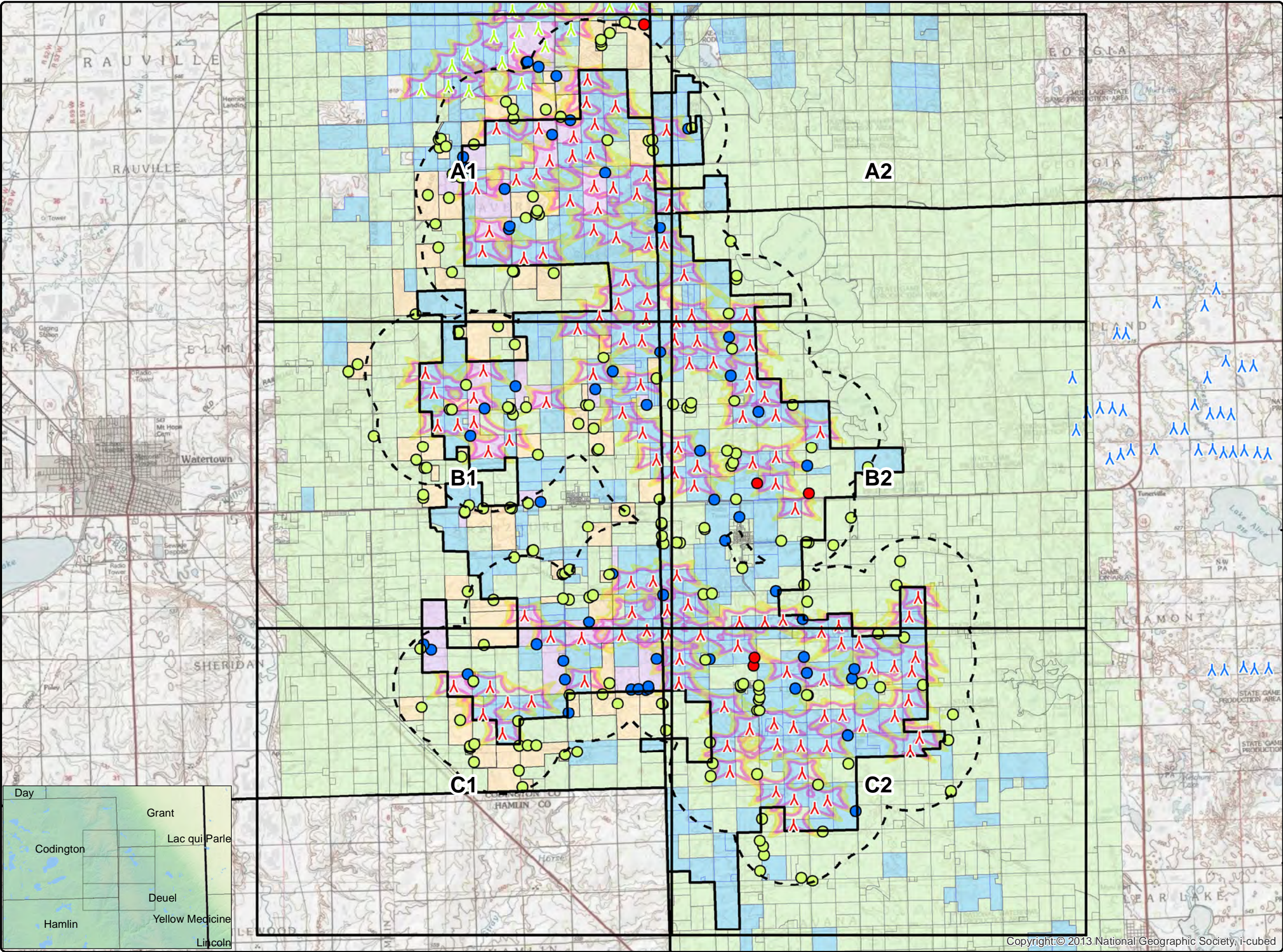
Receptor ID	Participation Status	Easting (m)	Northing (m)	Elevation AMSL (m)	Real Case Shadow (hrs/year)	Distance to Nearest Turbine (ft)
CR2-D85-NP	Non-P	669,593	4,976,302	603.0	4:36	1,965
CR2-D129-NP	Non-P	669,645	4,973,005	606.0	4:30	4,452
CR2-D220-NP	Non-P	670,260	4,967,728	597.0	3:14	2,211
CR2-D110-NP	Non-P	670,260	4,967,728	597.0	3:14	2,211
CR2-D126-NP	Non-P	670,227	4,967,455	593.3	3:04	2,749
CR2-D223-NP	Non-P	670,227	4,967,455	593.3	3:04	2,749
CR2-D20-NP	Non-P	675,261	4,968,400	579.0	3:00	2,313
CR2-D91-NP	Non-P	667,546	4,976,173	618.0	2:59	4,180
CR2-D36-NP	Non-P	669,812	4,966,746	591.0	2:59	2,854
CR2-D120-NP	Non-P	673,401	4,964,165	609.0	2:19	3,110
CR2-D79-NP	Non-P	672,172	4,974,737	585.0	2:16	1,962
CR2-D41-NP	Non-P	670,437	4,966,409	597.0	2:06	3,340
CR2-D224-NP	Non-P	669,887	4,966,846	590.6	1:40	3,261
CR2-D46-NP	Non-P	669,797	4,966,804	591.0	1:23	2,972
CR2-D45-NP	Non-P	668,018	4,976,064	611.5	0:55	4,393
CR2-D154-NP	Non-P	672,205	4,960,261	610.8	0:00	6,496
CR2-D180-NP	Non-P	671,823	4,960,368	615.0	0:00	5,856
