SOUND LEVEL 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 sound level modeling study for the Project. This report presents results of the study.

A sound level modeling analysis was conducted for 72 proposed wind turbines and 25 alternates. All wind turbines for this Project are proposed to be Vestas V136-4.2 serrated trailing edge blade units. The purpose of this assessment is to predict worst-case community sound levels in Codington and Grant Counties when the wind turbines are operational and to compare the modeling results to applicable limits. Sound levels from wind energy systems (WES) are limited to 50 dBA at off-site residences' property lines in Codington County and 50 dBA at off-site residences and accessory structures in Grant County.

Using the Project specific data provided by Apex, the sound levels modeled at existing off-site residences, businesses, churches, and buildings owned and/or maintained by a governmental entity ("sensitive receptors") in Codington County ranged from 17 to 43 dBA and sound levels modeled at sensitive receptors in Grant County ranged from 22 to 45 dBA. Supplementary modeling was performed at accessory structures with results that ranged from 14 to 43 dBA in Codington County and from 23 to 47 dBA in Grant County. All sound levels are well below the respective county limits of 50 dBA. Sound level isoline results show no location where Project-related noise exceeds 50 dBA at any off-site property line within Codington County. Therefore, the Project meets the requirements with respect to sound in the regulations.

2.0 INTRODUCTION

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

A detailed discussion of sound from wind turbines is presented in a white paper prepared by the Renewable Energy Research Laboratory.[1] A few points are repeated herein. Wind turbine noise can originate from two different sources; mechanical sound from the interaction of turbine components, and aerodynamic sound produced by the flow of air over the rotor blades. Prior to the 1990's, both were significant contributors to wind turbine noise. However, recent advances in wind turbine design have greatly reduced the contribution of mechanical noise. Aerodynamic noise has also been reduced from modern wind turbines due to slower rotational speeds and changes in materials of construction. Aerodynamic noise, in general, is broadband (has contributions from a wide range of frequencies). It originates from encounters of the wind turbine blades with localized airflow inhomogeneities and wakes from other turbine blades and from airflow across the surface of the blades, particularly the front and trailing edges. Aerodynamic sound generally increases with increasing wind speed up to a certain point, then typically remains constant, even with higher wind speeds. However, sound levels in general also increase with increasing wind speed with or without the presence of wind turbines.

This report presents the findings of a sound level modeling analysis for the Project. The wind turbines were modeled with the Cadna/A software package using sound data from Vestas technical documents. The results of this analysis are found within this report.

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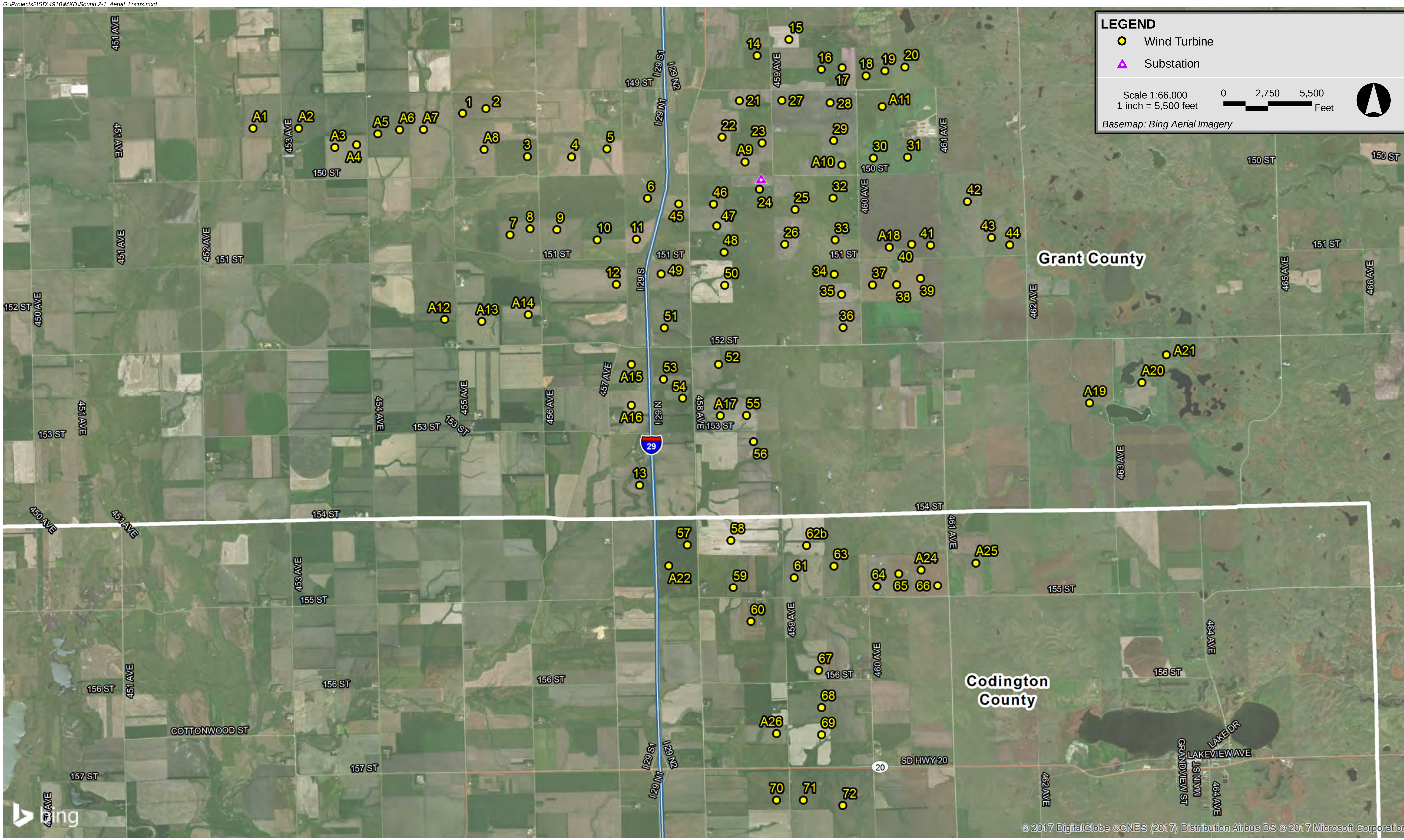
1 Renewable Energy Research Laboratory, Department of Mechanical and Industrial Engineering, University of Massachusetts at Amherst, Wind Turbine Acoustic Noise, June 2002, amended January 2006.



Dakota Range Wind Grant County/Codington County, South Dakota

Epsilon Associates Inc.

Figure 2-1
Aerial Locus

3.0 SOUND TERMINOLOGY

There are several ways in which sound (noise) levels are measured and quantified. All of them use the logarithmic decibel (dB) scale. The following information defines the sound level measurement terminology used in this analysis.

The decibel scale is logarithmic to accommodate the wide range of sound intensities found in the environment. A property of the decibel scale is that the sound pressure levels of two or more separate sounds are not directly additive. For example, if a sound of 50 dB is added to another sound of 50 dB, the total is only a 3-decibel increase (53 dB), which is equal to doubling in sound energy but not equal to a doubling in decibel quantity (100 dB). Thus, every 3-dB change in sound level represents a doubling or halving of sound energy. Relative to this characteristic, a change in sound levels of less than 3 dB is imperceptible to the human ear.

Another mathematical property of decibels is that if one source of noise is at least 10 dB louder than another source, then the total sound level is simply the sound level of the higher-level source. For example, a sound source at 60 dB plus another sound source at 47 dB is equal to 60 dB.

