Acoustic Assessment

Foxtail Wind Energy Center
Foxtail Wind, LLC
Dickey County, North Dakota

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EXECUTIVE SUMMARY

An acoustic assessment has been completed by AECOM for the proposed Foxtail Wind Energy Center (Project) located in Dickey County, North Dakota. If constructed, the Project would consist of 75 wind turbine generators (WTGs) and associated access roads, a substation, switch yard, laydown yard, an operations and maintenance building, a meteorological tower, collection lines, and a concrete batch plant. For the acoustic assessment, two Project WTG layout designs were considered: one with alternates (78 WTGs), and the other without (75 WTGs). The WTGs comprising these layout designs include two Vestas Wind Systems WTG model types, a 2.0 megawatt (MW) V-116 generator, and a 2.0 MW V-110 generator. The objective of this assessment was to determine whether nominal operations of the Project would be compliant with the applicable North Dakota Public Service Commission (Commission) 50 dBA noise limit.

WTG noise source data was obtained from Vestas Wind Systems via NextEra Energy Resources, LLC (NEER) for the proposed V-116 and V-110 2.0 MW generators. Outdoor sound propagation modeling of aggregate WTG operation noise was performed with Datakustik CadnaA software, a commercially available computer software program that predicts noise levels near industrial noise sources based on International Organization of Standardization (ISO) 9613-2 standards for outdoor sound propagation calculation (ISO 1996). This software uses industry-accepted propagation algorithms and accepts input of sound reference levels as provided by equipment manufacturers and other sources of relevant information.

Future predicted noise levels attributed to aggregate WTG operation were predicted and compared with the Commission threshold at each occupied residential land use in the Project vicinity. The results of this assessment conclude that there will be a total of two impacts at occupied residences (identified as receptors R07 and R32) under two of the three operation scenarios for both WTG layouts. NEER has obtained waivers from the property owners of the two aforementioned impacted receivers. Thus, the Project is compliant with regulatory noise thresholds.

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1.0 INTRODUCTION

Foxtail Wind, a wholly owned, indirect subsidiary of NextEra Energy Resources, LLC (NEER), proposes to develop the Foxtail Wind Energy Center (Project) in Dickey County, in southeastern North Dakota. Northern States Power Company (NSP), doing business as Xcel Energy (Xcel), plans to construct and operate the Project. NEER and NSP/Xcel are collaborating on development of the Project to reflect the engineering and design inputs necessary to transfer ownership of the Project to NSP/Xcel at the end of 2017 according to the executed Purchase & Sale Agreement (PSA). NSP/Xcel currently proposes to construct the Project in two phases between 2018 and 2019. Both the NEER and NSP/Xcel teams will be involved in the engineering design of the Project to be constructed, although NSP/Xcel will ultimately construct the Project.

If constructed, the Project would consist of 75 WTGs consistent with the intended nameplate capacity of 150 MW; in addition, the Project would establish a concrete batch plant to help prepare foundations for the WTGs, and a parcel containing a switchyard and substation to collect produced power. Two Project WTG layout designs were studied for the purposes of this predictive noise analysis—one featuring the aforementioned minimum of 75 WTGs, and the other augmented by an additional three alternate WTGs having the same model and wind energy conversion capacity (2.0 MW). Both alternatives were designed to have a combination of Vestas Wind Systems WTG model types, including V-116 WTGs throughout the Project area, and a total of seven V-110 WTGs near the northeast Project extents. Foxtail Wind designed the Project using a minimum turbine setback of three-times the turbine height from occupied residences per North Dakota Administrative Code (NDAC) Section 69-06-08-01(2). The two studied WTG layouts are based on the site layout dated July 14, 2017.

1.1 Study Area and Existing Environment

The Foxtail Wind Project area encompasses approximately 20,029 acres in western Dickey County. The broader noise study area encompasses approximately 51,070 acres, approximately bounded on the north by 86th Street SE, on the east by County Road 2, on the south by 97th Street SE, and on the west by 67th Avenue SE. The major roadways within the Project vicinity are 68th Avenue SE (State Highway 56) and 96th Street SE (State Highway 11), which generally follow the western and southern boundaries of the study area respectively. The land uses within the study area are primarily agricultural, with rural farmstead residences and ancillary structures dispersed throughout the study area. The topography in this region is characterized by rolling grassy terrain, interspersed with natural lakes and ponds.

The noise-sensitive land uses in the area are solely rural farmstead residences. All structures (whether in habitable condition or not) were analyzed for Project-related noise impacts. A total of 50 structures were identified within the study area, 26 of which are considered unlikely to be or unequivocally unoccupied, with the remaining 24 structures considered either inhabited or capable of habitation. Determination of habitation for existing structures was limited to public knowledge and roadside surveys in order to reduce disturbances to non-participating land owners. For purposes of conservatism in this analysis, all structures located on non-participating land that were identified as capable of habitation were considered active residential structures. Receptors that were identified as participating in the Project are associated with the wind farm development via a legal agreement with the owner of the subject property.

Dickey County, ND would generally be considered a rural agricultural area and thus would be expected to have reasonably low ambient noise levels. Existing noise sources in the area are likely dominated by distant traffic noise from the nearby arterial highways, and would also include intermittent aircraft overflights, noise from agricultural operations, and wind-generated noises.

1.2 Acoustical Terminology

For purposes of document brevity, AECOM assumes the reader is familiar with basic acoustical principles. Readers desiring an expanded introduction to noise fundamentals beyond what is presented in this section should consult industry-accepted reference texts such as *Noise & Vibration Control Engineering* (Beranek & Ver 1992) or *Engineering Noise Control* (Bies & Hansen 2003). Fundamental concepts and terms related to noise, as discussed in this technical report, are summarized in the following paragraphs.

Noise is generally defined as loud, unpleasant, unexpected, or undesired sound that is typically associated with human activity and that interferes with or disrupts normal activities. Although exposure to high noise levels has been demonstrated to cause hearing loss, the principal human response to environmental noise is annoyance. The response of individuals to similar noise events is diverse and influenced by the type of noise, the perceived importance of the noise and its appropriateness in the setting, the time of day and the type of activity during which the noise occurs, and the sensitivity of the individual.

Sound is a physical phenomenon consisting of minute vibrations that travel through a medium, such as air, and are sensed by the human ear. Sound is generally characterized by several variables, including frequency and intensity. Frequency describes the pitch of the sound and is measured in cycles per second or Hertz (Hz), while intensity describes the sound's loudness and is measured in decibels (dB) using a logarithmic scale.

Sound level is usually expressed by reference to a known standard. This report refers to both sound pressure level (SPL) and sound power level (PWL). In expressing sound pressure on a logarithmic scale, the sound pressure is compared to a reference value of 20 microPascals (µPa). SPL depends not only on the power of the source, but also on the distance from the source and on the acoustical characteristics of the space surrounding the source. Unlike sound pressure, which varies with distance from a source, sound power is the acoustic power of a source typically expressed in Watts. Sound power is the acoustic power radiated from a source, expressed in decibels as a sound power level (PWL) using a reference power value of 10^{-12} Watts.

Due to its definition with respect to a reference sound pressure, a sound level of 0 dB is not the complete absence of sound but instead the approximate threshold of average healthy human hearing and is barely audible under extremely quiet listening conditions. Normal speech has a sound level of approximately 60 dB. Sound levels above approximately 110 dB begin to be felt inside the human ear as discomfort and eventually pain at 120 dB and higher levels. The minimum change in the sound level of individual events that an average human ear can detect under laboratory conditions is about 1 to 2 dB. A 3 to 5 dB change, on the other hand, is readily perceived under most circumstances. A change in sound level of about 10 dB is usually perceived by the average person as a doubling (or if decreased by 10 dB, halving) of the sound's loudness, even though the actual change in sound energy is an order of magnitude.