CR2-D103-NP	Non-P	670,588	4,961,119	615.0	0:00	4,606
CR2-D63-NP	Non-P	670,546	4,961,419	615.0	0:00	4,065
CR2-D106-NP	Non-P	667,315	4,965,297	594.0	0:00	5,351
CR2-D112-NP	Non-P	667,666	4,971,554	604.6	0:00	3,553
CR2-D113-NP	Non-P	667,774	4,971,544	606.9	0:00	3,537
CR2-D189-NP	Non-P	667,228	4,971,527	606.0	0:00	3,757
CR2-D72-NP	Non-P	671,925	4,970,149	603.0	0:00	4,495
CR2-D84-NP	Non-P	667,159	4,972,169	598.2	0:00	5,535
CR2-D97-NP	Non-P	667,164	4,972,232	600.0	0:00	5,371
CR2-D96-NP	Non-P	672,899	4,971,469	594.0	0:00	5,827
CR2-D100-NP	Non-P	668,589	4,972,064	609.9	0:00	4,708
CR2-D9-NP	Non-P	668,597	4,971,999	611.5	0:00	4,921
CR2-D190-NP	Non-P	675,131	4,970,954	573.0	0:00	4,485
CR2-D95-NP	Non-P	671,994	4,971,562	600.0	0:00	3,930
CR2-D116-NP	Non-P	673,491	4,972,398	577.8	0:00	6,220
CR2-D92-NP	Non-P	671,159	4,971,610	597.2	0:00	3,881
CR2-D73-NP	Non-P	672,072	4,971,556	600.0	0:00	4,035
CR2-D82-NP	Non-P	669,855	4,970,718	603.0	0:00	5,935
CR2-D205-NP	Non-P	670,455	4,960,601	611.6	0:00	6,194
CR2-D206-NP	Non-P	676,828	4,963,231	588.0	0:00	6,365
CR2-D207-NP	Non-P	676,828	4,963,280	588.0	0:00	6,250