A sound level meter (SLM) that is used to measure sound is a standardized instrument.[2] It contains "weighting networks" (e.g., A-, C-, Z-weightings) to adjust the frequency response of the instrument. Frequencies, reported in Hertz (Hz), are detailed characterizations of sounds, often addressed in musical terms as "pitch" or "tone". The most commonly used weighting network is the A-weighting because it most closely approximates how the human ear responds to sound at various frequencies. The A-weighting network is the accepted scale used for community sound level measurements; therefore, sounds are frequently reported as detected with a sound level meter using this weighting. A-weighted sound levels emphasize middle frequency sounds (i.e., middle pitched – around 1,000 Hz), and de-emphasize low and high frequency sounds. These sound levels are reported in decibels designated as "dBA". Sound pressure levels for some common indoor and outdoor environments are shown in Figure 3-1.

Because the sounds in the environment vary with time, many different sound metrics may be used to quantify them. There are two typical methods used for describing variable sounds. These are exceedance levels and equivalent levels, both of which are derived from a large number of moment-to-moment A-weighted sound pressure level measurements. Exceedance levels are values from the cumulative amplitude distribution of all of the sound levels observed during a measurement period. Exceedance levels are designated L_n, where "n" is a value (typically an integer between 1 and 99) in terms of percentage. Equivalent

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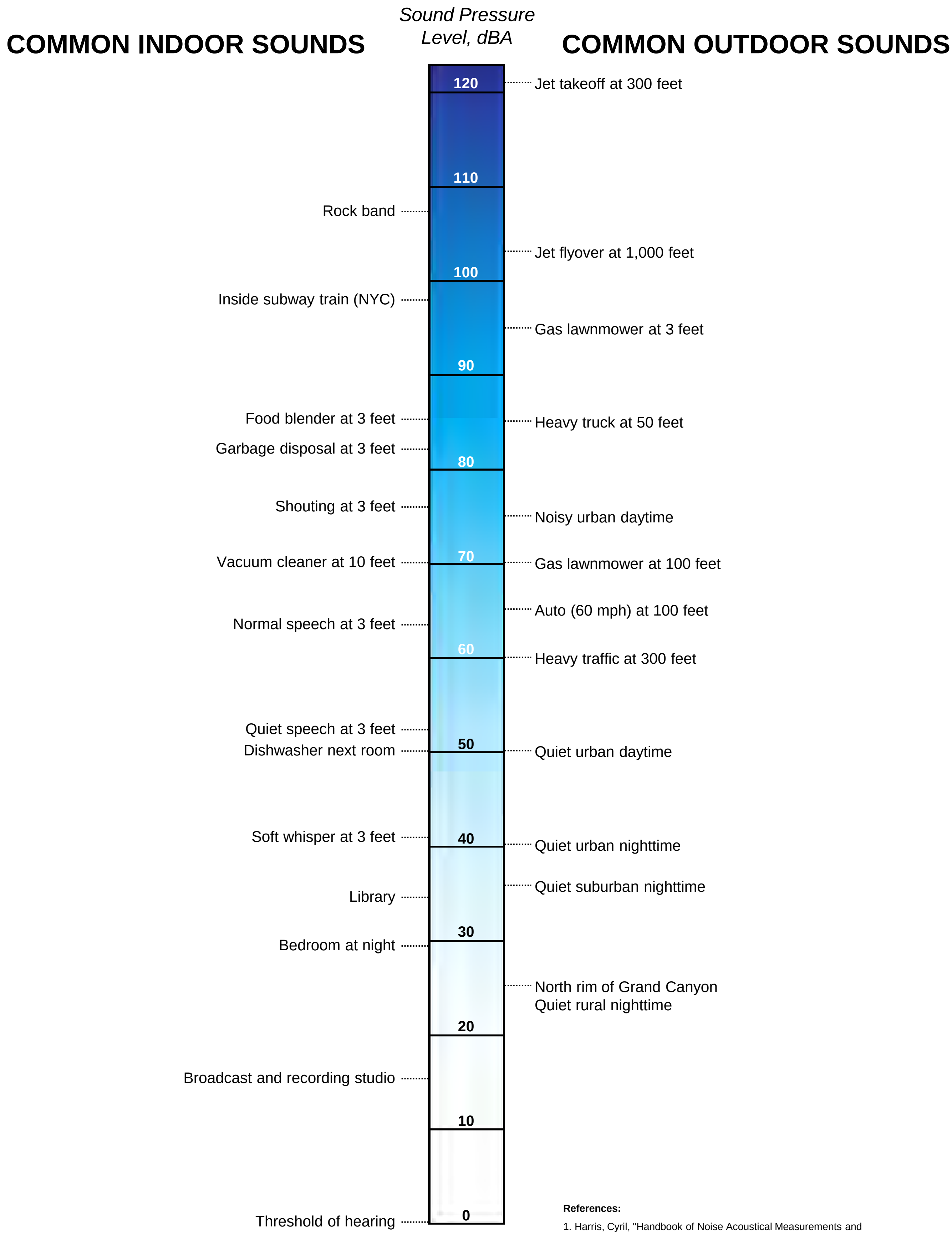
2 *American National Standard Specification for Sound Level Meters*, ANSI S1.4-1983 (R2006), published by the Standards Secretariat of the Acoustical Society of America, Melville, NY.

levels are designated L_{eq} and quantify a hypothetical steady sound that would have the same energy as the actual fluctuating sound observed. The two sound level metrics that are commonly reported in community noise monitoring and are utilized in this report are described below.

- L_{90} is the sound level in dBA exceeded 90 percent of the time during a measurement period. The L_{90} is close to the lowest sound level observed. It is essentially the same as the residual sound level, which is the sound level observed when there are no obvious nearby intermittent noise sources.

- L_{eq}, the equivalent level, is the level of a hypothetical steady sound that would have the same energy (*i.e.,* the same time-averaged mean square sound pressure) as the actual fluctuating sound observed. The equivalent level is designated L_{eq} and is commonly A-weighted. The equivalent level represents the time average of the fluctuating sound pressure, but because sound is represented on a logarithmic scale and the averaging is done with time-averaged mean square sound pressure values, the L_{eq} is mostly determined by occasional loud noises.



References:

1. Harris, Cyril, "Handbook of Noise Acoustical Measurements and Noise Control", p 1-10., 1998
2. "Controlling Noise", USAF, AFMC, AFDTC, Elgin AFB, Fact Sheet, August 1996
3. California Dept. of Trans., "Technical Noise Supplement", Oct, 1998

Figure 3-1

Common Sound Levels in the Environment

4.0 NOISE REGULATIONS

4.1 Federal Regulations

There are no federal community noise regulations applicable to this Project.

4.2 South Dakota State Regulations

There are no current state community noise regulations applicable to this Project. The South Dakota Public Utilities Commission (SDPUC) 2009 model ordinance for siting wind energy systems is no longer in effect.[3]

4.3 Local Regulations

4.3.1 Codington County

The section of the proposed Dakota Range Wind Project within Codington County, SD is subject to the following sound level requirements in Section 5.22.03(12) of Ordinance #65 Zoning Ordinance of Codington County, Noise subsection of General Provisions for Wind Energy Systems (WES):

> *Noise level shall not exceed 50 dBA, average A-weighted Sound pressure[4] including constructive interference effects at the property line of existing off-site residences, businesses, and buildings owned and/or maintained by a governmental entity.*

Therefore, the above listed sensitive receptors were evaluated in this analysis against the 50 dBA limit. Sound level isolines overlaying aerial imagery are also presented in this report to show sound levels at property lines.

4.3.2 Grant County

The section of the proposed Dakota Range Wind Project within Grant County, SD is subject to the following sound level requirements in Section 1211.04(13) of the Zoning Ordinance for Grant County, Noise subsection of General Provisions for Energy Systems (WES):

3 NC Clean Energy Technology Center. http://programs.dsireusa.org/system/program/detail/3943. Accessed December 2017.

4 Epsilon assumes the ordinance intends to read "sound pressure level" reported in dBA, whereas "sound pressure" is reported in units of Pascals.