Due to the logarithmic nature of the decibel unit, sound levels cannot be added or subtracted directly and are somewhat cumbersome to handle mathematically; however, some simple rules are useful in dealing with sound levels. First, if a sound's intensity is doubled, the sound level increases by 3 dB, regardless of the initial sound level. For example: 60 dB + 60 dB = 63 dB, and 80 dB + 80 dB = 83 dB.

Hertz is a measure of how many times each second the crest of a sound pressure wave passes a fixed point. For example, when a drummer beats a drum, the skin of the drum vibrates a number of times per second. When the drum skin vibrates 100 times per second, it generates a sound pressure wave that is oscillating at 100 Hz, and this pressure oscillation is perceived by the ear/brain as a tonal pitch of 100 Hz. Sound frequencies between 20 and 20,000 Hz are within the range of sensitivity of the best human ear.

Sound from a tuning fork contains a single frequency (a pure tone); however, most sounds one hears in the environment do not consist of a single frequency but rather a broad band of frequencies differing in sound level. The method commonly used to quantify environmental sounds consists of evaluating all frequencies of a sound according to a weighting system that represents human hearing, which is less sensitive at low frequencies and extremely high frequencies than at the mid-range frequencies. This is called “A weighting,” and the decibel level measured is called the A-weighted sound level (dBA). In practice, the level of a noise source is conveniently measured using a sound level meter that includes a filter corresponding to the dBA curve of frequency-dependent adjustments.

Although dBA may adequately indicate the level of environmental noise at any instant in time, community noise levels vary continuously. Most environmental noise includes a mixture of noise from distant sources that creates a relatively steady background noise in which no particular source is identifiable. A single descriptor called the equivalent sound level (L_{eq}) may be used to describe sound that is changing in level. L_{eq} is the energy-mean dBA during a measured time interval. It is the “equivalent” constant sound level that would have to be produced by a given source to equal the acoustic energy contained in the fluctuating sound level measured. In addition to the energy-average level, it is often desirable to know the acoustic range of the noise source being measured. This is accomplished through the maximum (L_{max}) and minimum (L_{min}) indicators that represent the root-mean-square maximum and minimum noise levels measured during the monitoring interval. The L_{min} value obtained for a particular monitoring location is often called the “acoustic floor” for that location.

2.0 REGUALTORY SETTING & NOISE IMPACT CRITERIA

A review was conducted of Federal, State, and Local laws, ordinances, regulations, and standards (LORS), applicable to noise generated by Project construction and operation. This review did not identify any applicable LORS at the federal level. At the state level, the State of North Dakota Public Service Commission (Commission) establishes noise or "sound" limits which apply to wind energy conversion facilities within the state. No applicable LORS at the local level (participating counties/municipalities) were identified.

2.1 State of North Dakota

NDAC Section 69-06-08-01(4) reads as follows:

> *A wind energy conversion facility site must not include a geographic area where, due to operation of the facility, the sound within one hundred feet of an inhabited residence or a community building will exceed fifty dBA. The sound level avoidance area criteria may be waived in writing by the owner of the occupied residence or the community building.*

Project aerial mapping was reviewed to identify all structures, including residential and community buildings, within the Project vicinity. Sound levels produced by the Project were predicted at a distance of 100-feet from all inhabited structures and assessed for compliance against the Commission maximum sound level of 50 dBA. Although not required for compliance assessment, sound levels were also predicted at identified uninhabited structures and are included in detailed modeling result tables in **Appendix A**.

2.2 Dickey County

Dickey County does not have a legislative code; thus, noise regulations rely on State legislation.

3.0 NOISE PREDICTION METHODOLOGY & RESULTS

3.1 Review of Sound Generated by WTG Facilities

Sound generated by operation of a modern downwind-mast (i.e., the supporting tower is downstream of the spinning bladed rotor) WTG is an amalgam of the following noise-producing sources:

- Interaction of the bladed rotor with incoming wind, and to a lesser degree the aerodynamic wake of the bladed rotor with the WTG mast; and
- The mechanical equipment housed within the nacelle just behind the WTG bladed rotor hub, which includes a gearbox, generator, and cooling fan.

For large, utility-scale WTGs currently engineered and offered by leading manufacturers, such as the 2.0 MW models considered for this Project, mechanical noises from the nacelle tend to be much less than the dominant sound produced from aerodynamic effects resulting from rotor interaction with the incoming wind.

At rest when there is little or no wind energy to convert, a WTG produces negligible sound. As wind speeds rise up to a “cut-in” magnitude, the WTG bladed rotor begins rotation and generates power. WTG energy conversion and corresponding aerodynamic noise then increases with increasingly greater received wind speed up to a maximum rotational speed when the WTG maximum power capacity is attained. Although the WTG may experience elevated wind speeds that exceed what is necessary for this maximum power capacity, the rotor rotational speed would not increase further and thus produce an essentially constant sound power level under such elevated wind conditions.

While the WTG sound power may thus achieve a maximum level associated with full power production capacity under wind conditions that exceed those necessary for maximum blade rotation, those same elevated wind conditions are likely to produce greater outdoor background sound levels that would acoustically contribute to the ambient sound as measured and perceived at a receiver location on the ground. Although the Commission ignores this non-Project acoustical contribution to the ambient sound environment, background SPL due to steady winds traversing the Project vicinity may be estimated as follows (Hau, 2000):

$$SPL_{wind} \text{ (dBA)} = 27.7 + 2.5 * V_{wind}; \text{ where } V_{wind} \text{ is in meters per second (m/s)}$$

Thus, with sustained steady winds at 4 m/s, the background SPL is likely to be as high as 38 dBA. At receiver positions sufficiently distant from Project WTGs that are exposed to high wind velocities, the background noise may actually be dominant and mask the Project-attributed sound contribution to the measured and perceived ambient sound level.

3.2 Modeling Software and Calculation Methods

The DataKustik CadnaA® Noise Prediction Model (Version 2017) was used to estimate the aggregate SPL from proposed Project operation layouts at the identified noise-sensitive receptors. CadnaA® is a Windows® based software program that predicts noise levels near noise sources based on ISO 9613-2 standard for outdoor sound propagation calculation. The model uses these industry-accepted propagation algorithms and accepts full-octave band (1/1) PWL (in dB re: one picoWatt) provided by the equipment manufacturer and other sources.

The software’s calculations account for classical sound wave geometric divergence, reflection off of surfaces, source directivity, meteorological effects, and attenuation factors resulting from air absorption, basic ground effects, and barrier/shielding from structures and/or topography. Topographical information was imported into the model using official United States Geological Survey (USGS) National Elevation Dataset (NED) to accurately represent existing topography in the Project area.

3.3 Modeling Input Parameters

3.3.1 Meteorological Input and Model Configuration

The sound propagation prediction model developed for this analysis assumed an outdoor air temperature of 50-degrees Fahrenheit (ºF), a relative humidity of 70%, and an average ground absorption coefficient, which can range from zero (0, for acoustically reflective surfaces, such as water or pavement) to unity (1, for acoustically absorptive ground coverings, such as loose porous soils or snow), set to a conservative and industry-recommended average of 0.5. All three of these parameters are consistent with modeling recommendations from the Institute of Acoustics (IOA 2013).

Sound attenuation due to atmospheric absorption improves with increasing acoustical frequency, and varies with temperature and moisture content. While sound attenuation due to this environmental factor is generally modest at distances less than 1,000 feet, over greater distances the result will be substantially reduced high frequency noise and the apparent preservation of low frequency noise that attenuates (due to ground and atmospheric absorption) at much lower rates.

