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25-0444 CRI BESS Sound Study Letter Report.docx

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Epsilon Ref. 25-0444

Mr. Alexander Murphy
Senior Project Management Consultant
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Juno Beach, FL 33408
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Subject: **Sound Level Analysis**
Crowned Ridge Energy Storage I Project, Codington County, South Dakota

Dear Mr. Murphy,

Epsilon Associates, Inc. (Epsilon) is pleased to provide this letter report to NextEra Energy Resources, LLC (NEER) for a Battery Energy Storage System (BESS) in Codington County, South Dakota (the Project). The Project is expected to be approximately 120 MW in size and will consist of 150 battery containers and 50 inverters. The Project design includes a 20-foot-tall sound wall that runs along the project fence line to the north and west of the BESS area.

Cumulative impacts with the existing Crowned Ridge Wind, Crowned Ridge Wind II, and Dakota Range wind projects were considered. The locations of the turbines included in the cumulative analysis are shown in Figure 1, attached. To reduce cumulative sound levels, turbines T-25 and T-26 of Crowned Ridge Wind were placed in Noise-Reduced Operations (NRO) mode. A sound level modeling study of the facility was performed using data provided by NEER, the proposed site layout, and the CadnaA sound propagation modeling software. This report presents the results of the acoustic modeling and an evaluation against the relevant sound level regulations.

Sound Level Regulations

Neither the state of South Dakota nor Codington County have regulatory sound limits for BESS. Therefore, the Project has been evaluated against the state sound level limits for wind as agreed upon by the Codington County Commission and the Project team. The sound level limits evaluated at participating and non-participating residences are shown in Table 1.

Table 1 Project Sound Level Limits

Participation Status	Sound Level Limit, dBA
Participating	50
Non-Participating	45

Sound Level Modeling Methodology

The primary sources of sound from the BESS Project will be the battery containers and the inverters. There are 150 LG DC Link 5.1 battery containers and 50 PE PCSM Gen3 inverters proposed for the BESS facility. The inverters were modeled at 100% fan speed with the manufacturer's sound attenuation kits, and the battery containers were modeled with 3 dB of additional sound mitigation. Source locations are based on the Project layout dated February 19, 2026. The proposed battery container and inverter locations are shown in Figure 2.

Sound power level or sound pressure level data for this equipment was provided by the Project for the battery containers and the inverters. The sound data from LG is confidential and has been redacted from this report. The sound source quantities and sound power levels that were used to model the BESS components are shown in Table 2. A summary of acoustical terminology is included in Appendix A, attached.

Table 2 Modeled Battery Container and Inverter Sound Power Levels (per unit)

Project Component	Model	Quantity	Broadband Sound Power Level (dBA)
Battery Container	LG JF2 DC Link 5.1	150	CONFIDENTIAL
Inverter[1]	PE PCSM Gen3	50	93

Notes:
1. With manufacturer sound attenuation kit, 100% fan speed

The cumulative impact of the Project with three existing wind farms in the region was modeled. Wind turbine and associated substation locations were sourced from publicly available documents the SDPUC docket[1]. Crowned Ridge Wind consists of 87 turbines, and Crowned Ridge Wind II consists of 88 turbines. Both projects used GE 2.x-116 turbines with low noise trailing edges (LNTE). Dakota Range Wind consists of 64 Vestas V136-4.2 turbines, 7 Vestas V136-3.6 turbines, and 1 Vestas V120-2.2 turbine. The sound power data for the Dakota Range turbines was taken from the Dakota Range Wind

[1] Project dockets are accessible at sd.gov. Docket numbers are: EL19-003 (Crowned Ridge Wind), EL19-027 (Crowned Ridge Wind II), and EL 18-003 (Dakota Range).

Project Acoustic Assessment report by AECOM dated August 13, 2020. The Project provided sound power level data from GE detailing unmitigated and NRO modes for the GE 2.x-116 turbine. For Crowned Ridge Wind, T25 and T26 were modeled in NRO103 mode.