Noise level shall not exceed 50 dBA, average A-weighted Sound pressure[5] *including constructive interference effects at the perimeter of the principal and accessory structures of existing off-site residences, businesses, and buildings owned and/or maintained by a governmental entity.*

Therefore, the above listed sensitive receptors were evaluated in this analysis against the 50 dBA limit.

[5] Epsilon assumes the ordinance intends to read "sound pressure level" reported in dBA, whereas "sound pressure" is reported in units of Pascals.

5.0 FUTURE CONDITIONS

5.1 Equipment and Operating Conditions

The sound level analysis includes 97 wind turbines, of which 25 are considered alternate locations but were conservatively included as active wind turbines. Global coordinates for the 97 wind turbines are provided in Appendix A. All wind turbines are 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. A technical report from Vestas[6] was provided by Apex which documented the expected sound power levels associated with the Vestas V136-4.2 wind turbine. According to this technical document, which included broadband and one-third octave-band A-weighted sound power levels for various wind speeds, the maximum sound power level for the V136-4.2 of 103.9 dBA occurs at hub height wind speeds of 9 m/s (and above). These sound power levels represent an "upper 95% confidence limit for the wind turbine performance" and do not include any additional uncertainty factor. Octave-band sound levels were calculated from the third octave-band levels representing the maximum sound power level for the sound modeling.

In addition to the wind turbines, there will be a collector substation associated with the Project. The substation is proposed to be located north of wind turbine #24 as shown in Figure 5-1. Two 167 megavolt-ampere (MVA) transformers are proposed for the substation. Epsilon has estimated octave-band sound power levels using the MVA rating provided by Apex and techniques in the Electric Power Plant Environmental Noise Guide (Edison Electric Institute), Table 4.5 Sound Power Levels of Transformers. Table 5-1 below summarizes the sound power level data used in the modeling.

Table 5-1 Modeled Substation Transformer Sound Power Levels

		Sound Power Levels per Octave-Band Center Frequency [Hz]								
Maximum	Broadband	31.5	63	125	250	500	1k	2k	4k	8k
Rating	dBA	dB	dB	dB	dB	dB	dB	dB	dB	dB
167 MVA	102	98	104	106	101	101	95	90	85	78

5.2 Modeling Scenarios

The noise impacts associated with the proposed wind turbines were predicted using the Cadna/A noise calculation software developed by DataKustik GmbH. This software uses the ISO 9613-2 international standard for sound propagation (Acoustics - Attenuation of sound during propagation outdoors - Part 2: General method of calculation). The benefits

6 Vestas Wind Systems A/S, V136-4.0 MW Third octave noise emission, 2017. Confidential documentation and information.

of this software are a more refined set of computations due to the inclusion of topography, ground attenuation, multiple building reflections, drop-off with distance, and atmospheric absorption. The Cadna/A software allows for octave band calculation of sound from multiple sources as well as computation of diffraction.

Inputs and significant parameters employed in the model are described below:

- *Project Layout:* A project layout dated December 18, 2017 was provided by Apex. The 72 proposed wind turbines and 25 alternates were input into the model. The substation transformer location was provided by Apex on December 7, 2017. The proposed wind turbines and substation are shown in Figure 5-1.

- *Modeling Locations:* A modeling receptor dataset with participation status information dated November 17, 2017 was provided by Apex. The dataset included receptors at a significant distance from wind turbines (greater than 5 miles from the wind turbines) and these receptors were excluded from the analysis. The remaining 189 receptors from this dataset (86 in Codington County, 103 in Grant County) were input into the Cadna/A model. These sensitive receptors were modeled as discrete points at a height of 1.5 meters above ground level (AGL) to mimic the ears of a typical standing person. These locations are shown in Figure 5-1. In addition, a dataset containing parcel boundaries and lease status dated November 10, 2017 was provided by Apex. Parcels identified as "agreement signed" were included as participating and are identified on Figure 5-1.

  A supplementary receptor dataset was provided by Apex on January 19, 2018 which contained accessory structures within the vicinity of the Project. The dataset was modified to exclude receptors greater than 5 miles from the wind turbines, for consistency. The remaining 555 accessory structures (267 in Codington County, 288 in Grant County) were input into Cadna/A as discrete points at a height of 1.5 meters above ground level. Modeling of these accessory structures was performed separately and the structures are not included in the modeling locations figure.

- *Terrain Elevation:* Elevation contours for the modeling domain were directly imported into Cadna/A which allowed for consideration of terrain shielding where appropriate. 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.

- *Source Sound Levels:* Octave-band sound power levels for the Vestas V136-4.2 wind turbines calculated from the provided third octave-band levels in technical report were input to the model. These sound levels represent "worst-case" operational sound level emissions. The substation transformer sound power levels as presented in Table 5-1 were input to the model.

- *Uncertainty factor:* No uncertainty factor was provided by the wind turbine manufacturer; however, based on experience with other wind turbine manufacturers, an uncertainty factor of 2.0 dBA was assumed and added to the sound power level for each modeled wind turbine.

- *Ground Attenuation:* Spectral ground absorption was calculated using a G-factor of 0.5 which corresponds to "mixed ground" consisting of both hard and porous ground cover.

The highest wind turbine sound power level for each wind turbine type including uncertainty (105.9 dBA) was input into Cadna/A to model wind turbine generated sound pressure levels during conditions when worst-case sound power levels are expected. Sound pressure levels due to operation of all 97 wind turbines and the substation transformer were modeled at 189 sensitive receptors and 555 accessory structures in Codington and Grant Counties. In addition to modeling at discrete points, sound levels were also modeled throughout a large grid of receptor points, each spaced 25 meters apart to allow for the generation of sound level isolines.

Several modeling assumptions inherent in the ISO 9613-2 calculation methodology, or selected as conditional inputs by Epsilon, were implemented in the Cadna/A model to ensure conservative results (i.e., higher sound levels), and are described below:

- All modeled sources were assumed to be operating simultaneously and at the design wind speed corresponding to the greatest sound level impacts.

- As per ISO 9613-2, the model assumed favorable conditions for sound propagation, corresponding to a moderate, well-developed ground-based temperature inversion, as might occur on a calm, clear night or equivalently downwind propagation.

- Meteorological conditions assumed in the model (temperature = 10°C & relative humidity = 70%) were selected to minimize atmospheric attenuation in the 500 Hz and 1 kHz octave bands where the human ear is most sensitive.

- No additional attenuation due to tree shielding, air turbulence, or wind shadow effects was considered in the model.

5.3 Sound Level Results

Table B-1 in Appendix B shows the predicted "Project-Only" broadband (dBA) sound levels under conditions specified in the previous section for the 86 sensitive receptors in Codington County. These sound levels range from 17 to 43 dBA. The predicted "Project-

Only" broadband sound levels[7] at the 267 accessory structures in Codington County ranged from 14 to 43 dBA.

Table B-2 in Appendix B shows the predicted "Project-Only" broadband (dBA) sound levels for the 103 sensitive receptors in Grant County. These sound levels range from 22 to 45 dBA. The predicted "Project-Only" broadband sound levels[8] at the 288 accessory structures in Grant County ranged from 23 to 47 dBA.

In addition to the 189 receptor points, sound level isolines generated from the modeling grid are presented in Figure 5-2. Accessory structures are not included on the figure.

[7] Accessory structure results are excluded from Appendix B.

[8] Accessory structure results are excluded from Appendix B.