With respect to wind speed and direction, the ISO 9613-2 standard conservatively calculates attenuation for meteorological conditions considered “favorable” to propagation: downwind (i.e., the receiver of interest is downstream of the noise-producing source). Acknowledged as a physical impossibility (i.e., because wind is experienced as having direction), this downwind assumption is considered omnidirectional by ISO 9613-2 and intended to represent most meteorological conditions experienced by the Project and its vicinity. Such conditions are assumed to be valid for study of WTG operation noise for two scenarios: 1) WTG operation under wind conditions enabling “cut-in” bladed rotor speed and at which power conversion would begin to occur; and 2) WTG operation under wind conditions at which “maximum [rotor] rotational speed” is expected along with maximum power production per tower.

However, and as discussed in Clause 8 of the aforementioned ISO 9613-2 standard, anomalous meteorological conditions may occur that would enhance sound propagation from the aggregate operating WTGs. These uncommon conditions are characterized as a “C_{met}” value, which results in an additive dB adjustment to the values calculated from the aforementioned downwind-favoring ISO 9613-2 default method. The North Dakota Commission neither mandates nor recommends that these anomalous conditions be considered in an assessment of WTG operation noise; however, in the interest of providing NEER a conservative noise prediction assessment for the Project, this noise analysis includes study of a third scenario: maximum rotor speed under anomalous meteorological conditions. In other words, this third scenario includes consideration of C_{met}, which the CadnaA program includes as an input parameter for such anticipated circumstances. These anomalous meteorological conditions could include infrequently occurring periods of temperature inversions or stable air layers, resulting in wind shear, which would cause more emitted sound to refract towards the ground (and thus receivers) instead of upwards into the atmosphere.

3.3.2 Receiver Input

Representative receiver points were modeled at each identified residential structure in the Project area. The inhabitability of structures, while noted in the results section of this report, did not preclude a prediction of noise levels at the receiver location. Receivers were modeled at a height of 4 meters (relative to ground), which could be typical of the height of a second-story listener and is recommended for wind turbine noise modeling as it reduces the influence of ground absorption factors that may be misrepresented in prediction results.

Per the Commission noise regulation, sound levels from Project operations are to be assessed "within 100 feet of an inhabited residence," thus, modeled receiver locations were placed approximately 100 feet from each inhabited structure in the direction of the nearest proposed WTG. As mentioned in Section 1.1, modeled receiver locations were similarly placed near uninhabited structures.

3.3.3 Source Input

The Project plans to install Vestas-brand V-116 and V-110 WTG units throughout the Project vicinity. Sources in the model were located at each discrete proposed WTG pole location as a single, omnidirectional point source, with a relative height of 80 meters (specified hub height). Performance specifications and proprietary noise data for the selected WTG units were provided by the manufacturer for the purpose of this study. **Table 1** displays the various A-weighted sound power level ratings for the Vestas V-116 and V-110 WTGs at wind speeds of 3 to 11 meters per second.

Table 1. A-Weighted Sound Power Levels Correlated with Wind Speed

Hub Height Wind Speeds:	WTG Lmax Sound Power Level (PWL, dB) at Reference Wind Speed								
	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s
Vestas V-110	95.3	96.1	97.5	101.7	103.6	106.1	107.6	107.6	107.6
Vestas V-116	96.7	96.9	98.9	102.9	105.5	108.2	109.4	109.5	109.5

In addition to anticipated noise levels at various wind speeds and blade types, these specifications also reported the spectral content of the WTGs in one-third octave band center frequency (OBCF) resolution. These documents report that source measurements were conducted in accordance with the International Electrotechnical Commission (IEC) standard 61400-11 for acoustic measurement techniques. In order to process the specified sound levels provided by the manufacturer for model input, the one-third OBCF data were summed into full 1/1- OBCF values as presented in **Table 2**. Since no power level uncertainty values were provided in the manufacturer specifications, a typical +2 dB adjustment was applied across all frequency bands for each WTG source.

Table 2. WTG – Sound Power Level by Octave Band Center Frequency (OBCF)

WTG Model	Blade Type	Scenario	Wind Speed	OBCF A-Weighted Power Level, dBA									Total PWL
				31.5	63	125	250	500	1k	2k	4k	8k	
V-110	Standard	Cut-In	3 m/s	64.7	75.9	82.0	85.7	88.5	90.3	89.3	82.7	67.9	95.3
		Max	9 m/s	74.8	86.6	94.0	99.3	101.9	102.3	100.3	92.8	81.0	107.6
V-116	Standard	Cut-In	3 m/s	63.7	76.6	80.8	89.4	91.4	91.1	88.2	84.9	68.0	96.7
		Max	10 m/s	76.6	85.7	91.3	95.9	102.0	105.5	104.0	97.8	84.9	109.5

3.3.4 Modeled Scenarios

The predictive acoustic assessment reviewed two Project WTG layouts: one with additional WTG locations ("With Alternates"), and one without the additional WTGs ("No Alternates"). Both scenarios were modeled under the following operating/meteorological conditions, deemed representative of the entire operational range of the Project:

- Cut-In, or, the minimum wind speed required to generate electricity through rotor rotation;
- Maximum turbine rotational speed; and,

- Maximum turbine rotational speed under anomalous meteorological conditions.

3.4 Modeling Results

Each predictive operations model assumed that all WTGs would be operating concurrently at the same analyzed operation condition. Predicted levels in this section are presented in both tabulated form (**Tables 3** and **4**) and as noise contour plots (**Figures 1** through **6**), which depict the propagation of Project operational noise upon the Project area as color-coded isopleths (a.k.a., Project-attributed noise level "contours," reminiscent of topographical contours that depict equivalent grade elevation). While aggregate WTG operation noise may be compliant with the Commission requirements, under the right meteorological conditions, it may be possible for WTG noise to be audible at a noise-sensitive receptor (NSR).

Predicted operational noise levels associated with the "No Alternates" layout, for each of the above-mentioned operating conditions, are provided below in **Table 3**. **Figures 1** through **3**, located at the end of this section, display predicted noise level contours associated with each of these three operating conditions.

Table 3. Summary of Predicted Noise Levels, Occupied Structures, "No Alternates" Layout

Receiver ID	Nearest WTG ID	Distance to Nearest WTG (m)	Modeled Receiver Coordinates (UTM Zone 14, NAD 83)		Predicted Sound Level (dBA, SPL)		
			Easting (m)	Northing (m)	Cut-In Rotation	Maximum Rotation	Maximum Rotation Under Anomalous
R04	4	1198	504718	5110064	31	42	43
R05	4	2353	503234	5109794	24	35	36
R07	10	415	506666	5109352	41	53	56
R09	20	1140	506262	5105925	33	44	45
R14	38	2142	513814	5109359	21	33	34
R16	59	2832	506811	5102390	24	34	34
R18	68	2059	507343	5100283	25	35	36
R20	69	1051	508485	5099326	32	43	45
R21	74	2328	507782	5096671	22	32	33
R22	75	1925	511104	5096921	20	30	31
R25	67	1812	513250	5100181	26	37	38
R26	63	785	512553	5101399	31	42	45
R28	63	2252	513886	5102327	24	34	35
R32	51	413	509571	5104838	39	51	54
R34	38	3651	514856	5110461	14	26	27
R39	6	1137	506421	5110789	32	43	44
R45	38	3318	515481	5108010	19	30	31
R47	63	3185	514720	5100308	20	30	30
R48	73	3106	512740	5096871	21	31	32
R50	20	3294	505944	5103638	22	32	33
R51	3	2174	503289	5108224	26	36	37
R53	68	1906	507481	5100152	27	37	38
R23	73	2231	512329	5097789	24	35	36
R29	57	1373	513647	5103418	26	37	38

Predicted operational noise levels associated with the “With Alternates” layout are provided below in **Table 4**. **Figures 4** through **6**, located at the end of this section, display predicted noise level contours associated with each of the three operating conditions.