The substations associated with each wind farm were also included in the cumulative model. A 225 MVA substation transformer was included for both the Crowned Ridge Wind substation and the Crowned Ridge Wind II substation. A 167 MVA substation transformer was modeled for Dakota Range. The sound power level of the substation transformers was estimated using the techniques in the Electric Power Plant Environmental Noise Guide[2]. The substation sound power levels that were used in the models are shown in Table 3.

Table 3 Modeled Transformer Sound Power Levels (per unit)

Project Component	Quantity	Broadband Sound Power Level (dBA)
225 MVA Transformer	2	103
167 MVA Transformer	1	102

A sound wall is proposed to reduce sound level impacts and meet the sound level limits. A 20-foot-tall sound wall was modeled along the north and west sides of the BESS area fence line. The wall was modeled to be reflective on both sides with a noise reduction coefficient (NRC) of 0.21. The wall was modeled assuming it is sufficiently dense that sound transmission through it is negligible. The wall location is shown in Figures 2 and 3.

Sound levels from operation of the Project were predicted using the CadnaA sound calculation software developed by DataKustik GmbH. This software uses the ISO 9613-2 international standard for sound propagation.[3] The benefits of this software are a refined set of computations due to the inclusion of topography, ground attenuation, multiple building reflections, drop-off with distance, and atmospheric absorption. Elevation contours for the modeling domain were imported into CadnaA which allowed for consideration of terrain shielding where appropriate. The terrain for the modeling domain was generated from elevation information derived from Digital Elevation Models developed by the U.S. Geological Survey.

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2 Bolt Beranek and Newman Inc. (1984). *Electric Power Plant Environmental Noise Guide* (2nd ed.). Edison Electric Institute.

3 *Acoustics – Attenuation of sound during propagation outdoors – Part 2: Engineering method for the prediction of sound pressure levels outdoors,* International Standard ISO 9613-2:2024 (International Organization for Standardization, Geneva, Switzerland, 2024).

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

- All modeled sources were assumed to be operating simultaneously and at maximum level.
- The wind turbine sources were modeled with a ground absorption coefficient (G) of 0 and no additional uncertainty.
- The BESS sources were modeled with G set to 0 for the BESS and substation areas, and 0.5 for all other terrain. An additional 2 dB to account for uncertainty in the calculation methodology.
- 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 (T=10°C/RH=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.

Epsilon evaluated the sound level at eleven residential modeling locations in the Project area. All locations were modeled as discrete points at a height of 1.5 meters above ground level which is the approximate ear height of a typical standing person.

Sound Level Modeling Results and Evaluation

All modeled sound levels, as output from CadnaA, are A-weighted equivalent sound levels (L_{eq}, dBA). Table 4 below shows the predicted Project-only broadband sound levels at 11 modeling receptors. The receptor locations were provided by NEER and include all residential structures within a 1.5-mile radius of the Project ("sound study area"). The receptor locations are shown in Figure 3.

The values in Table 4 represent the worst-case future L_{eq} sound levels produced cumulatively by the Project and the three closest wind farms in the region. The sound modeling incorporates a 2 dB adjustment to all modeled BESS sources, making the predicted sound levels intentionally conservative. The model also assumes favorable conditions for sound propagation, including an omnidirectional wind such that the maximum sound level is propagated from each source in all directions, which is not a naturally occurring condition. In addition, the model includes all equipment operating at maximum sound output, whereas actual operations—particularly during cooler months—are expected to be below these levels, further reinforcing that the results represent a reasonably conservative scenario.