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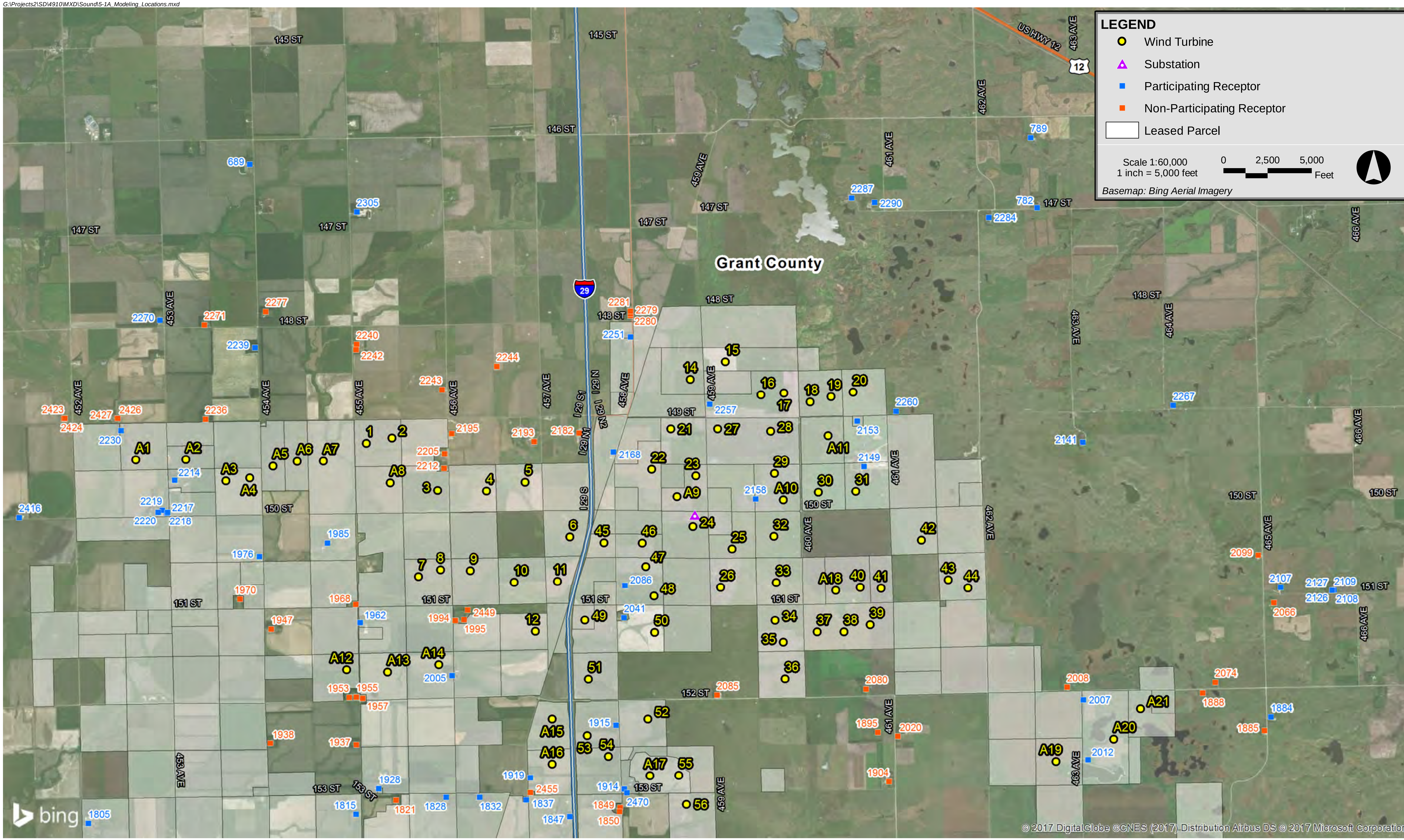

Dakota Range Wind **Grant County/Codington County, South Dakota**

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Figure 5-1A

Sound Level Modeling Locations

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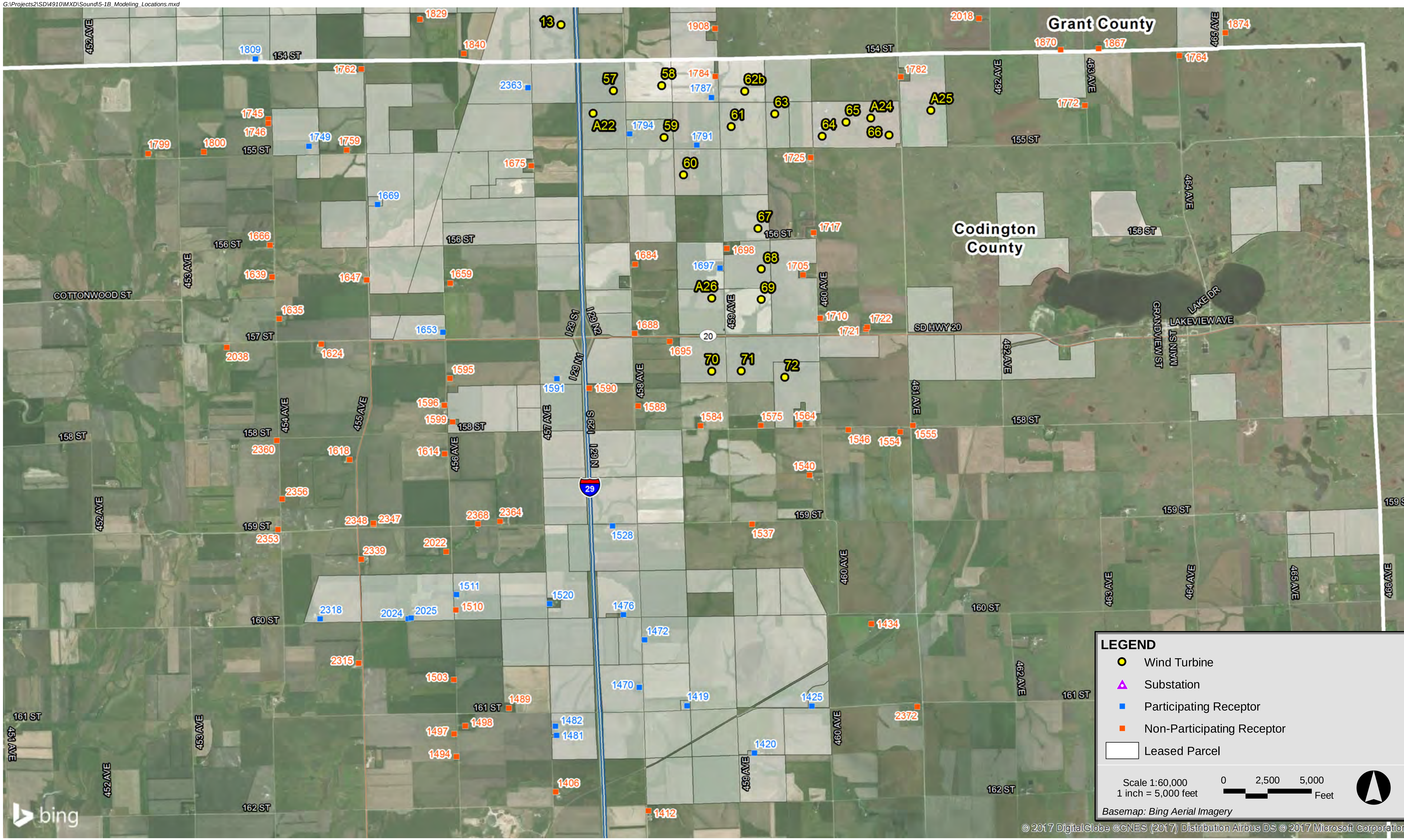

Dakota Range Wind Grant County/Codington County, South Dakota

Epsilon
ASSOCIATES INC.