Table 4. Summary of Predicted Noise Levels, Occupied Structures, “With Alternates” Layout

Receiver ID	Nearest WTG ID	Distance to Nearest WTG (m)	Modeled Receiver Coordinates (UTM Zone 14, NAD 83) Easting (m)	Northing (m)	Predicted Sound Level (dBA, SPL) Cut-In Rotation	Maximum Rotation	Maximum Rotation Under Anomalous
R04	4	1198	504718	5110064	31	42	43
R05	4	2353	503234	5109794	24	35	36
R07	10	415	506666	5109352	41	53	56
R09	20	1140	506262	5105925	33	44	45
R14	38	2142	513814	5109359	21	33	34
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R18	68	2059	507343	5100283	25	35	36
R20	69	1051	508485	5099326	32	43	45
R21	74	2328	507782	5096671	22	32	33
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R26	63	785	512553	5101399	31	42	45
R28	63	2252	513886	5102327	24	34	35
R32	51	413	509571	5104838	39	51	54
R34	38	3651	514856	5110461	14	26	27
R39	6	1137	506421	5110789	32	43	44
R45	38	3318	515481	5108010	19	30	31
R47	63	3185	514720	5100308	20	30	30
R48	73	3106	512740	5096871	21	31	32
R50	20	3294	505944	5103638	22	32	33
R51	3	2174	503289	5108224	26	36	37
R53	68	1906	507481	5100152	27	37	38
R23	73	2231	512329	5097789	24	35	36
R29	57	1373	513647	5103418	26	37	38

4.0 ADDITIONAL NOISE CONSIDERATIONS

4.1 Substation Noise

Noise generated by the substation would be dominated by “humming” sound from the transformer(s). Assuming the main transformer is rated for up to 162 megavolt-amperes (MVA) to accommodate power received from the Project WTGs, the Electric Power Plant Environmental Noise Guide (EPPENG) published by the Edison Electric Institute (EEI, 1984) suggests OBCF sound power levels for a “quiet” transformer as shown in **Table 5**. OBCF sound power levels for a “standard” type would be 10 dB higher per octave band.

Table 5. Substation – Sound Power Level by Octave Band Center Frequency (OBCF)

OBCF A-Weighted Power Level, dBA									Total PWL
31.5	63	125	250	500	1k	2k	4k	8k	
88	94	96	91	91	85	80	75	68	100

The substation is located on 71st Ave SE, south of 91st St SE and is no closer than approximately 5,000 feet from the two closest occupied NSRs: R16 to the south-southwest and R50 to the west. At this distance, noise from an operating “quiet” or “standard” type transformer would be far less than 50 dBA and thus compliant with the Commission requirements. At distances of no less than 500 feet, the 50 dBA threshold would still be met with a “quiet” transformer. For a “standard” transformer, this minimum distance would be 1,300 feet. While compliant with this assessment criterion, under the right conditions it may be possible for transformer noise to be audible at an NSR.

4.2 Construction Noise

The Project will be constructed in multiple phases and will involve the development of access roads, excavation and forming of WTG foundations, site preparation for crane lifting, and WTG assembly and commission. Typical large-scale wind projects undergo the following construction phases:

1. *Site Clearing*: Predominantly characterized by establishing Project offices, equipment storage areas, and construction staging areas. Erosion and sedimentation control measures would be completed as well in preparation of initial hauling routes.
2. *Grading*: The Project area access roads will be graded and formed during this phase. Excavation would also occur at WTG locations in preparation of foundation installations in Phase 3.
3. *Foundation Work*: Foundations constructed from reinforced concrete would be constructed at each WTG location.
4. *WTG Installation*: After delivery of WTG components, a single crane will house pole segments, nacelle housing, and the rotor/propeller assembly into position, followed by commission of the WTG.

Depending on the finalized schedule and anticipated delivery of WTG components and assembly equipment, construction phases throughout the Project area may overlap, as WTGs are commonly erected in small groups or strings as site development progresses. Aside from WTG construction, additional activities would include the construction of maintenance facilities, transmission line installation, and other supporting infrastructure.

The amount of construction equipment and the number of workers in any given area of the Project area would vary, but activity would tend to be concentrated in certain areas and then move as the

WTGs would be erected in a manner resembling an assembly line. These variations would also result in varying levels of construction-related noise.

Conventional construction activities at the Project site would result in a short-term, temporary increase in the ambient noise level resulting from the operation of construction equipment. The increase in noise level would primarily be experienced close to the noise source(s). The estimated magnitude of the noise effects would depend on the type of construction activity, noise level generated by construction equipment, duration of the construction, and the distance between the noise source and receiver of interest. Project construction traffic, consisting of delivery of WTG components and other materials, along public roads and Project access routes can also temporarily elevate typical roadway traffic volumes and thus increase noise levels experienced at receivers near such ground transportation routes. While most construction activities would be expected to occur during daytime hours, WTG sites can often require limited nighttime activities such as concrete pours for tower foundations.

4.3 Maintenance Noise

Upon completion and commissioning of the Project, an appropriate set of vehicles and related equipment can be expected to travel to and from, as well as within, the Project site in order to conduct regular inspections and maintenance of the WTGs and substation. Vehicles may also be involved for conducting regular security patrols of the Project site. Noise from these post-construction vehicles and activities are thus generally expected to be intermittent in nature and temporarily occurring over the life of the Project. Additionally, noise levels from such vehicles and activities are expected to be insignificant compared to expected nominal WTG operations.

5.0 CONCULSIONS

Project operational noise has been predicted and assessed against the 50 dBA Commission noise limit. The predictive operational noise modeling, performed with CadnaA software (and its algorithm basis per ISO 9613-2) and inclusive of conservative parameter assumptions and uncertainty corrections, demonstrates that there will be a total of two impacts at occupied residences which will occur in maximum rotational wind speed scenarios for both WTG layouts: Receiver R07, which experiences predicted levels of 53 to 56 dBA, and R32, which experiences predicted levels ranging from 51 to 54 dBA. As described above, NEER has executed waivers with the property owners of the two impacted residences.