Table 4 Sound Level Modeling Results

Receptor ID	Participation Status	Cumulative Modeled Sound Level, L_{eq} dBA	Sound Level Limit, L_{eq} dBA
1	Non-Participating	42	45
2	Non-Participating	41	
3	Participating	43	50
4	Non-Participating	45	45
5	Participating	48	50
6	Participating	46	
7	Participating	45	
8	Participating	49	
9	Non-Participating	42	45
10	Non-Participating	42	45
11	Non-Participating	41	

The Project has been evaluated against the sound level limits shown in Table 1. In the cumulative analysis, the highest sound level at a participating residential receptor is 49 dBA. This sound level occurs at Receptor 8. This is below the sound level limit at participating residences of 50 dBA. The highest sound level at a non-participating receptor is 45 dBA, meeting the sound level limit of 45 dBA for non-participating residences. This sound level occurs at Receptor 4.

A modeling grid with a 10-meter spacing was calculated for the entire Project area. This modeling grid allowed for the creation of sound level isopleths. Figure 3 shows sound level isopleths due to the cumulative impact of the Project and the three nearest wind farms.

Conclusions

With the mitigation measures described in this report, sound modeling indicates that cumulative sound level impacts from the Project, Crowned Ridge Wind, Crowned Ridge Wind II, and Dakota Range will be at or below the regulatory sound level limits at all residential receptors in the sound study area. The mitigation required includes NRO operations for turbines T-25 and T-26 of Crowned Ridge Wind, silencing kits on the battery containers and inverters, and a 20-foot-tall sound wall along the north and west fence lines of the BESS area.

If you have any questions on this report, please feel free to call me at (503) 927-9026 or e-mail me at lmorrill@epsilonassociates.com.

Sincerely,

EPSILON ASSOCIATES, INC.

Laurie Morrill
Lead Scientist

Attachments

Appendix A: Sound Terminology
Figure 1: Aerial Locus
Figure 2: Aerial Locus – BESS Area
Figure 3: Sound Level Modeling Results
Figure 4: Common Indoor and Outdoor Sound Levels

Appendix A – Sound Terminology

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

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 do not add linearly. 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. The human ear does not perceive changes in the sound pressure level as equal changes in loudness. Scientific research demonstrates that the following general relationships hold between sound level and human perception for two sound levels with the same or very similar frequency characteristics[4]:

- 3 dB increase or decrease results in a change in sound that is just perceptible to the average person,
- 5 dB increase or decrease is described as a clearly noticeable change in sound level, and
- 10 dB increase or decrease is described as twice or half as loud.

Another mathematical property of decibels is that if one source of sound 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. It contains "weighting networks" (e.g., A-, C-, and 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 common weighting network is the A-weighting network 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". Z-weighted sound levels are measured sound levels without any weighting curve and are otherwise referred to as "unweighted". Sound pressure levels for some

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4 Bies, David, and Colin Hansen. 2009. *Engineering Noise Control: Theory and Practice*, 4th Edition. New York: Taylor and Francis.

common indoor and outdoor environments are shown in Figure 4.

Because the sounds in our environment vary with time they cannot simply be described with a single number. Two methods are used for describing variable sounds. These are exceedance levels and the equivalent level, both of which are derived from some number of moment-to-moment A-weighted sound 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 can have a value between 0 and 100 in terms of percentage. Several sound level metrics that are reported in community sound evaluations are described below.

- L_{90} is the sound level exceeded 90 percent of the time during the 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 sound 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 typically 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 linear mean square sound pressure values, the L_{eq} is mostly determined by loud sounds if there are fluctuating sound levels.