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## **APPENDIX D: STANDARD RESOLUTION SHADOW FLICKER MAPS**







**EAPC**  
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**Crowned Ridge II Wind Farm  
300 MW  
Shadow Overview Map**

Client

SWCA Environmental Consultants

Project Description

Wind turbine layout with occupied structures within 2 km.

Predicted shadow flicker levels at existing residences.

Location: Watertown, SD

Project #: 20174431


Issue Dates


1	Original	2020.05.07
#	Description	Date


Drawn By: AS


Checked By: JH


Legend


 Crowned Ridge II Turbines 300 MW


 Crowned Ridge Turbines


 Deuel Harvest Turbines


 2 km Turbine Buffer

 County Lines


 CR II Project Boundary


 CR II Intervenor


 Non-Participants Noise


 Participants Noise


**Shadow Flicker (hr/yr)**


 15


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
 25

 30


 Non-Participating Codington Parcels

 Participating Codington\_Parcels

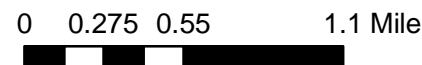
 Non-Participating Parcels

 Participating Parcels

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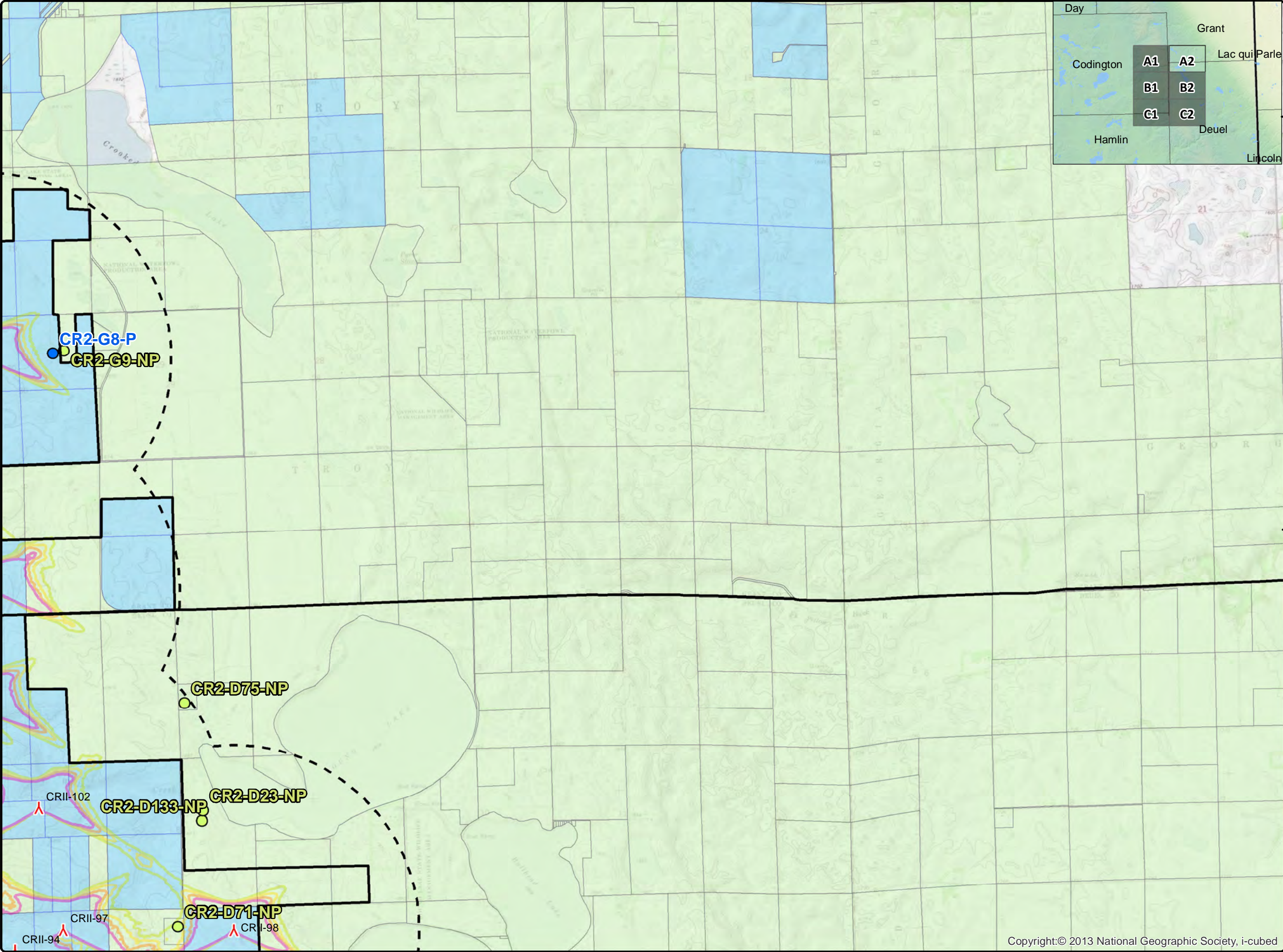







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WIND ENERGY

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**Crowned Ridge II Wind Farm  
300 MW  
Shadow Flicker Iso-Lines**

**Client**  
SWCA Environmental Consultants

**Project Description**  
Wind turbine layout with occupied structures within 2 km.  
  
Predicted shadow flicker levels at existing residences.