6.0 LITERATURE CITED

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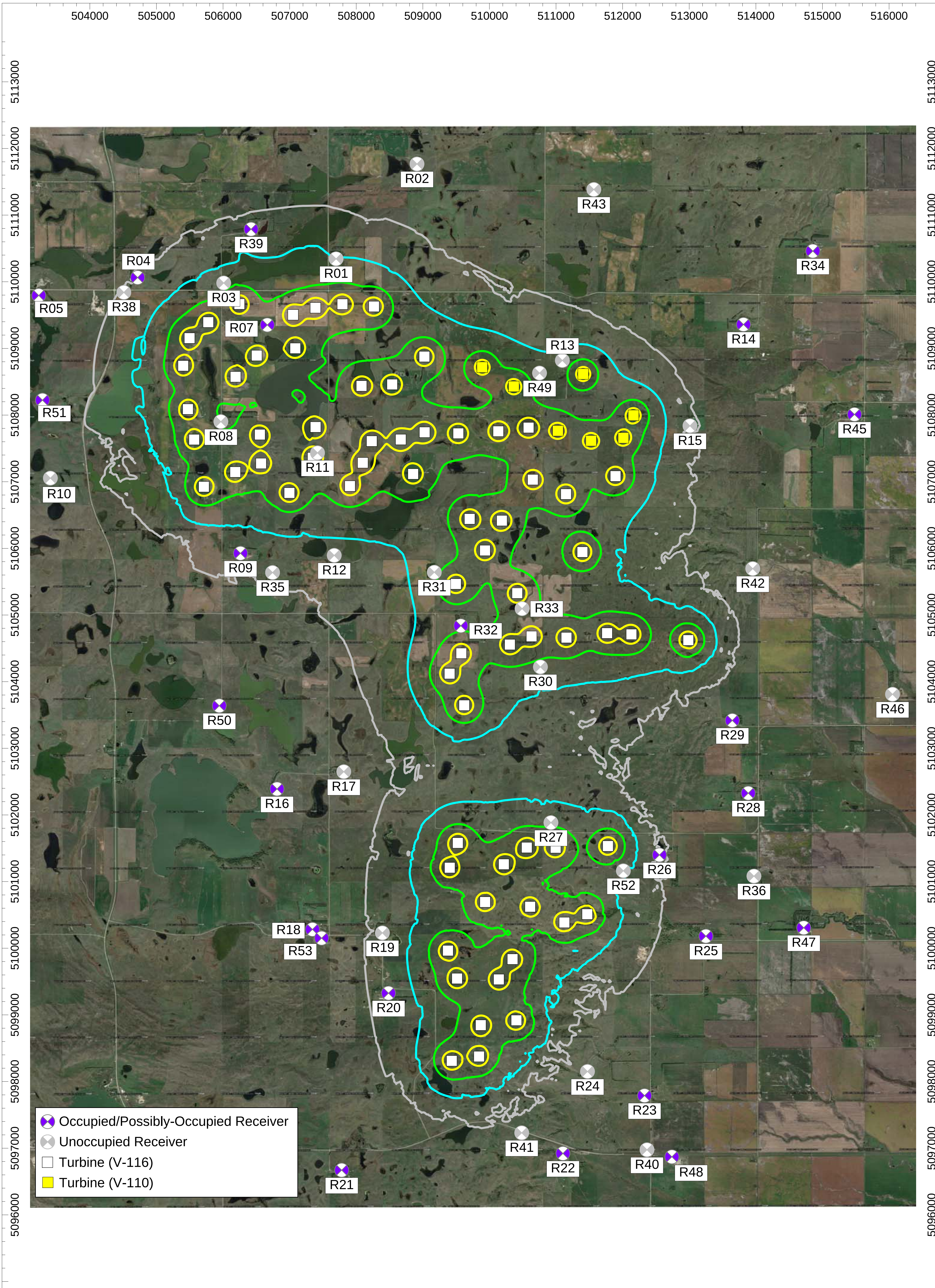
Figures



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CK

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Figure 1: No Alternates - Wind Turbines at Cut-In Wind Speed and Typical Meterological Conditions

Predicted Project Operation Noise Contours
Foxtail Wind Project - Dickey County, ND
NextEra Energy Resources, LLC

Sound Level Contour Ranges (dBA)