Data Source: Bureau of Geographic Information (MassGIS), Commonwealth of Massachusetts, Executive Office of Technology and Security Services

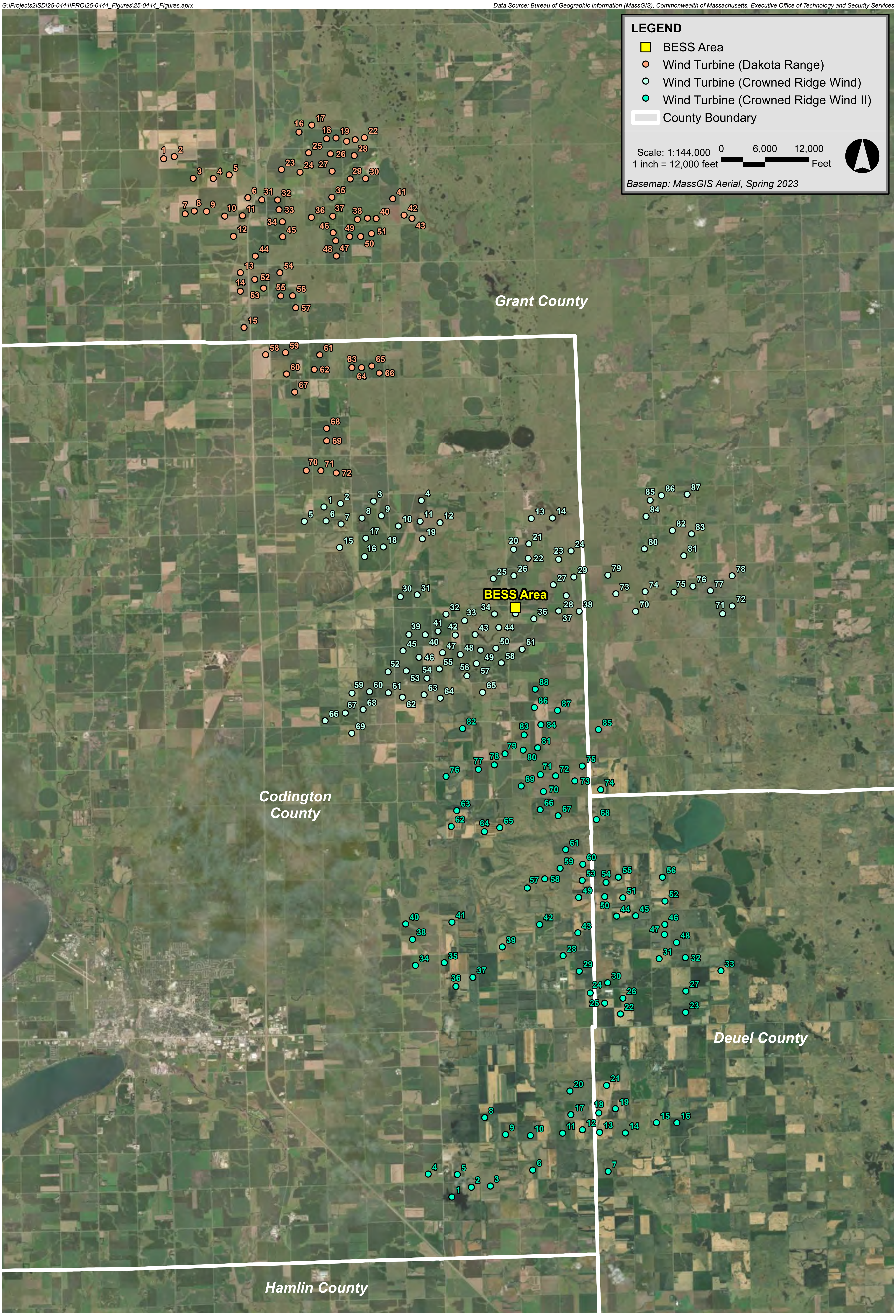

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Figure 1
Aerial Locus

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Data Source: Bureau of Geographic Information (MassGIS), Commonwealth of Massachusetts, Executive Office of Technology and Security Services