**Location:** Watertown, SD  
**Project #:** 20174431

**Issue Dates**


1	Original	2020.05.07
#	Description	Date

Drawn By: AS      Checked By: JH

**Legend**

- Crowned Ridge II Turbines 300 MW
- Crowned Ridge Turbines
- Deuel Harvest Turbines
- 2 km Turbine Buffer
- County Lines
- CR II Project Boundary
- CR II Intervenor
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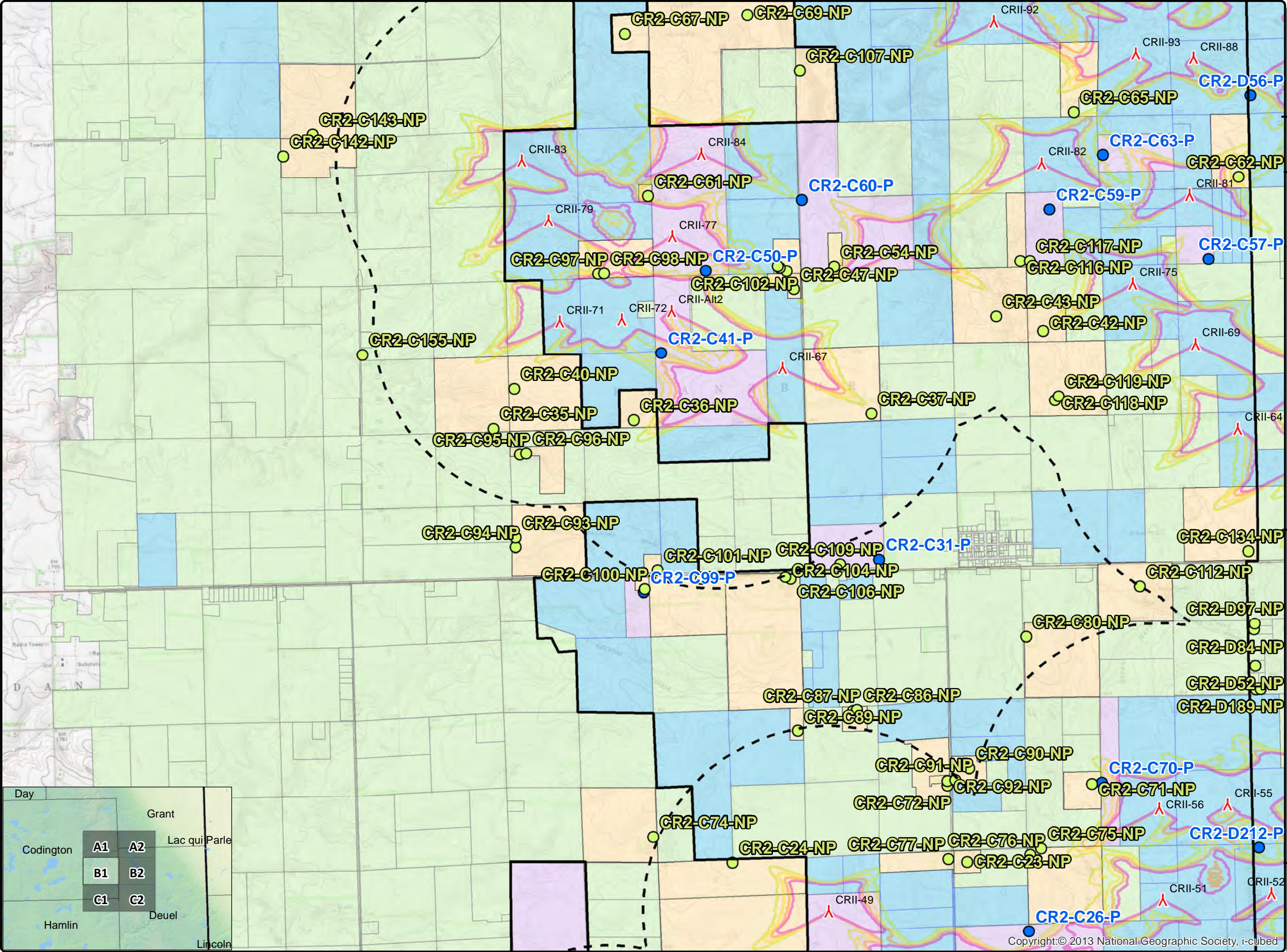
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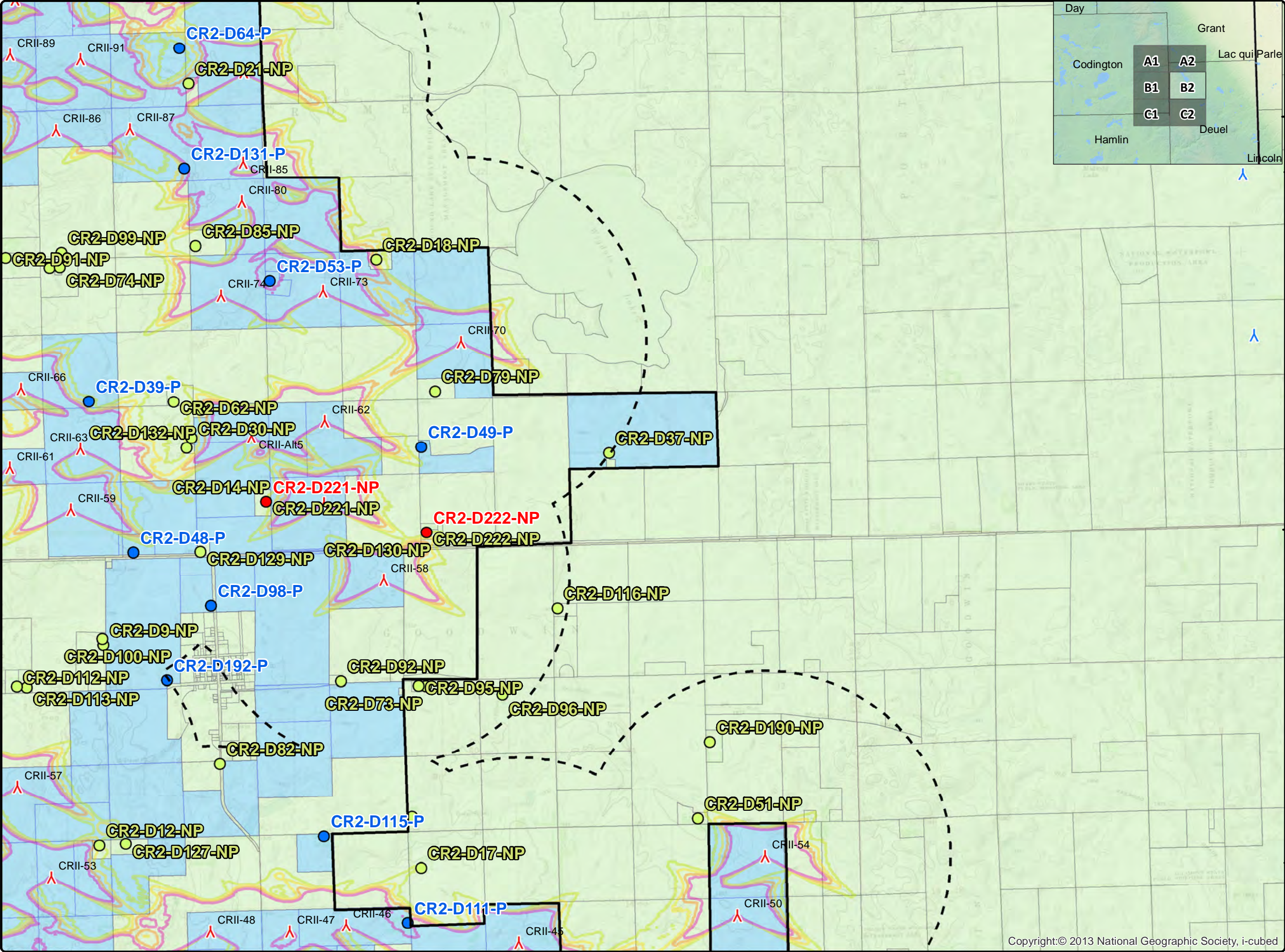
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