Figure 5-1B

Sound Level Modeling Locations

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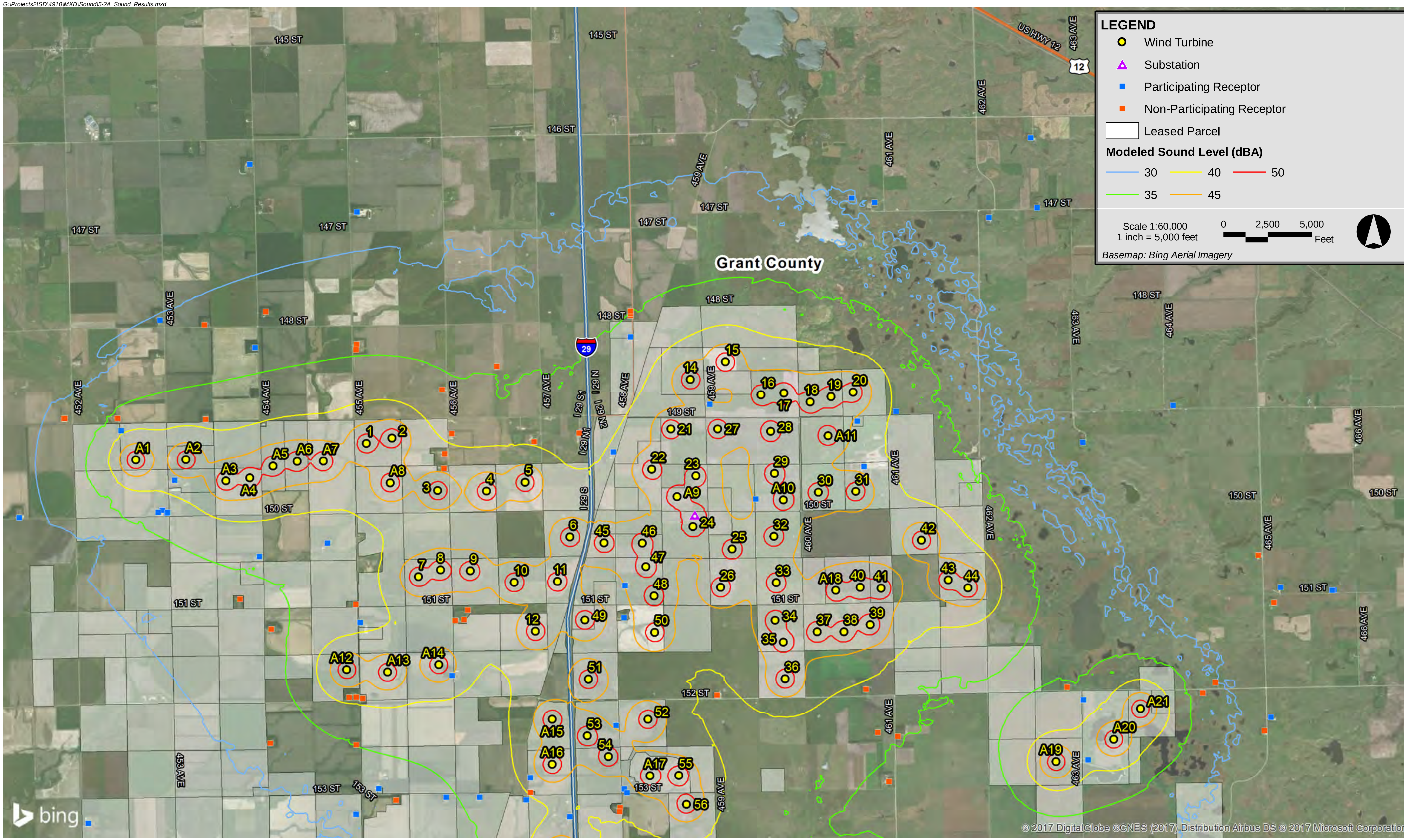

Dakota Range Wind **Grant County/Codington County, South Dakota**

Epsilon ASSOCIATES INC.

Figure 5-2A

Sound Level Modeling Results

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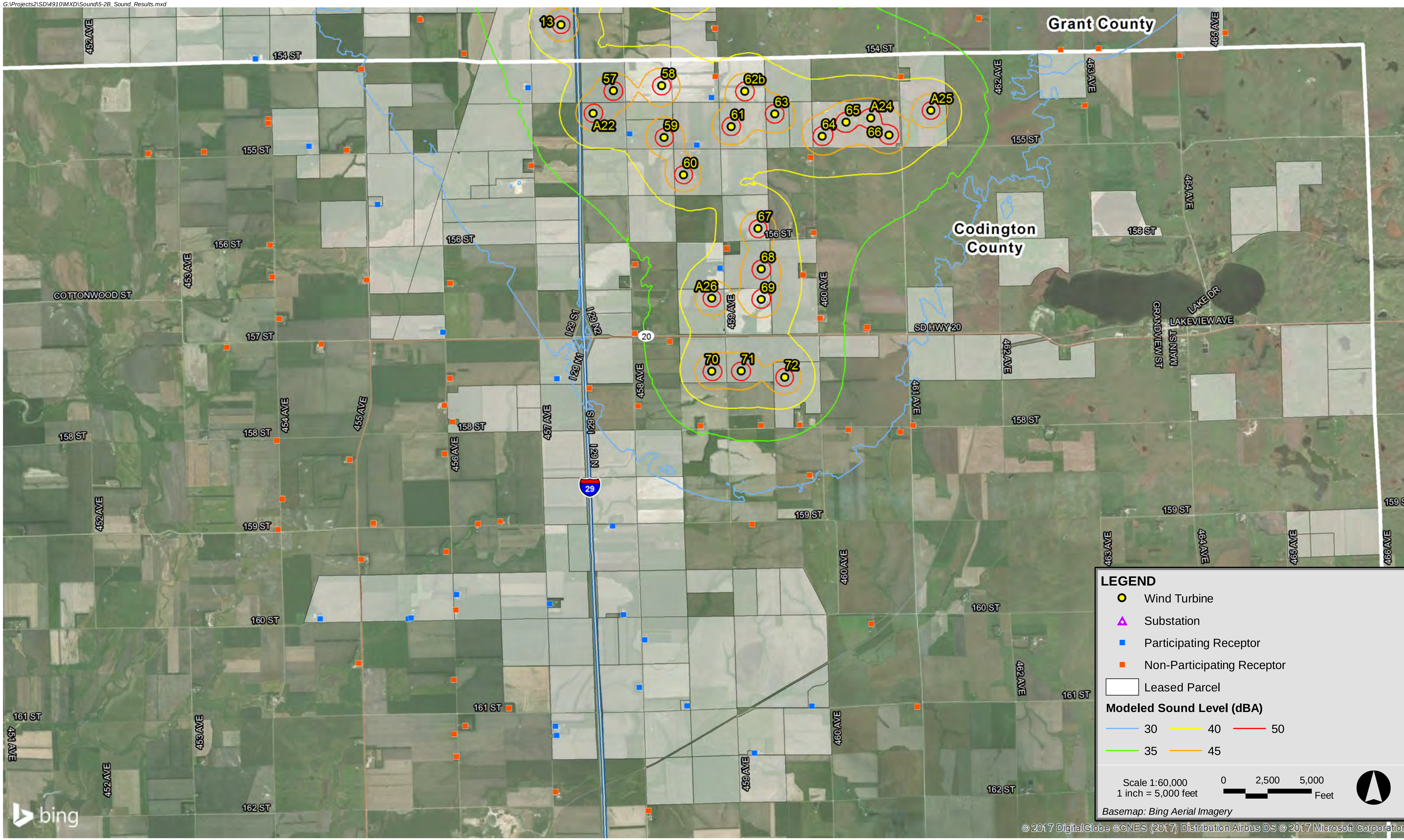

Dakota Range Wind Grant County/Codington County, South Dakota

Epsilon ASSOCIATES INC.

Figure 5-2B

Sound Level Modeling Results

6.0 CONSTRUCTION NOISE

The majority of the construction activity related to the Dakota Range Wind Project will occur around each of the wind turbine sites. By its very nature, construction activity moves around the site. Full construction activity will generally occur at one wind turbine site at a time, although there will be some overlap at adjacent sites for maximum efficiency. There are generally three phases of construction at a wind energy project – excavation, foundations, and turbine erection. Table 6-1 presents the equipment sound levels for the louder pieces of construction equipment expected to be used at this site along with their phase of construction. Reference sound source information in Table 6-1 was obtained from either Epsilon field measurements or the FHWA's Roadway Construction Noise Model database.