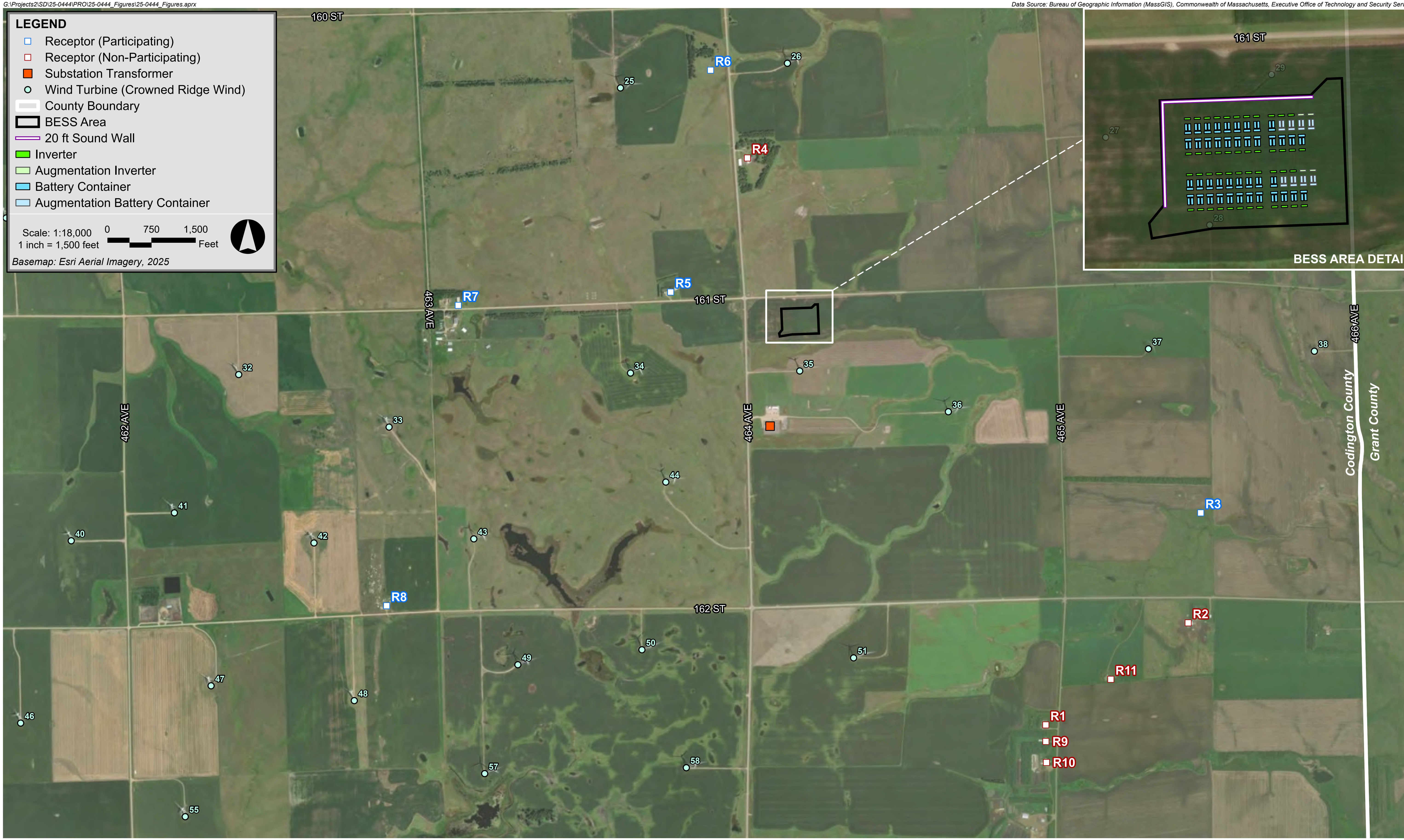

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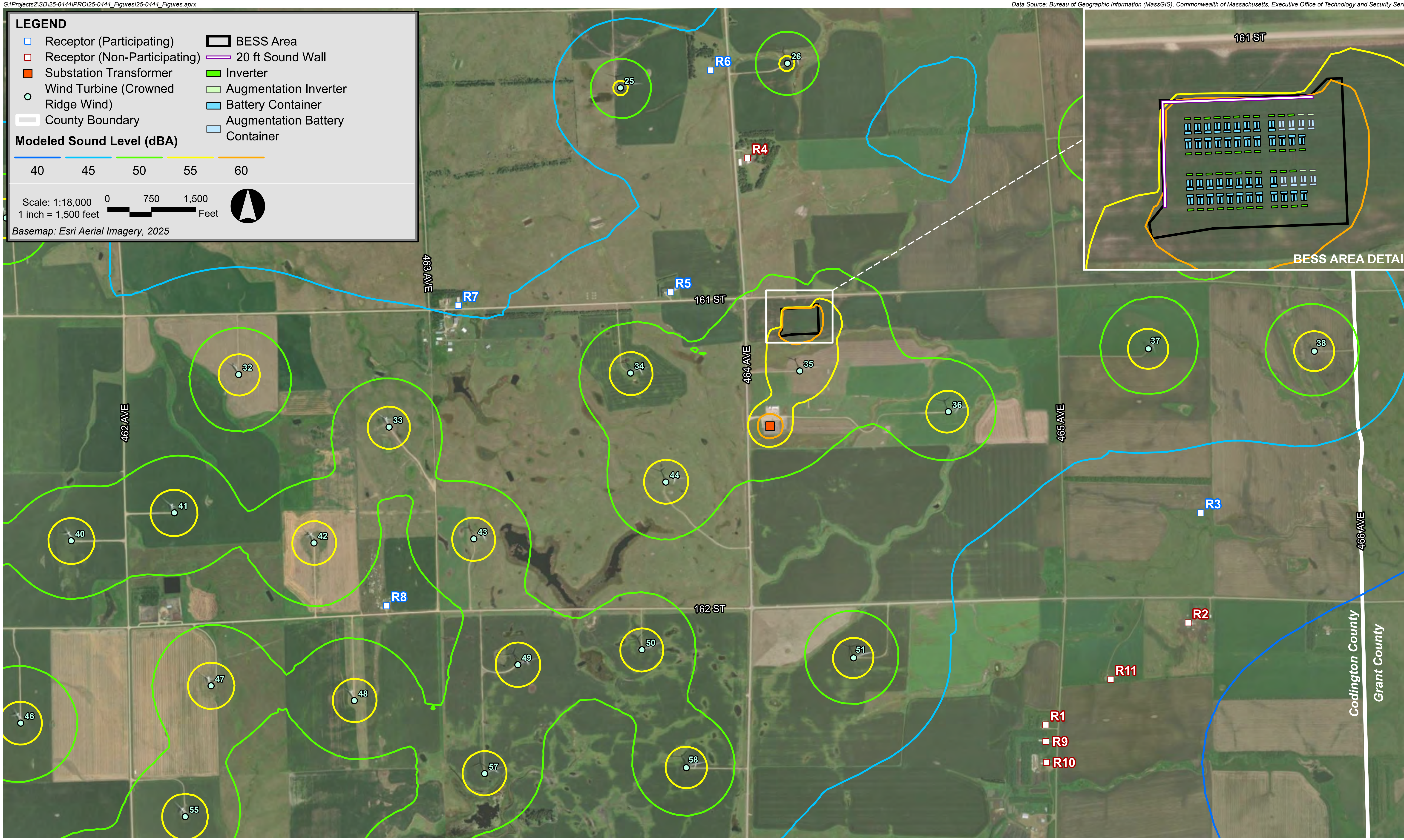
Figure 2

Aerial Locus - BESS Area

Data Source: Bureau of Geographic Information (MassGIS), Commonwealth of Massachusetts, Executive Office of Technology and Security Services