30 dBA
35 dBA
40 dBA
45 dBA
50 dBA
55 dBA

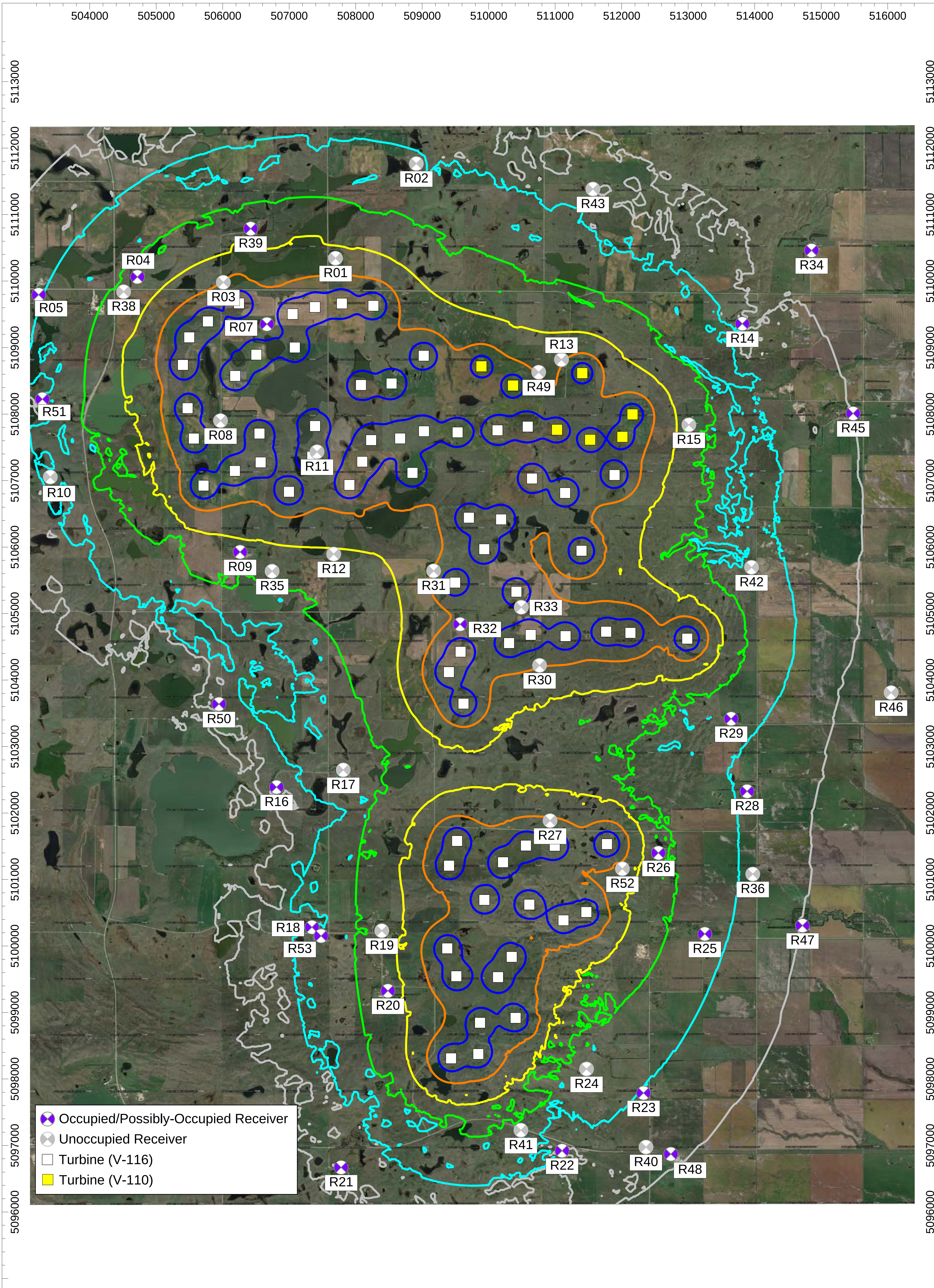

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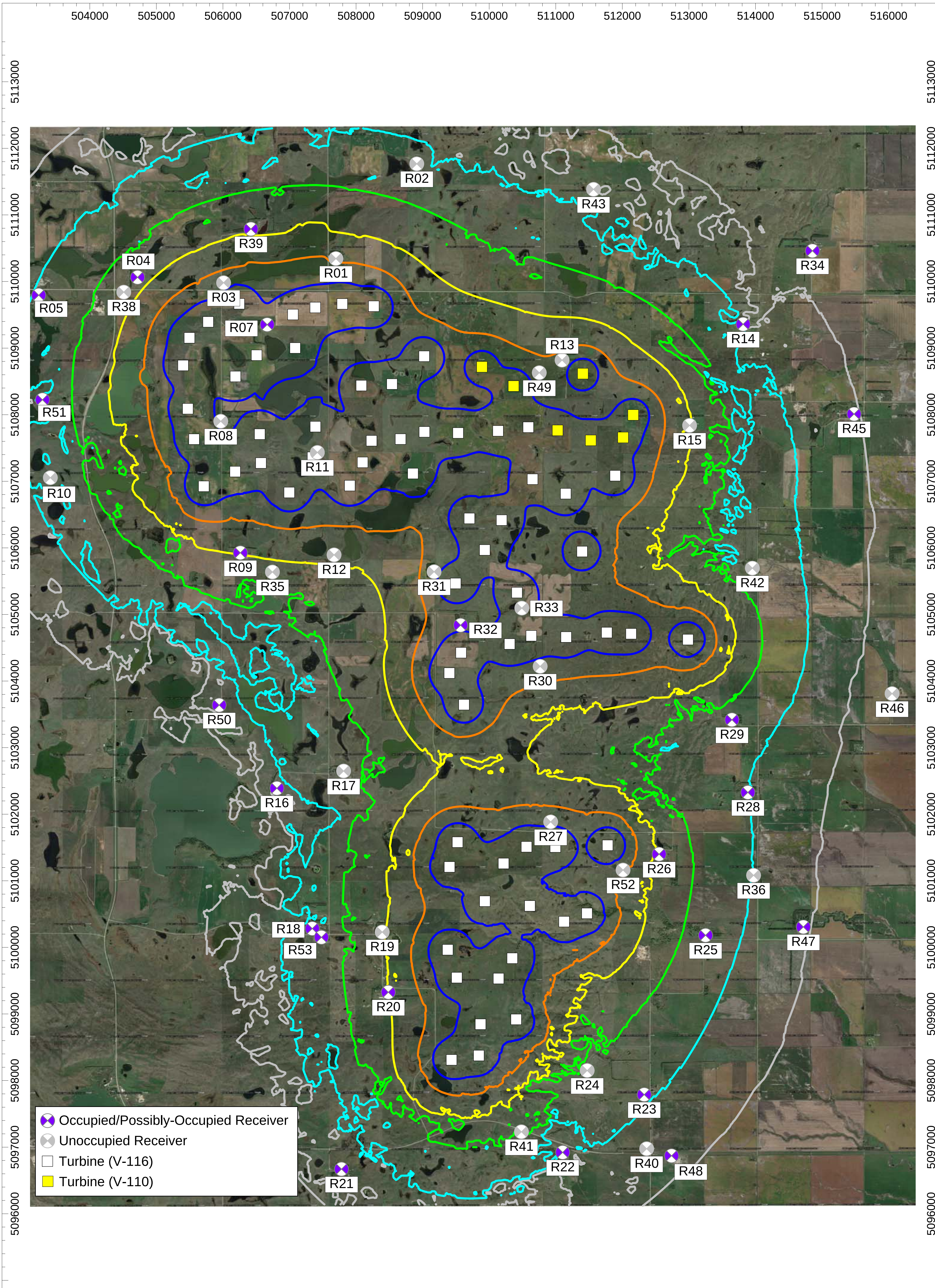
Figure 2: No Alternates - Wind Turbines at Maximum Rotational Wind Speed and Typical Meterological Conditions

Predicted Project Operation Noise Contours
Foxtail Wind Project - Dickey County, ND
NextEra Energy Resources, LLC

Sound Level Contour Ranges (dBA)

- 30 dBA
- 35 dBA
- 40 dBA
- 45 dBA
- 50 dBA
- 55 dBA



N	Date Created: 08/10/2017	**Figure 3: No Alternates - Wind Turbines at Maximum Rotational Wind Speed and Anomalous Meterological Conditions**	**Sound Level Contour Ranges (dBA)**
	Created by: CK		30 dBA 35 dBA 40 dBA 45 dBA 50 dBA 55 dBA
AECOM Acoustics & Noise Control Practice		**Predicted Project Operation Noise Contours** **Foxtail Wind Project - Dickey County, ND** **NextEra Energy Resources, LLC**	

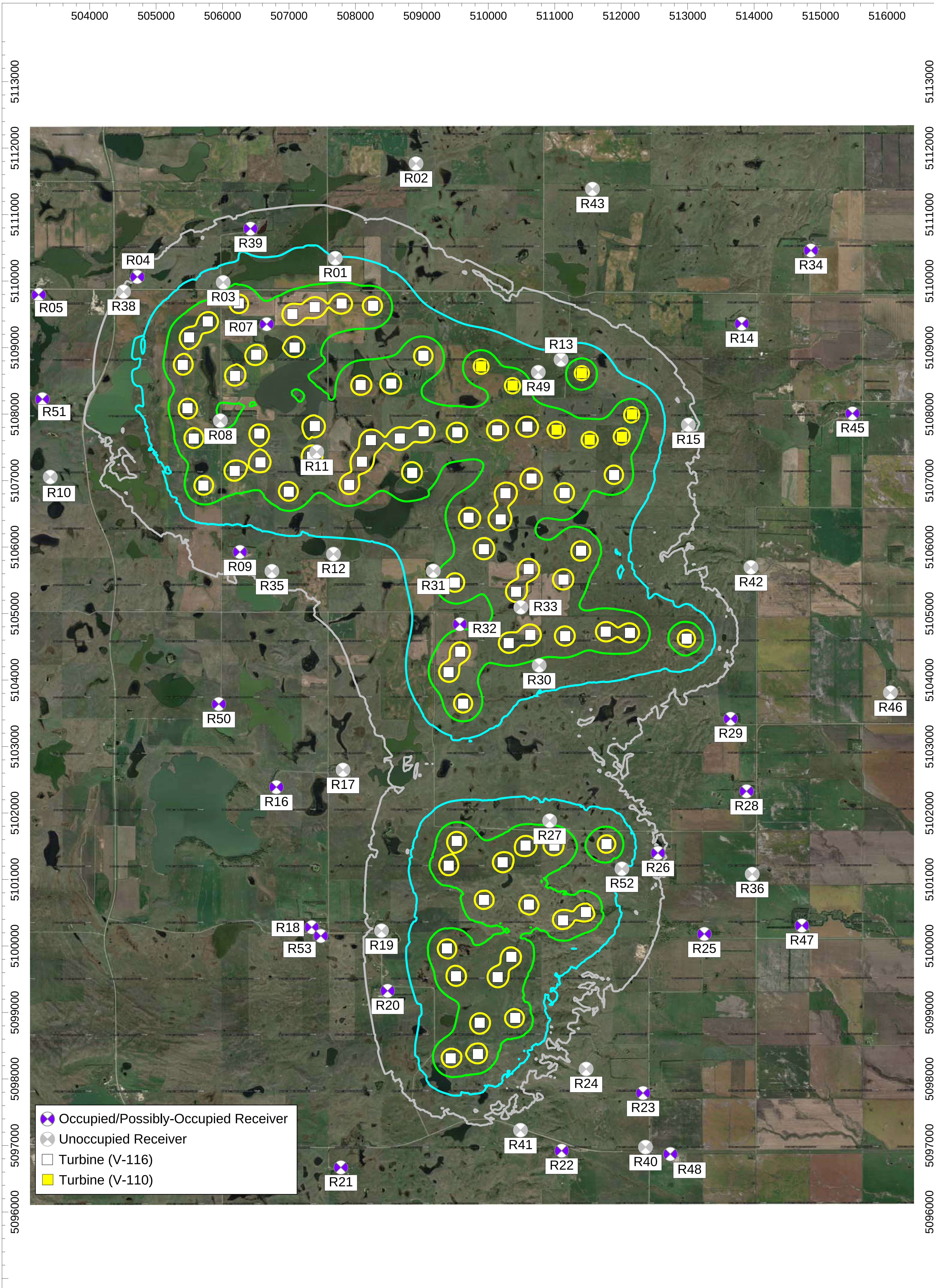


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Figure 4: With Alternates - Wind Turbines at Cut-In Wind Speed and Typical Meterological Conditions

Predicted Project Operation Noise Contours
Foxtail Wind Project - Dickey County, ND
NextEra Energy Resources, LLC

Sound Level Contour Ranges (dBA)