Construction of the Project is expected to take multiple months. Construction of a single wind turbine from excavation to foundation pouring to turbine erection is roughly a three week process. However, work will not proceed in that order for each wind turbine to be erected. For example, all foundations will typically be poured before any turbine erection work begins. Excavation work is expected to occur from early morning to the evening. Concrete foundation work and turbine erection work could extend into the overnight hours depending on the weather and timing of a concrete pour which must be continuous. Excavation work will typically be daytime only.

Table 6-1 Sound Levels for Construction Noise Sources

Phase	Equipment	Sound Level at 50 feet (dBA)
Excavation	Grader	85
Excavation	Bulldozer	82
Excavation	Front-end loader	79
Excavation	Backhoe	78
Excavation	Dump truck	76
Excavation	Roller	80
Excavation	Excavator	81
Excavation	Rock drill	89
Foundation	Concrete mixer truck	79
Foundation	Concrete pump truck	81
Foundation	Concrete batch plant	83
Turbine erection	Large crane #1	81
Turbine erection	Large crane #2	81
Turbine erection	Component delivery truck	84
Turbine erection	Air compressor	78

7.0 EVALUATION OF SOUND LEVELS

7.1 Modeled Sound Levels

All modeled sound levels, as output from Cadna/A and presented in Appendix B, are A-weighted equivalent sound levels (L_{eq}, dBA). These levels may be used in evaluating measured sound pressure levels over typical averaging durations, (i.e., 10 minutes or 1 hour).

7.2 Codington County Evaluation

The Project is subject to the requirements contained in the Zoning Ordinance of Codington County, South Dakota for WES. The sound level limit in this regulation for a WES is 50 dBA at a property line of an existing off-site occupied structure. The predicted worst-case sound levels from the Dakota Range Wind Project are well below the 50 dBA limit at all modeled occupied structures in Codington County. A review of Table B-1 in Appendix B shows the highest sound level to be 43 dBA at receptor #1725. This is at a non-participating occupied structure. Sound levels at the modeled accessory structures do not exceed 43 dBA. Sound level isolines in Figure 5-2 show no location where Project-related noise exceeds 50 dBA at any off-site property line. Therefore, the Project meets the requirements with respect to sound in the county regulation.

7.3 Grant County Evaluation

The Project is subject to the requirements contained in the Zoning Ordinance for Grant County, South Dakota for WES. The sound level limit in this regulation for a WES is 50 dBA at the perimeter of an existing off-site principal (occupied) and accessory structure. The predicted worst-case sound levels from the Dakota Range Wind Project are well below the 50 dBA limit at all modeled occupied structures in Grant County. A review of Table B-2 in Appendix B shows the highest sound level to be 45 dBA at receptor #2158. This is at a participating occupied structure. The highest modeled sound level at a non-participating receptor (#2212) is 44 dBA. Additionally, the highest sound level modeled at an accessory structure in Grant County is 47 dBA. This is at a participating accessory structure and the highest modeled sound level at a non-participating accessory structure is 44 dBA. Therefore, the Project meets the requirements with respect to sound in the county regulation.

8.0 CONCLUSIONS

A comprehensive sound level analysis was conducted for the proposed Dakota Range Wind Project within Codington and Grant Counties. A total of 72 wind turbines are proposed for this Project. Sound levels resulting from the operation of these 72 wind turbines and 25 alternates were calculated at 189 sensitive receptor points (i.e., existing off-site residences, businesses, churches, and buildings owned and/or maintained by a governmental entity), and isolines were generated from a grid encompassing the area surrounding the wind turbines using the proposed layout. The sound levels modeled at sensitive receptors[9] in Codington County ranged from 17 to 43 dBA and sound levels modeled at sensitive receptors[10] in Grant County ranged from 22 to 45 dBA. All sound levels are well below the respective county limits of 50 dBA. Sound level isoline results show no location where Project-related noise exceeds 50 dBA at any off-site property line within Codington County. Therefore, the Project meets the requirements with respect to sound in the regulations.

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[9] Excludes accessory structures for which sound levels ranged from 14 to 43 dBA in Codington County.

[10] Excludes accessory structures for which sound levels ranged from 23 to 47 dBA in Grant County.

Appendix A

Wind Turbine Coordinates

Table A-1: Wind Turbine Coordinates

Wind Turbine ID	Coordinates NAD83 UTM Zone 14N (meters)	
	X (Easting)	Y (Northing)
1	649150.68	5009210.55
2	649592.64	5009301.39
3	650382.14	5008394.08
4	651221.24	5008388.66
5	651887.81	5008536.33
6	652659.21	5007595.70
7	650048.07	5006906.21
8	650429.11	5007023.84
9	650941.68	5007007.69
10	651702.10	5006813.09
11	652445.44	5006824.28
12	652067.96	5005967.41
13	652508.47	5002155.46
14	654738.65	5010309.74
15	655342.56	5010617.87
16	655959.75	5010046.16
17	656353.73	5010078.42
18	656807.12	5009925.65
19	657165.19	5010016.56
20	657545.03	5010093.22
21	654403.27	5009456.11
22	654073.85	5008759.99
23	654834.57	5008649.35
24	654782.01	5007771.84
25	655461.81	5007386.09
26	655262.58	5006726.86
27	655209.73	5009458.69
28	656123.54	5009415.49
29	656190.63	5008691.29
30	656948.30	5008364.53
31	657593.24	5008379.77
32	656181.41	5007604.26
33	656220.17	5006808.38
34	656202.73	5006154.17
35	656341.29	5005779.24
36	656373.09	5005145.37
37	656928.93	5005957.45
38	657387.82	5005959.70
39	657839.76	5006079.27
40	657670.73	5006726.57
41	658031.93	5006708.57
42	658728.18	5007539.26
43	659189.32	5006853.26
44	659530.88	5006717.26
45	653250.85	5007492.28
46	653912.36	5007486.35
47	653971.67	5007079.89

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

Table A-1: Wind Turbine Coordinates

Wind Turbine ID	Coordinates NAD83 UTM Zone 14N (meters)	
	X (Easting)	Y (Northing)
48	654112.53	5006577.23
49	652919.63	5006162.99
50	654125.10	5005948.82
51	652979.75	5005140.46
52	654007.77	5004448.60
53	652959.73	5004165.46
54	653326.71	5003802.14
55	654539.43	5003479.34
56	654671.50	5002980.82
57	653412.66	5001019.09
58	654243.67	5001103.58
59	654285.80	5000211.18
60	654621.54	4999566.28
61	655443.20	5000399.81
62b	655678.86	5001007.79
63	656197.91	5000617.81
64	657012.96	5000231.13
65	657424.44	5000476.02
66	658166.89	5000251.64
67	655906.42	4998639.32
68	655964.72	4997936.95
69	655962.56	4997416.19
70	655110.53	4996175.39
71	655618.94	4996179.18
72	656367.12	4996073.95
A1	645172.45	5008926.68
A2	646038.25	5008927.64
A3	646726.68	5008563.81
A4	647137.99	5008616.63
A5	647539.89	5008820.59
A6	647956.98	5008901.81
A7	648409.37	5008903.36
A8	649560.48	5008528.49
A9	654509.77	5008288.83
A10	656345.65	5008235.30
A11	657114.06	5009343.43
A12	648810.69	5005302.13
A13	649516.40	5005259.92
A14	650398.22	5005389.99
A15	652354.92	5004448.62
A16	652353.57	5003672.36
A17	654041.01	5003475.27
A18	657249.87	5006672.81
A19	661049.92	5003716.42
A20	662041.92	5004103.34
A21	662506.37	5004630.35
A22	653061.13	5000624.85