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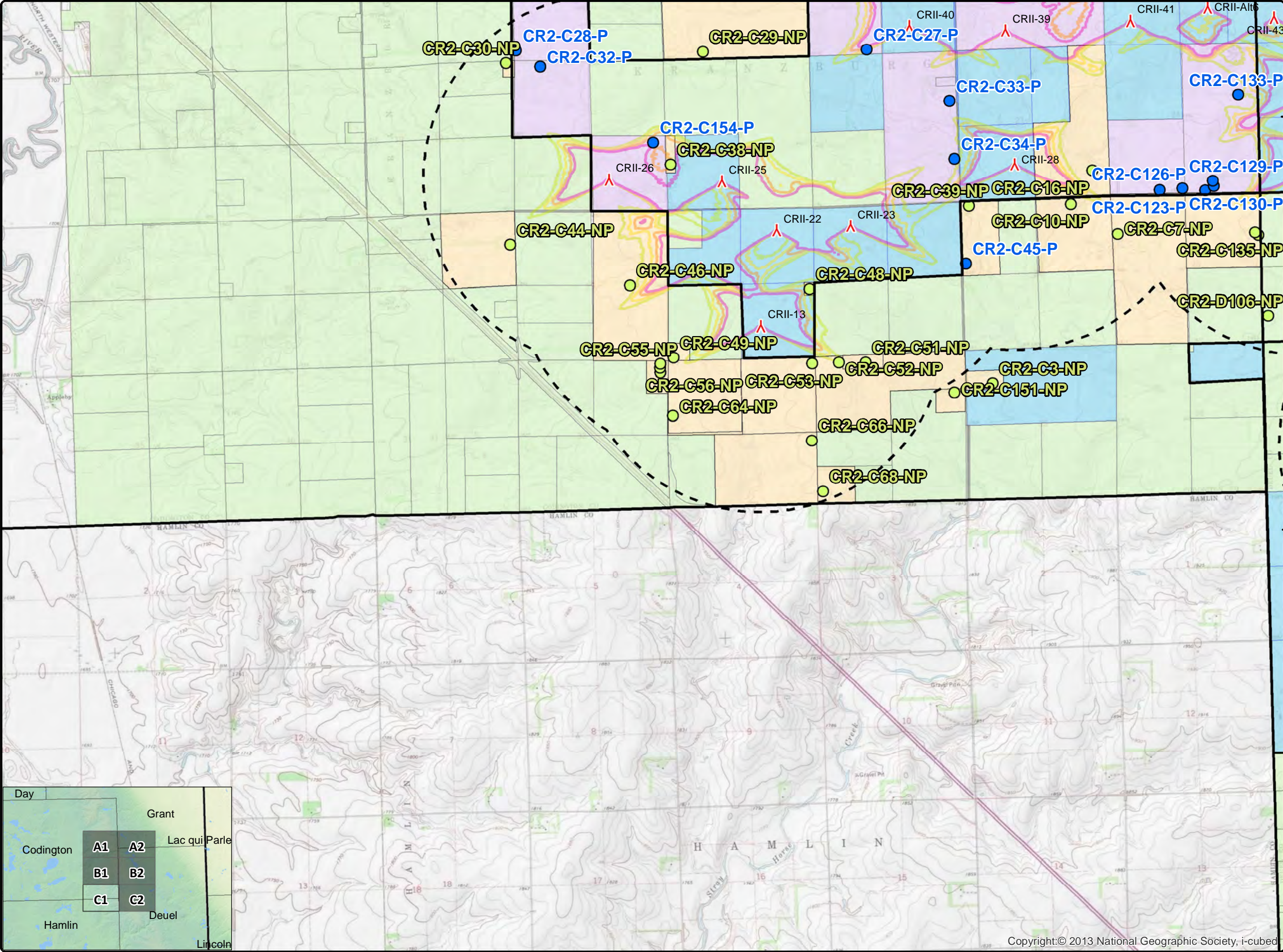
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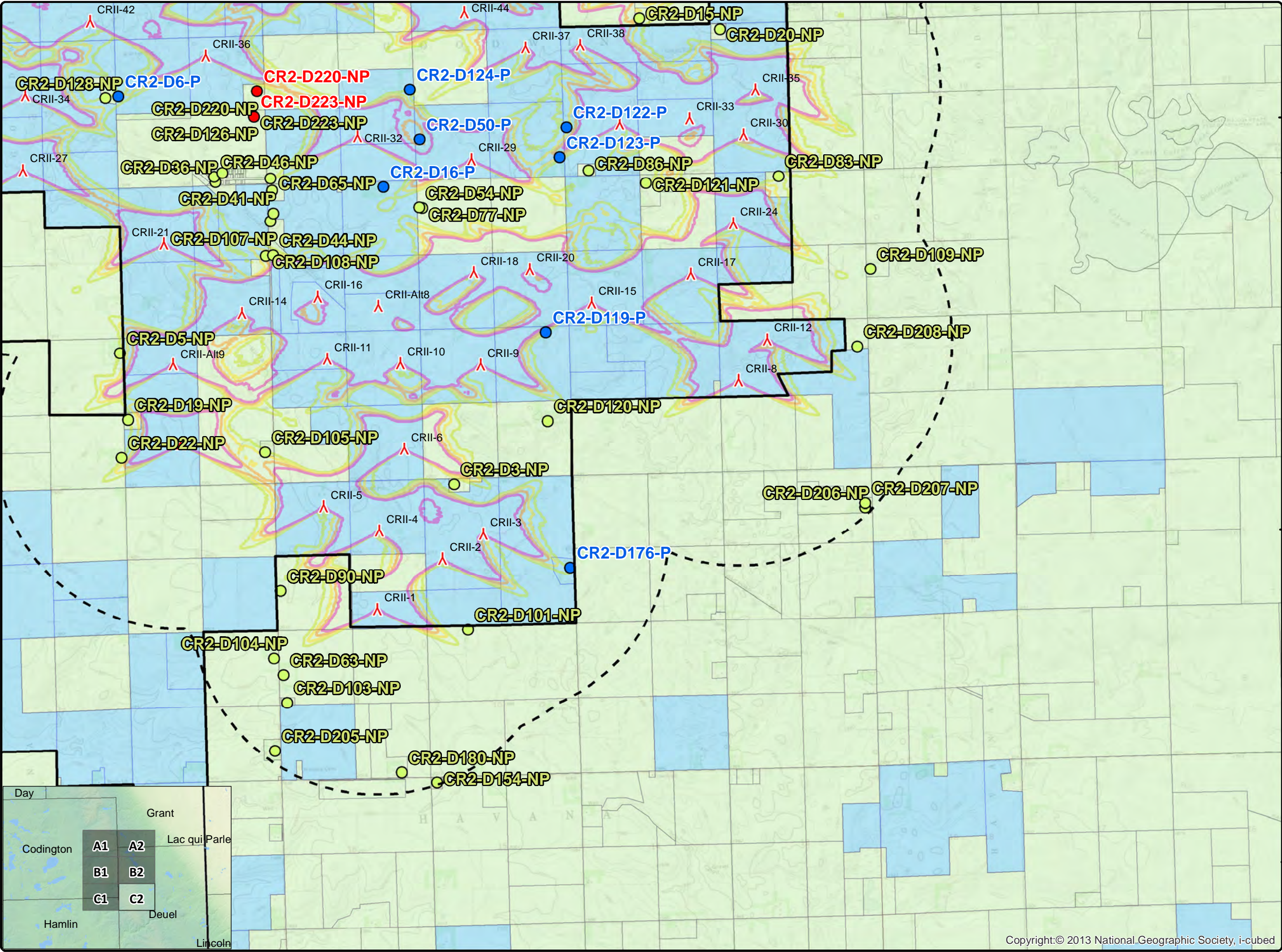
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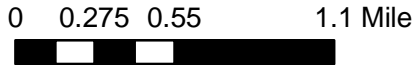
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