- 30 dBA
- 35 dBA
- 40 dBA
- 45 dBA
- 50 dBA
- 55 dBA

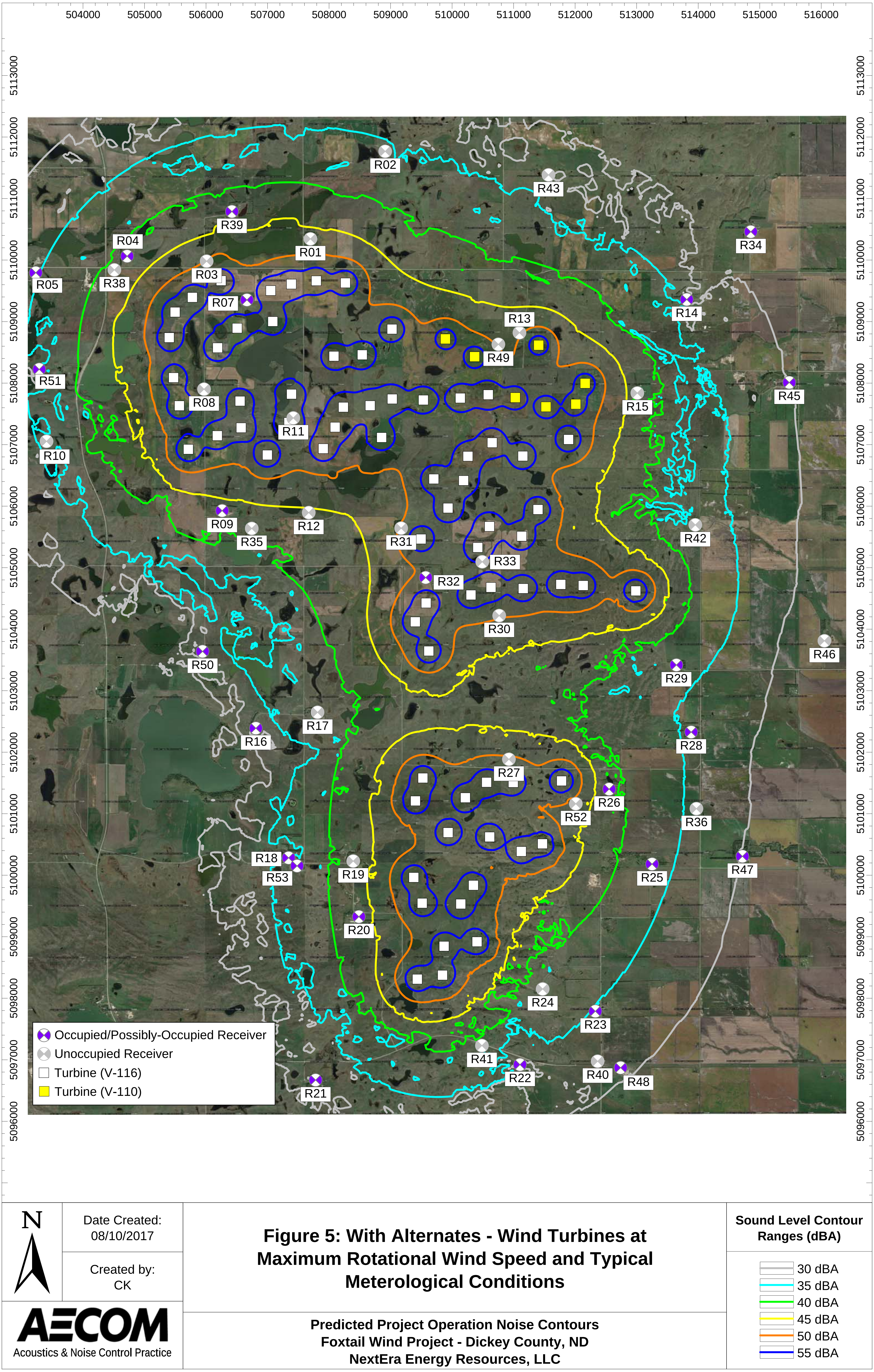

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Figure 5: With Alternates - Wind Turbines at Maximum Rotational Wind Speed and Typical Meterological Conditions

Predicted Project Operation Noise Contours
Foxtail Wind Project - Dickey County, ND
NextEra Energy Resources, LLC

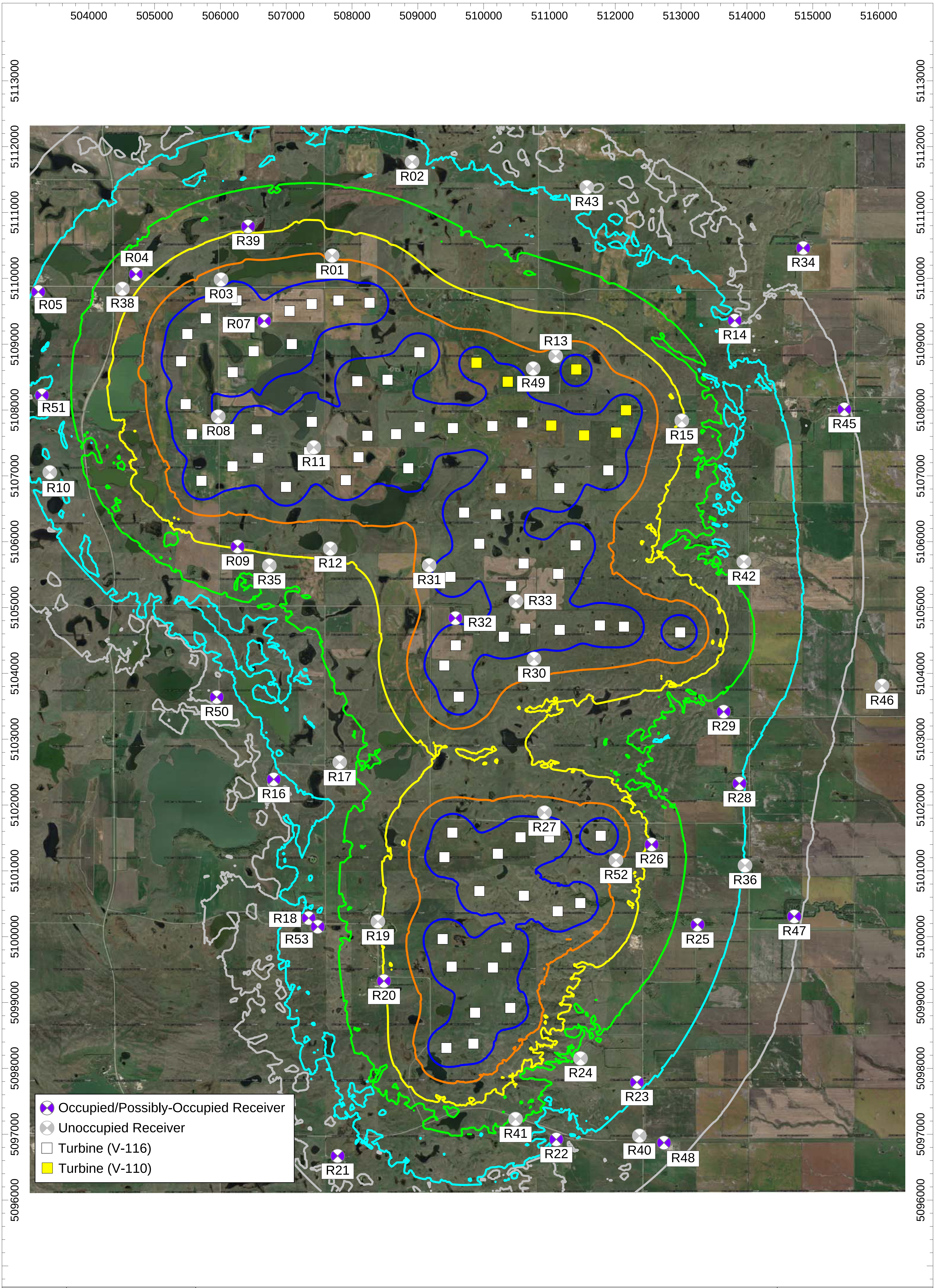

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Figure 6: With Alternates - Wind Turbines at Maximum Rotational Wind Speed and Anomalous Meterological Conditions