Crowned Ridge Energy Storage I Codington County, South Dakota

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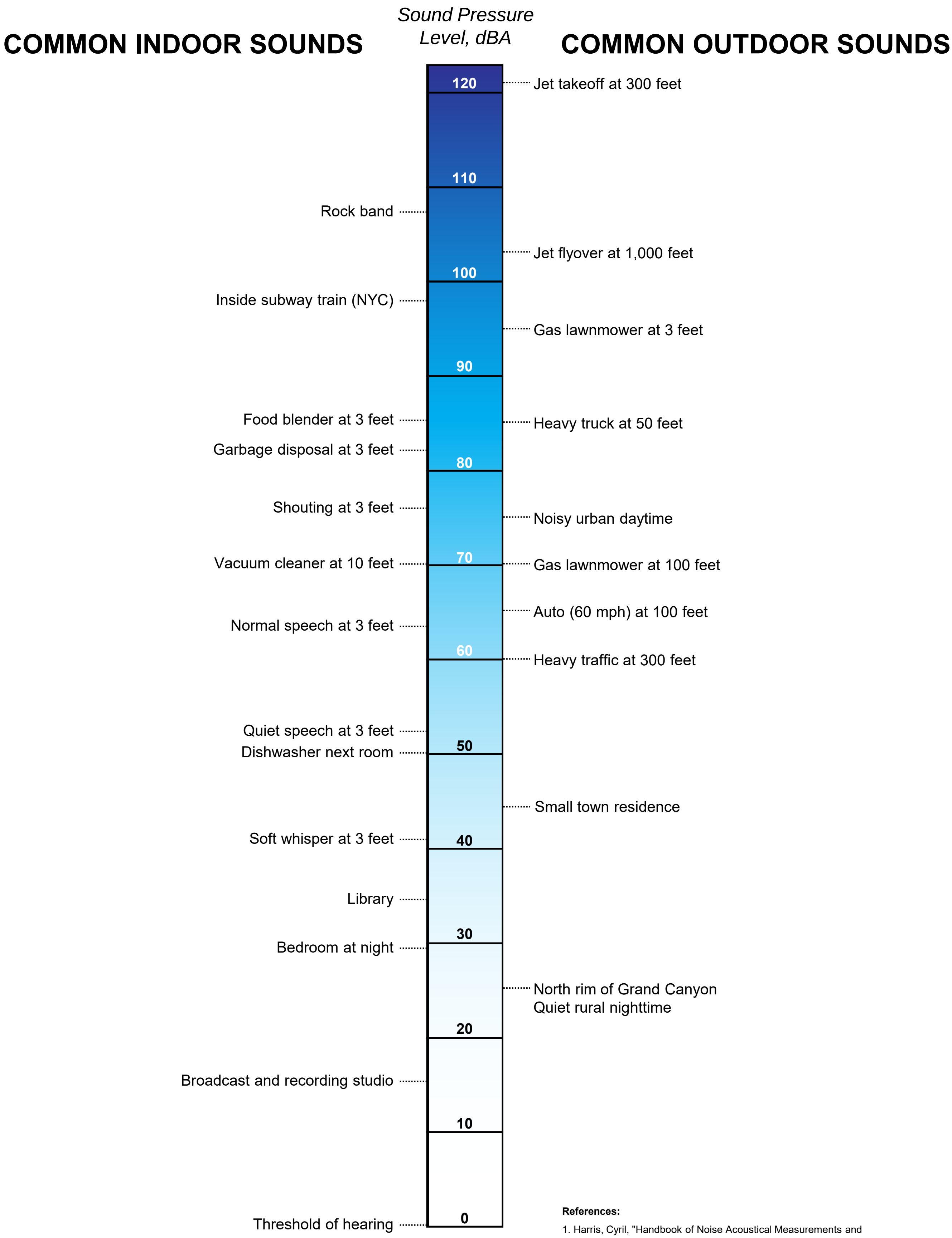
Figure 3

Sound Level Modeling Results



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 4

Common Indoor and Outdoor Sound Levels