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

Table A-1: Wind Turbine Coordinates

Wind Turbine ID	Coordinates NAD83 UTM Zone 14N (meters)	
	X (Easting)	Y (Northing)
A24	657850.58	5000545.83
A25	658890.90	5000677.60
A26	655109.25	4997437.35

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

Appendix B

Predicted Wind Energy System Sound Levels at Sensitive Receptors

Table B-1: Modeled Sound Pressure Levels at Sensitive Receptors in Codington County

Receptor ID	Coordinates UTM NAD83 Zone 14N		County	Participation Status	Source Only Broadband Sound Level (dBA)	Regulation Evaluation	
	X (m)	Y (m)				Limit (dBA)	Exceed Limit?
1406	652415.58	4988918.69	Codington	Non-Participating	19	50	No
1412	654015.11	4988590.25	Codington	Non-Participating	19	50	No
1419	654681.58	4990406.38	Codington	Participating	17	50	No
1420	655846.86	4989588.29	Codington	Participating	19	50	No
1425	656834.67	4990400.04	Codington	Participating	20	50	No
1434	657862.31	4991817.05	Codington	Non-Participating	18	50	No
1470	653857.99	4990720.09	Codington	Participating	23	50	No
1472	653950.59	4991543.64	Codington	Participating	24	50	No
1476	653587.51	4991975.31	Codington	Participating	25	50	No
1481	652432.12	4989894.34	Codington	Participating	17	50	No
1482	652413.64	4990050.68	Codington	Participating	20	50	No
1489	651609.43	4990364.76	Codington	Non-Participating	22	50	No
1494	650703.87	4989527.33	Codington	Non-Participating	19	50	No
1497	650662.06	4989915.49	Codington	Non-Participating	21	50	No
1498	650856.93	4990053.74	Codington	Non-Participating	21	50	No
1503	650657.74	4990852.72	Codington	Non-Participating	22	50	No
1510	650692.61	4992057.70	Codington	Non-Participating	23	50	No
1511	650706.98	4992320.66	Codington	Participating	23	50	No
1520	652311.29	4992164.18	Codington	Participating	24	50	No
1528	653394.86	4993505.03	Codington	Participating	27	50	No
1537	655804.37	4993535.65	Codington	Non-Participating	29	50	No
1540	656798.10	4994383.05	Codington	Non-Participating	31	50	No
1546	657464.70	4995163.56	Codington	Non-Participating	32	50	No
1554	658362.21	4995127.56	Codington	Non-Participating	30	50	No
1555	658578.51	4995244.25	Codington	Non-Participating	29	50	No
1564	656621.54	4995250.50	Codington	Non-Participating	36	50	No
1575	655954.93	4995240.17	Codington	Non-Participating	37	50	No
1584	654917.16	4995237.31	Codington	Non-Participating	36	50	No
1588	653838.26	4995578.48	Codington	Non-Participating	33	50	No
1590	652995.68	4995885.56	Codington	Non-Participating	31	50	No
1591	652436.54	4996047.89	Codington	Participating	30	50	No
1595	650593.29	4996054.48	Codington	Non-Participating	27	50	No
1596	650496.01	4995587.28	Codington	Non-Participating	27	50	No
1599	650636.90	4995303.04	Codington	Non-Participating	26	50	No
1614	650501.55	4994753.62	Codington	Non-Participating	26	50	No
1618	648862.47	4994649.83	Codington	Non-Participating	24	50	No
1624	648375.40	4996645.46	Codington	Non-Participating	25	50	No
1635	647647.95	4997080.29	Codington	Non-Participating	25	50	No
1639	647523.41	4997799.99	Codington	Non-Participating	26	50	No
1647	649154.79	4997753.24	Codington	Non-Participating	27	50	No
1653	650473.00	4996848.32	Codington	Participating	28	50	No
1659	650595.55	4997697.39	Codington	Non-Participating	29	50	No
1666	647488.92	4998352.98	Codington	Non-Participating	26	50	No
1669	649340.75	4999049.86	Codington	Participating	28	50	No
1675	651994.47	4999721.14	Codington	Non-Participating	34	50	No
1684	653787.02	4998022.59	Codington	Non-Participating	35	50	No
1688	653778.28	4996825.57	Codington	Non-Participating	34	50	No
1695	654384.51	4996687.82	Codington	Non-Participating	38	50	No
1697	655253.74	4997956.71	Codington	Participating	42	50	No
1698	655368.87	4998297.41	Codington	Non-Participating	42	50	No
1705	656685.45	4997836.26	Codington	Non-Participating	40	50	No
1710	656976.54	4997093.04	Codington	Non-Participating	37	50	No
1717	656867.97	4998569.91	Codington	Non-Participating	38	50	No
1721	657770.19	4996904.04	Codington	Non-Participating	34	50	No
1722	657792.58	4996940.40	Codington	Non-Participating	34	50	No
1725	656815.87	4999863.27	Codington	Non-Participating	43	50	No
1745	647461.13	5000525.45	Codington	Non-Participating	28	50	No
1746	647456.46	5000456.03	Codington	Non-Participating	28	50	No
1749	648159.89	5000058.41	Codington	Participating	28	50	No
1759	648809.41	4999992.49	Codington	Non-Participating	29	50	No
1762	649063.96	5001386.23	Codington	Non-Participating	30	50	No
1764	663178.63	5001621.05	Codington	Non-Participating	29	50	No
1772	661543.34	5000761.33	Codington	Non-Participating	29	50	No

Table B-1: Modeled Sound Pressure Levels at Sensitive Receptors in Codington County

Receptor ID	Coordinates UTM NAD83 Zone 14N		County	Participation Status	Source Only Broadband Sound Level (dBA)	Regulation Evaluation	
	X (m)	Y (m)				Limit (dBA)	Exceed Limit?
1782	658372.24	5001257.48	Codington	Non-Participating	40	50	No
1784	655170.00	5001262.14	Codington	Non-Participating	42	50	No
1787	655103.41	5000902.29	Codington	Participating	43	50	No
1791	654852.45	5000075.99	Codington	Participating	43	50	No
1794	653692.68	5000273.03	Codington	Participating	42	50	No
1799	645387.42	4999931.96	Codington	Non-Participating	25	50	No
1800	646345.40	4999959.62	Codington	Non-Participating	26	50	No
2022	650528.30	4993061.83	Codington	Non-Participating	23	50	No
2024	649871.67	4991903.75	Codington	Participating	23	50	No
2025	649921.89	4991917.62	Codington	Participating	23	50	No
2038	646743.98	4996587.90	Codington	Non-Participating	24	50	No
2315	649018.76	4991138.66	Codington	Non-Participating	21	50	No
2318	648352.31	4991902.58	Codington	Participating	22	50	No
2339	649064.44	4992930.45	Codington	Non-Participating	23	50	No
2347	649279.70	4993533.72	Codington	Non-Participating	24	50	No
2348	649271.45	4993557.43	Codington	Non-Participating	24	50	No
2353	647627.18	4993444.66	Codington	Non-Participating	22	50	No
2356	647698.06	4993969.91	Codington	Non-Participating	23	50	No
2360	647604.47	4994983.66	Codington	Non-Participating	24	50	No
2363	651937.86	5001067.18	Codington	Participating	36	50	No
2364	651457.46	4993586.61	Codington	Non-Participating	25	50	No
2368	651076.00	4993539.97	Codington	Non-Participating	24	50	No
2372	658654.33	4990392.79	Codington	Non-Participating	21	50	No