Predicted Project Operation Noise Contours
Foxtail Wind Project - Dickey County, ND
NextEra Energy Resources, LLC

Sound Level Contour Ranges (dBA)

- 30 dBA
- 35 dBA
- 40 dBA
- 45 dBA
- 50 dBA
- 55 dBA

Appendix A

Detailed Modeling Results

Receiver ID	Occupation Status	Receptor Located on Participating Land?	Nearest WTG ID	Distance to Nearest WTG (m)	Modeled Receiver Coordinates (UTM Zone 14, NAD 83) Easting (m)	Northing (m)	Predicted Opertion Noise Levels (Leq, dBA) Per Scenario: No Alternates Cut-In	No Alternates Maximum Rotational	No Alternates CMET Anomalous	With Alternates Cut-In	With Alternates Maximum Rotational	With Alternates CMET Anomalous
R04	Occupied	No	4	1198	504717.7	5110063.6	30.5	41.6	43.2	30.5	41.6	43.2
R05	Occupied	No	4	2353	503233.5	5109794.4	24.4	34.6	35.5	24.4	34.6	35.5
R07	Occupied	Yes	10	415	506665.7	5109352.1	40.9	52.9	55.7	40.9	52.9	55.7
R09	Occupied	No	20	1140	506262.4	5105925.4	32.5	43.5	45.2	32.5	43.6	45.2
R14	Occupied	No	38	2142	513814.5	5109359.4	20.8	32.7	33.6	21.1	32.9	33.8
R16	Occupied	No	59	2832	506810.5	5102390.2	23.7	33.6	34.3	23.7	33.6	34.3
R18	Occupied	No	68	2059	507342.8	5100282.6	24.9	35.3	36.2	24.9	35.3	36.2
R20	Occupied	No	69	1051	508485.3	5099326.5	32.0	43.2	45.1	32.0	43.2	45.1
R21	Occupied	No	74	2328	507781.6	5096670.6	22.0	32.2	33.0	22.0	32.2	33.0
R22	Occupied	Yes	75	1925	511103.7	5096921.4	19.5	29.8	30.8	19.5	29.8	30.8
R25	Occupied	No	67	1812	513250.1	5100181.3	26.3	36.7	37.8	26.3	36.7	37.8
R26	Occupied	No	63	785	512552.8	5101399.5	30.6	42.1	44.6	30.6	42.1	44.6
R28	Occupied	No	63	2252	513886.4	5102327.3	24.2	34.3	35.2	24.3	34.4	35.3
R32	Occupied	Yes	51	413	509570.5	5104838.3	39.1	51.0	53.7	39.2	51.1	53.8
R34	Occupied	No	38	3651	514856.4	5110460.9	13.8	26.0	26.6	13.8	26.0	26.6
R39	Occupied	No	6	1137	506420.7	5110789.2	31.5	42.5	44.1	31.5	42.5	44.1
R45	Occupied	No	38	3318	515480.6	5108010.1	18.8	30.0	30.6	18.8	30.0	30.6
R47	Occupied	No	63	3185	514719.7	5100307.6	19.9	29.8	30.4	19.9	29.8	30.4
R48	Occupied	No	73	3106	512740.0	5096870.9	20.9	30.8	31.5	20.9	30.8	31.5
R50	Occupied	No	20	3294	505944.2	5103638.2	22.2	32.0	32.6	22.2	32.0	32.6
R51	Occupied	No	3	2174	503289.2	5108223.5	26.0	36.4	37.3	26.0	36.4	37.3
R53	Occupied	No	68	1906	507480.5	5100151.8	26.6	37.1	38.1	26.6	37.1	38.1
R23	Possibly Occupied	No	73	2231	512328.6	5097789.4	24.4	34.7	35.6	24.4	34.7	35.6
R29	Possibly Occupied	Yes	57	1373	513646.8	5103418.3	26.1	36.9	38.3	26.2	36.9	38.3

Receiver ID	Occupation Status	Receptor Located on Participating Land?	Nearest WTG ID	Distance to Nearest WTG (m)	Modeled Receiver Coordinates (UTM Zone 14, NAD 83) Easting (m)	Northing (m)	Predicted Opertion Noise Levels (Leq, dBA) Per Scenario — No Alternates: Cut-In	Maximum Rotational	CMET Anomalous	With Alternates: Cut-In	Maximum Rotational	CMET Anomalous
R01	Not occupied	No	12	688	507697.7	5110344.3	35.2	46.8	49.3	35.2	46.8	49.3
R02	Not occupied	No	13	2234	508912.5	5111767.4	25.4	35.8	36.6	25.4	35.8	36.6
R03	Not occupied	No	6	394	506010.0	5109981.6	38.1	50.1	52.9	38.1	50.1	52.9
R08	Not occupied	No	1	482	505968.0	5107901.4	39.9	51.8	54.6	39.9	51.8	54.6
R10	Not occupied	No	1	2236	503408.5	5107052.9	25.6	35.8	36.7	25.6	35.8	36.7
R11	Not occupied	Yes	25	102	507418.8	5107433.3	47.2	59.7	62.7	47.2	59.7	62.7
R12	Not occupied	Yes	27	1067	507669.1	5105894.4	33.5	44.5	46.0	33.6	44.6	46.1
R13	Not occupied	Yes	19	373	511094.7	5108819.4	37.0	49.2	51.8	37.0	49.2	51.8
R15	Not occupied	No	38	863	513010.8	5107838.3	31.2	43.2	45.3	31.4	43.3	45.4
R17	Not occupied	Yes	59	2018	507812.6	5102648.2	26.3	36.7	37.6	26.4	36.7	37.7
R19	Not occupied	No	68	1020	508392.8	5100230.1	31.7	42.8	44.6	31.7	42.8	44.6
R24	Not occupied	No	73	1315	511472.3	5098151.1	24.9	36.1	37.6	24.9	36.1	37.6
R27	Not occupied	No	62	384	510923.7	5101884.5	38.9	50.9	53.7	38.9	50.9	53.7
R30	Not occupied	Yes	53	477	510765.4	5104220.7	38.5	50.4	53.2	38.8	50.6	53.3
R31	Not occupied	No	45	368	509172.5	5105641.4	38.6	50.5	53.2	38.8	50.7	53.3
R33	Not occupied	Yes	47	243	510490.7	5105095.1	42.3	54.6	57.4	42.9	55.1	58.0
R35	Not occupied	No	24	1121	506744.0	5105637.2	31.3	42.1	43.5	31.3	42.1	43.5
R36	Not occupied	No	63	2238	513971.4	5101082.2	24.0	34.0	34.9	24.0	34.0	34.9
R38	Not occupied	No	4	1202	504511.0	5109840.9	30.5	41.4	43.0	30.5	41.4	43.0
R40	Not occupied	No	73	2760	512365.2	5096975.8	22.2	32.2	32.9	22.2	32.2	32.9
R41	Not occupied	Yes	75	1313	510484.5	5097230.6	28.0	39.0	40.6	28.0	39.0	40.6
R42	Not occupied	Yes	57	1444	513953.6	5105695.0	25.3	36.3	37.7	25.5	36.4	37.8
R43	Not occupied	Yes	19	2773	511566.8	5111384.1	20.2	31.3	32.1	20.2	31.4	32.1
R46	Not occupied	No	57	3171	516052.0	5103810.2	16.0	25.8	26.5	16.0	25.8	26.5
R49	Not occupied	Yes	18	436	510752.1	5108630.0	37.5	49.6	52.2	37.5	49.6	52.3
R52	Not occupied	Yes	63	437	512011.0	5101161.6	35.4	47.6	50.5	35.4	47.6	50.5