Table B-2: Modeled Sound Pressure Levels at Sensitive Receptors in Grant County

Receptor ID	Coordinates UTM NAD83 Zone 14N		County	Participation Status	Source Only Broadband Sound Level (dBA)	Regulation Evaluation	
	X (m)	Y (m)				Limit (dBA)	Exceed Limit?
689	647139.01	5014024.33	Grant	Participating	27	50	No
782	660720.97	5013271.92	Grant	Participating	22	50	No
789	660610.61	5014484.49	Grant	Participating	24	50	No
1805	644356.98	5002651.43	Grant	Participating	26	50	No
1809	647235.37	5001567.12	Grant	Participating	28	50	No
1815	648970.50	5002809.01	Grant	Participating	32	50	No
1821	649665.32	5003050.76	Grant	Non-Participating	33	50	No
1828	650524.49	5003103.91	Grant	Participating	35	50	No
1829	650075.00	5002248.60	Grant	Non-Participating	33	50	No
1832	651107.55	5003102.45	Grant	Participating	36	50	No
1837	651909.87	5003057.90	Grant	Participating	39	50	No
1840	650832.97	5001658.43	Grant	Non-Participating	33	50	No
1847	652660.85	5002765.85	Grant	Participating	41	50	No
1849	653530.94	5002924.70	Grant	Non-Participating	41	50	No
1850	653518.23	5002856.66	Grant	Non-Participating	41	50	No
1867	661784.38	5001742.15	Grant	Non-Participating	30	50	No
1870	661126.69	5001722.46	Grant	Non-Participating	31	50	No
1874	663970.35	5002019.97	Grant	Non-Participating	28	50	No
1884	664755.72	5004486.66	Grant	Participating	27	50	No
1885	664644.10	5004250.93	Grant	Non-Participating	29	50	No
1888	663576.49	5004901.72	Grant	Non-Participating	33	50	No
1895	657975.48	5004220.64	Grant	Non-Participating	36	50	No
1904	658164.88	5003370.45	Grant	Non-Participating	35	50	No
1908	655165.86	5002087.27	Grant	Non-Participating	39	50	No
1914	653600.45	5003245.37	Grant	Participating	44	50	No
1915	653456.51	5004343.87	Grant	Participating	45	50	No
1919	651979.07	5003440.36	Grant	Participating	42	50	No
1928	649363.69	5003248.44	Grant	Participating	33	50	No
1937	648977.78	5004008.60	Grant	Non-Participating	35	50	No
1938	647494.42	5004033.38	Grant	Non-Participating	32	50	No
1947	647511.12	5006001.75	Grant	Non-Participating	34	50	No
1953	648855.29	5004824.59	Grant	Non-Participating	41	50	No
1955	648976.90	5004831.73	Grant	Non-Participating	42	50	No
1957	649090.23	5004809.12	Grant	Non-Participating	41	50	No
1962	649045.78	5006117.82	Grant	Participating	39	50	No
1968	648969.51	5006429.63	Grant	Non-Participating	38	50	No
1970	646968.92	5006520.98	Grant	Non-Participating	34	50	No
1976	647303.97	5007251.04	Grant	Participating	36	50	No
1985	648480.56	5007489.68	Grant	Participating	38	50	No
1994	650684.64	5006150.39	Grant	Non-Participating	41	50	No
1995	650837.63	5006168.70	Grant	Non-Participating	41	50	No
2005	650626.79	5005202.02	Grant	Participating	45	50	No
2007	661518.31	5004784.40	Grant	Participating	38	50	No
2008	661242.84	5005002.70	Grant	Non-Participating	36	50	No
2012	661599.97	5003749.29	Grant	Participating	42	50	No
2018	659717.08	5002264.17	Grant	Non-Participating	34	50	No
2020	658319.47	5004153.08	Grant	Non-Participating	36	50	No
2041	653593.66	5006201.50	Grant	Participating	44	50	No
2066	664805.69	5006459.59	Grant	Non-Participating	24	50	No
2074	663797.17	5005085.81	Grant	Non-Participating	32	50	No
2080	657770.35	5004970.01	Grant	Non-Participating	39	50	No
2085	655202.17	5004865.99	Grant	Non-Participating	40	50	No
2086	653612.64	5006755.67	Grant	Participating	45	50	No
2099	664537.21	5007281.04	Grant	Non-Participating	25	50	No
2107	664924.28	5006725.78	Grant	Participating	22	50	No
2108	665843.59	5006677.49	Grant	Participating	24	50	No
2109	665811.13	5006675.75	Grant	Participating	24	50	No
2126	665811.13	5006675.75	Grant	Participating	24	50	No
2127	665811.13	5006675.75	Grant	Participating	24	50	No
2141	661510.62	5009229.70	Grant	Participating	26	50	No
2149	657734.58	5008810.13	Grant	Participating	43	50	No
2153	657618.71	5009594.79	Grant	Participating	44	50	No
2158	655865.10	5008248.23	Grant	Participating	45	50	No

Table B-2: Modeled Sound Pressure Levels at Sensitive Receptors in Grant County

Receptor ID	Coordinates UTM NAD83 Zone 14N		County	Participation Status	Source Only Broadband Sound Level (dBA)	Regulation Evaluation	
	X (m)	Y (m)				Limit (dBA)	Exceed Limit?
2168	653411.62	5009060.41	Grant	Participating	41	50	No
2182	652821.24	5009387.00	Grant	Non-Participating	38	50	No
2193	652045.23	5009239.11	Grant	Non-Participating	40	50	No
2195	650621.29	5009376.36	Grant	Non-Participating	39	50	No
2205	650503.26	5009033.74	Grant	Non-Participating	41	50	No
2212	650493.66	5008776.86	Grant	Non-Participating	44	50	No
2214	645840.98	5008574.90	Grant	Participating	43	50	No
2217	645708.61	5008004.25	Grant	Participating	37	50	No
2218	645720.53	5008021.46	Grant	Participating	38	50	No
2219	645631.03	5008056.63	Grant	Participating	38	50	No
2220	645560.46	5008023.00	Grant	Participating	37	50	No
2230	644920.93	5009426.30	Grant	Participating	39	50	No
2236	646374.72	5009624.58	Grant	Non-Participating	39	50	No
2239	647229.03	5010859.63	Grant	Participating	33	50	No
2240	648982.24	5010914.63	Grant	Non-Participating	34	50	No
2242	648974.09	5010822.91	Grant	Non-Participating	35	50	No
2243	650458.09	5010135.55	Grant	Non-Participating	37	50	No
2244	651399.84	5010537.19	Grant	Non-Participating	35	50	No
2251	653709.32	5011041.66	Grant	Participating	36	50	No
2257	655074.36	5009886.86	Grant	Participating	45	50	No
2260	658287.22	5009765.21	Grant	Participating	39	50	No
2267	663067.37	5009863.43	Grant	Participating	22	50	No
2270	645591.52	5011330.52	Grant	Participating	30	50	No
2271	646356.26	5011253.61	Grant	Non-Participating	31	50	No
2277	647415.35	5011482.18	Grant	Non-Participating	32	50	No
2279	653707.33	5011412.61	Grant	Non-Participating	35	50	No
2280	653706.52	5011445.93	Grant	Non-Participating	35	50	No
2281	653705.48	5011488.76	Grant	Non-Participating	35	50	No
2284	659888.06	5013103.47	Grant	Participating	27	50	No
2287	657521.45	5013443.09	Grant	Participating	30	50	No
2290	657917.63	5013363.29	Grant	Participating	29	50	No
2305	648987.99	5013202.15	Grant	Participating	29	50	No
2416	643160.20	5007930.05	Grant	Participating	29	50	No
2423	643933.96	5009635.42	Grant	Non-Participating	31	50	No
2424	643946.39	5009641.33	Grant	Non-Participating	31	50	No
2426	644853.33	5009638.98	Grant	Non-Participating	37	50	No
2427	644862.14	5009641.30	Grant	Non-Participating	37	50	No
2449	650900.06	5006334.22	Grant	Non-Participating	42	50	No
2455	651981.94	5003185.29	Grant	Non-Participating	40	50	No
2470	653647.87	5003180.53	Grant	Participating	43	51	No